C.14.5.1 The vessel shall comply with all stability criteria as set out in C.14.3.1 to C.14.3.3.

C.14.5.2 Specific data listed in C.14.3.4 is required.

C.14.5.3 Intact stability under bare poles is to be assessed for at least the following conditions:-

(a) loaded departure with 95% consumables

(b) loaded arrival with 10% consumables

C.14.5.4 The area under the static stability curve above the combined heeling moment due to passenger crowding and wind pressure calculated up to an angle θ shall be at least

$$1.60\left(\frac{30}{\theta}\right) \text{ metre degrees}$$

where θ is the lesser of GZ max or 30 degrees.

C.14.5.5 Damaged stability under bare poles is to be assessed for the conditions set out in Appendix 3 Section 5 Sub-Section C.

C.14.5.6 The area under the GZ curve for the damaged condition, above the wind heeling moment based upon a pressure of 100 Pa (25kts) shall be at least 1.6 metre degrees up to the angle of downflooding.

C.14.6 All sailing catamarans over 15m measured length operating in any area.

C.14.6.1 A full analysis acceptable to the Authority for typical operating conditions under sail shall be presented.

(a) to enable designers to audit the expected performance of the vessel and provide basic information for the operator
(b) to provide operators with data to generate comprehensive training, operation and maintenance programs
(c) to provide information to enable the authority to assess the levels of safety proposed for the vessels overall operation

An analysis similar to that detailed in the High Speed Craft (HSC) Code using recognised values for dynamic and static stability is required.

C.14.6.2 The specific data set out in C.14.3.4 shall be presented.

C.14.6.3 Watertight subdivision and loadline provisions shall be in accordance with the relevant sections of the USL Code.

(Amendment dated 4 March 1997)

C.15 Catamarans and Trimarans (Powered)

C.15.1 Catamarans and trimarans which are powered by means other than by sails shall meet the stability criteria applicable to the purpose for which the craft are designed. The effects of lifting a hull from the water for seagoing vessels shall be indicated.

C.16 Landing Barges

C.16.1 Where the criteria laid down in C.2 cannot be met, the following modified criteria may be applied.

C.16.2 The area under the righting lever curve shall be:

(a) not less than 6.30 metre-degrees up to an angle of heel of 15° when the maximum righting lever occurs at 15°;

(b) not less than 4.30 metre-degrees up to an angle of 20° when the maximum righting lever occurs at 20°, or

(c) not less than 3.15 metre-degrees up to an angle of 30° when the maximum righting lever occurs at 30° or an angle greater than 30°, or

(d) an area, when the maximum righting lever occurs at angles between 15° and 20° or 20° and 30°, up to the angle of maximum righting lever, obtained by linear interpolation; and

(e) not less than 1.72 metre-degrees between the angles of heel of 30° and 40° or between 30° and the angle of flooding if less than 40°.

Note:
The angle of flooding is the angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight commence to immerse. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

C.16.3 The maximum righting lever which shall occur at an angle of heel not less than 15°, shall be at least 0.2 metres.

C.16.4 The initial transverse metacentric height shall be not less than 0.15 metres.

APPENDIX A GUIDANCE ON A METHOD OF CALCULATION OF THE EFFECT OF SEVERE WIND AND ROLLING IN ASSOCIATED SEA CONDITIONS

The ability of the vessel to withstand the effect of gusts and severe winds and rolling should be demonstrated using dynamic wind heeling moment taking into consideration the rolling angle due to waves. The criterion for adequate stability under these circumstances should show that the effect of the dynamic heeling moment M_w (as indicated in Figure l) caused by wind pressure in the worst operating condition, taking into account the rolling angle, is equal to or less than the effect of the excess restoring moment (area 'b' or the area under the corresponding excess restoring arm). This condition is considered to be fulfilled when the following condition is satisfied:

The ratio $C_{wr} = \frac{\text{Area 'b'}}{\text{Area 'a'}}$ should not be less than unity.

