

C.6.3 Operating with hold spaces closed

For ships designed to operate with their hold spaces closed with either hatch covers or by permanent means the investigation of the stability by the 'spill-out' method is inappropriate. In such cases the normal free surface correction should be applied for the cargo in the hold (suitably amended for density) when calculating the stability for various conditions of loading.

The Authority is prepared however to consider dispensing with the free surface correction for the cargo in the hold provided either the shipbuilders or their consultants can show to the satisfaction of the Authority that during the collection of the dredgings the water content is removed expeditiously. In this case the ship's stability should be investigated by assuming the cargo of dredgings to shift as the ship rolls. The intact stability could then be considered adequate if after taking account of any cargo shift the following maintains:

- (a) the angle of heel does not exceed 65 per cent of the angle at which the deck edge is immersed in still water; and
- (b) the residual dynamic stability measured up to 30° beyond the angle of heel is not less than 0.573 metre-degrees.

The cargo shift moments for any one continuous section of the hold should be calculated as follows:

$$\text{horizontal heeling moment} = \frac{1}{12} p \tan a \int_0^g b^3$$

$$* \text{ vertical moment} = \frac{1}{24} p \tan^2 a \int_0^g b^3$$

where: g = length of section of hold
 b = breadth of section of hold
 p = density of cargo
 a = surface angle shift (to be taken as 20°)

* This value divided by the ship's displacement will give the resultant rise in the ship's KG.

The ship will be required to comply in all other respects with the requirements of A.4.1.15, C.6.2.1 and C.6.2.2.

C.6.4 Less than statutory minimum freeboards

The Authority is prepared to consider applications for the assignment of a freeboard based on a tabular freeboard reduced to † (Table B), subject to a minimum freeboard of 150 mm and to the following:

- (a) the strength of the vessel being shown to be adequate at the draught associated with the decreased freeboard.
- (b) the vessel being of the 'hopper' type, i.e. fitted with bottom doors in the shell or having other similar means capable of quickly jettisoning the cargo under all seagoing conditions and in an emergency. In each case details of the arrangements are to be submitted to the Authority for examination and approval.
- (c) the operational limits (normally not exceeding 15 miles from land) and weather conditions having been agreed by the Authority.
- (d) the intact stability criteria given in C.2 being achieved at the proposed decreased freeboard.

C.6.5 Dredgers—Bucket

When bucket dredgers and similar type vessels undertake coastal or international voyages, either under their own power or under tow, special consideration should be given to the preparation of the vessel for the intended voyage to ensure that there will be adequate stability. The Authority will take into account the following:

- (a) These vessels usually have high 'beam to draught' ratios and relatively small freeboards.
- (b) Owing to the large amount of top weight normally carried they are very susceptible to rolling.

- (c) The necessity to prepare a 'curve of statical stability' for seagoing conditions when investigating the stability characteristics.
- (d) The following stability standard which is recommended as a minimum for such vessels:
 - (i) the voyage freeboard should be sufficient to prevent the freeboard deck edge becoming immersed before an angle of heel of $12\frac{1}{2}^{\circ}$ is reached;
 - (ii) the range of stability should be at least 45° ;
 - (iii) the maximum GZ value should be at least 0.61 metre; and
 - (iv) the minimum GM value should be not less than 1.22 metres.

Whenever any such ship is required to make an extended voyage details of the preparation of the ship and the stability characteristics should be submitted to the Authority for approval.

C.7 Crane and Derrick Barges

C.7.1 Stability requirements for crane or derrick barges operating in smooth waters are given in C.3.4.

C.7.2 Stability requirements for crane or derrick barges operating in partially smooth waters are given in C.3.3.

C.7.3 The stability characteristics of crane or derrick barges operating in unrestricted water and having proportions which fall within the following ranges:

Length to beam 3.20 to 4.50

Beam to depth 3.40 to 4.75

Draught to depth 0.60 to 0.85

should be such that heel should not exceed an angle equivalent to half the freeboard in the condition considered, or five (5) degrees whichever is less, when the crane or derrick has its working load extended over the side at the maximum outreach.

