



**INTLREG**  
INTERNATIONAL REGISTER OF SHIPPING

# RULES AND REGULATIONS FOR CLASSIFICATION OF STEEL VESSELS

## Part 8 STABILITY

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**CHANGES HISTORY**

Refer Changes history in Part 1

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## CHAPTER 1 STABILITY

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SECTION 1 APPLICATION, DEFINITIONS AND DOCUMENT  
REQUIREMENTS

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**1.1 Application**

- 1.1.1 All vessels with a freeboard length ( $L_F$ ) of 24 m and above shall comply with the stability requirements of this section, as applicable for the main class. For definition of  $L_F$ , refer Part 3, Ch 1 Sec 2.1.1.
- 1.1.2 The requirements in this section are in compliance with IMO 2008 Intact Stability Code (IMO Res.MSC.267(85)) and cover IACS UR L2.
- 1.1.3 For vessels with service restrictions as described in Pt 1, Ch 1, Sec 4, table 1.1, modified stability requirements may be considered if consistent with the applicable service restriction.
- 1.1.4 Vessels with a free board length  $L_F$  of 24 m and above and with additional class notations shall comply with additional stability requirements as given in the appropriate rule chapters.
- 1.1.5 Ships with loading computer systems intended for stability control shall comply with IACS UR L5.
- 1.1.6 The stability for vessels for which lifting operations are the main or one of the main functions shall also be in compliance with the criteria given in Pt.5 Ch.7 Sec.17.  
The crane criteria shall be applied when the maximum heeling arm created by the crane and its load exceeds 0.10 m at any operational displacement.

**1.2 Terms**

- 1.2.1 *External watertight integrity*  
The capability of the hull structure and its external closing appliances to prevent downflooding to volumes assumed buoyant. The external watertight integrity includes position and type of closing appliances, alarms, indicators, remote controls and signboards fitted to such appliances.
- 1.2.2 *Weathertight*  
Weathertight means that in any sea conditions water will not penetrate into the ship.
- 1.2.3 *Watertight*  
Capable of preventing ingress of water during static submersion under a head of water for which the surrounding structure is designed.  
A watertight closing appliance is also considered weathertight.
- 1.2.4 *Downflooding*  
Ingress of water through external openings to buoyancy volumes.
- 1.2.5 *Downflooding angle related to intact stability*  
The minimum heel angle where an external opening without weathertight closing appliance is submerged.
- 1.2.6 *Lightweight*

Lightweight is the displacement of a ship in tonnes without cargo, fuel, lubricating oil, ballast water, fresh water and feed water in tanks, consumable stores, and passengers and crew and their effects.

The lightweight definition stated in the Stability Manual indicates which items are included or not included in the lightweight.

**Remark:** *The approved lightweight data are the data which are approved for the purpose of stability approval and control but not necessarily for determination of the deadweight.*

#### 1.2.7 Maximum allowable vertical center of gravity

The maximum vertical center of gravity of the vessel, corrected for free surface effect, which complies with the stipulated stability requirements for the draught in question.

#### 1.2.8 Preliminary stability documentation

The stability documentation which is based on estimated lightweight data.

#### 1.2.9 Final stability documentation

The stability documentation which is based on approved lightweight data obtained from an inclining test or lightweight survey.

### 1.3 Documentation requirements

#### 1.3.1 Documentation shall be submitted as required by Table 1.1

| Table 1.1 Documentation requirements           |                                                 |                        |                                           |
|------------------------------------------------|-------------------------------------------------|------------------------|-------------------------------------------|
| Object                                         | Documentation type                              | Additional description | For approval (AP) or For information (FI) |
| Stability                                      | Lines plan and offset tables                    |                        | FI                                        |
|                                                | External watertight integrity plan              |                        | FI                                        |
|                                                | Preliminary stability manual                    |                        | AP                                        |
|                                                | Inclining test and lightweight survey procedure | For each vessel        | AP                                        |
|                                                | Inclining test or lightweight survey report     |                        | AP                                        |
|                                                | Final stability manual                          |                        | AP                                        |
| External watertight and weathertight integrity | Freeboard plan                                  |                        | FI                                        |

- 1.3.2 If the assignment of class shall be based on the approval of the Flag Administration according Pt 1 Ch1 Sec 8, a copy of the final stability documentation stamped by the Flag Administration and the approval letter issued by the Flag Administration shall be submitted to Intreg.

