

Australian Transport Council

**National Standard**  
**for**  
**Commercial Vessels**

**PART C**  
**DESIGN AND CONSTRUCTION**

**SECTION 6**  
**STABILITY**

**Subsection 6A**  
**INTACT STABILITY REQUIREMENTS**

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## FOREWORD

This Subsection of the National Standard for Commercial Vessels (NSCV) was developed following a review of the Uniform Shipping Laws (USL) Code Section 8: Stability, Subsection 8A: Preliminary, Subsection B: Simplified Presentation of Stability and Sub-Section C: Stability Criteria. In reviewing the USL Code and preparing this Subsection, consideration was given to a number of factors, including:

- a) The National Marine Safety Strategy.
- b) Current vessel designs and construction practices.
- c) Relevant national and international standards.
- d) Provisions no longer used.
- e) Current survey practice, both formal and informal.
- f) Discretionary requirements which rely on Authority approval.
- g) Current technical standards format and style.

This Part of the National Standard for Commercial Vessels must be read in conjunction with Part A—Safety Obligations, Part B—General Requirements, Part C—Design and Construction Subsection 2A—Watertight and Weathertight Integrity—Load Line Vessels, Subsection 6B—Buoyancy and Stability After Flooding and Subsection 6C—Stability Tests and Stability Information.

This Subsection of the NSCV was prepared by the NMSC Secretariat in consultation with a working group comprising representatives from the various State and Territory marine authorities. In addition specialist advice was sought on a number of issues.

This draft Subsection was released for public comment on 10 October 2005, along with a draft Regulatory Impact Statement (RIS). A reference group comprising industry and government reviewed the public comment on Subsection 6A on 13 and 14 March 2006 and 29 and 30 May 2006. Due to the extent of changes arising from their deliberations, the reference group recommended that the revised draft be subject to a second round of public comment. The second draft was released for public comment on 10 October 2006. The reference group met on 20 and 21 March 2007, with recommendations forwarded to NMSC.

NMSC approved this Subsection on 30 May 2007, with the Office of Best Practice Regulation reporting that the final RIS was satisfactory on the 28 September 2007. The Australian Transport Council (ATC) endorsed the document for publication on 29 February 2008.

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## CHAPTER 1 PRELIMINARY

### 1.1 SCOPE

Section 6 specifies the requirements for stability of vessels. This Subsection specifies the minimum required intact stability criteria for vessels.

This Subsection shall be read in conjunction with Part B—General Requirements, Part C Section 2A—Watertight and Weathertight Integrity, Subsection 6B—Buoyancy and Stability After Flooding, and Subsection 6C—Stability Tests and Stability Information.

#### NOTES:

1. The provisions of this Subsection are minimum required standards and should not be considered adequate for every circumstance.
2. Provisions relevant to the broader safety obligations of persons to provide for adequate safety are contained in Part A—Safety Obligations.
3. Provisions relevant to the operational measures required to maintain stability are contained in Part E—Operational Practices.

### 1.2 APPLICATION

This Subsection applies to all vessels other than Special Vessels provided for in NSCV Part F of this standard, unless NSCV Part F specifies otherwise.

Guidance for the application of this Subsection is provided in Clause 1.5.

NOTE: Criteria contained in this Subsection are applicable to specified Fast Craft and Hire and Drive vessels, but see Part F Sections 1 and 2 for specific limitations and/or additional requirements.

### 1.3 OBJECTIVES OF NSCV PART C SECTION 6

The objective of Section 6 is to—

- a) minimise the likelihood of sudden or progressive capsize or foundering; and
- b) prevent excessive angles of heel or trim that could—
  - i) reduce the safety of persons on board;
  - ii) hamper the crew in the performance of their duties; or
  - iii) interfere with the safe functioning of the vessel and its essential equipment.

### 1.4 OBJECTIVES OF SUBSECTIONS 6A AND 6C

The objectives of Subsections 6A and 6C are as follows:

- a) To reduce the risk of capsize or excessive heel of a vessel to acceptable levels during normal or abnormal conditions of operation, assuming the vessel has not taken on water into normally buoyant spaces.
- b) To provide a consistent and auditable benchmark for determining initial and ongoing compliance of a vessel to these standards.

- c) To provide relevant information on the stability characteristics of a vessel, needed by the operators to discharge their safety obligations.
- d) To provide uniform procedures for undertaking tests and calculations to facilitate the accurate and consistent determination of a vessel's stability characteristics.

## NOTES:

1. The stability characteristics of a vessel are largely the function of three factors:
  - the geometric characteristics of the hull, superstructures, deckhouses and points of downflooding;
  - the mass of the vessel and the vertical, transverse and longitudinal distribution of that mass; and
  - the magnitude and nature of overturning influences such as those listed under hazards below.
2. Hazards that may lead to excessive heel or capsizing of an intact vessel include: overloading, excessive mass high in the vessel, premature loss of waterplane area, unsymmetrical loading of persons, steady or gusting wind loads, rolling in a seaway, the effects of a rapid change in course, loads arising when lifting or releasing masses, trawling or towing, free surface of liquids in tanks and other spaces, shifting of cargo, seawater on deck, premature immersion of ventilation and other openings, or a combination of these effects.
3. Consequences that may arise from inadequate stability or capsize include: catastrophic and sudden loss of the vessel through flooding, disabling of the vessel, shifting of masses on the vessel (further increasing the tendency to capsize), inability to activate or continue to operate emergency systems, entrapment of persons, personal injury arising from excessive heel, drowning, hypothermia.

## 1.5 USE OF NSCV PART C SUBSECTION C6A OF THE NATIONAL STANDARD

A flowchart is provided as Figure 1 to assist users applying this Subsection. This illustrates the process for determining the applicable intact stability criteria for a particular vessel.

## 1.6 REFERENCED DOCUMENTS

The following documents are referenced in this Subsection. Any document referenced should be considered to be the latest revision of the document, including amendments, unless stated otherwise.

### AUSTRALIAN TRANSPORT COUNCIL

#### *National Standard for Commercial Vessels*

#### Part B—General Requirements

#### Part C—Design and Construction

##### Section 2: Watertight and Weathertight Integrity

##### Section 6: Stability

##### Subsection 6B— Buoyancy and Stability After Flooding

##### Subsection 6C—Stability Tests and Stability Information

#### Part E—Operational Practices

#### Part F—Special Vessels

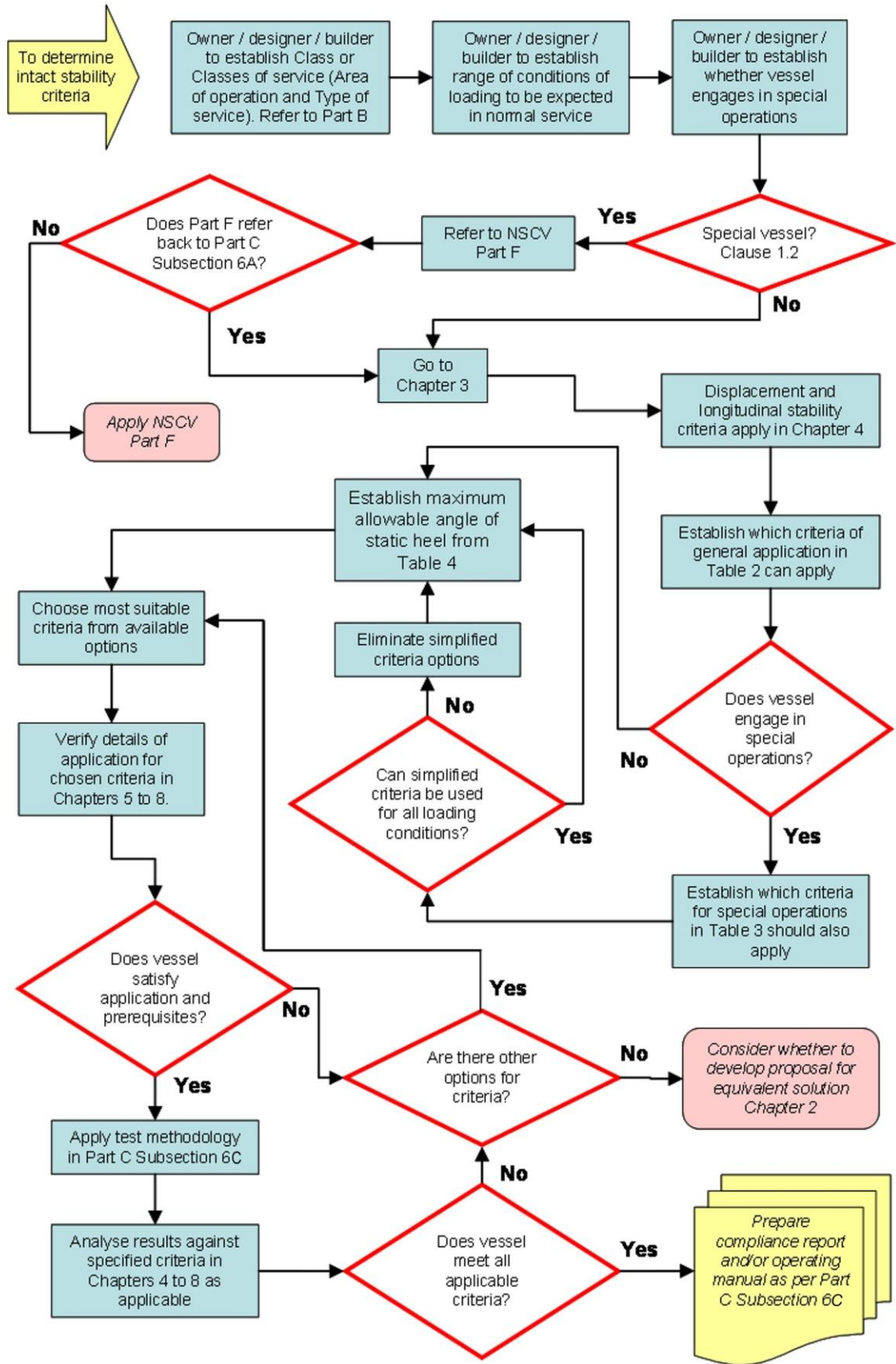


Figure 1 — Guidance for determining applicable intact stability criteria

## INTERNATIONAL MARITIME ORGANIZATION

*IMO Resolution A.749 (18) Code on Intact Stability for all Types of Ships Covered by IMO Instruments as amended by Resolution MSC.75(69).*

## STANDARDS AUSTRALIA

*AS 1799—Small Pleasure Boats Code*

Part 1: General requirements for power boats

## 1.7 DEFINITIONS

For the purposes of this Subsection —

- a) the definitions provided in this Clause shall apply;
- b) the following definitions provided in Part B—General Requirements of the NSCV shall apply: abnormal conditions, accommodation spaces, Authority, crew, depth, fast craft, fish, fishing vessel, hazard, hire and drive vessel, length, maximum speed, may, measured length, must, non-passenger vessel, normative, operational area, owner, passenger, passenger vessel, risk, seagoing, shall, sheltered waters, should, superstructure, vessel;
- c) required outcome, deemed-to-satisfy solution, equivalent solution, vessel use categories (Class 1, Class 2, etc), operational area categories (Operational Area A, Operational Area B, etc) and service categories (Class 1A, Class 2A, etc) shall have the meanings specified in Part B—General Requirements of the NSCV; and
- d) where there is any duplication in the terms defined between this Clause and Part B, the definitions in this clause shall apply.

