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# RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

## Part U INTACT STABILITY

### Chapter 1 GENERAL

#### 1.1 General

##### 1.1.1 Application\*

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.

##### 1.1.2 Special Cases in Application\*

In case of the ships considered inadequate to be fully and/or directly applied the requirements in this Part because of some special reasons (*e.g.* novel design features, unusual form of ships), stability will be individually determined by the Society.

##### 1.1.3 National Requirements

The Society may make special requirements as instructed by the flag-governments of ships or the governments of the sovereign nations in which ships navigate.

##### 1.1.4 Definitions\*

For the purpose of the application of this part, the following definitions apply.

- (1) The definition of “downflooding angle” refers to the angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight, immerse.
- (2) The definition of “mobile offshore drilling unit” is according to **Part P**.
- (3) “Timber deck cargo” means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck. The term does not include wood pulp or similar cargo.

#### 1.2 Stability Information

##### 1.2.1 Stability Information Booklet\*

Ships are to be provided with a stability information booklet approved by the Society, to ensure the enough stability of the ship under varying conditions of service. Such booklet is to include principal particulars regarding the ship’s stability, the results of stability experiments and information as necessary by the master to verify the ship’s stability.

##### 1.2.2 Stability Computer\*

1 Where a computer for stability calculation is on board the ship as a supplement to the stability information booklet, such computer is to be approved by the Society.

2 The computer specified in -1 above, is to be provided with an operation manual.

##### 1.2.3 Special Requirements for Bulk Carriers\*

1 Bulk carriers as defined in **An1.2.1(1), Annex 1.1, Part 2-2, Part C**, of less than 150m in length  $L_f$  but not less than 500 gross

*tonnage* are to be fitted with a stability computer approved by the Society, as a supplement to the stability information booklet.

2 Notwithstanding the provisions of preceding -1, bulk carriers not engaged on international voyages with Class Notation “*Coasting Service*”, “*Smooth Water Service*” or equivalent need not to be fitted with the stability computer.

3 Notwithstanding the provisions of preceding -1, for bulk carriers not engaged on international voyages, where deemed appropriate by the Society taking account of various conditions of such ships related to the navigation, the requirements of the stability computer need not to be applied to.

### 1.3 Marking of Draughts

#### 1.3.1 Marking of Bow and Stern Draughts

Every ship is to have scales of draughts marked clearly at the bow and stern. In the case where the draught marks are not located where they are easily readable, or operational constraints for a particular trade make it difficult to read the draught marks, then the ship is to also be fitted with a reliable draught indicating system by which the bow and stern draughts can be determined.

## Chapter 2 STABILITY REQUIREMENTS

### 2.1 General

#### 2.1.1 General\*

1 Stability curves and heeling moment curves are to be prepared by the method deemed appropriate by the Society for all designed loading conditions and they are to be verified to comply with the requirements in 2.2 and 2.3.

2 Free surface effects are to be accounted for in all conditions of loading.

3 In cases where anti-rolling devices are installed in a ship, the requirements given in 2.2 and 2.3 are to be satisfied when such devices are in operation and when there is either a failure of power supply to the device(s) or a failure of the device(s)

4 Influences such as the icing of topsides, water trapped on deck, etc., adversely affect stability and the Administration is advised to take these into account, so far as is deemed necessary.

5 Provisions are to be made for a safe margin of stability at all stages of the voyage, regard being given to additions of weight, such as those due to the absorption of water and icing as well as to losses of weight such as those due to the consumption of fuel and stores.

6 Curves or tables of minimum operational metacentric height (GM) or maximum centre of gravity (VCG) are to extend over the full range of operational trims.

#### 2.1.2 Calculation on Stability\*

Stability is to be calculated under the following conditions.

- (1) In preparing stability curves, the position centre of gravity is to be determined on the basis of the data obtained at inclining test required in 2.1.7-8, Part B.
- (2) Free surface effects of liquid in tanks are to be of what the stability during navigation under all loading condition is most severely affected.
- (3) Where anti-rolling devices are installed in a ship, the requirements in 2.2 are to be satisfied whether the devices are in operation or not.

### 2.2 General Stability Requirements

#### 2.2.1 Stability Curves\*

1 The stability curves are to comply with the following requirements in Fig. U2.1.

- (1)  $A_1$  is not to be less than  $0.055m \cdot rad$ .
- (2)  $A_2$  is not to be less than  $0.03m \cdot rad$ .
- (3)  $(A_1 + A_2)$  is not to be less than  $0.09m \cdot rad$ .
- (4)  $GZ$  is to be at least  $0.20m$  at an angle of heel equal to or greater than  $30^\circ$ .
- (5)  $\theta_{max}$  is not to be less than  $25^\circ$ .
- (6)  $G_0M$  is not to be less than  $0.15 m$ .

where

$A_1$ : Area under stability curve between  $0^\circ$  and  $30^\circ$  ( $m \cdot rad$ ).

$A_2$ : Area under stability curve between  $30^\circ$  and  $\theta_u$  ( $m \cdot rad$ ).

$\theta_u$ : Heeling angle (*degree*) to be taken of whichever is less, downflooding angle in the relevant loading condition or  $40^\circ$ .

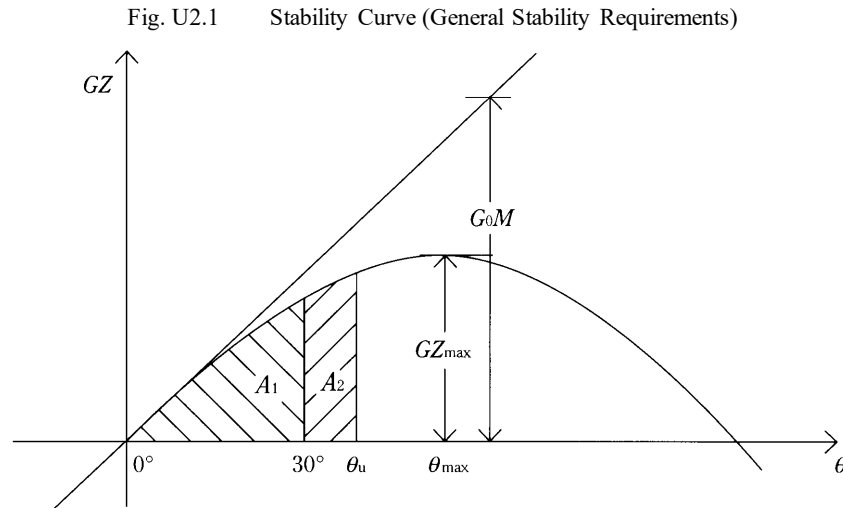
$GZ_{max}$ : Maximum righting lever ( $m$ ).

$\theta_{max}$ : Heeling angle at which the righting arm reaches maximum (*degree*).

$G_0M$ : Initial metacentric height corrected by free surface effect ( $m$ ).

2 For ships loaded with timber deck cargoes, notwithstanding the provisions of the preceding -1, the stability curves may comply with the following requirements in Fig. U2.1 in cases where deemed acceptable by the Society.

- (1)  $(A_1 + A_2)$  is not to be less than  $0.08m \cdot rad$ .
- (2)  $GZ_{max}$  is not to be less than  $0.25m$ .
- (3)  $G_0M$  is not to be less than  $0.10m$  during navigation taking into account the absorption of water by deck cargo and/or ice accretion on exposed surfaces.
- (4) The value of all symbols in this Part is to be one in relevant loading condition except the case that it is particularly specified.  
 $A_1, A_2, \theta_u, GZ_{max}, \theta_{max}$  and  $G_0M$ : As given in (1) above.



## 2.3 Stability Requirements in Wind and Waves

### 2.3.1 Stability Curves and Wind-heeling Moment Lever Curves\*

1 Stability curves and wind-heeling moment lever curves of ships are to comply with the following requirements in [Fig. U2.2](#).

- (1) Heeling angle caused by steady wind is to be less than  $16^\circ$  or an angle corresponding to 80% of immersing angle of deck edge, whichever is less.
- (2) Area “b” is not to be less than area “a”.

where

$l_{w1}$ : Heeling moment lever caused by steady wind ( $m$ ) given by the following formula :

$$\frac{0.0514AZ}{W'}$$

$A$ : Projected lateral area of hull and cargoes on deck above waterline ( $m^2$ ).

$Z$ : Vertical distance between the centre of “ $A$ ” and the centre of underwater projected lateral area of hull ( $m$ ). In general, the centre of underwater projected lateral area may be approximated to locate at half the draught.

$W'$ : Displacement ( $t$ ).

$l_{w2}$ : Heeling moment lever caused by gust ( $m$ ) given by the following formula :

$$1.5l_{w1}$$

$a$ : Area encircled by stability curve,  $l_{w2}$  and  $\theta_r$  ( $m \cdot rad$ ).

$b$ : Area encircled by stability curve,  $l_{w2}$  and  $\theta_2$  ( $m \cdot rad$ ).

$\theta_r$ : Angle of rolling stop motion (*degree*). In general, it may be given by the formula  $(\theta_0 - \theta_1)$ .

$\theta_c$ : Heeling angle at the second intersection between heeling moment lever and stability curve (*degree*).

$\theta_2$ : Heeling angle (*degree*) to be taken of whichever is the least, downflooding angle,  $\theta_c$  or  $50^\circ$ .