C.7.4 Where the proportions of the barge fall outside the ranges given in C.7.3, then the dynamic check given in C.7.6 should be applied.

C.7.5 For barges with proportions falling within the ranges given in C.7.3, in lieu of the criterion given in C.7.3, the dynamic check given in C.7.6 may be applied.

C.7.6 The vessel should have residual dynamic stability between the curve of righting levers for the condition considered and the heeling arm curve for the maximum load/maximum outreach condition, not less than 4.584 metre-degrees.

The residual dynamic stability shall be measured between the first intercept and the angle corresponding to the maximum residual ordinate or 40° whichever is less. The angle of downflooding should not be less than 40° .

The mass of the load shall be taken to act at the derrick or jib head for the purposes of calculating the vertical centre of gravity.

C.7.7 When barges are in transit in a seaway under tow, conditions likely to lead to capsize may be more severe than with the derrick or crane operating. Special attention should be paid to the probable effect of strong winds upon the lateral areas. The following should be used for guidance:

- (a) All practical efforts should be made to ensure that the height of the centre of gravity is such that at an angle of heel of 15° , a vertical line through the CG will not be beyond the line of the deck edge (see Figure 9).
- (b) The ratio between the minimum capsizing moment as determined from the dynamical stability curve and the heeling moment produced by a wind pressure of 600 Pascals applied to the lateral windage area (the lever for this moment being measured to an axis at mid draught) should not be less than 1.75 (see Figure 10).
- (c) The windage area, its centre, and the lever to mid-draught are to be stated in the stability book.
- (d) When subjected to a wind moment equal to that given in (b) above, the craft should not heel to an angle where a vertical line through the KG (in the inclined position) would lie beyond the deck edge or to an angle of 15° whichever is the lesser. (see Figure 9).

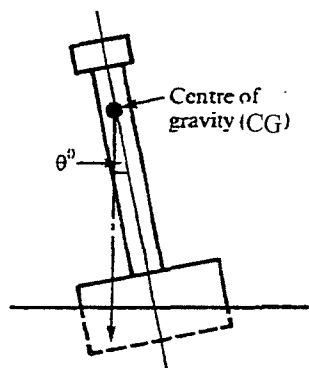
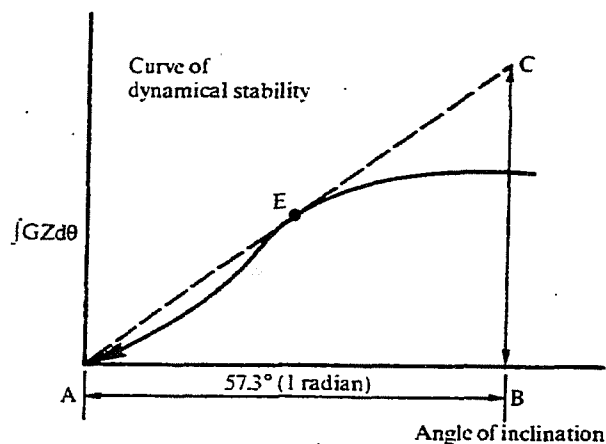


Figure 9



To obtain minimum capsizing moment, draw AC tangential to curve, then erect vertical BC at one radian from original point A. The minimum capsizing moment $\Delta = BC$ and $\frac{\Delta \times BC}{\text{wind heeling moment}} \geq 1.75$

Figure 10

C.8 Hydrofoil Boats

C.8.1 Application

These criteria apply to hydrofoil boats which:

- carry more than 12 passengers but not over 450 passengers with all passengers seated; and
- do not proceed in the course of their voyage more than 100 nautical miles from a place of refuge.