SECTION 2 SURVEYS AND TESTS

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**2.1 General**

2.1.1 The following surveys and tests shall be carried out:

- external watertight integrity survey with respect to unprotected and protected openings together with their closing appliances, alarms, indicators and signboards, normally covered by the load line initial survey
- checking of draught marks
- remote draught measurement and tank gauging systems
- Inclining test or lightweight survey.

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**3.1 Stability book**

- 3.1.1 An approved stability booklet shall be provided onboard. The stability booklet shall include information as is necessary to enable the master by a rapid and simple process to obtain accurate guidance as to the stability of the ship under varying conditions of service.

**Remark:**

*The format and content of the stability book is further described in IACS UI LL45.*

- 3.1.2 Stability data and associated plans shall include a translation into English, if English is not used as official language.

**3.2 Fixed ballast**

- 3.2.1 If used, fixed ballast shall be installed in a manner that prevents shifting of position.

**3.3 Draught marks**

- 3.3.1 The ship shall have scale of draught marks at the bow and stern on both port and starboard side.

**Remark:**

*The draught marks should reflect the extreme draught at the location where they are fitted. The stability manual should contain guidance on, from draught mark readings, how to utilize the stability information contained therein.*

**3.4 Loading computer system**

- 3.4.1 Loading computers for stability calculation shall be considered as supplementary to the approved stability booklet.
- 3.4.2 Loading computers for stability control shall comply with IACS UR L5.

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## SECTION 4 INTACT STABILITY CRITERIA

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## 4.1 General stability criteria

### 4.1.1 The following criteria are given for all ships:

- The area under the righting lever curve (GZ curve) shall not be less than 0.055 meter-radians up to  $\Phi = 30^\circ$  angle of heel and not less than 0.09 meter-radians up to  $\Phi = 40^\circ$  or the angle of down-flooding  $\Phi_f$  if this angle is less than  $40^\circ$ . Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of  $30^\circ$  and  $40^\circ$  or between  $30^\circ$  and  $\Phi_f$ , if this angle is less than  $40^\circ$ , shall not be less than 0.03 meter-radians.
- The righting lever GZ shall be at least 0.20 m at an angle of heel equal to or greater than  $30^\circ$ .
- The maximum righting lever should occur at an angle of heel preferably exceeding  $30^\circ$  but not less than  $25^\circ$ .
- The initial metacentric height  $GM_0$  shall not be less than 0.15 m.

#### Remark:

*For ships carrying timber deck cargoes and provided that:*

- *the cargo extends longitudinally between superstructures end, or where there is no limiting superstructure at the after end, the timber deck cargo shall extend at least to the after end of the aftermost hatchway*
- *the cargo extends transversely for the full beam of the ship after due allowance for a rounded gunwale not exceeding 4% of the breadth of the ship*
- *supporting uprights are secured and remain securely fixed at large angles of heel*

*The following criteria may be used instead of the criteria in 4.1.1:*

- *the area under the righting lever curve (GZ curve) should not be less than 0.08 metre-radians up to  $\Phi = 40^\circ$  angle of heel or the angle of flooding  $\Phi_f$  if this angle is less than  $40^\circ$*
- *the maximum value of the righting lever (GZ) should be at least 0.25 m*
- *at all times during the voyage, the metacentric height  $GM_0$  should be positive after correction for the free surface effects of liquid in tanks and, where appropriate, the absorption of water by the deck cargo and/or ice accretion on the exposed surfaces. Additionally, in the departure condition, the metacentric height  $GM_0$  should not be less than 0.10 m.*

### 4.1.2 The following equivalent criteria are recommended where a vessel's characteristics render compliance with 4.1.1 impracticable (based on IMO 2008 IS Code Part B Ch.2.4.5):