$\theta_0$ : Angle of heel under action of steady wind (*degree*).

$\theta_1$ : Angle of roll to windward due to wave action (*degree*) given by the following formula :

$$109x_1x_2k\sqrt{rs}$$

$x_1$ : Values obtained from [Table U2.1](#) according to the value of  $B/d'$  In case the value of  $B/d'$  becomes

intermediate, values are to be determined by interpolation.

$B$ : Moulded breadth of the ship ( $m$ ).

$d'$ : Mean moulded draught of the ship ( $m$ ).

$x_2$ : Values obtained from **Table U2.2** according to  $C_b$ . In case  $C_b$  becomes intermediate, values are to be determined by interpolation.

$C_b$ : Block coefficient given by the following formula:

$$\frac{W'}{1.025L'Bd'}$$

$L'$ : Length of the ship at waterline ( $m$ ).

$k$ : Values determined as follows;

For round-bilged ships having neither bilge keels nor bar keels: 1.0

For ships with sharp bilges: 0.7

For ships with bilge keel and/or bar keels: Values obtained from **Table U2.3** according to the value of  $100A_k/L'B$ . In case  $100A_k/L'B$  becomes intermediate, values are to be determined by interpolation.

$A_k$ : Total area of bilge keels, projected lateral area of bar keels or sum of those areas ( $m^2$ ).

$r$ : Values obtained from the following formula.

$$0.73 + 0.6 \frac{OG}{d'}$$

$OG$ : Distance between the centre of gravity and the waterline ( $m$ ), and is taken as positive when the centre of gravity is above waterline.

$s$ : Values obtained from **Table U2.4** according to the value of  $T$ . In case  $T$  becomes intermediate, values are to be determined by interpolation.

$T$ : Rolling period (seconds) obtained from the following formula. However, value of  $T$  based on information considered sufficient may be used instead.

$$\frac{2B}{\sqrt{G_0M}} \left( 0.373 + 0.023 \frac{B}{d'} - 0.043 \frac{L'}{100} \right)$$

$G_0M$ : As specified in **2.2.1**

**2** For ships loaded with timber deck cargo, notwithstanding the provisions of the preceding **-1**, stability curves may comply with the following requirements in **Fig. U2.2** in cases where deemed acceptable by the Society.

(1)  $\theta_0$  is to be less than  $16^\circ$ .

(2) Stability curves and wind-heeling moment lever curves of ships are to comply with **-1(2)** above.

**3** Where the requirements specified in above **-1** and **-2** apply to the ships registered as restricted service, the values of  $l_{w1}$  may be reduced when deemed acceptable by the Society.

Fig. U2.2 Stability and Wind-heeling Moment Lever Curve (Stability Requirements in Wind and Waves)

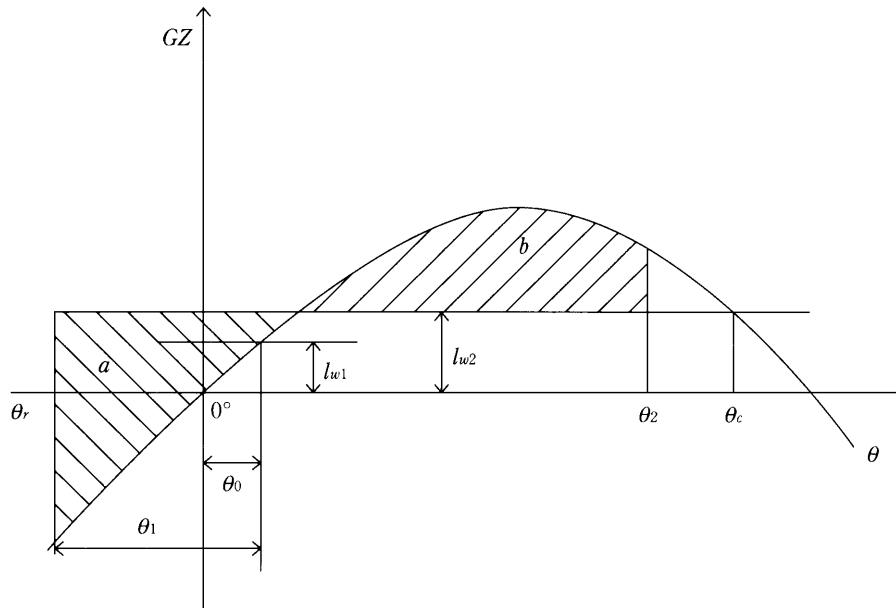


Table U2.1 Value of  $x_1$

$B/d'$	$\leq 2.4$	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	$\geq 3.5$
$x_1$	1.0	0.98	0.96	0.95	0.93	0.91	0.90	0.88	0.86	0.84	0.82	0.80

Table U2.2 Value of  $x_2$

$C_b$	$\leq 0.45$	0.50	0.55	0.60	0.65	$\geq 0.70$
$x_2$	0.75	0.82	0.89	0.95	0.97	1.0

Table U2.3 Value of  $k$

$100A_k/L'B$	0	1.0	1.5	2.0	2.5	3.0	3.5	$\geq 4.0$
$k$	1.0	0.98	0.95	0.88	0.79	0.74	0.72	0.70

Table U2.4 Value of  $s$

$T$	$\leq 6$	7	8	12	14	16	18	$\geq 20$
$s$	0.100	0.098	0.093	0.065	0.053	0.044	0.038	0.035

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# GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

## Part U INTACT STABILITY

### U1 GENERAL

#### U1.1 General

##### U1.1.1 Application

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, and 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.

$$M_L = 0.67 \times \Delta \times G_0 M \times \left( \frac{f}{B} \right)$$

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

$G_0 M$  : 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**.

$\Delta$  : 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%.

##### U1.1.2 Special Cases in Application

- 1 For certain ships which have comparatively wider beams and smaller depths than typical ships (about  $B/D \geq 2.5$ ),

notwithstanding the provisions of **2.2.1-1, Chapter 2, Part U of the Rules**, stability curves may comply with the following requirements in cases where deemed acceptable by the Society.

- (1) Stability curves are to be comply with the requirements given in **2.2.1-1(1) to (4) and (6), Chapter 2, Part U of the Rules**.
- (2)  $\theta_{max}$  is to be comply with the following requirements:
  - (a)  $\theta_{max}$  is not to be less than  $15^\circ$ .
  - (b) With respect to the requirements given in **Fig. U2.1, Part U** of the Rules, the area under a stability curve between  $0^\circ$  and  $\theta_{max}$  ( $m \cdot rad$ ) is to be not less than:
 
$$0.055 + 0.001(30^\circ - \theta_{max})$$

where  $\theta_{max}$  is as given in **2.2.1-1, Chapter 2, Part U of the Rules**.

**2** Intact stability (hereinafter referred to as “stability” in this Part) of steel barges, which are 24 metres in length and over and registered for unrestricted service according to **Part Q** of the Rules, is to be as follows;

- (1) The requirements of **Chapter 2, Part U** of the Rules are to apply.
- (2) Notwithstanding above **(1)**, in the case of the steel barges complying with the requirement in **1.1.1-2(2), Part Q of the Rules** and following **(a) to (d)** (hereinafter referred to as “the pontoon barge” in this Part), the requirements of **U2.2.1-2** and **U2.3.1-3** may apply.
  - (a) To be non self-propelled and unmanned during navigation
  - (b) Block coefficient ( $C_b$ ) is to be not less than 0.9.
  - (c) The ratio  $B/D$  is to be greater than 3.0.
  - (d) No opening except small manholes fitted with watertight steel covers is to be provided in deck.

**3** For container ships of 100m in length and over, notwithstanding the provisions of **2.2, Chapter 2, Part U of the Rules**, Chapter 2.3, Part B of *IMO Res. MSC.267(85) “International Code on Intact Stability 2008 (2008 IS Code)”* or other provisions deemed by the Society to be equivalent may apply.

**4** In applying the provision of **2.3.1-1, Chapter 2, Part U of the Rules**, the value of  $l_{w1}$  may be determined by model tests using the procedure described in *MSC.1/Circ.1200* or by another method deemed by the Society to be equivalent.

**5** In applying the provision of **2.3.1-1, Chapter 2, Part U of the Rules**, in cases where a ship corresponds to any of the following **(1) to (4)**, the value of  $\theta_1$  may be determined by model tests using the procedure described in *MSC.1/Circ.1200* or by another method deemed by the Society to be equivalent.

- (1) the ratio  $B/D$  is not less than 3.5.
- (2)  $KG/d-I$  is equal to or less than -0.3, or equal to or greater than 0.5.
- (3)  $T$  is not less than 20 (seconds).
- (4) Other deemed appropriate by the Society.

#### **U1.1.4 Definitions**

**1** In applying the requirements of **1.1.4(1), Part U of the Rules**, “openings in the hull, superstructures or deckhouses which cannot be closed weathertight” include ventilators provided with weathertight closing appliances in accordance with the requirements of **14.12.3.1-3, Part 1, Part C of the Rules** or **21.6.5-2, Part CS of the Rules** that for operational reasons have to remain open to supply air to the engine room, emergency generator room or closed ro-ro and vehicle spaces (if the same is considered buoyant in the stability calculation or protecting openings leading below) for the effective operation of the ship. Where it is not technically feasible to treat some closed ro-ro and vehicle space ventilators as unprotected openings, an alternative arrangement that provides an equivalent level of safety may be used provided that it is deemed appropriate by the Administration.