**amidships —**

a point located at the mid length of the vessel's length on the design waterline ( $L_{DWL}$ )

**barge—**

a vessel having a flush weathertight deck intended to carry cargo that may be dry or liquid either internally within holds or tanks, or on deck.

## NOTES:

1. A barge is often flat bottomed of rectangular shape and shallow depth.
2. Some vessels commonly referred to as barges such as hopper vessels, open barges, landing barges (landing craft) and barges without a weathertight deck are not included within this definition for the purposes of this Subsection.

**baseline—**

the line parallel to the designed load waterline passing through the datum for the aft draft marks. In the case of vessels not required to have draft marks, the baseline is a line parallel to the designed load waterline which coincides with the lowest point of the vessel's hull.

**bare poles—**

the condition of a vessel that is capable of setting sail when no sails are set.

**collared vessel—**

a vessel with a rigid hull provided with one or more buoyant collars around the periphery of the vessel such that—

- a) the buoyant volume of the collars constitute greater than one-fifth of the total intact buoyant volume of the vessel, and
- b) inclusion of the buoyancy of the collars is essential for the vessel to meet the applicable intact or damaged stability criteria.

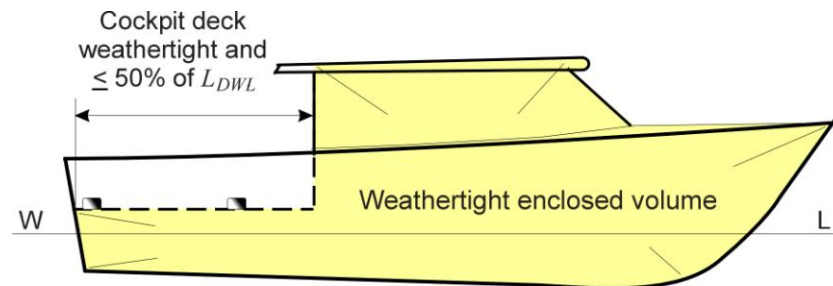
## NOTES:

1. The collar may be inflatable, foam filled or of rigid construction.
2. Collared rigid boats include RIBs (rigid inflatable boats).

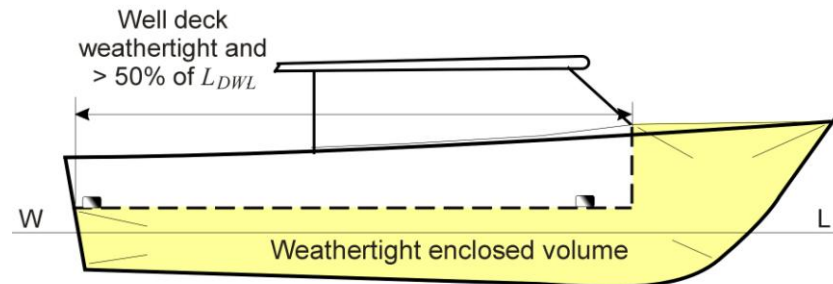
**cockpit vessel—**

a vessel having an exposed recess—

- a) not within the forward 10 per cent of the waterline length ( $L_{DWL}$ ) of the vessel from the stem, and
- b) extending not more than 50 per cent of the waterline length ( $L_{DWL}$ ) of the vessel (see Figure 2a)).



a) Cockpit vessel



b) Well deck vessel

**Figure 2 — Difference between cockpit and well deck vessels****comprehensive stability criteria—**

a set of deemed-to-satisfy stability criteria that require the analysis of stability *righting lever curves* ( $G_fZ$  curves) derived from individual loading conditions.

**crane barge—**

a barge on which is mounted a crane (that might also be a sheerlegs or derrick type) that is secured against tipping, either as a permanent fixture or as a mobile crane secured onto the deck of the barge.

NOTE: Mobile cranes that are not secured would be assessed as a proposal for an equivalent solution.

**deadweight—**

the difference measured in units of mass between the displacement of the vessel in a particular condition of loading and the displacement of the vessel in the lightship condition.

NOTE: The deadmass corresponds to the total mass of consumables, stores, cargo, passenger and effects, crew and effects, and any liquids on board except machinery and piping fluids.

**decked vessel—**

a vessel that is enclosed by a continuous weathertight deck and which is neither a cockpit vessel nor a *well deck vessel*.

**depth at amidships ( $D_{DWL}$ )—**

the moulded depth of the vessel measured at the middle of the length on design waterline ( $L_{DWL}$ ) measured from the underside of the deck material at side to the rabbet line or, on vessels with a plate keel, to the top of the plate.

NOTE: In practical terms the location of amidships being the middle of the length on design waterline ( $L_{DWL}$ ) may be very close to the middle of the measured length and thus the depth ( $D$ ) maybe very similar to the depth at amidships ( $D_{DWL}$ ).

**design waterline—**

the waterline corresponding to the maximum operational displacement of the vessel with no lift or propulsion machinery active.

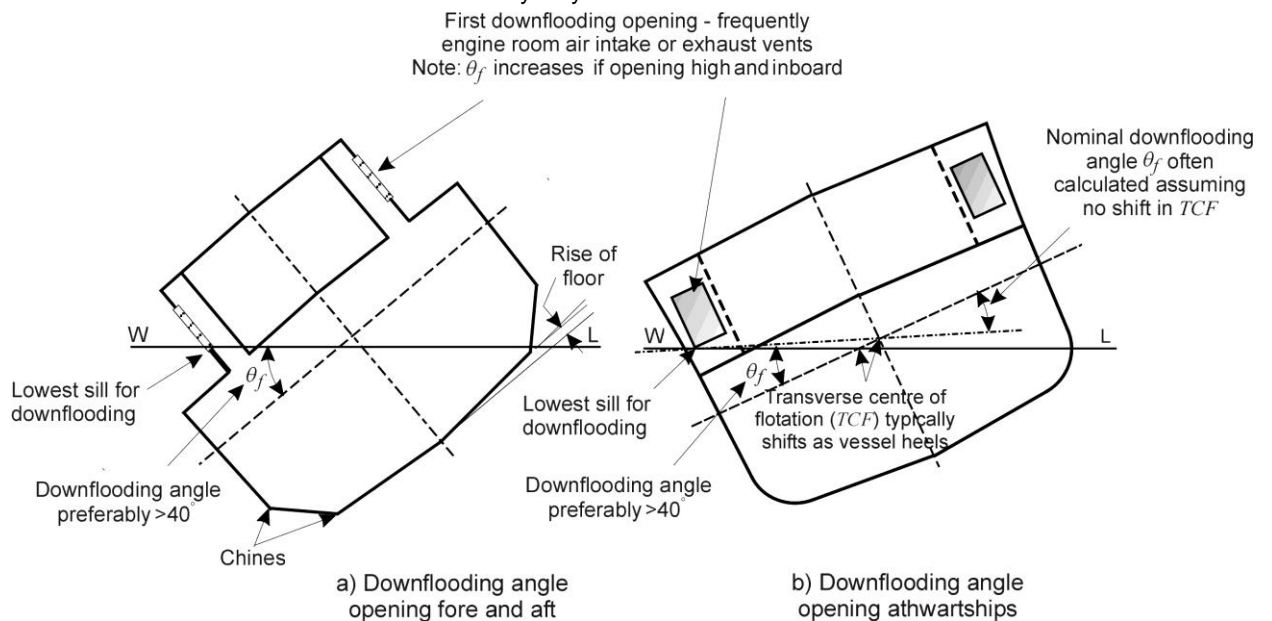
**displacement ( $\Delta$ )—**

the mass of water that the vessel displaces when afloat, in tonnes.

**downflooding angle ( $\theta_f$ ) —**

the smallest angle of heel at which downflooding will occur, if all weathertight closing appliances are properly secured (see Figure 3 and Figure 6).

NOTE: The downflooding angle is often calculated assuming the centre of transverse flotation remains at the centre line of the vessel. This approximation tends to become less accurate at larger angles of heel. It is normally conservative on vessels that have considerable reserve buoyancy, but can overstate the downflooding angle on vessels that have minimal reserve buoyancy.



**Figure 3 — Downflooding angle**

**draft at amidships ( $T$ ) —**

the vertical distance from the base line at amidships to the waterline, in metres.

**dredger —**

a vessel that is fitted with suction, grab or cutter equipment to excavate seabed material.

**dredgings—**

the material collected from the sea bed by a dredger.

NOTE: Dredgings are cargo if recovered for commercial use or spoil if recovered in the process of maintaining harbours and rivers.

**flush decked vessel—**

a decked vessel, which has no break in or superstructure on the freeboard deck.

**freeboard deck—**

for the purposes of this Subsection, a line that represents the lowest continuous deck, exposed to weather and sea, which has—

- a) permanent weathertight means of closing all openings in the part exposed to the weather; and
- b) below which all openings in the sides of the vessel are fitted with permanent watertight means of closing.

NOTE: In practice, the 'freeboard deck' may follow a notional deck line in way of the break of superstructures or discontinuities in sheer.

**freeing port—**

a direct opening through a bulwark provided for rapidly and completely draining overboard large quantities of seawater that may have accumulated on a weather deck.

NOTE: See also definition of scupper.

**free surface—**

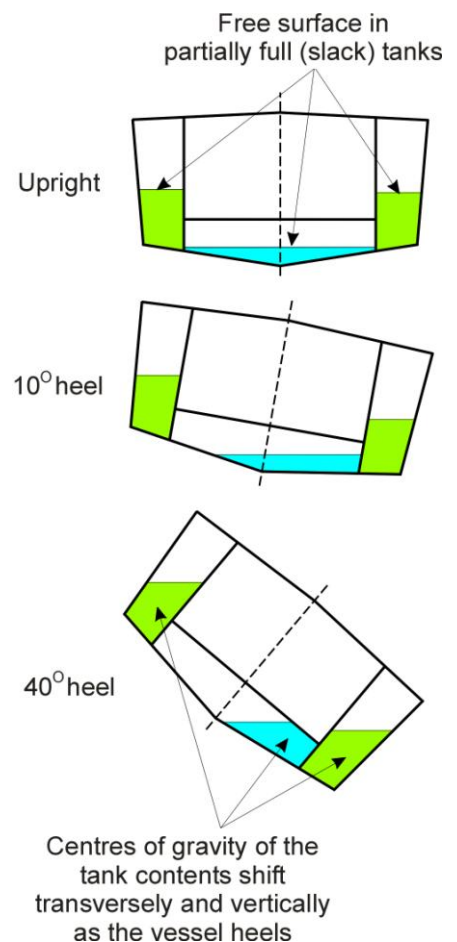
the exposed top surface of a quantity of liquid contained within a slack tank, bilge or other space that permits a degree of free movement of the liquid as the vessel heels or trims, see Figure 4.