The Authority will determine the extent to which these criteria apply to craft which exceed the limits specified above and if necessary, develop additional requirements providing the appropriate safety level for such craft.

C.8.2 Definitions

C.8.2.1 A *hydrofoil boat* is a craft which is supported above the water in normal operating conditions by hydrodynamic forces generated on foils.

C.8.2.2 *Critical design conditions* mean the limiting specified conditions chosen for design purposes, which should be more severe than 'the worst intended conditions' by a suitable margin acceptable to the Authority.

C.8.2.3 *Worst intended conditions* means the specified environmental conditions within which the international operation of the craft is provided for in the certification of the craft. This should take into account parameters such as the worst conditions of wind force, allowable wave height (including unfavourable combinations of length and direction of waves), minimum air temperature, visibility and depth of water for safe operation and such other parameters as the Authority may require in considering the type of craft in the area of operation.

C.8.3 Intact Stability

The stability of a craft in the displacement mode should be such that when in still water conditions, the inclination of the craft from the horizontal would not exceed 8° in any direction under all permitted cases of loading and uncontrolled passenger movements as may occur. A calculation of the dynamic stability should be made with respect to critical design conditions. Methods relating to the verification of the stability of hydrofoil boats fitted with surface piercing foils and fully submerged foils are outlined in C.8.4.

C.8.4 Methods Relating to the Intact Stability Investigation of Hydrofoil Boats

C.8.4.1 The stability of these craft should be considered in the hull-borne, transient and foil-borne modes. The stability investigation should also take into account the effects of external forces. The following procedures are outlined for guidance in dealing with stability.

C.8.4.2 Surface Piercing Hydrofoils

C.8.4.2.1 Hull-borne Mode

C.8.4.2.1.(a) Sufficiency

The stability should be sufficient to satisfy C.8.3 and C.8.5 of this Section.

C.8.4.2.1.(b) Heel Moment Due to Turning

The heeling moment developed during manoeuvring of the craft in the displacement mode may be derived from the following formula:

$$M_R = \frac{0.0053 V_o^2 \Delta KG}{L}$$

where:

M_R = moment of heeling (tonnes metres)

V_o = speed of the craft in the turn (knots)

Δ = displacement (tonnes)

L = length of the craft on the waterline (metres)

KG = height of the centre of gravity above the keel (metres)

This formula is applicable when the ratio of the radius of the turning circle to the length of the craft is 2 to 4.

C.8.4.2.1.(c) Relationship Between the Capsizing Moment and Heeling Moment to Satisfy the Weather Criterion

The stability of a hydrofoil boat in the displacement mode can be checked for compliance with the weather criterion K as follows:

$$K = \frac{M_c}{M_v} \geq 1$$

where:

M_c = minimum capsizing moment as determined when account is taken of rolling

M_v = dynamically applied heeling moment due to the wind pressure.

C.8.4.2.1.(d) Heeling Moment Due to Wind Pressure

The heeling moment M_v is a product of wind pressure P_v , the windage area A_v and the lever of windage area Z .

$$M_v = 1.02 \times 10^{-4} P_v A_v Z \text{ tonne metres}$$

The value of the heeling moment is taken as constant during the whole period of heeling.

The windage area A_v is considered to include the projections of the lateral surfaces of the hull, superstructure and various structures above the waterline. The windage area lever Z is the vertical distance to the centre of the windage from the waterline and the position of the centre of windage may be taken as the centre of the area.

The values of the wind pressure in Pascals associated with Force 7 Beaufort Scale depending on the position of the centre of windage are given in the Table.

Table
TYPICAL WIND PRESSURES FOR BEAUFORT SCALE 7 100 NAUTICAL MILES
FROM LAND

Z above waterline (metres)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
P_v (Pascals)	460	460	500	530	560	580	600	620	640

Note:

These values may not be applicable in all areas.

The value of the heeling moment is taken as constant during the whole period of heeling.