**2** For the purpose of the application of this part, timber deck cargo specified in **1.1.4(3), Part U of the Rules**, is to be stowed complying with the provisions of Chapter 3 of the *CODE OF SAFE PRACTICE FOR SHIPS CARRYING TIMBER DECK CARGOES, 1991* (resolution A.715(17)). Otherwise, special consideration is required.

## **U1.2 Stability Information**

### **U1.2.1 Stability Information Booklet**

The stability information booklet specified in **1.2.1, Part U** of the Rules is to be prepared in accordance with **Annex U1.2.1 “GUIDANCE FOR STABILITY INFORMATION FOR MASTER”** or in accordance other provisions deemed by the Society to

be equivalent. Notwithstanding the above, for ships applied **1.1.2, Part U of the Rules**, the requirements for the booklet may be modified. In cases where deemed appropriate by the Society, as an alternative to the stability information booklet, a simplified booklet containing sufficient information to enable the master to safely operate the ship.

### **U1.2.2 Stability Computer**

**1** The computer for stability calculation and the operation manual specified in **1.2.2, Part U of the Rules** is to be prepared in accordance with **Annex U1.2.1 “GUIDANCE FOR STABILITY INFORMATION FOR MASTER”**. Software for the stability calculation is to be determined corresponding to the stability requirements applied to the ship and, in general, according with the followings.

- (1) For ships other than those specified in **(2)** or **(3)** (e.g., dry cargo ships of less than 80m in subdivision length ( $L_s$ ) defined in **2.3.1.2(6), Part 1, Part C of the Rules**, ships assigned to  $B-60$  or  $B-100$  freeboard in accordance with the provisions of **Part V of the Rules**), software is to be able to calculate intact stability for each loading condition (Type 1).
- (2) For ships subject to the subdivision requirements specified in **2.3, Part 1, Part C** or **Chapter 4, Part CS**, as applicable, but excluding bulk carriers as specified in **(3)**, software is to be able to calculate intact stability as specified in **(1)** and checking damage stability by showing a limit  $G_0M$  curve or previously approved loading conditions (Type 2).
- (3) For tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk, and ships bulk carriers subject to the requirements of **An2., Annex 1.1, Part 2-2, Part C of the Rules** and the compliance with the requirements of **An2.1.1-2, Annex 1.1, Part 2-2, Part C of the Rules** has been done for all conditions loaded to the summer load line, software is to be able to calculate intact stability and damage stability by direct application of pre-programmed damage cases for each loading condition (Type 3).

**2** The case where a computer for stability calculation is on board the ship as a supplement to the stability information booklet, as specified in **1.2.2-1, Part U of the Rules**, means where a computer for stability calculation or a computer in which a software for stability calculation is installed, is on board the ship for use of the calculation at the navigation bridge, the cargo control room, etc.

### **U1.2.3 Special Requirements for Bulk Carriers**

Stability computers as specified in **1.2.3, Part U of the Rules** are to be in accordance with the provisions of **U1.2.2**.

## U2 STABILITY REQUIREMENTS

### U2.1 General

#### U2.1.1 General

1 With respect to preparing the stability curves and heeling moment curves specified in **2.1.1-1, Chapter 2, Part U of the Rules**, the effects of changes in trim during heeling are to be taken into account.

2 In addition to the loading conditions expected throughout the duration of the voyage, all designed loading conditions specified in **2.1.1-1, Chapter 2, Part U of the Rules** are to contain the standard loading condition described in **Annex U1.2.1 “GUIDANCE FOR STABILITY INFORMATION FOR MASTER”** or another standard loading condition deemed by the Society to be equivalent.

3 For all loading conditions throughout the duration of the voyage, stability is to comply with **2.2 and 2.3, Chapter 2, Part U of the Rules**. For the conditions other than those during voyage (for example, during cargo loading),  $G_0M$  is to be always kept positive.

4 Notwithstanding the provisions of the preceding **-3**, stability for liquified gas carriers in all seagoing conditions and during loading and unloading cargo, including partial filling and loading and unloading at sea, is to comply with **2.2 and 2.3, Chapter 2, Part U of the Rules**.

#### U2.1.2 Calculation on Stability

1 In calculation of stability curves, the following portions may be included in addition to hull below upper deck.

- (1) Superstructures of first and second tiers above freeboard deck complying with the requirements in (10) (b) of Regulation 3, Annex I of Attachment 1 of International Convention on Load line, 1966 (hereinafter referred to as “*ILLC*” in this Part).
- (2) Deckhouses of first tier above freeboard deck complying with the requirements in (10) (b) of Regulation 3, *ILLC*.
- (3) Trunks
- (4) Hatchways with effective closing means
- (5) Portion of superstructures or deckhouses up to an angle above which seawater will flow -in through openings, even though the superstructure or deckhouse is not regarded as enclosed.

In a heeled condition exceeding the angle above, the flooded space is to be considered to have no buoyancy.

2 In calculation of stability curves, all openings within any deckhouses may be regarded as closed. However, such openings within the deckhouse, of which the doors do not comply with the requirements in Regulation 12, *ILLC* are to be fitted with closing devices complying with the requirements in Regulations 15, 17 and 18, *ILLC*.

3 The free surface effect is to be assessed in accordance with the following **(1)** to **(10)** or in accordance with other provisions deemed by the Society to be equivalent.

- (1) For tanks with fixed filling levels (e.g. liquid cargo, water ballast), the free surface correction is to be determined using the actual filling level of each tank.
- (2) For tanks with variable filling levels (e.g. consumable liquids such as fuel oil, diesel oil, and fresh water, and also liquid cargo and water ballast during liquid transfer operations), except as permitted in **(4)** and **(5)**, the free surface correction is to be determined using the maximum value attainable between the filling limits envisaged for each tank, consistent with any operating instructions.
- (3) In calculating the free surface effects in tanks containing consumable liquids, it is to be assumed that for each type of liquid at least one transverse pair or a single centreline tank has a free surface and the tank or combination of tanks taken into account is to be those where the effect of free surfaces is the greatest.
- (4) Where water ballast tanks, including anti-rolling tanks and anti-heeling tanks, are to be filled or discharged during the course of a voyage, the free surface effects are to be calculated taking into account the most onerous transitory stage relating to such operations.
- (5) For ships engaged in liquid transfer operations, the free surface corrections at any stage of the liquid transfer operations may be determined in accordance with the filling level in each tank at that stage of the transfer operation.
- (6) Free surface effects are to be considered whenever the filling level in a tank is less than 98% full. Free surface effects need not be considered in cases where a tank is nominally full, i.e. the filling level is 98% or above. However, nominally full cargo tanks

are to be corrected for free surface effects at a 98% filling level. In doing so, the correction to initial metacentric height is to be based on the inertia moment of the liquid surface at a 5° heeling angle divided by displacement, and the correction to righting lever is suggested to be on the basis of the real shifting moment of cargo liquids.

- (7) Free surface effects for small tanks may be ignored under the conditions specified in **1.3.10-3(2)(b)ii**, **Annex U1.2.1 “GUIDANCE FOR STABILITY INFORMATION FOR MASTER”**.
- (8) The corrections to the initial metacentric height and to the righting lever curve are to be addressed separately according to the following **(a)** to **(c)**.
- (a) In determining the correction to initial metacentric height, the transverse moments of the inertia of the tanks are to be calculated at a 0° angle of heel according to **(1)** and **(2)** above.
- (b) The righting lever curve may be corrected by any of the following methods in cases where deemed appropriate by the Society:
- i) correction based on the actual moment of fluid transfer for each angle of heel calculated; or
  - ii) correction based on the moment of inertia, calculated at a 0° angle of heel, modified at each angle of heel calculated.
- (c) The corrections **(a)** and **(b)** above may be calculated according to **(6)** above.
- (9) Whichever method is selected for correcting the righting lever curve is to be clearly specified in the ship stability booklet. However, in cases where an alternative method for manually calculated loading conditions is specified, an explanation of the differences which may be found in the results as well as an example correction for each alternative are to be included.
- (10) The usual remainder of liquids in empty tanks need not be taken into account in calculating corrections in cases where the total of such residual liquids does not constitute a significant free surface effect.

**4** For ships without a deck camber, or that have installed gutter bars with a height in excess of the camber, and tankers that have cargo tanks exceeding 60% of the ship’s maximum beam at midships regardless of gutter bar height, the free surface effect caused by liquids contained by the gutter bars is to be taken into account for compliance with the relevant intact stability requirements.

**5** With respect to icing, reference is to be made to the provisions of Chapter 6, Part B of *IMO Res. MSC.267(85) “International Code on Intact Stability 2008 (2008 IS Code)”* as amended or other provisions deemed by the Society to be equivalent.

## U2.2 General Stability Requirements

### U2.2.1 Stability Curves

**1** For ships applying **2.1.1-2, Chapter 2, Part U of the Rules**, stability may be calculated under following conditions, provided that the requirements in Regulation 44, *ILLC* are complied with and timber cargoes are stowed in full breadth of ships. However, when the ship has a rounded gunnel, allowance not exceeding 4 per cent of the breadth of ships for loading may be given.