**free surface effect—**

is the transverse and upward shift of the centre of gravity of the tank contents of a slack tank as a vessel heels, see Figure 4. For the purposes of this Subsection, free surface shall be accounted for whenever a slack tank is less than 98 per cent of the full capacity.

**free surface correction—**

the effective upward shift of the centre of gravity of a vessel that results from free surface within tanks that are neither full nor empty.



**Figure 4 — Free surface effect**

**hopper vessel—**

a vessel that has one or more holds intended for the carriage of dredgings. The hold has either hopper doors or the vessel is of split and hinged design that allows the dredgings to be discharged through the bottom of the hold.

NOTE: Hopper vessels include hopper dredges and hopper barges.

**landing craft—**

a vessel designed for beaching to enable the loading and discharge of cargo or persons by foot or vehicle directly from or onto the shoreline without the use of wharfs or other shore side facilities.

**immersed profile—**

the profile of the vessel below a waterline when viewed from the transverse direction. The area and centroid of the immersed profile is calculated including rudder, shafting and shaft brackets; but excluding propellers and ignoring any deduction from transverse side thruster tunnels.

**length on waterline ( $L_{DWL}$ ) —**

the length of the vessel measured along the waterline taken at the extremities of the design waterline line, in metres.

NOTE: The design waterline is normally determined before a vessel is completed, reflecting the anticipated deepest draft waterline.

**lightship condition—**

a vessel complete in all respects, but without consumables, stores, spares, cargo, passengers and effects, crew and effects, and without any liquids on board except machinery and piping fluids, such as lubricants and hydraulics, maintained at operating levels.

**lightship displacement—**

the displacement of the vessel in the lightship condition, in tonnes.

**offshore supply vessel—**

a vessel primarily engaged in the transport of stores, materials and equipment to offshore installations.

**open vessel—**

a vessel that is not arranged to prevent the accumulation of large quantities of water on deck or in buoyant spaces if swamped. Such vessels—

- a) are not provided with a deck that is effectively weathertight;
- b) have a freeboard deck line that is in whole or part located below the deepest waterline; or
- c) have weather decks forming wells above the deepest waterline that are not arranged for rapid drainage of large quantities of accumulated water.

**plain sail—**

on a fore and aft rigged vessel includes all working sails on a vessel such as jibs, genoas, staysails and mainsails, but excludes light weather sails such as spinnakers and gaff topsails.

**rabbit line—**

the intersection of the outboard surface of the shell with the side of the keel, see definition of depth in Part B for illustrations.



**righting lever curve ( $G_FZ$  curve)—**

a curve of the righting lever or  $G_FZ$  values plotted against the angle of heel of the vessel corresponding to a particular loading condition.

**ro-ro vessel—**

a vessel having ro-ro spaces with decks that are loaded and unloaded in a horizontal direction and which are arranged for the stowage of wheeled vehicles or for the loading and unloading of goods by wheeled vehicles. Ro-ro spaces extend either a substantial length or the entire length of the vessel and are not normally subdivided.

**scupper—**

a drainage hole through a deck or bulwark provided for the drainage of rain and/or other relatively small quantities of water.

NOTE: See also the definition of freeing port.

**simplified stability criteria—**

a set of deemed-to-satisfy stability criteria that do not require the full analysis of stability using individual loading conditions to derive righting lever curves ( $G_FZ$  curves).

NOTES:

1. Simplified stability criteria are applied to enable the use of simplified test methods.
2. Simplified stability criteria are strictly limited in their application to avoid potential inaccuracies and erroneous conclusions as to a vessel's stability characteristics.

**simplified stability test methods—**

test methods that, if properly applied, can provide a simplified and normally less expensive approach to the determination of stability characteristics of certain specified types of vessels.

NOTES:

1. Simplified test methods are not suitable where comprehensive intact stability criteria apply.
2. Simplified test methods may involve stability proof testing where measurements are taken of freeboards and angles of heel, or alternatively a practical inclining experiment for determining  $G_FMO$ .

**slack tank—**

a tank that is neither completely empty nor full. For the purposes of this standard, a partially-full tank that is less than 98% full is considered to be a slack tank.

NOTE: The free surface of slack tanks is included in loading conditions undertaken to verify compliance with stability criteria.

**superstructure deck—**

a deck forming the top of a superstructure.

**waterplane (of the vessel)—**

a horizontal plane through the hull of a vessel defined by the intersection of the shell and the water surface at a particular draft.

**watertight—**

a boundary that complies with the requirements for a watertight boundary in Part C Section 2.

**weather deck—**

a deck which is completely exposed to the weather from above and from at least two vertical boundaries to the space.

**weathertight—**

a boundary that complies with the requirements for a weathertight boundary in Part C Section 2.

NOTE: A watertight boundary also meets the requirements of a weathertight boundary.

**well deck vessel—**

a vessel having an exposed recess, which extends for more than 50 per cent of the waterline length of the vessel (see Figure 2b)).

**windage area—**

the maximum profile area above the waterline including the projected profile area of all bulwarks, deck fittings, masts, spars, deck cargo, safety equipment, seating, cranes, other fixtures mounted on the vessel, awnings and screens.

**1.8 BASIC CONCEPTS AND SYMBOLS**

The following is a list of basic symbols used throughout this Subsection and figures illustrating the basic stability measurement concepts. Clause specific symbols are defined in each clause.

NOTE: The units used in this Subsection are those in common usage within the Australian maritime industry. SI units may be substituted without affecting compliance with this Subsection where the vessel operator and other users are competent to work with those units. It should be noted that where SI units are utilised the formulae may require alteration to reflect the changes to units.

$AP$  = aft perpendicular, meaning the point of intersection of the design waterline with the after profile of the vessel

$B$  = the centre of buoyancy through which the upward force due to the water displaced by the vessel is assumed to act (see Figure 5)

$FP$  = forward perpendicular, meaning the point of intersection of the design waterline with the stem profile of the vessel

$G$  = the location of the centre of gravity (see Figure 5)

$g$  = the acceleration due to gravity,  $9.81 \text{ m/s}^2$

$G_F$  = the location of the centre of gravity adjusted for free surface

$G_F M_O$  = the initial metacentric height of the vessel corrected for any free surface effects (see Figure 5)

$GM_0$  = the initial metacentric height of the vessel in the 'solid' condition, i.e. without free surface effect measured from  $G$  to  $M$  (see Figure 5)

$G_F Z$  = the horizontal distance between the lines of action of the mass and buoyancy forces at any given angle of heel in metres (see Figure 5 and Figure 6)

$KM_0$  = the initial transverse metacentric height above baseline (see Figure 5)

$KN$  = the horizontal distance between the keel point (baseline) and the

line of action of the buoyancy force at any given angle of heel in metres (see Figure 5 and Figure 6)

$M$  = the vessel's metacentre, being the point at which the line of action of the upward buoyancy force intersects the centre line (see Figure 5)

$M_O$  = the vessel's metacentre at small angles of heel

$M_p$  = person heeling moment at angle of heel  $\theta$  in tonne-metres

$M_T$  = the moment from the effect of turn at angle of heel  $\theta$  in tonne-metres

$M_W$  = wind heeling moment at angle of heel  $\theta$  in tonne-metres.

$V$  = the maximum service speed of the vessel, in knots

$\theta$  = the transverse angle of heel of the vessel (see Figure 5)

$\theta_f$  = the downflooding angle of the vessel (see Figure 3 and Figure 6)

$\theta_h$  = the static angle of heel that a vessel attains when exposed to a heeling moment (see Figure 6)

$\theta_s$  = the maximum allowable static angle of heel  $\theta_h$  from a single heeling moment

$\theta_c$  = the maximum allowable static angle of heel  $\theta_h$  from a combined heeling moment

$\theta_{max}$  = the angle of heel, corresponding to the maximum  $G_FZ$  value (see Figure 6)

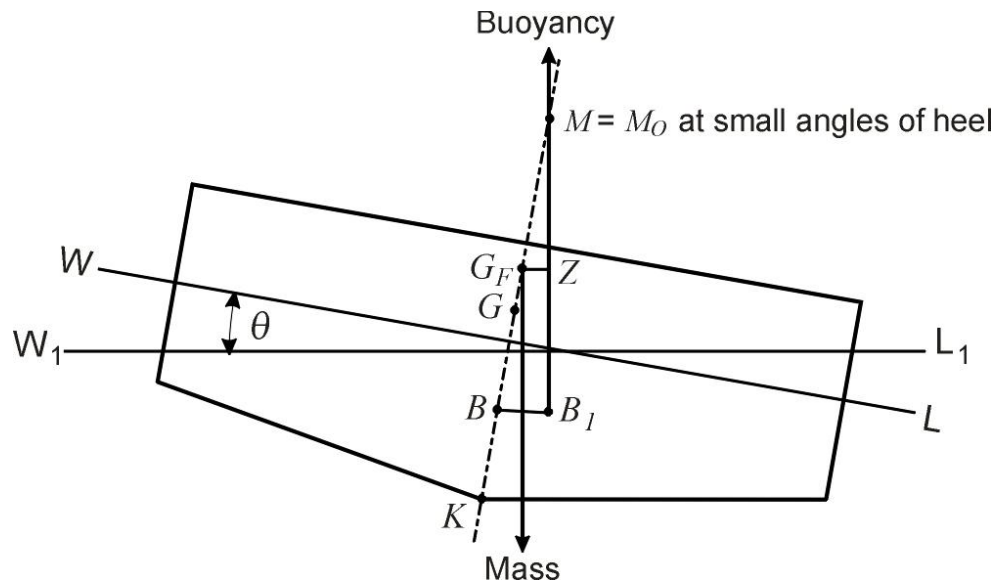
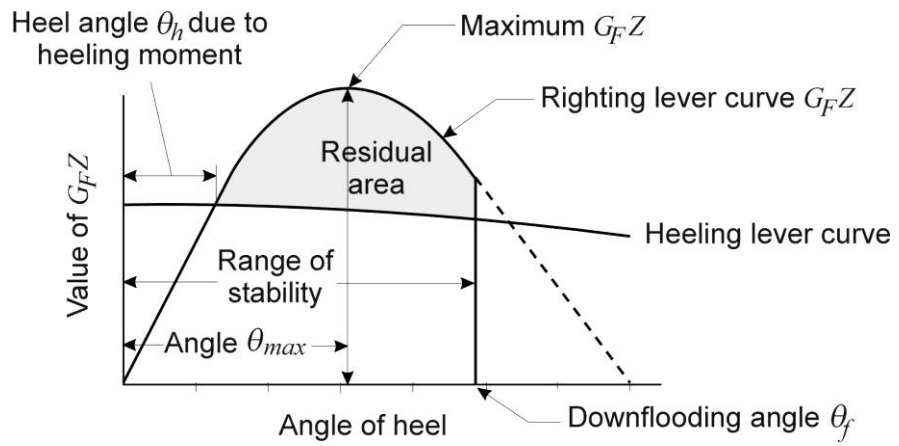


Figure 5 — Explanation of symbols



**Figure 6 — Typical righting lever ( $G_FZ$ ) curve**

## CHAPTER 2 INTACT STABILITY OUTCOMES AND SOLUTIONS

### 2.1 SCOPE

This Chapter specifies the required outcomes for intact stability and the corresponding requirements for deemed-to-satisfy and equivalent solutions. The required outcomes are mandatory to the extent that they are applicable to a vessel in the relevant deemed-to-satisfy solutions.