The windage area A_w is considered to include the projections of the lateral surfaces of the hull, super-structure and various structures above the water-line. The windage area lever Z is the vertical distance to the centre of the windage from the waterline and the position of the centre of windage may be taken as the centre of the area.

The values of the wind pressure in Pascals associated with Force 7 Beaufort Scale depending on the position of the centre of windage are given in the Table.

C.8.4.2.1.(e) Evaluation of the Minimum Capsizing Moment M_c in the Displacement Mode

The minimum capsizing moment is determined from the static and dynamic stability curves taking rolling into account.

- (i) When the static stability curve is used, M_c is determined by equating the areas under the curves of the capsizing and righting moments (or levers) taking rolling into account—as indicated in figure 11 where θ_z is the amplitude of roll and MK is a line drawn parallel to the abscissa axis such that the shaded areas S_1 and S_2 are equal.

$M_c = OM$ if the scale of the ordinates represents moments.

$M_c = OM \times \text{displacement}$ if the scale of the ordinates represents levers.

- (ii) When the dynamic stability curve is used, first an auxiliary point A must be determined. For this purpose the amplitude of heeling is plotted to the right along the abscissa axis and a point A^1 is found (see figure 12). A line AA^1 is drawn parallel to the abscissa axis equal to the double amplitude of heeling ($AA^1 = 2\theta_z$) and the required auxiliary point A is found. A tangent AC to the dynamic stability curve is drawn. From the point A the line AB is drawn parallel to the abscissa axis and equal to one radian (57.3°). From the point B a perpendicular is drawn to intersect with the tangent in point E.

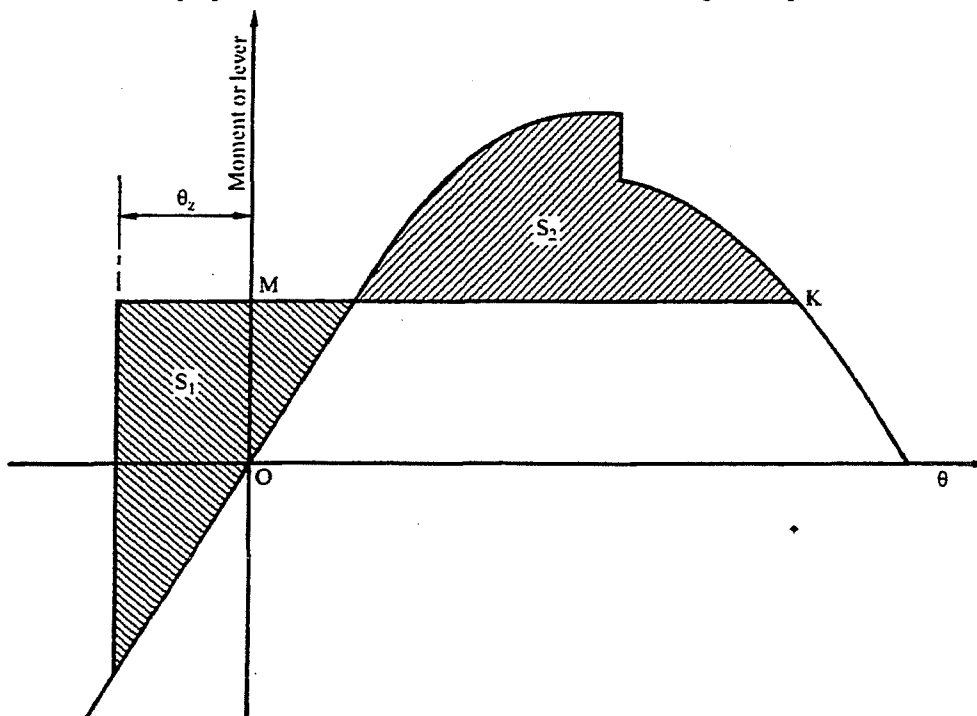


Figure 11

STATIC STABILITY CURVE