- (1) 75% of the volume occupied by timber may be added to buoyancy.
- (2) In arrival condition, timber weight is to be considered a 10% increase over departure condition due to absorption of water. However, attention is to be paid to the rate of increase determined by the flag state which ships are flying.

**2** Stability curves of the pontoon barge are to comply with the following requirements in **Fig. U2.2.1-2**.

- (1)  $A$  is to be not less than  $0.08 m \cdot rad$ .
- (2) Range of stability is to be not less than following value according to length of pontoon ( $L$ ).

In case of  $L \leq 100 m$  :20°

In case of  $L \geq 150 m$  :15°

In case that  $L$  becomes intermediate, the value is to be determined by interpolation.

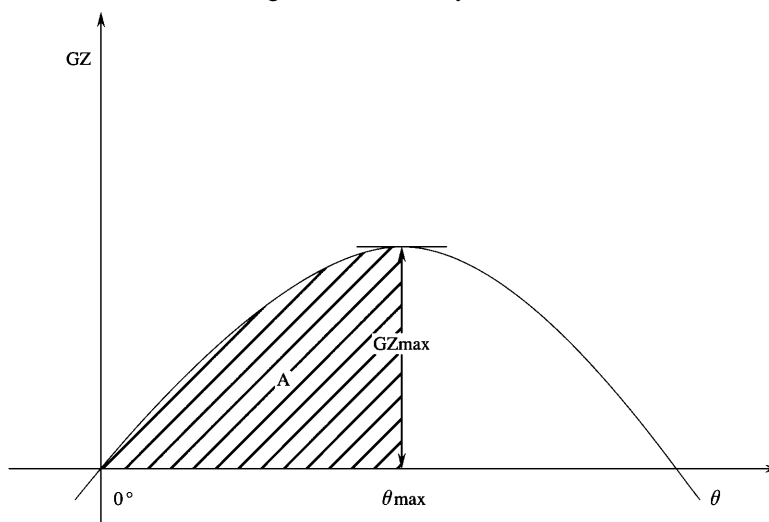
where

$A$ : Area under stability curve between 0° and  $\theta_{max}$  ( $m \cdot rad$ )

$\theta_{max}$ : An angle at which righting lever reaches maximum (°)

$GZ_{max}$ : Maximum righting lever ( $m$ )

Fig. U2.2.1-2 Stability Curves



### U2.3 Stability Requirements in Wind and Waves

#### U2.3.1 Stability Curves and Wind-heeling Moment Lever Curves

1 In applying the requirements in 2.3.1-1, Part U of the Rules,  $Z$ ,  $\theta_r$ ,  $B$ ,  $d'$  and immersing angle of deck edge may be as follows:

- (1) With the lower end of  $Z$ , the centre of underwater projected lateral area of hull is to be half of the draught.
- (2)  $\theta_r$  is generally to be  $(\theta_0 - \theta_1)$ .
- (3)  $B$  is constant unless the ship has inclined sides.
- (4)  $d'$  is to be of a corresponding moulded draught.
- (5) An immersing angle of deck edge is to be of the angle between the waterline in un-inclined condition of ship and the line linked deck edge to the point of intersection between the centre line and waterline in un-inclined condition of ship. Where, deck edge means the point of intersection between the continuation of top of freeboard deck at ship's side of lowest point of freeboard deck and the outside of side shell, in general. However, in cases where there are any openings under the deck edge, the lower edge of the opening is to be treated as the deck edge. In addition, in case of ships having superstructure decks of entire length, deck edge may be either of the following points.

- (a) Where side shells in way of superstructures have no opening or all openings are kept watertight closing devices:

The point of intersection between the continuation of top of superstructure deck at ship's side of lowest point of superstructure deck and the outside of side shell

- (b) Where side shells in way of superstructures have openings with weathertight covers:

The lowest point of such openings

2 Concerning the area between the stability curve and  $l_{w1}$ , if portions within the range of  $\pm\theta_1$  on both sides of  $\theta_0$  are significantly different from each other, angle of rolling stop motion is to be determined so that both areas will be equal. Even in this case, full rolling angle is to be kept to  $2\theta_1$ .

3 For the pontoon barge, the angle of heel caused by steady wind is to be less than the angle corresponding to a half of freeboard in relevant loading condition. In this case, lever of heeling moment is obtained from following formula;

$$0.0551AZ/W \text{ (m)}$$

where:

$A, Z$  and  $W$ : Value specified in 2.3.1-1, Part U of the Rules.

## **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:

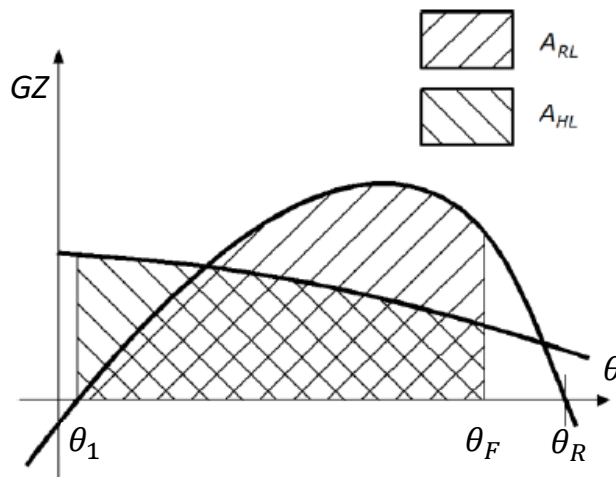
- (1) The equilibrium heel angle,  $\theta_1$ , is not to be greater than the maximum static heeling angle for which the lifting device is designed and which has been considered in the approval of the loading gear.
- (2) During lifting operations in non-exposed waters, the minimum distance between the 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,  $\theta_1$ , to the angle of down flooding,  $\theta_F$ , the angle of vanishing stability,  $\theta_R$ , 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,  $\theta_1$ , to the down flooding angle  $\theta_F$ , or 20 degrees, whichever is less, is not to be at least 0.03 m · rad.

Fig. 1 Intact criteria under Environmental and Operational limitations



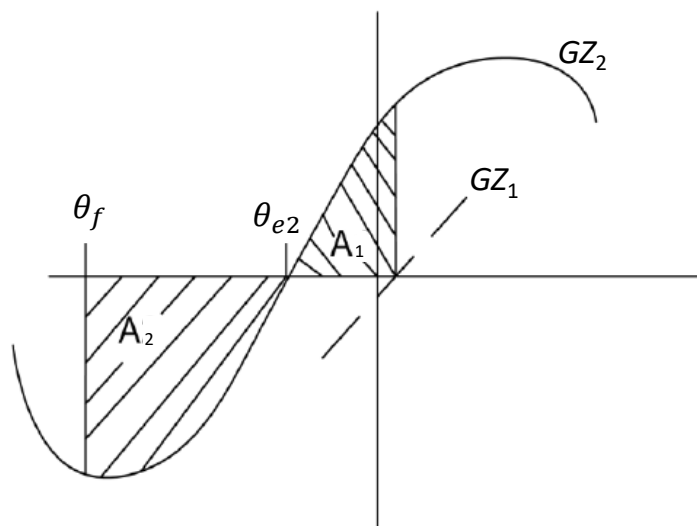


### 1.2.4 Sudden Loss of Hook Load

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.

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

$\theta_f$ : 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:

$HM_{\theta}$ : the heeling moment, in ( $t \cdot m$ ), due to the lift at  $\theta$

- $P_L$ : 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)**  
 $\theta$ : the angle (degrees) of heel  
 $HL_\theta$ : the heeling lever, in  $(m)$  due to the lift at  $\theta$   
 $\Delta$ : 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  $\theta_e$  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  $\theta_e$  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:

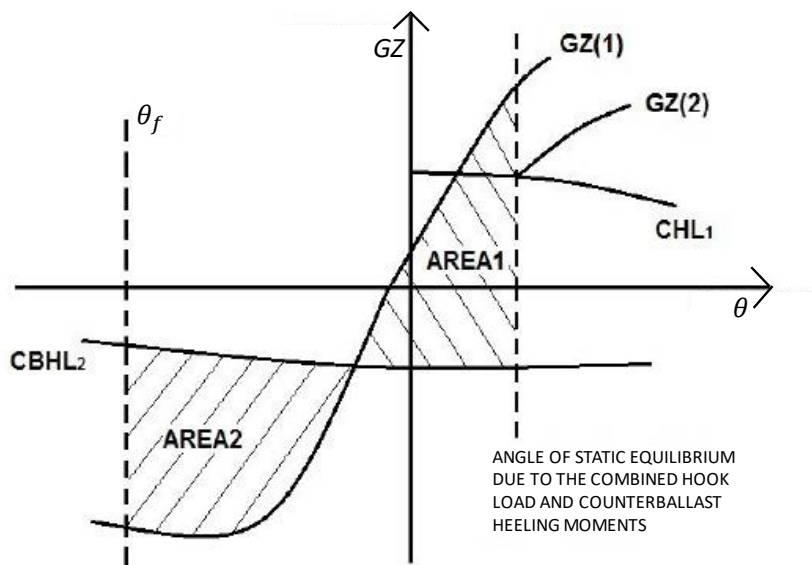
$$AREA2 - AREA1 > K,$$

where:

$$K = 0.037 m \cdot rad, \text{ for a lifting operation in waters that are exposed}$$

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

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  $\theta_e$ .