### REQUIRED OUTCOMES

#### 2.2 CONDITIONS OF LOADING TO BE SAFE

A vessel must have characteristics of stability over the range of foreseeable conditions of loading in both normal and abnormal conditions of operation, sufficient to:

- a) minimise the risk of the vessel capsizing;
- b) avoid excessive angles of heel that could threaten the safety of persons on the vessel; and
- c) return the vessel to the upright condition.

NOTES:

1. Foreseeable conditions of loading include light and laden conditions, arrival and departure conditions, and critical intermediate conditions.
2. Excessive angles of heel can result in personal injury, the shifting of cargo, furniture and other masses on the vessel, flooding of spaces, malfunction of essential machinery and systems, anxiety and fatigue of persons, as well as hampering the crew in performance of their duties.

#### 2.3 VESSEL TO BE CAPABLE OF WITHSTANDING THE EFFECT OF HEELING MOMENTS

A vessel must have characteristics of stability, when exposed to the effects of one or more heeling moments that are foreseeable in both normal and abnormal conditions of operation, sufficient to:

- a) minimise the risk of the vessel capsizing;
- b) avoid excessive angles of heel that could threaten the safety of persons on the vessel; and
- c) return the vessel to the upright condition.

NOTE: Heeling moments include one or more of those caused by wind, wave, persons, turning, lifting heavy masses, trawling and towing.

#### 2.4 STABILITY OF A VESSEL TO BE ESTABLISHED AND VERIFIED

The stability characteristics of a vessel must be established and documented to satisfy duty of care obligations for the safety of persons.

#### 2.5 STABILITY ANALYSIS TO BE APPROPRIATE

The stability criteria applied to a vessel must be appropriate taking into account the vessel's operation and form, the nature and likelihood of potential hazards and the consequences of inadequate stability.

## **2.6 STABILITY ANALYSIS TO BE SUFFICIENTLY ACCURATE**

Data and calculations used to verify compliance with the stability criteria must be sufficiently accurate to ensure persons that rely upon the information are not falsely led to believe that a vessel meets these minimum standards when, in fact, it falls below these minimum standards.

### **DEEMED-TO-SATISFY SOLUTIONS**

## **2.7 COMPLIANCE**

For the purpose of this National Standard, the intact stability of a vessel shall be deemed to satisfy the Required Outcomes in Clauses 2.2 to 2.6 to the extent specified by this Subsection if it complies with the relevant provisions of Chapter 3 to Chapter 8.

#### **NOTES:**

1. Chapter 3 to Chapter 8 refer to the contents of Subsection 6C —Stability Tests and Stability Information.
2. Other Sections of the NSCV may have provisions that also pertain to stability. See Part E—Operational Practices.

### **EQUIVALENT SOLUTIONS**

## **2.8 ASSESSMENT METHODS**

Assessment methods for equivalent solutions applicable to intact stability shall comply with Part B of this Subsection. Equivalent solutions applicable to intact stability shall be verified in a manner appropriate to the risks that would arise should the stability be found inadequate.

**NOTE:** Because of the high risks that arise if a vessel capsizes, assessment methods applicable to stability tend to be rigorous to promote a very high reliability of equivalence.

## CHAPTER 3 DETERMINING THE APPLICABLE INTACT STABILITY CRITERIA

### 3.1 SCOPE

This Chapter specifies the minimum deemed-to-satisfy intact stability criteria applicable to different classes of vessels and/or vessels engaged in specific operations.

NOTE: The criteria in this Subsection specify minimum values, but no maximum values are recommended. It is advisable to avoid excessive values. Excessive stability can result in acceleration forces that could be prejudicial to the vessel, its complement and equipment and to the safe carriage of the cargo.

### 3.2 APPLICATION

This chapter applies to all vessel types specified in this Subsection.

### 3.3 TYPES OF STABILITY CRITERIA

The stability criteria applicable to a vessel shall be appropriate for the area of operation and the types of heeling levers likely to be encountered in normal and abnormal conditions of operation. For the purposes of this standard, the different types of stability criteria contained in this Subsection are as specified in Table 1.

### 3.4 MULTIPURPOSE VESSELS

Where a vessel is intended for more than one area of service and/or type of operation, the vessel shall meet the intact stability criteria applicable to each such purpose, singly or in combination as appropriate.

### 3.5 DEEMED-TO-SATISFY CRITERIA

#### 3.5.1 Maximum displacement and longitudinal stability criteria

All vessels shall, for all normal conditions of loading and over the relevant range of drafts and trims, comply with the applicable criteria for maximum displacement and longitudinal stability specified in Chapter 4.

#### 3.5.2 Transverse stability

##### 3.5.2.1 *Criteria of general application*

The intact transverse stability of a vessel shall, for all foreseeable conditions of loading in normal operation, comply with any one of the applicable criteria specified in Table 2 subject to the relevant Operational Area, and any prerequisites and/or limits of application specified for the particular set of criteria.

##### 3.5.2.2 *Criteria for special operations*

In addition to the criteria of general application specified under Clause 3.5.2.1, a vessel engaged in special operations shall also comply with the applicable intact transverse stability criteria specified in Table 3 for all foreseeable conditions of loading when engaged in special operations,

subject to the relevant Operational Area, and any prerequisites and/or limits of application specified for the particular set of criteria.

**Table 1 — Table of intact stability criteria**

<b>Broad designation</b>	<b>Description</b>	<b>Criteria designation</b>	<b>Clause number</b>
Chapter 4	Maximum displacement and longitudinal stability criteria	Chapter 4A criteria—Maximum load criteria	Clause 4.3
		Chapter 4B criteria—Longitudinal stability criteria	Clause 4.4
Chapter 5	Comprehensive stability criteria of general application	Chapter 5A criteria—Comprehensive criteria of general application to all vessels	Clause 5.4
		Chapter 5B criteria—Alternative comprehensive criteria of general application to catamarans in operational areas B, C, D and E	Clause 5.5
		Chapter 5C criteria—Alternative comprehensive criteria of general application in operational areas D and E	Clause 5.6
		Chapter 5D criteria—Alternative comprehensive criteria for dumb barges	Clause 5.7
Chapter 6	Additional comprehensive stability criteria for special operations	Chapter 6A criteria—Additional criteria for monohull vessels that set sails	Clause 6.3.4
		Chapter 6B criteria—Alternative additional criteria for monohull vessels that set sail of length less than 24 m	Clause 6.3.5
		Chapter 6C criteria—Additional comprehensive criteria for catamaran vessels that set sails	Clause 6.4.4
		Chapter 6D criterion—Additional comprehensive criterion for vessels that lift masses	Clause 6.5.4
		Chapter 6E criteria—Alternative additional comprehensive criteria for vessels that lift masses	Clause 6.5.5
		Chapter 6F criterion—Additional comprehensive criterion for vessels that employ counter ballasting or counterweights when engaged in lifting	Clause 6.5.6
		Chapter 6G criterion—Additional comprehensive criterion for vessels engaged in towing	Clause 6.6.3
		Chapter 6H criteria—Additional comprehensive criteria for vessels engaged in trawling	Clause 6.7.3
		Chapter 6J Criteria— Additional comprehensive criteria for sheltered water crane barges while on transfer voyages at sea	Clause 6.8.2
		Chapter 6K Criteria— Additional criteria for sheltered water bucket dredgers while on transfer voyages at sea	Clause 6.9.2

(Continued)



Table 1 (Continued)

Broad designation	Description	Criteria designation	Clause number
Chapter 7	Simplified criteria of general application	Chapter 7A criteria—Alternative simplified criteria of general application in operational areas C, D and E	Clause 7.3
		Chapter 7B criteria—Alternative simplified criteria of general application in operational areas C, D and E	Clause 7.4
		Chapter 7C criteria—Alternative simplified criteria of general application to <i>collared vessels in operational areas C, D and E</i>	Clause 7.5
		Chapter 7D criteria—Alternative simplified criteria of general application to specified small vessels in operational areas D and E	Clause 7.6
		Chapter 7E criteria—Alternative simplified criteria of general application to catamaran vessels operating in operational areas D and E	Clause 7.7
		Chapter 7F criteria—Alternative simplified criteria of general application for dumb <i>barges in operational areas D and E</i>	Clause 7.8
Chapter 8	Simplified criteria for vessels engaged in special operations	Chapter 8A criterion—Alternative simplified criterion for monohull sailing vessels in operational areas D and E	Clause 8.3
		Chapter 8B criterion—Alternative simplified criterion for catamaran vessels that carry sail in operational areas D and E	Clause 8.4
		Chapter 8C criterion—Alternative simplified criterion for vessels lifting heavy loads in operational areas D and E	Clause 8.5
		Chapter 8D criterion—Alternative simplified criterion for dumb <i>barge lifting heavy loads</i>	Clause 8.6

### 3.6 MULTIHULL VESSELS WITH THREE OR MORE HULLS

The stability characteristics of vessels having three or more hulls may vary significantly, depending upon the size of the centre hull relative to the side hulls, the reserves of buoyancy in the side hulls and the overall beam. Some such vessels will have characteristics similar to a monohull while others might be more similar to a catamaran. Stability criteria applied to multihull vessels with three or more hulls shall initially be determined by application of criteria applicable to monohull vessels. Where a vessel is unable to meet the criteria for monohull vessels, then the comprehensive criteria applicable to catamarans may be applied.

NOTE: Simplified criteria for catamaran vessels may not be reliable on vessels having three or more hulls.