The wind force on every exposed lateral part of the vessel's side is assumed to have the same direction as the wind and to act at a height above the water level equal to the height of the centroid of the projected area of the part in question. This wind force may be calculated:

(a) for a uniform wind velocity acting on the complete profile area; or
(b) for a wind velocity which increases with the height above sea level acting on a number of elements of horizontal areas.

The wind heeling moment may be calculated as follows:

$$M_{wi} = \frac{0.5\rho K_i^2}{1000} \sum_{n=1}^{n=N} C_D V_n^2 A_n Z_n \quad \text{for i= 1 and 2}$$

where

M_{w1} = heeling moment due to steady wind (tonne metres)
M_{w2} = heeling moment due to gust or severe wind (tonne metres)
ρ = air density = 0.1249 kg sec^2/m^4 at 1013.25 millibars 15°C.
C_D = appropriate non-dimensional drag coefficient selected from the following:

Shape	C_D
Cylindrical	0.5
Large flat surfaces (e.g. hull, deckhouse etc.)	1.0
Block effect of clustered deckhouse	1.1
Lattice structure	1.25
Exposed beams and girders	1.30
Isolated shapes (crane, etc.)	1.50

K_i = Wind speed factor
K_1 = 1 for steady wind averaged over 1 hour
K_2 = 1.5 for gust wind averaged over 3 seconds

V_n = Wind speed at centroid of lateral area A_n (metres per second)
For open sea conditions a uniform steady wind velocity of not less than 55 knots should be used. If a wind velocity increasing with height above sea level is adopted the following scale should be used:
Less than 5 metres – 52 knots
5 metres and over but less than 10 metres – 55 knots
10 metres and over but less than 20 metres – 58 knots

A_n = projected lateral profile area of element n (metres^2)
Z_n = length of wind lever between centroid of A_n and assumed point of action of the opposing forces (normally to be taken as mid draught position) (metres)
n = integer
N = number of elements of horizontal areas

In Figure 1:

θ_0 = angle of heel under action of steady wind (degrees)
θ_1 = angle of roll to windward when rolling synchronously about θ_0 (degrees)
θ_2 = flooding angle (θ_f) or angle specified by the Authority (degrees).

The value of θ_1 is to be determined as follows:

$$\theta_1 = \sqrt{\frac{138 \times f \times S}{N}}$$

where

f = effective wave slope coefficient
= $0.75 + 0.6 \times \frac{OG}{d}$

d = mean draught (metres)

OG = KG – d (metres)
S = wave steepness
= $\frac{\text{wave height}}{\text{wave length}}$
$K_2 - K_3 \times T_S$
(Note: $0.100 \geq S \geq 0.035$)
N = Bertin's damping coefficient
= $0.020 \frac{1}{\text{degree}}$
T_S = period of roll
= $\frac{2\pi K}{\sqrt{gGM}}$
= $\frac{2.01K}{\sqrt{GM}}$ seconds
K = transverse radius of gyration
GM = metacentric height (metres).

K_2 and K_3 are to be selected from the following table.

Steady wind speed			
metres/sec.	*knots*	K_2	K_3
15	29	0.155	0.0130
19	37	0.153	0.0100
26	51	0.151	0.0072

Values for other speeds may be obtained by linear interpolation or extrapolation.