### 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.

## **Annex U1.2.1 GUIDANCE FOR STABILITY INFORMATION FOR MASTER**

### **1.1 General**

- (1) This guidance gives the standardized form and the items to be mentioned for preparation of Stability Information for Master (hereinafter referred to as “the information” in this guidance) of ships which are intended to be built to the classification with the Society and to which the requirements in **Part U of the Rules** are applied. The information for ships registered after construction, etc. is recommended to meet the requirements of this guidance as far as possible, even if satisfactory data are not available.
- (2) The information is to be written in the working language of the ship and any other language which is deemed necessary by the Society. Reference is also made to *IMO Res. A.741(18)* If a language other than English is used, English version is to be attached.
- (3) Items deemed necessary for special operating configuration, etc. are to be added.
- (4) It is considered beneficial that a computer for calculation of parameters of stability is provided on board. However, omission of the information is not permitted even in such cases.
- (5) Attention is to be paid to the fact that a certain government of flag states may impose additional requirements.
- (6) For combination carriers to which **3.2.2-7, Part 3 of Rules for Marine Pollution Prevention Systems** apply, in addition to the relevant requirements in this Guidance, the information for intact stability during the liquid transfer operations specified in **3.2.2-10, Part 3 of Guidance for Marine Pollution Prevention Systems** are to be added.
- (7) For ships loaded with timber deck cargo:
  - (a) comprehensive stability information is to be supplied which takes into account the timber deck cargo. Such information is to enable the master, rapidly and easily, to obtain accurate guidance as to the stability of the ship under varying conditions of service;
  - (b) the master is to be given information setting out the changes in deck cargo from that shown in the loading conditions, in cases where the permeability of the deck cargo is significantly different from 25% and deemed necessary by the Society; and
  - (c) conditions are to be shown indicating the maximum permissible amount of deck cargo in consideration of the lightest stowage rate likely during service.

### **1.2 Arrangement of Stability Information**

The information is to be generally arranged in the following order, and the details of what is to be contained in each content are described in the following paragraph **1.3**.

- (1) Table of contents
- (2) Notices on ship operation
- (3) Principal particulars
- (4) Explanation of symbols used
- (5) Stowage data
- (6) Results of stability experiment
- (7) Method of utilizing information
- (8) Applied stability requirements
- (9) Stability in standard loading condition
- (10) General information

### 1.3 The Details of Each Content

#### 1.3.1 Table of Contents

In the table of contents, the title and first page of each data are to be listed to ensure easy access.

#### 1.3.2 Notices on Ship Operation

1 The following statement is to be described in the information.

This stability information shows that the ship complies with definite intact stability requirements in all designed conditions and gives the data deemed necessary for the calculation and evaluation of stability to the master in order that he can take suitable measures for securing the stability in any service condition.

2 For a ship intended to load ballast during navigation in any particular loading condition, notices on the reason, timing, method, etc. of loading are to be described. In this case the results of a series calculation from the condition at the start of ballasting to the condition at the finish of ballasting are to be included in the data for **1.3.9-2(6)**.

3 If any special operation for keeping ample stability is required during cargo handling (for an example, a particular compartment selected from compartments for cargo, fuel oil or fresh water is fully or partly loaded), the procedure is to be stated.

4 If the buoyancy of superstructures of car carriers, etc. having bow doors, side doors and/or stern doors is included in stability calculation, statement is to be made that those doors must be closed in watertight or weathertight condition before departure and that the stability curve is prepared under the condition with those doors closed.

5 Notices on loading cargoes (e.g. designed maximum weight and height of cargoes), if any, are to be described.

6 Where the ships are loaded with timber deck cargoes and are applied to the requirements of **2.2.1-2, Part U of the Rules** and **U2.3.1-3 of the Guidance**, the condition that such cargo is stowed in accordance with the provisions of Chapter 3 of the *CODE OF SAFE PRACTICE FOR SHIPS CARRYING TIMBER DECK CARGOES, 1991* (resolution A.715(17)) are to be described.

7 Where the ships are loaded with timber deck cargoes, notices of paying attention to keep the stability of the ship positive at all times including during the process of loading and unloading, and that metacentric height should preferably not exceed 3% of the ships' breadth in order to prevent excessive accelerations in rolling, are to be stated.

8 Where the ships carrying oil-based pollutants in bulk, notices of paying attention that the stability criteria given in **2.2.1, Part U of the Rules** should be maintained during all loading and ballasting operations, are to be described.

9 It is essential to keep the ship upright at all times by a symmetrical distribution of masses. A general warning is to be given of any reduction of stability by a steady angle of heel of the ship.

10 If applicable, the preferred compensation of asymmetrical light ship mass by ballast, consumables or cargo is to be explained. A warning against compensation by solid bulk cargo is to be given.

11 All relevant operating limits, including allowable values for longitudinal strength and allowable cargo mass, with regard to loading and distribution of cargo and ballasting are indicated. Reference is to be made to the loading manual, the damage control plan and the cargo securing manual, if applicable.

12 Guidance for the safe operation of the ship under normal and emergency conditions is to be described.

13 General precautions for preventing unintentional flooding are to be described.

14 For ships in operation, that attention is to be paid so that an inclining test may be carried out according to the provisions of *SOLAS* regulation II-1/5 to confirm their stability is to be described.

15 Any other notices deemed necessary for stability are to be described.

#### 1.3.3 Principal Particulars

The following items are to be listed in general.

- (1) Name of ship
- (2) Builder and yard number of ship
- (3) Date of build (keel lay, launch, deliver) or conversion
- (4) Purpose of ship
- (5) Classification character and notations
- (6) Nationality, port of registry, official number and signal letters
- (7) Principal dimensions (length, breadth and depth)

- (8) Tonnage descriptions
- (9) Designed draught and corresponding deadweight
- (10) Limitation of draught at bow or stern, if any.
- (11) Output of main engine and ship speed.
- (12) When load line is assigned, the data stated in (9) may be omitted subject to following data being added.
  - (a) Convention or rules applied
  - (b) Type of freeboard (A, B, etc.)
  - (c) List of freeboard, draught, displacement and deadweight corresponding to load line of each season (This list may be attached to a deadweight scale.)
- (13) IMO number

#### **1.3.4 Explanation of Symbols Used**

Designations, symbols and abbreviations for various units used in stability information are to be described. The units used are preferably unified in a single system, and, if plural systems are inevitable, a conversion table between the systems is to be attached.

#### **1.3.5 Data for Cargoes, Stowage, etc.**

##### **1 Stowage list**

A list is to be prepared for densities or stowage factors of various cargoes intended to be loaded on board. Blank space is to be left for additional entries by master. Values assumed at design stage are to be specially mentioned to that effect.

##### **2 General arrangement**

Drawings in a suitable scale, which show the arrangement of cargo spaces, tanks, lockers and stores, machinery spaces, accommodation spaces, compartments, closing apparatuses and vents together with their name, downflooding angles, permanent ballast, allowable deck loadings and freeboard, are to be attached.

In case of ships to which the requirements in **2.3, Part 1, Part C of the Rules** apply, the plans showing clearly the boundaries of each compartment (shells, decks and bulkheads), the openings therein with the control positions of closing apparatuses, and the arrangements of means, if fitted, to ensure the stability of the ship after flooding are to be attached in addition to above. However, if these plans are permanently posted on the bridge, these requirements may be waived.

##### **3 Weight and position of centre of gravity**

As to weight and location of centre of gravity of following items which are used in stability calculation, assumed total weight and position of centre of gravity and the basis of assumption are to be listed with, if appropriate.

- (1) Passengers and their effects.
- (2) Crew and their effects.
- (3) Motorcars in case of car carriers or car ferries.
- (4) Deck cargoes. If deck cargoes are anticipated to absorb water, the weight of them is to be increased by absorbed water in arrival condition.
- (5) Hanging cargoes.
- (6) Container cargoes. For the ships intended to carry containers, the plan of loading arrangement of containers is to be provided, in which maximum gross weight, tare weight and centre of gravity of each container are described and each container is numbered in consideration of easy identification.

#### **1.3.6 Results of Stability Experiments**

**1** The results of inclining tests are to include the undermentioned data. If inclining test has been omitted, the reason is to be stated. When the data are based on the record of a sister ship, the inclining test report, the builder and yard number of the ship are to be added to the undermentioned data. If the values different from a sister ship are used, the reason and a summary of the method used to determine those particulars are to be explained. When any permanent ballasts are included in light condition, the material, weight and arrangement of them are to be described by the drawing.

- (1) Light weight and location of centre of gravity (in longitudinal direction, vertical direction and, if necessary, transverse direction).
- (2) Place and date of inclining test.

**2** When oscillation tests were carried out, the details of test procedures are to be included in the test results. And an explanation of the relation between rolling period and  $G_0M$  is to be attached.

### 1.3.7 Method of Utilizing Information

Explanations for following items are to be stated. For calculations, assumptions are to be added to explanations. In order that the master calculates stability curves (hereinafter referred to as “GZ-curve” in this guidance) and evaluates the stability of ship, examples of calculations are to be added and the basis of all data are to be clarified. Examples of calculations are to include a loading condition which is considered with at least one fuel or fresh water tank partly filled. In cases where a computer for stability calculations is not on board ship, blank forms for calculation are to be attached.