**Table 2 — Deemed-to-satisfy solutions for criteria of general application**

Vessel type	Operational area A	Operational area B	Operational area C	Operational area D	Operational area E
Vessels carrying less than 50 pax	Ch.5A	Ch.5A	Ch.5A	Ch.5A, Ch.5C	Ch.5A, Ch.5C
			If less than 20 m: Ch.7A, Ch.7B	If less than 35 m: Ch.7A, Ch.7B	If less than 35 m: Ch.7A, Ch.7B
collared vessels carrying less than 50 pax	Ch.5A	Ch.5A	Ch.5A	Ch.5A, Ch.5C	Ch.5A, Ch.5C
			If less than 20 m: Ch.7A, Ch.7B	If less than 35 m: Ch.7A, Ch.7B	If less than 35 m: Ch.7A, Ch.7B
			If less than 12 m Ch.7C	If less than 12 m Ch.7C	If less than 12 m Ch.7C
Catamarans	Ch.5A	Ch.5A, Ch.5B	Ch.5A, C.5B	Ch.5A, Ch5B, Ch.5C	Ch.5A, Ch.5B, Ch.5C
Class 2 or 3 catamarans	Ch.5A	Ch.5A, Ch.5B	Ch.5A, Ch.5B	Ch.5A, Ch5B, Ch.5C	Ch.5A, Ch.5B, Ch.5C
				If less than 20 m: Ch.7E	If less than 20 m: Ch.7E
Class 2 or 3 dumb barges	Ch.5A, Ch.5D	Ch.5A, Ch.5D	Ch.5A, Ch.5D	Ch.5A, Ch.5C, Ch.5D	Ch.5A, Ch.5C, Ch.5D
Class 2 or 3 dumb deck barges	Ch.5A, Ch.5D	Ch.5A, Ch.5D	Ch.5A, Ch.5D	Ch.5A, Ch.5C, Ch.5D	Ch.5A, Ch.5C, Ch.5D
				If less than 50 m: Ch.7F	If less than 50 m: Ch.7F
Class 2 or 3 vessels less than 7.5 m	Ch.5A	Ch.5A	Ch.5A	Ch.5A, Ch.5C	Ch.5A, Ch.5C
			Ch.7A, Ch.7B	Ch.7A, Ch.7B, Ch.7D	Ch.7A, Ch.7B, Ch.7D
All other vessels	Ch.5A	Ch.5A	Ch.5A	Ch.5A, Ch.5C	Ch.5A, Ch.5C

**KEY:**

Yellow (or light grey) shaded cells denote comprehensive stability criteria

Blue (or dark grey) shaded cells denote simplified stability criteria

**Table 3 — Deemed-to-satisfy solutions for vessels engaged in special operations**

Operation	Type of analysis	Operational areas A and B	Operational area C	Operational area D	Operational area E	Designation	Application
Sailing	Comprehensive	Monohulls	Monohulls	Monohulls	Monohulls	Ch.6A	Clause 6.3.4.1
	Comprehensive	Monohulls less than 24m length	Monohulls less than 24m length	Monohulls less than 24m length	Monohulls less than 24m length	Ch.6B	Clause 6.3.5.1
	Comprehensive	Catamarans	Catamarans	Catamarans	Catamarans	Ch.6C	Clause 6.4.4.1
	Simplified	Not applicable	Not applicable	Monohulls less than 15m length	Monohulls less than 15m length	Ch.8A	Clause 8.3.2
	Simplified	Not applicable	Not applicable	Catamarans less than 15m length	Catamarans less than 15m length	Ch.8B	Clause 8.4.2
Lifting	Comprehensive	Applicable	Applicable	Applicable	Applicable	Ch.6D	Clause 6.5.4.1
	Comprehensive	Applicable	Applicable	Applicable	Applicable	Ch.6E	Clause 6.5.5.1
	Comprehensive	Counter ballasting or counterweights	Counter ballasting or counterweights	Counter ballasting or counterweights	Counter ballasting or counterweights	Ch.6F	Clause 6.5.6.1
	Simplified	Not applicable	Not applicable	less than 50m length	less than 50m length	Ch.8C	Clause 8.5.2
	Simplified	Dumb barges less than 50m length less than 12 persons & within proportions	Dumb barges less than 50m length less than 12 persons & within proportions	Dumb barges less than 50m length less than 12 persons & within proportions	Dumb barges less than 50m length less than 12 persons & within proportions	Ch.8D	Clause 8.6.2
Towing	Comprehensive	Applicable	Applicable	Applicable	Applicable	Ch.6G	Clause 6.6.3.1
Trawling	Comprehensive	Applicable	Applicable	Applicable	Applicable	Ch.6H	Clause 6.7.3.1
Transfer voyages at sea	Comprehensive	Not applicable	Not applicable	crane barges	crane barges	Ch.6J	Clause 6.8.1
	Comprehensive	Not applicable	Not applicable	Bucket dredgers	Bucket dredgers	Ch.6K	Clause 6.9.1

KEY:

‘Comprehensive’ means that the criteria require the derivation and analysis of a  $G_{fZ}$  curve.‘Simplified’ means that the criteria can be verified by simplified methods that do not require the derivation and analysis of a  $G_{fZ}$  curve.

### 3.7 ANTI-ROLLING DEVICES

Where anti-rolling devices such as active or passive anti-roll tanks or active stabilising fins are fitted, the vessel shall meet the applicable intact stability criteria when these devices are in operation and when they are not in use. In addition, the vessel shall continue to meet the relevant criteria of general application in the event of a failure of power supply or failure of the devices themselves.

NOTES:

1. Anti-rolling tanks that are interconnected are considered as a single tank for the purposes of determining the free surface.
2. The response of a vessel to a failure of anti-rolling device may be essential information to be incorporated into an operating manual and/or emergency plan.

### 3.8 CRITERIA FOR MAXIMUM ALLOWABLE ANGLE OF HEEL DUE TO HEELING MOMENTS

For the purposes of compliance with the stability criteria specified in Chapter 5 to Chapter 8, the values  $\theta_s$  and  $\theta_c$  limit the maximum allowable static angle of heel  $\theta_h$  that a vessel may attain when exposed to a single or combined heeling moment, respectively. The values  $\theta_s$  and  $\theta_c$  shall be determined by the capacity of the vessel to control the risks as the static heel angle increases, in accordance with Table 4.

**Table 4 — Maximum allowable angles of static heel**

Heel consequence level	Allowable maximum angle of static heel for heeling moment(s)		Conditions of application
	Single $\theta_s$ degrees	Combined $\theta_c$ (A) degrees	
1. High	5	5	No specified conditions of application – applicable to any vessel that is unsuited to the application of large values of heel.
2. Moderate	10	15	$\theta_s$ or $\theta_c$ (if combined lever criteria are applied) may exceed 5 degrees where— <ol style="list-style-type: none"> <li>1. if the vessel is fitted with a slewing crane that is subject to the lifting criteria, the crane is capable of safe operation at angles of heel up to at least <math>\theta_s</math>; and</li> <li>2. if the vessel is carrying unsecured deck cargo, the deck cargo shall either—               <ol style="list-style-type: none"> <li>i) comprise vehicles having rubber tyres; or</li> <li>ii) have a maximum potential moment from cargo shifting that does not exceed 20 per cent of the greatest value of <math>M_P</math>, <math>M_W</math> or <math>M_T</math>.</li> </ol> </li> </ol>

(Continued)

Table 4 (Continued)

Heel consequence level	Allowable maximum angle of static heel for heeling moment(s)		Conditions of application
	Single $\theta_s$ degrees	Combined $\theta_c$ (A) degrees	
3. Low	14	18	$\theta_s$ may exceed 10 degrees or $\theta_c$ (if combined lever criteria are applied) may exceed 15 degrees where— <ol style="list-style-type: none"> <li>1. all cargo including deck cargo is secured against shifting;</li> <li>2. seating is provided for all persons;</li> <li>3. furniture is fixed when in use and/or when stowed;</li> <li>4. sufficient grab rails are provided in spaces that normally contain persons; and</li> <li>5. decks and deck surfaces are arranged to reduce slipping hazards.</li> </ol>

KEY:

(A) Combined moments apply only where combined levers are specified in the criteria.

### 3.9 TESTS AND CALCULATIONS USED TO DETERMINE COMPLIANCE

All calculations used in the verification of a vessel's stability against the stability criteria shall be derived from accurate information. The minimum deemed-to-satisfy standards for such information shall be as specified in Table 5. Specific deemed-to-satisfy requirements for tests and calculations are specified, as applicable, with each set of criteria.

Table 5 — Standards for calculations

Item	Standard
Hydrostatic and $KN$ data	Part C Subsection 6C
Stability tests	Part C Subsection 6C
Loading conditions	Worst case conditions unless otherwise specified for particular criteria (1)
Heeling moments	Annexes A to G

NOTE:

(1) The requirements for loading conditions to be presented in stability information specified in Subsection 6C provides a good starting point for fulfilling this requirement.

### 3.10 OPERATIONAL RESTRICTIONS

Where specific operational procedures or restrictions are required to achieve or maintain compliance with the intact stability criteria, details of all such procedures or restrictions shall be recorded in a form that is easily understandable and readily available to the persons responsible for the safe operation of the vessel.

NOTE: Over-reliance on operational procedures or restrictions increases the risks of human error and should be avoided.

## CHAPTER 4 MAXIMUM DISPLACEMENT AND LONGITUDINAL STABILITY CRITERIA

### 4.1 SCOPE

This Chapter specifies minimum criteria for maximum load and longitudinal stability.

### 4.2 APPLICATION

This Chapter applies to all vessels to the extent specified in the criteria.

### 4.3 CHAPTER 4A CRITERIA—MAXIMUM LOAD CRITERIA

A vessel that complies with the criteria listed in Table 6 over the range of normal operating conditions shall be deemed to satisfy the Chapter 4A criteria.

**Table 6 — Chapter 4A criteria— Maximum displacement**

Criterion No	Limits to application	Chapter 4A criterion description
4A.1	Vessels assigned a minimum geometric freeboard in Part C Section 2	The maximum <i>displacement</i> in a loading condition for the purposes of compliance with the intact stability criteria shall not exceed the <i>displacement</i> corresponding to the minimum freeboard that might be assigned in Part C Section 2.
4A.2	All vessels	The maximum <i>displacement</i> in a loading condition for the purposes of compliance with the intact stability criteria shall not exceed the maximum <i>displacement</i> assumed for the purposes of determining hull scantlings in Part C Section 3.
4A.3	Vessels required to satisfy buoyancy, subdivision or damaged stability standards in Part C Subsection 6C.	The maximum displacement in a loading condition for the purposes of compliance with the intact stability criteria shall not exceed the maximum intact displacement required to meet buoyancy, subdivision and/or damaged stability standards in Part C Subsection 6C.

### 4.4 CHAPTER 4B CRITERIA—LONGITUDINAL STABILITY CRITERIA

A vessel that complies with the criteria listed in Table 7 over the range of normal operating conditions shall be deemed to satisfy the Chapter 4B criteria.