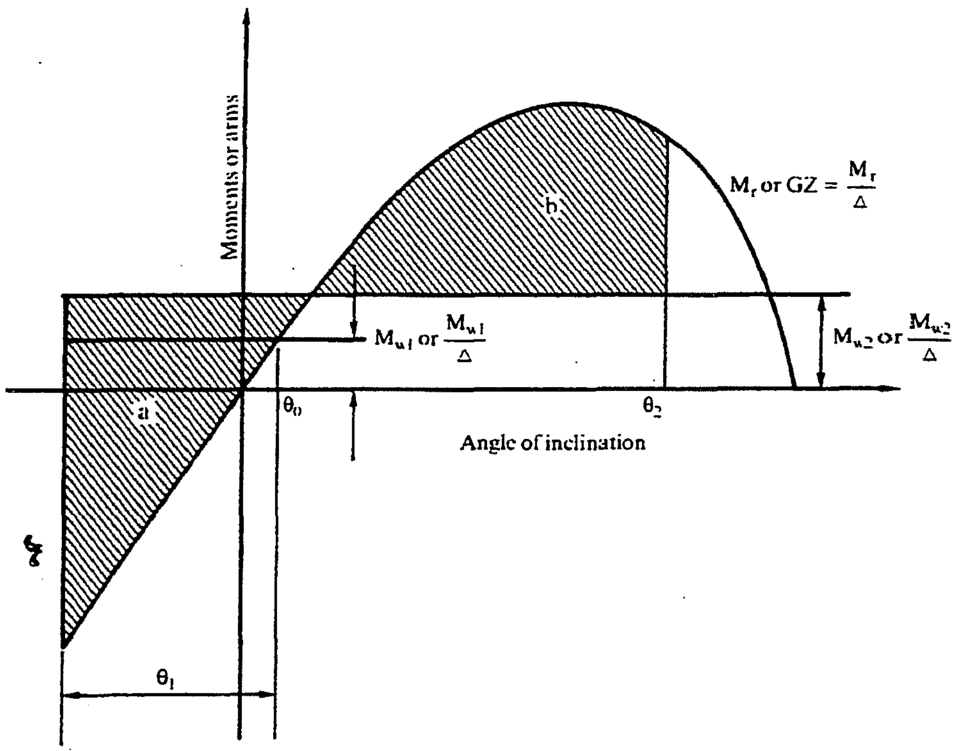


Figure 1. SEVERE WIND AND ROLLING

Appendix B

GUIDANCE ON A METHOD OF CALCULATION OF THE EFFECT OF WATER ON DECK

The ability of the vessel to withstand the heeling effect due to the presence of water on deck should be demonstrated by quasi-static method, with reference to Figure B1, when the following condition is satisfied with the vessel in the worst operating condition:

The ratio $C_{wod} = \frac{\text{area 'b'}}{\text{area 'a'}}$ should not be less than unity.

The angle which limits area 'b' should be equal to the flooding angle θ_f or 40 degrees whichever is the less.

The value of the heeling moment M_{wod} (or the corresponding heeling arm) due to the presence of water on deck should be determined assuming that the deck well is filled to the top of the bulwark at its lowest point and the vessel heeled up to the angle at which this point is immersed. For the determination of M_{wod} the following formula should be used:

$$M_{wod} = K\ M_x$$

where

M_x = static heeling moment due to water on deck

K = coefficient

(a) if M_{wod} is determined by a static approach
K= 1.0 may be applied.

(b) If M_{wod} is determined by a quasi-static approach, K may take into account the rolling period of the vessel and the dynamic effect of the water flow, including the effect of the disposition and configuration of deck wells and deckhouses. The value of K should be satisfactory, taking into account the type of vessel, area of operation, etc., and using the following table.

Angle of Deck Edge Immersion (θ_D)	*Angle of Bulwark Top Immersion (θ_B)*		*K*
Below 10°	Below 20°	greater than	1.0
10° to 20°	20° to 30°		1.0
Above 20°	Over 20°	less than	1.0

When calculating M_x the following assumptions should be made:

(a) at the beginning the vessel is in the upright condition;

(b) during heeling, trim and displacement are constant and equal to the values for the vessel without the water on deck; and

(c) the effect of freeing ports should be ignored.

The above provisions may be adjusted, taking into account the seasonal weather conditions and sea states in the areas in which the vessel will operate, the type of vessel and its mode of operation.

Other methods for the calculation of the effect of water on deck using the dynamic approach may be adopted.