- (1) Calculation for displacement and location of centre of gravity.
- (2) Calculation for draught and trim.
- (3) Method of preparation for GZ-curve.
- (4) Method of correction due to free-surface effect on GZ-curve and GM.
- (5) Method of estimating the effect of wind and waves (For an example, method of preparing wind-heeling moment lever curves is to be given.)
- (6) Method of evaluation for GZ-curve, etc. under the applicable stability requirements.
- (7) Method of utilizing the diagram required in 1.3.10-8.
- (8) Other items deemed necessary (for an example, when anti-rolling devices, heeling tanks, etc. are installed, the service procedures for them and operational restrictions thereto are to be explained. Instructions concerning the operation of means with descriptions of damage conditions which may require it, if fitted, to ensure the stability of the ship after flooding e.g. crossflooding are to be added.)

### 1.3.8 Applied Stability Requirements

It is to be described that the ship complies with the requirements in **Part U of the Rules** which meet the requirements in *IMO Res. MSC.267(85) “International Code on Intact Stability 2008 (2008 IS Code)”*. If any special requirements are made by the flag state other than the above-mentioned requirements, excerpts or summary of relevant provisions are given. For ships intended to navigate in area where icing is liable to occur, details of assumed icing are to be given together with location, weight and centre of gravity of icing.

### 1.3.9 Stability in Standard Loading Condition

#### 1 Standard loading condition

The undermentioned conditions are to be at least included in standard loading conditions unless they are clearly inappropriate. A departure condition means a condition in which provisions and fuel are fully loaded and an arrival condition means a condition in which 90% thereof are consumed. In full load departure conditions, it is to be assumed that water ballast tanks are empty and that the ship is loaded to its subdivision load line used for damage stability calculations according to 2.3, **Part 1, Part C of the Rules** or summer load line, if intended to carry a timber deck cargo, to the summer timber load line or for tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk assigned with a tropical load line, the ship should be assumed to be loaded to the tropical load line (if the tropical load line is not assigned to the ships, the ships should be assumed to be loaded to the summer load line). In all cases, the cargo in holds is assumed to be fully homogeneous unless this condition is inconsistent with the practical service of the ship.

- (1) Light condition
  - (2) Docking condition
  - (3) Ballast departure condition and ballast arrival condition
  - (4) Full load departure condition and full load arrival condition as following.
    - (a) In principle, all designed loading conditions are to be included; for example, such special loading conditions as loading cargoes on decks or in alternate holds, etc.
    - (b) If a dry cargo ship has tanks for liquid cargo, the effective deadweight in the loading conditions therein described is to be distributed according to the following two assumptions: (1) with cargo tanks full and (2) with cargo tanks empty.
  - (5) Loading condition in which the parameters of stability are liable to be changed on a large scale (e.g. ballasting during navigation, possible icing, etc.)
  - (6) Where the ships are loaded with timber deck cargoes, the loading condition with the summer timber load line (if the timber summer draught is not assigned to the ships, summer load line) with cargoes homogeneously distributed in the holds and with cargoes specified in extension and mass on deck.
- 2 Following items are to be stated concerning each loading condition. If there are any limitations placed upon loading, they are



to be included.

- (1) Arrangement in suitable scale showing distribution of all components constituting deadweight
- (2) Light weight, and weight, location of centre of gravity (longitudinal direction, vertical direction, and also transverse direction, if necessary), and weight moment of all components of deadweight together with displacement and location of centre of gravity of whole ship as a sum of each component.
- (3) Effect of free surface within all compartments which are liable to be partly filled.
- (4) Mean draught, positions of centre of buoyancy and centre of gravity (directions in longitudinal, vertical, and also transverse, if necessary), position of centre of floatation, *MTC*, trim, draughts at forward and aft perpendiculars (also at draught marks, as needed), *GG<sub>0</sub>*, *KG<sub>0</sub>* and *G<sub>0</sub>M*.
- (5) *GZ*-curves taking effect of free surface and changes in trim during heeling into account  
Values of downflooding angle, maximum righting lever and corresponding angle of heel, and vanishing angle of stability are also to be entered. Heeling moment lever curve due to external forces such as wind is to be superposed on the stability curve to verify that applicable stability requirements are complied with. Scale of these curves are to be the same as far as practicable in all loading condition.
- (6) If in any loading condition water ballast is necessary, the quantity and disposition of water ballast.
- (7) In all cases, in cases where deck cargo is carried, a realistic stowage mass and the height of the cargo.

**3** The following items are to be made into a list for convenience of use.

- (1) Displacement
- (2) Corresponding draught
- (3) Draught at fore perpendicular, aft perpendicular and midship
- (4) Draught at the position of fore and aft draught marks, if necessary
- (5) Trim
- (6)  $l_{cf}$ ,  $l_{cb}$ ,  $l_{cg}$
- (7) *MTC*, *TPC* and *TKM* (*LKM* to be included, if necessary)
- (8) *KG* and *GM* (*KB* to be included, if necessary)
- (9) *GG<sub>0</sub>*, *KG<sub>0</sub>* and *G<sub>0</sub>M*
- (10) Maximum righting lever and corresponding angle of heel and vanishing angle of stability
- (11) Downflooding angle
- (12) Evaluation of conformity with stability requirements
- (13) Others

where

$l_{cf}$ : Longitudinal centre of floatation

$l_{cb}$ : Longitudinal centre of buoyancy

$l_{cg}$ : Longitudinal centre of gravity

*MTC*: Moment to change trim one centimeter

*TPC*: Tons per centimeter immersion

*TKM*: Transverse metacentric height above base line

*LKM*: Longitudinal metacentric height above base line

*KG<sub>0</sub>*: Apparent vertical centre of gravity above base line

### 1.3.10 General Data

**1** As a general data, various data stated in following -2 to -13 (-2 to -7 for tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk) are to be presented in numerical tables or curves to give required values with sufficient accuracy. If any change in trim has a large effect on the values of various data, additional tables or curves for suitable range of trim is to be prepared or the method of correction to cope with the change in trim is to be given. With respect to hydrostatic curves or tables and cross curves of stability, each displacement and the effects of changes in trim during heeling are to be taken into account.

**2** Capacity, centre of capacity of compartments and centre of gravity

Capacity and the location of the centre of capacity (in longitudinal and vertical directions, and also transverse direction, if required) of all compartments such as cargo holds, fuel oil tanks, fresh water tanks and ballast tanks are to be expressed as the functions of the

liquid level or ullage of each compartment. When functions of ullage are used, reference point for ullage and the lowest point of that compartment are to be given. For deep tanks, side tanks, peak tanks and other tanks with unusual shape where the change of liquid level or ullage has a large effect on capacity or center of capacity, holding more than 0.1% of the ship's summer displacement, intervals of the liquid level or ullage are to be not more than 0.1m. In the range of liquid level or ullage where capacity and center of capacity vary linearly depending on the tank shape, larger intervals may be adopted. It is preferable that the moment of inertia of free surface is additionally given for all compartments which may be partly filled with liquid. For car carriers and car ferries, the location of centre of gravity of a car stowing compartment may be based on the location of centre of gravity of cars rather than the centre of the capacity. Capacity plans or tables showing capacities and centres of gravity for each cargo stowage space are to be included. Tank sounding tables showing capacities, centres of gravity, and free surface data for each tank are to be included.

### 3 Effect of free surface

For cargo holds and tanks which are partly filled with liquid and are also deep tanks, side tanks, peak tanks or other tanks with unusual shape where the change of liquid level or ullage has a large effect on capacity or center of capacity, holding more than 0.1% of the ship's summer displacement, the effect given by the free surface on the stability is to be given as the function of the volume or the liquid level. Intervals of the liquid level or ullage are to be not more than 0.1m. For tanks with a width of 0.6B or more, to indicate corrections to the righting lever in **(2)(b)**, the angle of heel ( $\theta$ ) is to be in the range from 10° to 80° and in intervals not more than 10°.

(1) Compartments where free surface is taken into account;

- (a) For compartments containing liquid which may be consumed or discharged during navigation, or for tanks, such as anti-rolling devices and heeling tanks containing liquid which may be transferred to and from other tanks, the expected maximum moment of free surface is to be given.
- (b) When liquid in a cargo hold or deep tank is maintained constant at partly filled condition during navigation, the moment of free surface may be calculated on the basis of actual quantity of the liquid.

(2) Free surface moment

- (a) Correction to initial metacentric height;

Vertical ascend of centre of gravity is calculated by the following formula:

$$GG_0 = \frac{\Sigma \gamma i}{W}$$

where:

Symbol  $\Sigma$  means that the values are to be summed up on all compartments having free surface inside. The same is applied to the subsequent formula **(b)**.

$\gamma$ : Specific weight of liquid ( $t/m^3$ ).

$i$ : Transverse moment of inertia of free surface ( $m^4$ )

$W$ : Displacement ( $t$ ).