**Table 7 — Chapter 4B criteria— Longitudinal stability**

Criterion No	Limits to application	Chapter 4B criterion description
4B.1	Vessels assigned a minimum bow height in Part C Section 2	The minimum bow height arising from the combination of draft and trim in all normal conditions of operation shall not be less than any minimum value applicable to the vessel specified in Part C Section 2.
4B.2a	Vessels with a <i>weathertight</i> deck	A vessel shall have characteristics of freeboard, trim and heel such that, during loading or unloading, the deck edge does not submerge at any point.
4B.2b	<i>open vessels</i>	An <i>open vessel</i> shall have characteristics of freeboard, trim and heel such that, during loading or unloading, the minimum distance from the gunwale to the waterline shall be not less than half the minimum operational freeboard.
4B.2c	<i>collared vessels</i>	A <i>collared vessel</i> shall have characteristics of freeboard, trim and heel such that, during loading or unloading, the minimum distance from the upper surface of the collar to the waterline shall be not less than half the minimum operational freeboard.
4B.3	<i>offshore supply vessels</i>	The minimum freeboard at the stern of an <i>offshore supply vessel</i> in all normal conditions of operation shall be not less than: $F_A = 0.005 L_M$ where $F_A$ = minimum freeboard at the stern, in metres $L_M$ = measured length of the vessel, in metres

#### 4.5 TESTING AND CALCULATIONS

Compliance with these criteria shall be established either through calculation using loading conditions or by practical demonstration during a stability proof test.

## CHAPTER 5 COMPREHENSIVE STABILITY CRITERIA OF GENERAL APPLICATION

### 5.1 SCOPE

This Chapter specifies the comprehensive stability criteria of general application to vessels.

### 5.2 APPLICATION

This Chapter contains intact stability criteria that are applicable to all vessels. The application of specific criteria contained within this Chapter shall be in accordance with Table 8 and Clauses 5.4.1, 5.5.1, 5.6.1 and 5.7.1:

NOTES:

1. The simplified alternative criteria contained in Chapter 7 and Chapter 8 may provide another simpler means of establishing compliance, but will be restricted in application to a limited group of vessels.
2. For specific types of operations, Chapter 3 requires that the criteria of general application be supplemented by additional criteria specified in Chapter 6.

**Table 8 — Comprehensive criteria of general application**

Type of vessel	Operational area	Criteria designation	Reference
All vessels	A, B, C, D, E	Chapter 5A	Clause 5.4
Catamarans	B, C, D, E	Chapter 5B	Clause 5.5
All vessels	D, E	Chapter 5C	Clause 5.6
Class 2 or 3 dumb barges	A, B, C, D, E	Chapter 5D	Clause 5.7

### 5.3 PREREQUISITES FOR APPLICATION OF COMPREHENSIVE CRITERIA OF GENERAL APPLICATION

#### 5.3.1 Data and information

To apply the criteria contained within this Chapter, the following information shall be established:

- a) Hydrostatic and cross-curve data, refer to Subsection 6C.
- b) Values for the vessel's lightship displacement, *VCG* and *LCG*, refer to Subsection 6C.
- c) Mass, *VCG* and *LCG* information for each item that comprises the deadmass including the contents of tanks, cargo, catch, persons and stores, refer to Subsection 6C.
- d) free surface moments for all tanks that are or may become partially filled.
- e) The range of loading conditions representative of the vessel's normal operations, including worst case scenarios where compliance with criteria is likely to be minimal, refer to Subsection 6C.

NOTE: The designer would normally rely on the owner and/or operator to provide the necessary information to ensure that the loading conditions analysed are realistic and sufficiently comprehensive.



- f) The magnitude of relevant heeling moments including person, wind, turning and, where applicable, sail, lifting, tow-rope and/or snagged net.

### 5.3.2 Methods of testing and calculation

Unless otherwise specified, the parameters used for the purposes of determining compliance with the criteria listed in this Chapter shall be determined in accordance with Table 9.

**Table 9 — Standard for tests and calculations**

Item	Standard
Hydrostatic and $KN$ data	Part C Subsection 6C
Lightship particulars	Part C Subsection 6C
Loading conditions	Part C Subsection 6A (1) and Part C Subsection 6C (2)
Maximum allowable angles of heel $\theta_s$ and $\theta_c$	Clause 3.8
Person heeling moment $M_p$	Annex A
Wind heeling moment $M_w$	Annex B
Turning moment $M_T$	Annex C

KEY:

(1) Refer to specific clauses within each particular set of criteria.

(2) Part C Subsection 6C specifies minimum requirements for loading conditions to be presented in stability information.

## 5.4 CHAPTER 5A CRITERIA—COMPREHENSIVE CRITERIA OF GENERAL APPLICATION TO ALL VESSELS

### 5.4.1 Application

The comprehensive criteria in this Clause are applicable to all vessels, subject to Clause 5.3 and any applicable alternative criteria specified in Table 2.

NOTE: Vessels engaged in special operations are also required to apply the additional criteria specified in Table 3.

### 5.4.2 Criteria

A vessel that complies with the criteria listed in Table 10 over the range of normal operating conditions shall be deemed to satisfy the Chapter 5A criteria.

**Table 10 — Chapter 5A criteria—Comprehensive criteria of general application to all vessels**

Criterion No	Limits to application	Chapter 5A criterion description
5A.1	All vessels within application, Clause 5.2	The angle of maximum righting lever $\theta_{max}$ shall occur at an angle of heel not less than 15 degrees.
5A.2a	Angle of maximum righting lever $\theta_{max}$ occurs at 15 degrees	The area under the <i>righting lever curve</i> up to an angle of 15 degrees shall not be less than 4.01 metre-degrees.
5A.2b	Angle of maximum righting lever $\theta_{max}$ occurs between 15 degrees and 30 degrees	The area under the <i>righting lever curve</i> up to the angle of maximum righting lever ( $\theta_{max}$ ) shall not be less than the area determined by use of the formula: $A_{0-\theta_{max}} = 3.15 + 0.057(30 - \theta_{max})$ where $A_{0-\theta_{max}}$ = the area under the <i>righting lever curve</i> up to the angle of maximum righting lever ( $\theta_{max}$ ), in m degrees $\theta_{max}$ = the angle of heel at which the <i>righting lever curve</i> reaches its maximum, in degrees
5A.2c	Angle of maximum righting lever $\theta_{max}$ 30 degrees or more	The area under the <i>righting lever curve</i> up to an angle of 30 degrees shall not be less than 3.15 metre-degrees.
5A.3	All vessels within application, Clause 5.2	The area under the <i>righting lever curve</i> up to an angle of 40 degrees, or the angle of flooding $\theta_f$ if this is less than 40 degrees, shall not be less than 5.16 metre-degrees.
5A.4	All vessels within application, Clause 5.2	The area under the <i>righting lever curve</i> between the angles of heel of 30 degrees and 40 degrees, or between 30 degrees and the angle of flooding $\theta_f$ if this angle is less than 40 degrees, shall be not less than 1.72 metre-degrees.
5A.5	All vessels within application, Clause 5.2	The righting lever shall have a value not less than 0.2 metres at an angle of heel equal to or greater than 30 degrees.
5A.6a	Class 1 (passenger vessels)	The minimum metacentric height ( $G_f M_o$ ) shall be not less than 0.15 m.
5A.6b	Class 2 (non-passenger vessels)	The minimum metacentric height ( $G_f M_o$ ) shall be not less than 0.20 m.
5A.6c	Class 3 (fishing vessels)	The minimum metacentric height ( $G_f M_o$ ) shall be not less than 0.35 m.
5A.7a	All vessels within application, Clause 5.2 (except as modified by 5A.7b)	The angle of heel $\theta_h$ shall not exceed $\theta_s$ degrees (see Table 4) when any of the individual heeling moments due to person crowding, wind or turn is applied.
5A.7b	All operational area A vessels, and operational area B vessels 24 m or more in length	Instead of the wind heeling criterion specified in Criterion 5A.8a, the vessel shall comply with the wind and wave criteria specified in Annex H.

(Continued)

Table 10 (Continued)

Criterion No	Limits to application	Chapter 5A criterion description
5A.8	Vessels carrying 50 or more passengers	The angle of heel $\theta_h$ shall not exceed $\theta_c$ degrees (see Table 4) when the combined effect of the two greatest heeling moments resulting from person crowding, the effect of wind or the effect of turn are applied simultaneously.
5A.9	Vessels having either of the following:  The angle of maximum righting lever $\theta_{max} < 25$ degrees (see criterion 5A.1), or  The maximum allowable angle $\theta_s > 10$ degrees and the angle of heel $\theta_h$ from a single heeling moment $> 10$ degrees (see criterion 5A.7a)	The area under the curve of righting levers and above the largest single heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), shall not be less than  $A_{RS} = 1.03 + 0.2 A_{40/\theta_f}$ where  $A_{RS}$ = minimum residual area under the curve of righting levers above the single heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees  $A_{40/\theta_f}$ = total area under the curve of righting levers up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees
5A.10	Vessels carrying 50 or more passengers where the maximum allowable angle $\theta_c > 15$ degrees and the angle of heel $\theta_h$ from a combined heeling moment $> 15$ degrees (see criterion 5A.8)	The area under the curve of righting levers and above the combined heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), shall not be less than  $A_{RC} = 0.65 + 0.13 A_{40/\theta_f}$ where  $A_{RC}$ = minimum residual area under the curve of righting levers above the combined heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees  $A_{40/\theta_f}$ = total area under the curve of righting levers up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees

## 5.5 CHAPTER 5B CRITERIA—ALTERNATIVE COMPREHENSIVE CRITERIA OF GENERAL APPLICATION TO CATAMARANS IN OPERATIONAL AREAS B, C, D AND E

### 5.5.1 Application

The comprehensive criteria in this Clause may be applied to a catamaran vessel operating in operational areas B, C, D and E as an alternative to the Chapter 5A criteria, subject to Clause 5.3.

NOTE: Vessels engaged in special operations are also required to apply the additional criteria specified in Table 3.

### 5.5.2 Criteria

A vessel that complies with the criteria listed in Table 11 over the range of normal operating conditions shall be deemed to satisfy the Chapter 5B criteria.