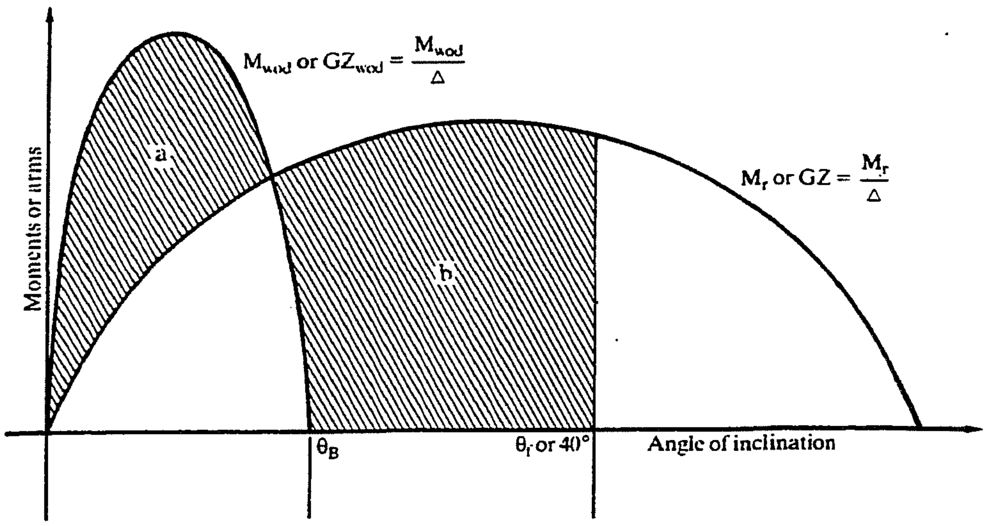
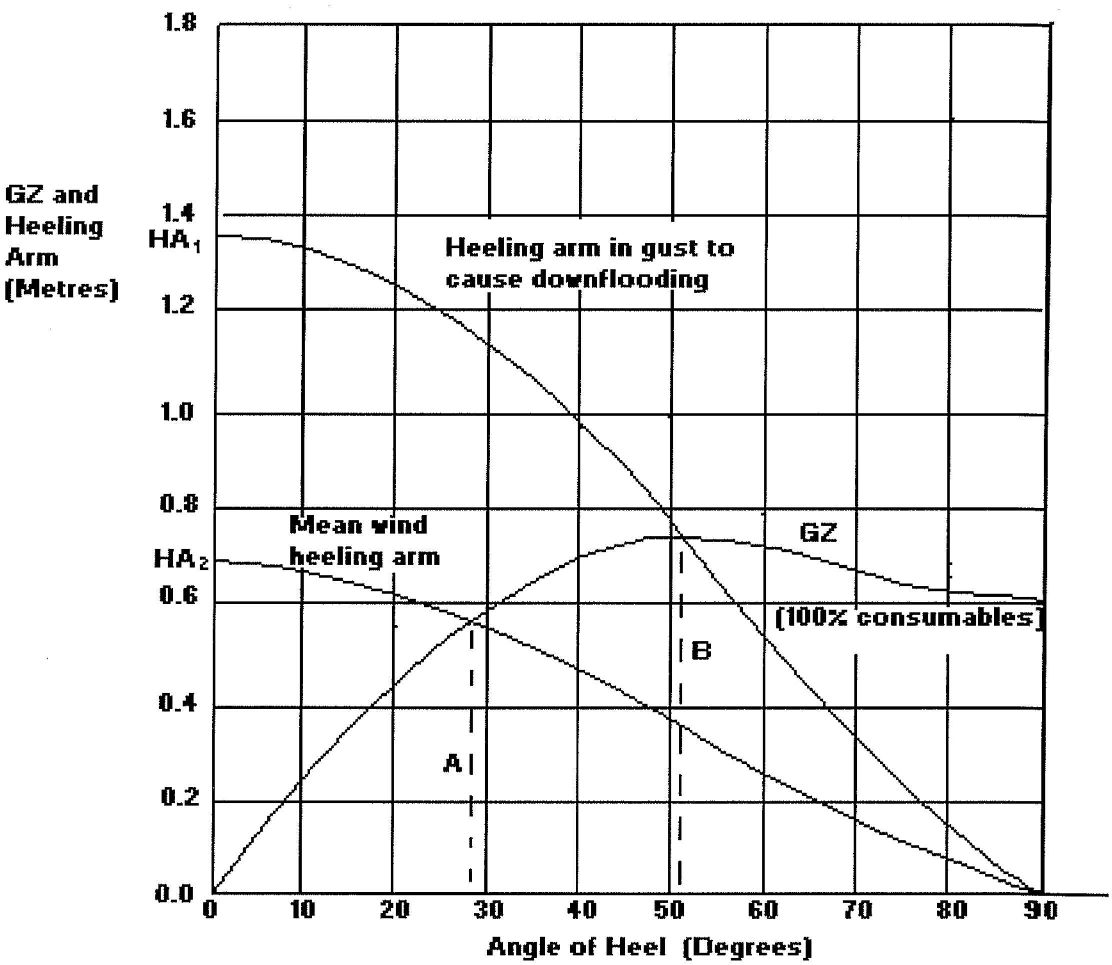