- The area under the righting lever curve (GZ curve) shall not be less than 0.070 meter-radians up to an angle of  $15^\circ$  when the maximum righting lever (GZ) occurs at  $15^\circ$  and 0.055 meter-radians up to and angle of  $30^\circ$  when the maximum righting lever (GZ) occurs at  $30^\circ$  or above. Where the maximum righting lever (GZ) occurs at angles of between  $15^\circ$  and  $30^\circ$ , the corresponding area under the righting lever curve should be:

$$0.055 + 0.001 (30^\circ - \phi_{max}) \text{ meter – radians}$$

## PART 8

### CHAPTER 1

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- Where  $\Phi_{\max}$  is the angle of heel in degrees at which the righting lever curves reaches it maximum
  - The area under the righting lever curve (GZ curve) between the angles of heel of  $30^\circ$  and  $40^\circ$ , or between  $30^\circ$  and  $\Phi_r$  this angle is less than  $40^\circ$ , should be not less than 0.03 meter-radians.
  - The righting lever (GZ) should be at least 0.20 m at an angle of heel equal to or greater than  $30^\circ$ .
  - The maximum righting lever (GZ) should occur at an angle of heel not less than  $15^\circ$ .
  - The initial transverse metacentric height ( $GM_0$ ) should not be less than 0.15 m.
- 4.1.3 When anti-rolling devices are installed in a ship, the applicable intact stability criteria shall be satisfied when the devices are in operation.
- 4.1.4 For certain ship types additional or alternative intact and damage stability criteria have been specified. These vessels (or class notations) are given in table 4.1

**Table 4.1 Stability design requirements for different ship type and class notations**

| <i>Class notation/Ship type</i>                      | <i>Intact</i> | <i>Damage</i> | <i>INTLREG Requirement</i> | <i>IMO Reference</i> |
|------------------------------------------------------|---------------|---------------|----------------------------|----------------------|
| <b>1A1</b>                                           |               |               |                            |                      |
| <b>1A1, offshore/harbor service vessels</b>          |               |               |                            |                      |
| <b>1A1, wind</b>                                     |               |               |                            |                      |
| <b>1A1, timber</b>                                   |               |               |                            |                      |
| <b>Tanker for Oil</b>                                |               |               |                            |                      |
| <b>Offshore service vessel</b>                       |               |               |                            |                      |
| <b>SF</b>                                            |               |               |                            |                      |
| <b>Tug</b>                                           |               |               |                            |                      |
| <b>Fire Fighter I (or II or III)</b>                 |               |               |                            |                      |
| <b>CRANE</b>                                         |               |               |                            |                      |
| <b>Diving support vessel</b>                         |               |               |                            |                      |
| <b>DEICE</b>                                         |               |               |                            |                      |
| <b>Offshore vessels</b>                              |               |               |                            |                      |
| <b>Well Stimulation Vessel</b>                       |               |               |                            |                      |
| <b>Escort</b>                                        |               |               |                            |                      |
| <b>Standby Vessel</b>                                |               |               |                            |                      |
| <b>Other vessels</b>                                 |               |               |                            |                      |
| <b>Passenger Ship</b>                                |               |               |                            |                      |
| <b>Car Ferry, Train Ferry or Car and Train Ferry</b> |               |               |                            |                      |

|                                                               |  |  |  |  |
|---------------------------------------------------------------|--|--|--|--|
| Fishing Vessel or Stern Trawler                               |  |  |  |  |
| Icebreaker/POLAR                                              |  |  |  |  |
| Barge for Deck Cargo                                          |  |  |  |  |
| SPS(<240 persons<br>SPS(240 persons or more)<br>All SPS ships |  |  |  |  |

## 4.2 Weather criterion

4.2.1 For all ships with length  $L_F$  of 24m and above, the criteria listed below shall be complied with (based on IMO 2008 IS Code Part A Ch 2.3)