**Table 11 — Chapter 5B criteria—Alternative comprehensive criteria of general application to catamarans in operational areas B, C, D and E**

Criterion No	Limits to application	Chapter 5B criterion description
5B.1	All vessels within Clause 5.5.1	<p>The area (<math>A_1</math>) under the righting lever (<math>G_{fZ}</math>) curve up to an angle <math>\theta</math> shall be at least:</p> $A_1 = 3.15 \left( \frac{30^\circ}{\theta} \right)$ <p>where</p> <p><math>A_1</math> = the area under the righting lever (<math>G_{fZ}</math>) curve, in metre-degrees (see)</p> <p><math>\theta</math> = the least angle, in degrees, of the following:</p> <ol style="list-style-type: none"> <li>1) The <i>downflooding angle</i> <math>\theta_f</math> in degrees.</li> <li>2) The angle <math>\theta_{max}</math> at which maximum <math>G_{fZ}</math> occurs in degrees.</li> <li>3) 30 degrees.</li> </ol>
5B.2	All vessels within Clause 5.5.1	The angle of maximum righting lever $\theta_{max}$ shall occur at an angle of heel not less than 10 degrees.
5B.3	All vessels within Clause 5.5.1	The angle of heel $\theta_h$ shall not exceed $\theta_s$ degrees (see Table 4) when any of the individual heeling moments due to person crowding, wind or turn is applied, (see Figure 7a)).
5B.4	All vessels within Clause 5.5.1	Heel due to the crowding of persons on one side of the vessel or due to turning, whichever is greater, shall be applied in combination with the heeling lever due to wind $HZ_2$ (see Clause 5.5.3) to obtain the heeling lever $HZ_{TL}$ . The resultant angle of heel $\theta_h$ shall not be greater than 16 degrees, (see Figure 7b)).
5B.5	All vessels within Clause 5.5.1	The effect of rolling in a seaway upon the vessel's stability shall be demonstrated mathematically. The residual area under the righting lever ( $G_{fZ}$ ) curve ( $A_2$ ), between the angle of heel ( $\theta_h$ ) and the angle of roll ( $\theta_r$ ) shall be at least 1.61 metre-degrees (see b) and Figure 7c)). (see Note)

NOTE: In the absence of model test or other data,  $\theta_s$  shall be taken as 15 degrees or an angle of  $(\theta_f - \theta_h)$  degrees whichever is less. (see Figure 7)

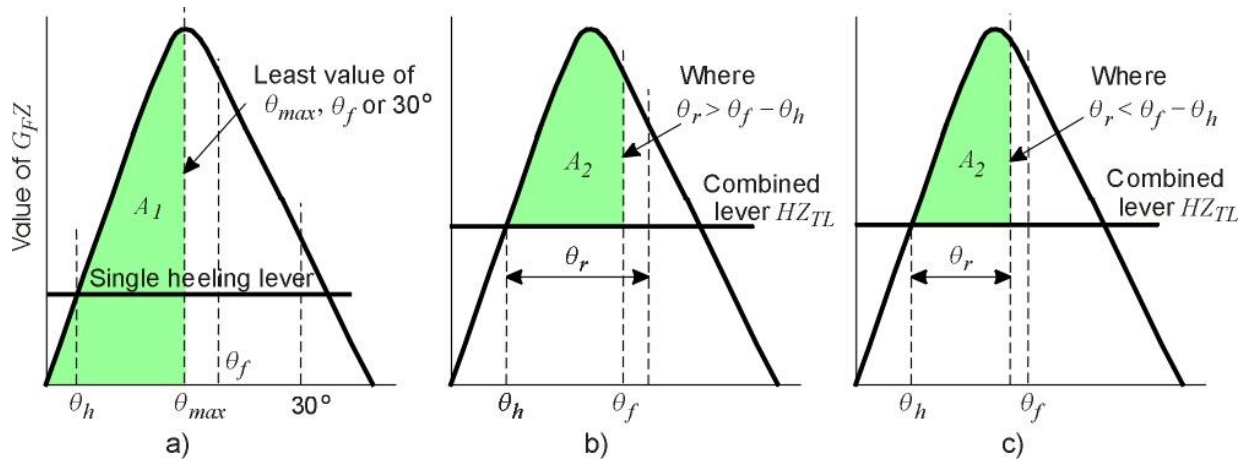


Figure 7 — Chapter 5B catamaran intact stability

### 5.5.3 Methods of calculation

For the purposes of determining compliance with Chapter 5B criteria—

- the moments for person crowding and heel due to turning calculated in Annex A and Annex C shall be assumed to remain the same as the upright value at all angles of inclination; and
- the wind heeling moment shall be calculated in accordance with the following formula and shall be assumed the same as the upright value at all angles of vessel inclination.

$$HZ_2 = 1.5 HZ_1$$

where

$HZ_2$  = the heeling lever due to wind, including gusting, in metres

$HZ_1$  = the heeling lever due to wind, in metres

$$= \frac{P_w A_w h}{1000g \Delta}$$

where

$P_w$  = the wind pressure shall be taken as 500 Pa for operational areas A, B, C. For operational areas D and E, the wind pressure may be reduced to 360 Pa and 300 Pa respectively

$A_w$  = the projected lateral area of that portion of the vessel above the lightest service waterline in square metres

$h$  = the vertical distance from the centre of area A to a point one half the lightest service draft in metres

$g$  = the acceleration due to gravity, 9.81 m/s<sup>2</sup>

$\Delta$  = the displacement of the vessel in tonnes

## 5.6 CHAPTER 5C CRITERIA—ALTERNATIVE COMPREHENSIVE CRITERIA OF GENERAL APPLICATION IN OPERATIONAL AREAS D AND E

### 5.6.1 Application

The comprehensive criteria in this Clause may be applied to a vessel operating in operational areas D and E as an alternative to the Chapter 5A criteria, subject to Clause 5.3.

NOTE: Vessels engaged in special operations are also required to apply the additional criteria specified in Table 3.

### 5.6.2 Criteria

A vessel that complies with the criteria listed in Table 12 over the range of normal operating conditions shall be deemed to satisfy the Chapter 5C criteria.

**Table 12 — Chapter 5C criteria—Alternative comprehensive criteria of general application to vessels in operational areas D and E**

Criterion No	Limits to application	Chapter 5C criterion description
5C.1	All vessels	The angle of heel $\theta_h$ shall not exceed $\theta_s$ degrees (see Table 4) when any of the individual heeling moments due to person crowding, wind or turning is applied.
5C.2	Vessels carrying 50 or more passengers	The angle of heel $\theta_h$ shall not exceed $\theta_c$ degrees (see Table 4) when the combined effect of the two greatest heeling moments resulting from person crowding, the effect of wind or the effect of turn are applied simultaneously.
5C.3	All vessels	The righting lever $G_fZ$ at the intersection of the <i>righting lever curve</i> and the heeling lever curve due to the effects of person crowding, wind heel or turning, shall not exceed 60 per cent of the maximum righting lever $G_{FZ_{max}}$ . (See Figure 8)
5C.4	Vessels having either of the following:  The angle of maximum righting lever $\theta_{max} < 25$ degrees, or  The maximum allowable angle $\theta_s > 10$ degrees and the angle of heel $\theta_h$ from a single heeling moment $> 10$ degrees (see criterion 5C.1)	The area under the curve of righting levers and above the largest single heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), shall not be less than $A_{RS} = 1.03 + 0.2 A_{40/\theta_f}$ where $A_{RS}$ = minimum residual area under the curve of righting levers above the single heeling lever curve up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees $A_{40/\theta_f}$ = total area under the curve of righting levers up to $40^\circ$ (or the angle of flooding $\theta_f$ if this angle is less than $40^\circ$ ), in metre-degrees
5C.5	Vessels carrying 50 or more passengers	The area under the <i>righting lever curve</i> above the heeling lever arising from the combined effects of the largest two of wind heel, person crowding or turning lever curve ( $A_{RC}$ ), taken up to the angle of flooding ( $\theta_f$ ) or the second intercept with the <i>righting lever curve</i> (whichever is less), shall be not less than 25 per cent of the total area ( $A_T$ ) under the <i>righting lever curve</i> up to the angle of flooding $\theta_f$ or the second intercept whichever is less (See Figure 9).

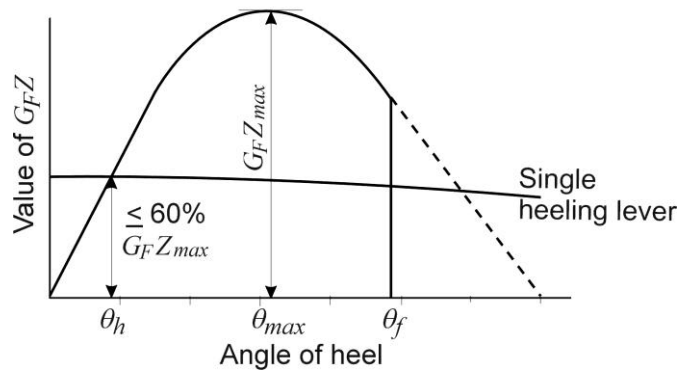


Figure 8 — Proportion of  $G_F Z_{max}$  criterion for single heeling levers

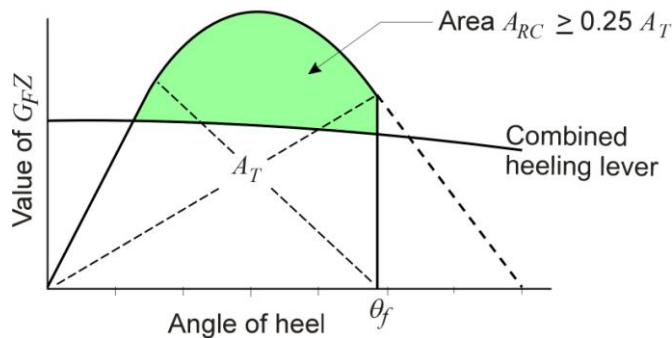


Figure 9 — Residual area criterion for combined levers

## 5.7 CHAPTER 5D CRITERIA—ALTERNATIVE COMPREHENSIVE CRITERIA FOR DUMB BARGES

### 5.7.1 Application

The comprehensive criteria in this Clause may be applied to a barge as an alternative to the Chapter 5A criteria, subject to Clause 5.3 and the following:

- The barge is not self-propelled.
- The barge is not for Class 1 operations.
- The barge does not have overnight accommodation spaces for persons.

NOTE: barges engaged in special operations are also required to apply the additional criteria specified in Table 3.

### 5.7.2 Criteria

A vessel that complies with the criteria listed in Table 13 over the range of normal operating conditions shall be deemed to satisfy the Chapter 5D criteria.

**Table 13 — Chapter 5D criteria—Alternative criteria for dumb barges**

Criterion No	Limits to application	Chapter 5D criterion description
5D.1a	Seagoing <i>barges</i> Operational areas A, B, C	The area beneath the $G_{fZ}$ curve measured between 0 degrees and the angle of maximum righting arm $G_{fZ_{max}}$ , the <i>downflooding angle</i> $\theta_f$ , or 40 degrees, whichever angle is smallest shall not be less than 4.58 metre-degrees.
5D.1b	Sheltered water <i>barges</i> Operational areas D, E	The area beneath the $G_{fZ}$ curve measured between 0 degrees and the angle of maximum righting arm $G_{fZ_{max}}$ , the <i>downflooding angle</i> $\theta_f$ , or 40 degrees, whichever angle is smallest shall not be less than 3.05 metre-degrees.



## CHAPTER 6 ADDITIONAL COMPREHENSIVE STABILITY CRITERIA FOR SPECIAL OPERATIONS

### 6.1 SCOPE

This Chapter specifies additional comprehensive stability criteria applicable to vessels that are exposed to particular hazards during operation. Such hazards would not be adequately assessed and/or controlled by the vessel's compliance with just the comprehensive criteria of general application.

### 6.2 APPLICATION

This Chapter applies to the vessels specified in Table 14.