Figure 2. **WATER ON DECK**

Appendix C **Notes For Consultants On The Derivation Of The Maximum Steady Heel Angle To Prevent Downflooding In Gusts**



Line A is the Maximum recommended steady heel angle
Line B is the downflooding angle

$$HA_1 = \frac{GZ_f}{\text{Cos}^{1.3}\theta_f}$$

Where HA_1 is the magnitude of the actual wind heeling lever at 0 degrees which would cause the ship to heel to the downflooding angle (θ_f) or 60 degrees whichever is least

GZ_f Is the lever of the ship's GZ curve at the downflooding angle θ_f or 60 degrees whichever is least

HA_2 Is the mean wind heeling arm at any angle θ degrees
$= 0.5 \times HA_1 \times \text{Cos}^{1.3}\theta$

(Amendment dated 4 March 1997)

APPENDIX D

Appendix D

General

If half hull emersion is considered to have the same recovery potential for catamarans as knock - down has for a monohull, then the next step, full hull emersion, could be equated with the down flooding angle for a monohull.

A comparison of the typical static stability curves (in fig.4) for a catamaran, with full hull emersion from 10 to 15 degrees, and a monohull with a downflooding angle from 50 to 60 degrees illustrates the impracticability of using balance of areas under the static stability curve as a criteria for sailing catamarans.

Instead, the dynamic stability curve is used to analyse the residual stability between the righting moment and the wind heeling moment.