- 1 The ability of a ship to withstand the combined effects of beam wind and rolling shall be demonstrated, with reference to 4.1 as follows:
  - 1.1 The ship is subjected to a steady wind pressure acting perpendicular to the ship's centerline which results in a steady wind heeling lever ( $l_{w1}$ );
  - 1.2 From the resultant angle of equilibrium ( $\Phi_0$ ), the ship is assumed to roll owing to wave action to an angle of roll ( $\Phi_1$ ) to windward. Attention should be paid to the effect of steady wind so that excessive resultant angles of heel are avoided.  
The angle of heel under action of steady wind ( $\Phi_0$ ) should be limited to certain angle to the satisfaction of INTLREG. Generally,  $16^\circ$  or 80% of the angle of deck edge immersion, whichever is less, is suggested.
  - 1.3 The ship is then subjected to a gust wind pressure which results in a gust wind heeling lever ( $l_{w2}$ ); and
  - 1.4 Under these circumstances, area b shall be equal to or greater than area a, as indicated in figure 4.1
  - 1.5 Free surface effects should be accounted for in the standard conditions of loading as set out in 4.3.1

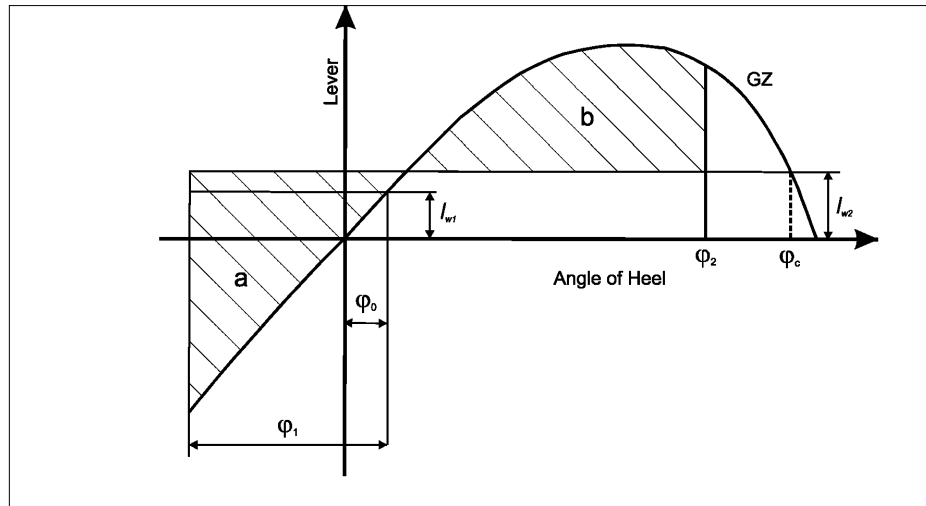


Figure 4.1: Severe wind and rolling

The angles in figure 4.1 are defined as follows:

$\Phi_0$  = Angle of heel under action of steady wind (refer 1.2 and 1.3)

$\Phi_1$  = Angle of roll to windward due to wave action

$\Phi_2$  = Angle of down-flooding ( $\Phi_f$ ) or  $50^\circ$  or  $\Phi_c$ , whichever is less,

Where:

$\Phi_f$  = Angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weather tight immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

$\Phi_c$  = Angle of second intercept between wind heeling lever  $l_{w2}$  and GZ curves.

## 2 Wind heeling levers

The wind heeling levers  $l_{w1}$  and  $l_{w2}$  referred to in 1.1 and 1.3, are constant values at all angles of inclination and shall be calculated as follows:

$$l_{w1} = \frac{P \cdot A \cdot Z}{1000 \cdot g \cdot \Delta} \quad (\text{m}) \text{ and}$$

$$l_{w2} = 1.5 \cdot l_{w1} (\text{m})$$

Where:

$P$  = Wind pressure of 504 N/m<sup>2</sup> (wind speed = 29 m/s). The value of  $P$  used for ships in restricted service and/or for ships with very large windage areas (due to coherence length for wind speed), may be reduced subject to the approval of INTLREG.

$A$  = Projected lateral area of the portion of the ship and deck cargo above the waterline (m<sup>2</sup>).

$Z$  = Vertical distance from the center of  $A$  to the center of the underwater lateral area or approximately to a point at one half the mean draught (m).

$\Delta$  = Displacement (t);

$g$  = Gravitational acceleration of 9.81 m/s<sup>2</sup>.

The angle of roll ( $\Phi_1$ ) referred to in 1.2 above, shall be calculated as follows:

$$\Phi_1 = 109 * k * X_1 * X_2 * \sqrt{r * s} \text{ (Degrees)}$$

**Remark:** The angle of roll for ships with anti-rolling devices should be determined without taking into account the operation of these devices.