- (b) Correction to righting lever;

- i) The righting lever is reduced by the amount obtained from the following formula:

$$\Delta GZ = \frac{\Sigma M_{fs}}{W}$$

$$M_{fs} = \gamma v b K \sqrt{\delta}$$

Since above-mentioned formula for  $M_{fs}$  is prepared for the case where liquid is half filled in a compartment of approximately rectangular section, direct calculation is required separately for each compartment if the above condition is not met. For the cases where deemed necessary by the Society, however, other suitable methods may be applied.

$$\delta = \frac{v}{b \ell h}$$

$v$ : Total volume of tanks ( $m^3$ )

$b, \ell, h$ : Maximum length ( $m$ ), maximum breadth ( $m$ ), and maximum depth ( $m$ ) of the tank, respectively

$K$ : Value determined by following formulae according to  $\cot \theta$  and  $b/h$ ;

In case of  $\cot \theta \geq b/h$ :

$$K = \frac{\sin\theta}{12} \left( 1 + \frac{\tan^2\theta}{2} \right) \frac{b}{h}$$

In case of  $\cot \theta < b/h$ :

$$K = \frac{\cos\theta}{8} \left( 1 + \frac{\tan\theta}{b/h} \right) - \frac{\cot\theta}{12(b/h)^2} \left( 1 + \frac{\cot^2\theta}{2} \right)$$

$\theta$ : Angle of heel (°)

$\gamma, W$ : As given in above (a)

- ii) In the case of tanks, of which  $M_{fs}$  specified in above i) complies with following at when angle of heel ( $\theta$ ) is 30°, the correction to righting lever may be omitted.

$$M_{fs} < 0.01W_{min}$$

where:

$W_{min}$ : Displacement ( $t$ ) in light condition, in general.

#### 4 Hydrostatic values

Hydrostatic values in the range of light draught to 115% of the maximum draught in intervals not more than 5cm are to be presented on the basis of mean draught above underside of keel in the designed trim condition. Stability information is to show the influence of various trims on hydrostatic values for a suitable range of trim in cases where the operational trim range exceeds +/- 0.5% of  $L_s$  specified in **2.3.1.2(6), Part 1, Part C of the Rules**. The following items are to be included:

- (1) Mould displacement and displacement including shell platings, etc. (Specific gravity of sea water is to be 1.025( $t/m^3$ ). Lower specific gravity may be adopted subject to the approval by the Administration.)
- (2)  $TPC, MTC$
- (3)  $TKM$  ( $LKM$  to be included, if necessary)
- (4)  $l_{cb}, l_{cf}$  ( $KB$  to be included, if necessary)
- (5)  $C_b$
- (6) Thickness of keel plates

#### 5 Cross curves

Cross curves showing the relationship between righting lever, angle of heel and displacement or draft is to be presented considering trim.

When structures and cargoes on the upper deck accepted as reserve buoyancy are included in calculations, data showing their particulars are to be added.

The cross curves are to cover the following range;

- (1) Full range of displacement or draft extending from light draft to 115% of the maximum draught in intervals not more than 5cm.
- (2) The range of the angle of heel extending from 10° to 80° in intervals not more than 10°. (However, closer spacing may be required according to the ship form and proportions.)

#### 6 Curve of downflooding angle

The angle of heel, ranging up to which the lower edge of an opening without weathertight closing means reaches water surface, is to be specified as a function of displacement or draft. A diagram showing the position of the said opening is to be attached.

Curve of downflooding angle may be indicated as tables.

#### 7 Projected lateral windage area

Projected lateral area of hull structure, deck cargoes, etc. above water line receiving wind pressure and the vertical distance between the centre of its area and the centre underwater projected lateral area are to be given as the functions of the draught. The centre of underwater projected lateral area may be approximately assumed to locate at half the draught.

#### 8 Maximum permissible height of centre of gravity, etc.

The diagram by which the master is able to confirm easily that the stability of his ship complies with the requirements in **1.3.8** in any loading condition, given in the functions and format deemed adequate by the Society taking ship type and service area into account are to be supplied.

For an example, it is to be of the curve of minimum permissible  $G_0M$  (or maximum permissible  $KG_0$ ) and maximum permissible trim in which draught and  $G_0M$  (or  $KG_0$ ) are respectively used as ordinate and abscissa.

- 9 The intact and damage stability information are to be presented as consolidated data and encompass the full operating range

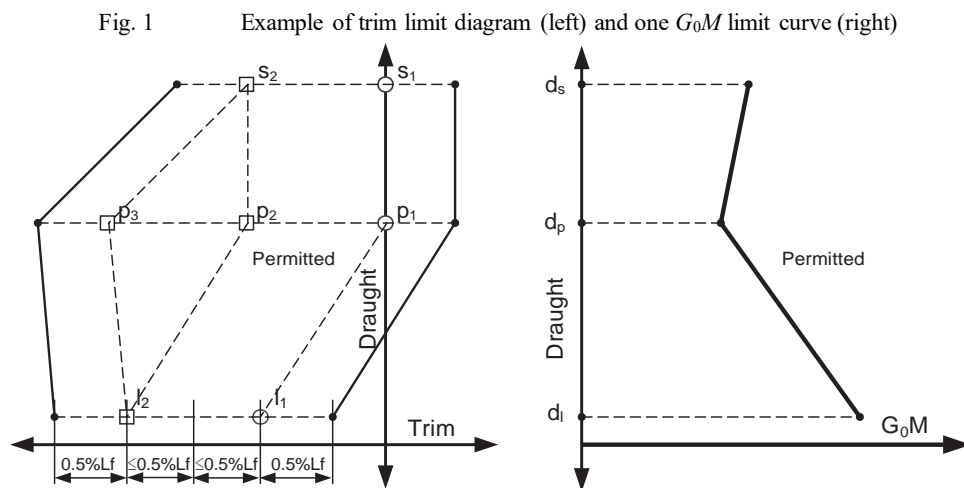
of draught and trim. Applied trim values are to coincide in all stability information intended for use on board. Information not required for determination of stability and trim limits is to be excluded from this information.

**10** If the damage stability is calculated in accordance with the requirements specified in 2.3 or 2.4.1.1-4(1), Part 1, Part C of the Rules, a stability limit curve is to be determined using linear interpolation between the minimum required  $G_0M$  assumed for each of the three draughts  $d_s$ ,  $d_p$  and  $d_l$ . When additional subdivision indices are calculated for different trims, a single envelope curve based on the minimum values from these calculations is to be presented. When it is intended to develop curves of maximum permissible  $KG_0$  it is to be ensured that the resulting maximum  $KG_0$  curves correspond with a linear variation of  $G_0M$ . When light service draught is not with the same trim as other draughts,  $TKM$  for draughts between partial and light service draught are to be calculated for trims interpolated between trim at partial draught and trim at light service draught.

**11** As an alternative to the single envelope curve specified in -10 above, the calculations for additional trims may be carried out with one common  $G_0M$  for all of the trims assumed at each subdivision draught. The lowest values of each partial index  $A_s$ ,  $A_p$  and  $A_l$  across these trims are then to be used in the summation of the attained subdivision index  $A$  according to the requirements specified in 2.3, Part 1, Part C of the Rules. This will result in one  $G_0M$  limit curve based on the  $G_0M$  used at each draught. A trim limit diagram showing the assumed trim range is to be developed. (See Fig. 1)

**12** Where temporary loading conditions occur with a draught less than the light service draught  $d_l$  due to ballast water exchange requirements, etc., the  $G_0M$  limit value at  $d_l$  is to be used for draughts below  $d_l$ .

**13** Where ships are permitted to sail at draughts above the deepest subdivision draught  $d_s$ , e.g. using the tropical freeboard, the  $G_0M$  limit value at  $d_s$  is to be used for draughts above  $d_s$ .



## Annex U1.2.2 GUIDANCE FOR STABILITY COMPUTER

### 1.1 General

#### 1.1.1 Application

This guidance applies to computers for stability calculation on board the ship as a supplement to the stability information booklet.

#### 1.1.2 General Requirements

- 1 Stability computers are to be in accordance with the stability information booklet as approved by the Society and are to perform all calculations as necessary to ensure compliance with the applicable stability requirements.
- 2 Where ships are to be complying with damage stability requirements by other rules, stability computers for such ships are to perform all calculations or checks as necessary to ensure compliance with the applicable damage stability requirements.
- 3 Stability computers are to at least include all information as necessary by the applicable requirements specified in the above -1 and -2.
- 4 The input/output information is to be easily comparable with approved stability information booklet.
- 5 An operation manual is to be provided for the onboard stability computer.
- 6 The language in which the stability information is displayed and printed out as well as the operation manual is written, is to be the same as used in the ship's approved stability information booklet.
- 7 Appropriate measures are to be taken for the prevention of imprudent modifications of the program and the data for the stability computer.

### 1.2 Software for Stability Calculation

#### 1.2.1 Types of Software

Software for stability calculation is categorized as following (1) to (3), corresponding to the stability requirements applied to the ship.

- (1) Type 1: Software calculating intact stability for each loading condition
- (2) Type 2: Software calculating intact stability as specified in (1) and checking damage stability by showing a limit  $G_0M$  curve or checking all the stability requirements (intact and damage stability) on the basis of a limit curve.
- (3) Type 3: Software calculating intact stability and damage stability by direct application of pre-programmed damage cases according to the applicable rules for each loading condition. Damage stability is to be based on a hull form model, that is, directly calculated from a full three-dimensional geometric model.

#### 1.2.2 Functional Requirements for Software

1 The calculation program of the software for stability calculation is to present relevant parameters of each loading condition in order to assist the Master in his judgement on whether the ship is loaded within the approval limit. The following parameters are to be presented for a given condition.