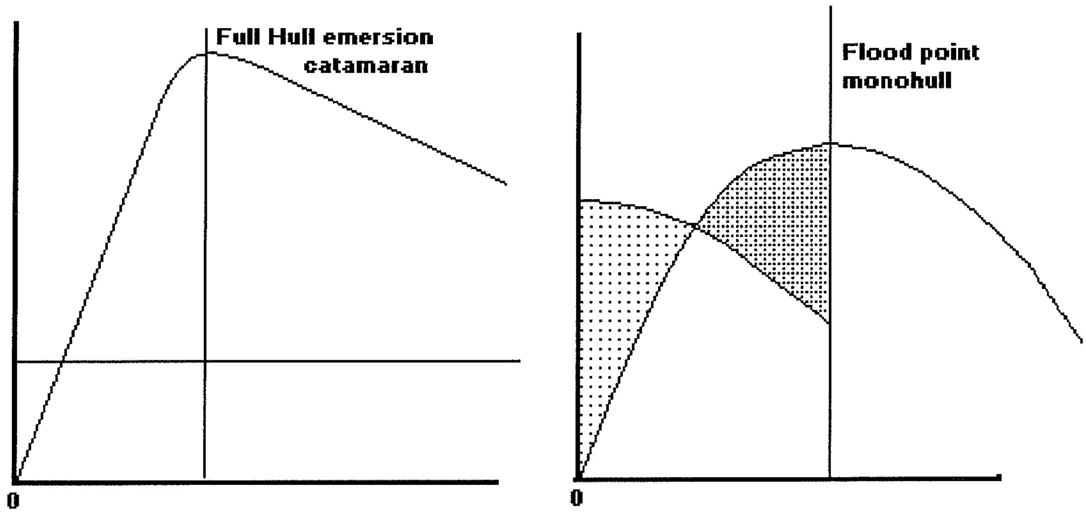


Fig. 4

The analogy with the inertia of rolling taking the vessel past the angle at which the GZ curve is cut will be appreciated in the following construction.

Calculation of capsizing moment

When the dynamic stability curve is used, an auxiliary point A for a relevant heel angle must be determined. For sailing catamarans, the angle of heel of interest is when full hull emersion occurs. This angle is plotted to the right along the abscissa axis and a perpendicular is taken up to cut the dynamic curve in A1 (see fig. 5). A line A1 - A is drawn parallel to the abscissa axis equal to the double amplitude of the heel angle and the required auxiliary point is found.

A tangent AC to the dynamic stability curve is drawn, the line A - A1 is extended to a point B one radian from A, and a perpendicular is taken up to cut the tangent in point E.

The distance BE is equal to the numerical value of the capsizing moment to the same scale as the ordinate axis.

Calculation of the wind heeling moment

The wind heeling moment is calculated using a pressure of 100 Pa (25kts) using the working sail plan. This comprises all sails that may be set when proceeding with the true wind less than 60 degrees off the bow.

As the wind heeling moment is to be considered as constant for all angles of heel, the area under the wind curve (a rectangle with length (57.3 - θ) where θ is the angle of max GZ) is calculated to the same scale as the dynamic curve and represented by a straight line cutting the RH ordinate in W, the calculated value.

$$\frac{\text{capsizing moment}}{\text{wind heeling moment}} > 1.0$$

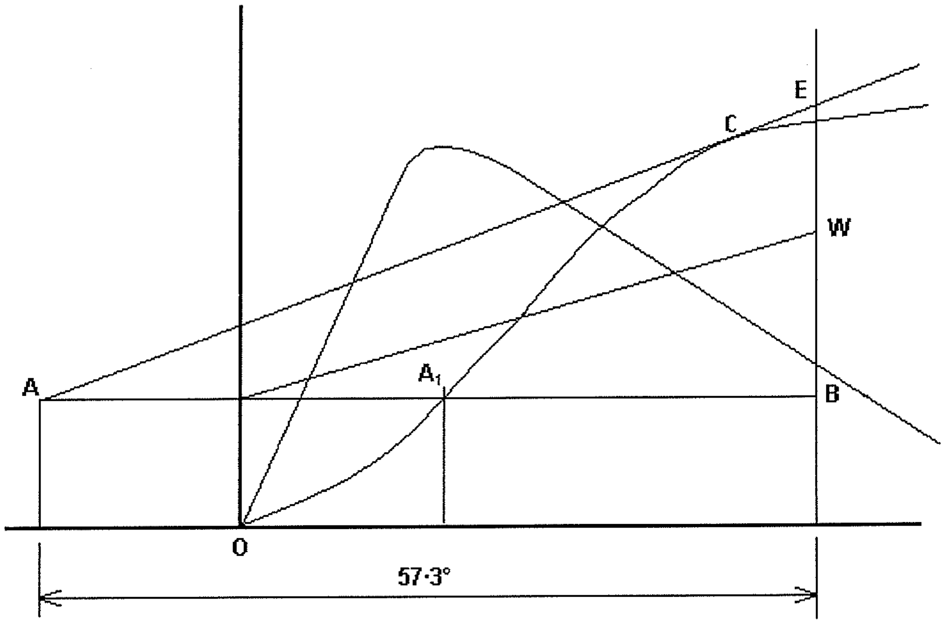


Fig. 5

(Amendment dated 4 March 1997)