Where:

$X_1$  = Factor as shown in Table 4.2

$X_2$  = Factor as shown in Table 4.3

$k$  = Factor as follows:

= 1.0 for round-bilged ship having no bilge or bar keels;

= 0.7 for a ship having sharp bilges;

= as shown in Table 4.4 for a ship having bilge keels, a bar keel or both.

$$r = 0.73 \pm 0.6 \text{ } OG/T_m$$

where:

$OG$  = distance between center of gravity and the waterline (m) (+ve if center of gravity is above the waterline, -ve if it is below)

$T_m$  = mean molded draft of the ship (m)

$s$  = Factor as shown in Table 4.5, where  $T$  is the ship roll natural period. In absence of sufficient information, the following approximate formula can be used:

$$T = \frac{2 * C * B_m}{\sqrt{GM}} (s)$$

Where,

$$C = 0.373 + 0.023(B_m/T_m) - 0.043(L_{wl}/100)$$

The symbols used in tables 4.2 to 4.5 and the formula for the rolling period are defined as follows:

$L_{wl}$  = Length of the ship at waterline (m)

$B_m$  =Molded breadth of the ship (m)

$T_m$  =Mean molded draught of the ship (m)

$C_B$  =Block coefficient

$A_k$  =Total overall area of bilge keels, or area of the lateral projection of the bar keel, or sum of these areas (m<sup>2</sup>)

$GM$  =Metacentric height corrected for free surface effect (m)

**Table 4.2: Values of factor  $X_1$**

| $B_m/T_m$  | $X_1$ |
|------------|-------|
| $\leq 2.4$ | 1.0   |
| 2.5        | 0.98  |
| 2.6        | 0.96  |
| 2.7        | 0.95  |
| 2.8        | 0.93  |
| 2.9        | 0.91  |
| 3.0        | 0.90  |
| 3.1        | 0.88  |
| 3.2        | 0.86  |
| 3.4        | 0.82  |
| $\geq 3.5$ | 0.80  |

**Table 4.3: Values of factor  $X_2$**

| $C_B$       | $X_2$ |
|-------------|-------|
| $\leq 0.45$ | 0.75  |
| 0.50        | 0.82  |
| 0.55        | 0.89  |
| 0.60        | 0.95  |
| 0.65        | 0.97  |
| $\geq 0.70$ | 1.00  |

Table 4.4: Values of factor k

| $\frac{A_k \times 100}{L_{WL} \times B_m}$ | k    |
|--------------------------------------------|------|
| 0                                          | 1.0  |
| 1.0                                        | 0.98 |
| 1.5                                        | 0.95 |
| 2.0                                        | 0.88 |
| 2.5                                        | 0.79 |
| 3.0                                        | 0.74 |
| 3.5                                        | 0.72 |
| ≥4.0                                       | 0.70 |

Table 4.5: Values of factor s

| T   | s     |
|-----|-------|
| ≤6  | 0.100 |
| 7   | 0.098 |
| 8   | 0.093 |
| 12  | 0.065 |
| 14  | 0.053 |
| 16  | 0.044 |
| 18  | 0.038 |
| ≥20 | 0.035 |

(Intermediate values in these tables shall be obtained by linear interpolation)

- 4.2 Other calculation methods of equivalent safety level may be accepted as an alternative to the above.

**Remark:** For some ships, the formulas may over-estimate the roll angle. As an alternative, the roll angle can be determined by model tests or direct calculations carried out for sea-states corresponding to the recommended wind speed.

#### 4.3 Assumptions concerning intact stability criteria and calculations

- 4.3.1 For all loading conditions the initial metacentric height and the stability curves shall be corrected for the effect of free surface of liquid in tanks.