- (1) Deadweight data
- (2) Lightship data
- (3) Trim
- (4) Draft at the draft marks and perpendiculars
- (5) Summary of loading condition displacement,  $VCG$ ,  $LCG$  and, if applicable,  $TCG$
- (6) Downflooding angle and corresponding downflooding opening (not applicable for type 2 software which uses limit curve for checking all stability requirements. However, if intact stability criteria are given in addition to the limit curve, downflooding angle and the corresponding downflooding opening are to be indicated.)
- (7) Compliance with stability criteria: Listing of all calculated stability criteria, the limit values, the obtained values and the conclusions (criteria fulfilled or not fulfilled) (not applicable for type 2 software which uses limit curve for checking all the

stability requirements. However, if intact stability criteria are given in addition to the limit curve, the limit values, the obtained values and the conclusion are to be indicated.)

(8) Other parameters deemed necessary by the Society

**2** A clear warning is to be given on screen and in hard copy printout if any of the loading limitations are not complied with. Loading limitations are to include, but may not be limited to the following.

- (1) Trim, draught, liquid densities, tank filling levels, initial heel
- (2) Use of limit  $KG_0 / G_0M$  curves in conjunction with above for type 2
- (3) Restrictions to the stowage height for timber where timber load lines are assigned

**3** For type 3 software, each relevant damage case (damage on both sides of the ship, on the port side, and on the starboard side) according to the applicable requirements is to be pre-defined for automatic checking of a given loading condition, and the system is to be pre-loaded with a detailed computer model of the complete hull, including appendages, all compartments, tanks and the relevant parts of the superstructure considered in damage stability calculations, wind profiles, down-flooding and up-flooding openings, cross-flooding arrangements and internal compartments.

**4** For type 1 and type 2 software, in case a full three dimensional model is used for stability calculations, the requirements of the computer model are to be as per **-3** above to the extent as applicable and according to the type of stability software.

**5** Regarding the output on screen and in hard copy printout, the data with units of measurement are to be presented in clear unambiguous manner with units of measurement. The data and time of a saved calculation and identification of the calculation program including version number are also to be presented.

### **1.2.3 Computational Accuracy of Program**

**1** For the computational accuracy of the stability calculation program, tolerances of the calculation results from the approved stability information booklet are, in general, to be zero.

**2** Notwithstanding the provisions of **-1**, for programs which use hull form models as their basis for stability calculations, the tolerances of the calculation results from the approved stability information booklet may be within the acceptable tolerances as shown in **Table 1**.

**3** The computational accuracy of the program for the particular ship is to be verified so that the calculation results are within the acceptable tolerances specified in **-1** or **-2** as applicable. Such calculation is to be made by using actual ship data for at least four loading conditions which are selected from the ship's approved stability information booklet (except the light ship condition) in accordance with the following **(1)** to **(3)**. Notwithstanding the above, for programs approved for not-particular ships in accordance with **1.2.4**, such verification may be done for one loading condition. Where deemed as necessary by the Society, submission of detail data for the verification may be required.

- (1) Loading conditions for the verification (hereinafter, referred to as test loading conditions) are to be full of variety as possible and include a cargo loaded condition with the deepest draught and a ballast condition with the lightest draught. For ships carrying liquid cargoes in bulk, at least one of the conditions is to include partially filled tanks. For ships carrying grain in bulk, one of the grain loading conditions is to include a partially filled grain compartment.
- (2) Within the test loading conditions each main compartment (cargo spaces, ballast tanks, etc.) is to be loaded at once.
- (3) The test loading conditions are to include at least one departure and one arrival condition.

Table 1 Acceptable Tolerances

Hull form dependent	
Displacement	+/- 2%
Longitudinal centre of buoyancy, from <i>AP</i>	+/- 1% / 50 cm
Vertical centre of buoyancy	+/- 1% / 5 cm
Transverse centre of buoyancy	+/- 0.005 <i>B</i> / 5 cm
Longitudinal centre of flotation, from <i>AP</i>	+/- 1% / 50 cm
Moment to trim 1 cm	+/- 2%
Transverse metacentric height	+/- 1% / 5 cm
Longitudinal metacentric height	+/- 1% / 50 cm
Cross curves of stability	+/- 5 cm
Compartment dependent	
Volume or deadweight	+/- 2%
Longitudinal centre of gravity, from <i>AP</i>	+/- 1% / 50 cm
Vertical centre of gravity	+/- 1% / 5 cm
Transverse centre of gravity	+/- 0.005 <i>B</i> / 5 cm
Free surface moment	+/- 2%
Shifting moment	+/- 5%
Level of contents	+/- 2%
Trim and stability	
Draughts (forward, aft, mean)	+/- 1% / 5 cm
<i>GM</i> , <i>G<sub>0</sub>M</i> (transverse metacentric height from centre of gravity)	+/- 1% / 5 cm
<i>GZ</i> values (righting arm)	+/- 5% / 5 cm
Downflooding angle	+/- 2 degrees
Equilibrium angles	+/- 1 degree
Distance from <i>WL</i> to unprotected and weathertight openings, or other relevant point, if applicable	+/- 5% / 5 cm
Areas under righting arm curve	+/- 5% / 0.0012 m-rad

Notes:

- 1 Deviation in % means a ratio of the difference between the calculation results and values of the approved stability information booklet, to the values of the booklet.
- 2 When applying the tolerances in **Table 1** having two values, the allowable tolerance is the greater of the two values.
- 3 Where differences in calculation methodology exist between the programs used in the comparison, this may be a basis for accepting deviations greater than that specified in **Table 1** provided a software examination is carried out in sufficient detail to clearly document that such differences are technically justifiable.
- 4 Deviation from these tolerances is not to be accepted unless the Society considers that there is a satisfactory explanation for the difference and that it is clearly evident from the Society's stability calculations that the deviation does not impact compliance with the required stability criteria for the ship under consideration.

#### 1.2.4 Approval of Software

The Society may approve software as a stability calculation program which does not depend on data of a particular ship. In this case, the Society examines such software in accordance with the procedures specified in the following (1) to (4) and then, may issue a certificate of approval after success in the examination.

- (1) Verify the compliance with the functional requirements as specified in **1.2.2**.
- (2) Verify the compliance with the requirements of the computation accuracy in **1.2.3**, by using at least three data sets of different types of ship which are containing of four loading conditions selected in accordance with **1.2.3-3(1)** to (3). In such case, the

tolerances are to be evaluated from calculation results by the stability calculation program which is provided by the Society. For the purpose of the verification, the type of ship is, in general, categorized into the following four types.

- (a) Tankers, ships carrying dangerous chemicals in bulk, ships carrying liquefied gases in bulk and ships having loading conditions as similar to such type of ship
  - (b) Bulk carriers and ships having loading conditions as similar to such type of ship
  - (c) Container carriers and ships having loading conditions as similar to such type of ship
  - (d) Other cargo ships and passenger ships
- (3) Notwithstanding the above (2), for software which applicable type of ship is limited, the verification may be made by using at least three data sets of ships having different hull forms of applicable type of ship.
- (4) For the approval of software, any applicant is to submit the following documents in addition to the software.
- (a) Application form (including applicable type of ship, where it is limited) (**Form-SCPsoftware**)
  - (b) General information of the software (including information regarding its version)
  - (c) Operation manual
  - (d) Necessary data regarding displacement, compartmentation, weight, centre of gravity, loaded cargoes and loading conditions of the ships used for the verification of the computational accuracy (lines, hydrostatic curves, tank capacity plan, etc.)

### 1.3 Hardware for Stability Computer

#### 1.3.1 Hardware Requirements

1 Hardware for stability computers is recommended to be of approved type in accordance with the requirements of **Chapter 2, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use “APPROVAL OF USE OF LOADING COMPUTER”**.

2 Where a wide use computer adapts to the use of this purpose, it is recommended to provide two or more computers on board the ship.

### 1.4 Operation Manual

#### 1.4.1 Contents of Operation Manual

Operation manual for the stability computers is to contain at least the following descriptions and instructions.

- (1) General instruction
- (2) Instructions for function keys
- (3) Instructions for menu displays
- (4) Instructions for input and output data
- (5) Descriptions regarding required minimum hardware to operate the software, where the software is supplied separate from hardware
- (6) Instructions for use of the test loading conditions
- (7) Descriptions regarding computer-guided dialogue steps
- (8) List of warnings in operation

### 1.5 Testing

#### 1.5.1 Installation Testing

When the stability computer is installed on board the ship or the software is installed the computer or renewed, a performance test is to be carried out so as to ensure correct working in accordance with the procedures specified in the following (1) to (4).

- (1) Retrieve at least one condition of the test loading conditions in the operation manual, carry out a stability calculation and compare stability results with those in the operation manual.
- (2) Change several items of input data sufficiently to change the draught or displacement by at least 10%. The results are to be



reviewed to ensure that they differ in a logical way from those of the test condition as mentioned in (1) above.

- (3) Revised the modified load condition as mentioned in (2) above to restore the initial test condition as mentioned in (1) above and compare the results.
- (4) Alternative to the provisions of (2) and (3) above, one or more conditions of the test loading conditions, other than that mentioned in (1) above, are selected and the test calculation performed by entering all deadweight data for each selected test condition into the program as if it were a proposed loading. The results are to be verified as identical to the results of the test conditions.

#### **1.5.2 Periodical Testing**

At each periodical survey of the ship, a performance test is to be carried out in the same manner as the provisions of 1.5.1. However, at each special survey, the performance test is to be carried out for all test loading conditions.