**Remark:** The free surface should be taken into account as described in the IACS UI LL61.

- 4.3.2 Compliance with the stability criteria shall be checked for the main loading conditions intended by the owner in respect of the vessel's operation.
- 4.3.3 If the owner does not supply sufficiently detailed information regarding such loading conditions, calculations shall be made for the standard loading conditions in 4.3.4 and 4.3.5

- 4.3.4 The following standard loading conditions apply to cargo ships:
- ship in the fully loaded departure condition, with cargo homogeneously distributed throughout all cargo spaces and with full stores and fuel
  - ship in the fully loaded arrival condition, with cargo homogeneously distributed throughout all cargo spaces and with 10% stores and fuel remaining
  - ship in ballast in departure condition, without cargo but with full stores and fuel
  - ship in ballast in arrival condition, without cargo and with 10% stores and fuel remaining.
- 4.3.5 The following additional loading conditions apply to cargo ships intended to carry deck cargoes:
- ship in the fully loaded departure condition with cargo homogeneously distributed in the holds and with cargo specified in extension and weight on deck, with full stores and fuel
  - ship in the fully loaded arrival condition with cargo homogeneously distributed in the holds and with cargo specified in extension and weight on deck, with 10% stores and fuel.
- 4.3.6 In the fully loaded departure conditions in 4.3.5 and 4.3.5 the ship shall be assumed loaded to the summer load waterline, or if intended to carry timber deck cargo, to the summer timber load line. The water ballast tanks should normally be assumed empty.
- 4.3.7 In all cases, the cargo in holds is assumed fully homogeneous unless this is inconsistent with the practical service of the ship.
- 4.3.8 Where timber deck cargoes are carried, the amount of cargo and ballast shall correspond to the worst service condition in which all the stability criteria in 4.1 are met. In the arrival condition, it shall be assumed that the weight of the deck cargo has increased by 10% due to water absorption.
- 4.3.9 In all cases, when deck cargo is carried, a realistic stowage weight shall be assumed and stated, including the height of the cargo.
- Remark:** *For ships carrying timber deck cargoes conditions should be shown indicating the maximum permissible amount of deck cargo having regard to the lightest stowage rate likely to be met in service.*
- 4.3.10 Only those parts of the ship that are adequately protected by weathertight closing are accepted included as buoyant in the stability calculations.
- Remark:** *Reference is made to IMO Intact Code IMO 2008 IS Code Part B Ch.3.5 and the IACS UI LL62.*
- 4.3.11 INTLREG may allow account to be taken in stability calculations of the buoyancy of the deck cargo assuming that such cargo has a permeability of 0.25.

## SECTION 5 DAMAGE STABILITY

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**5.1 Damage stability**

- 5.1.1 Vessels with additional class notations shall comply with the additional damage stability requirements as given in the appropriate rule chapters.
- 5.1.2 When INTLREG is authorized to carry out stability approval on behalf of the Flag Administration, compliance with the damage stability provisions required for issuance of the relevant international certificates shall be demonstrated.

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## SECTION 6 DETERMINATION OF LIGHTWEIGHT DATA

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**6.1 Application**

- 6.1.1 Every passenger ship and cargo ship with length more than 24 meters shall be inclined upon its completion and the lightweight displacement and center of gravity determined.
- 6.1.2 The inclining test required in 6.1.1 may be waived if basic stability data are available from the inclination test of a sister ship and it is shown that reliable stability information for the exempted ship can be obtained from such basic data.

**Remark 1:**

*Dispensation according to 6.1.2 is not considered applicable to passenger ships and other ships where the lightweight is more than 75% of the total displacement.*

**Remark 2:**

*The criteria for dispensation according to 6.1.2 are given in SOLAS Reg. II-1/5.2*

**6.2 Procedure**

- 6.2.1 The inclining test shall be carried out in accordance with an approved test procedure. Procedure as outlined in IS Code 2008 Chapter 8, Annex 1 may be taken as reference for conducting inclining test. The inclining test shall be carried out in the presence of an INTLREG representative.
- 6.2.2 The inclining test report shall be signed by the person responsible for the test and by INTLREG representative.
- 6.2.3 The approved lightweight and center of gravity shall be used in the final stability booklet.

**6.3 Lightweight survey**

- 6.3.1 A lightweight survey shall be carried out if an inclining test has been dispensed with according to 6.1.1
- 6.3.2 A lightweight survey shall be carried out with the same procedure and accuracy as an inclining test but the shifting of weights (inclination) can be omitted.