**Table 14 — Additional criteria for specific operations**

Type of operation	Application	Criteria designation	Reference
Monohulls that set sails	All vessels	Ch. 6A	Clause 6.3.4
	Alternative for vessels up to 24 m length	Ch. 6B	Clause 6.3.5
Catamarans that set sails	All vessels	Ch. 6C	Clause 6.4.4
Vessels engaged in lifting	All vessels	Ch. 6D	Clause 6.5.4
	Alternative for all vessels	Ch. 6E	Clause 6.5.5
	Vessels that use counterweights or counter ballast	Ch. 6F	Clause 6.5.6
Vessels engaged in towing	All vessels within Clause 6.6.3.1	Ch. 6G	Clause 6.6.3
Vessels engaged in trawling	All vessels	Ch. 6H	Clause 6.7.3
Sheltered water vessels undergoing transfer voyages at sea	crane barges	Ch. 6J	Clause 6.8.2
	Bucket dredgers	Ch. 6K	Clause 6.9.2

### 6.3 SAIL CRITERIA FOR MONOHULLS

#### 6.3.1 Application

Clause 6.3 applies to monohull vessels that set sail where the sail area has not been included as part of the windage area used for determining windage moment in applying general criteria.

NOTE: As an alternative to the criteria specified in this Clause, a vessel that sets relatively small steadying sails may be assessed using the stability criteria of general application if the area of sail is included in the windage calculation.

### 6.3.2 Prerequisites for application of sail criteria

The application of criteria that use a wind pressure less than that specified in Annex B is subject to the following prerequisites:

- a) A vessel that sets sail shall be arranged to allow ready and rapid handling of all sails by the crew over the anticipated range of wind and weather conditions, and without assistance from other persons on board. Sails shall be arranged so that they can be effectively and quickly—
  - i) eased to spill wind in gusting or squall conditions; and
  - ii) reefed and/or furled to avoid excessive heeling moments in high wind or squall conditions, or in anticipation of such conditions.

NOTE: A vessel that sets square sails, spinnakers or other sails that are relatively cumbersome to quickly ease, reef or furl would need to be assessed as a proposal for an equivalent solution; see Part B of this Standard.

- b) The vessel shall be provided with an auxiliary means of propulsive power sufficient to control and manoeuvre the vessel when under bare poles.
- c) Deck openings shall be—
  - i) fitted with weathertight closures;
  - ii) arranged to minimise the possibility of flooding the hull at large angles of heel by being located on or near the centre line of the vessel; and
  - iii) arranged to ensure that, apart from air pipes to tanks, no opening regardless of size which may lead to progressive flooding shall be immersed at an angle of heel of less than 40 degrees.

### 6.3.3 Movable ballast arrangements

Monohull vessels fitted with arrangements that modify the stability characteristics of the vessel while underway (such as canting keels, water ballast systems or keels that raise or lower) shall comply with the relevant stability criteria in all conditions of operation.

### 6.3.4 Chapter 6A criteria—Additional criteria for monohull vessels that set sails

#### 6.3.4.1 Application

The criteria in this Clause apply to monohull vessels that set sail. They are additional to the criteria of general application in Chapter 4 and Chapter 5 and are subject to Clauses 6.3.2 and 6.3.3.

NOTES:

1. Alternative comprehensive criteria for vessels of length less than 24 m are specified in Clause 6.3.5.
2. Alternative simplified criteria for sheltered water vessels of length less than 15 m are specified in Clause 8.3.

#### 6.3.4.2 Criteria

A vessel that complies with the criteria listed in Table 15 over the range of loading conditions during which sail may be set shall be deemed to satisfy the Chapter 6A criteria.

**Table 15 — Chapter 6A criteria—Additional criteria for monohull vessels that set sail**

Criterion No	Limits to application	Chapter 6A criterion description
6A.1a	Operational areas A, B	The positive range of stability from upright to the angle of negative $G_{FZ}$ (exclusive of the effect of downflooding points) shall not be less than 90 degrees.
6A.1b	Operational areas C, D, E	The positive range of stability from upright to the angle of negative $G_{FZ}$ (exclusive of the effect of downflooding points) shall not be less than 70 degrees.
6A.2	All vessels within application	With all <i>plain sail</i> set and subject to a steady beam wind corresponding to a pressure of 105 Pa (equivalent to 26 knots average) the vessel shall not heel beyond the angle for deck edge immersion $\theta_{de}$ (see Figure 10).
6A.3a	Operational areas A, B	With all <i>plain sail</i> set and subject to a gusting beam wind corresponding to a pressure of 182 Pa (equivalent to 34 knots gusting), the vessel shall maintain sufficient residual area under the righting lever ( $G_{FZ}$ ) curve to achieve dynamic balance when heeled to the angle of downflooding $\theta_f$ or 60 degrees, whichever is the lesser.
6A.3b	Operational areas C, D, E	With all <i>plain sail</i> set and subject to a gusting beam wind corresponding to a pressure of 115 Pa (equivalent to 27 knots gusting), the vessel shall maintain sufficient residual area under the righting lever ( $G_{FZ}$ ) curve to achieve dynamic balance when heeled to the angle of downflooding $\theta_f$ or 60 degrees, whichever is the lesser.
6A.4a	Operational areas A, B	With all <i>plain sail</i> set and subject to a gusting beam wind corresponding to a pressure of 204 Pa (equivalent to 38 knots gusting), the vessel shall maintain sufficient residual area under the righting lever ( $G_{FZ}$ ) curve to achieve dynamic balance when heeled to the limit of positive stability or 90 degrees, whichever is the greater.
6A.4b	Operational areas C, D, E	With all <i>plain sail</i> set and subject to a gusting beam wind corresponding to a pressure of 130 Pa (equivalent to 29 knots gusting), the vessel shall maintain sufficient residual area under the righting lever ( $G_{FZ}$ ) curve to achieve dynamic balance when heeled to the limit of positive stability or 90 degrees, whichever is the greater.

**6.3.4.3 Methods of calculation**

The windage area under sail shall be determined for all plain sail without reefing and in accordance with Clause D3. The windage moment under sail shall be determined as specified in Annex D. The criteria specified in Clause 6.3.4.2 shall be determined using the methods specified in Annex J.

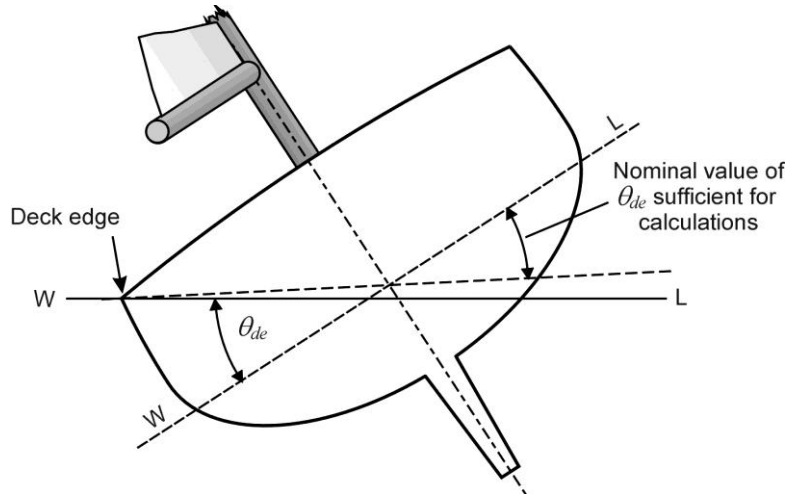


Figure 10 — Angle of heel to deck edge immersion

**6.3.5 Chapter 6B criteria—Alternative additional criteria for monohull vessels that set sail of length less than 24 m**

**6.3.5.1 Application**

The criteria in this Clause apply to monohull vessels that set sail of length less than 24 m. They are additional to the criteria of general application in Chapter 4 and Chapter 5 and are subject to Clauses 6.3.2 and 6.3.3.

NOTES:

1. Alternative comprehensive criteria are specified in Clause 6.3.4.
2. Alternative simplified criteria for specified sheltered water vessels of length less than 15 m are specified in Clause 8.3.

**6.3.5.2 Criteria**

A vessel that complies with the criteria listed in Table 16 for all combinations of sail over the range of loading conditions during which sail may be set shall be deemed to satisfy the Chapter 6B criteria.

**Table 16 — Chapter 6B criteria—Alternative additional criteria for monohull vessels that set sail of length less than 24 m**

Criterion No	Limits to application	Chapter 6B criterion description
6B.1	All vessels	The righting lever ( $G_fZ$ ) curve for each condition of loading shall demonstrate that the vessel has a minimum positive range of stability of at least 110 degrees.
6B.2	All vessels	The angle of heel $\theta_h$ obtained from the intersection of the mean wind heeling lever curve, with the righting lever ( $G_fZ$ ) curves for each condition shall be greater than 15 degrees.
6B.3	All vessels	No opening regardless of size which may lead to progressive downflooding shall be immersed at an angle of heel of less than 40 degrees.  NOTE: Air pipes serving tanks that normally contain consumables or that are full during a particular condition of loading need not be considered as openings that may lead to progressive downflooding.

### 6.3.5.3 **Methods of calculation**

The windage area and wind heeling moment under sail shall be determined in accordance with Annex D. The mean wind heeling lever ( $HZ$ ) shall be calculated and plotted on each of the righting lever ( $G_fZ$ ) curves to determine the maximum recommended steady heel angle. The method for calculating the mean wind heeling lever shall be as specified in Annex K.

## 6.4 **SAIL CRITERIA FOR CATAMARANS**

### 6.4.1 **Application**

Clause 6.4 applies to catamaran vessels that set sail where the sail area has not been included as part of the windage area used for determining windage moment in applying general criteria.

NOTE: As an alternative to the criteria specified in this Clause, a vessel that sets relatively small steadying sails may be assessed using the stability criteria of general application if the area of sail is included in the windage calculation.

### 6.4.2 **Prerequisites for application of catamaran sail criteria**

The application of criteria that use a wind pressure less than that specified in Annex B is subject to the following prerequisites:

- a) A catamaran vessel that sets sail shall be arranged to allow ready and rapid handling of all sails by the crew over the anticipated range of wind and weather conditions, and without assistance from other personnel. Sails shall be arranged so that they can be effectively and quickly—
  - i) eased to spill wind in gusting or squall conditions; and
  - ii) reefed and/or furled to avoid excessive heeling moments in high wind or squall conditions, or in anticipation of such conditions.

NOTE: A vessel that sets spinnakers or other similar sails that are relatively cumbersome to quickly ease, reef or furl would need to be assessed as a proposal for an equivalent solution; see Part B of this Standard.

- b) The vessel shall be provided with an auxiliary means of propulsive power sufficient to control and manoeuvre the vessel when under bare poles.
- c) Deck openings shall be fitted with weathertight closures arranged to minimise the possibility of flooding the hull at large angles of heel.

### 6.4.3 **Movable ballast arrangements**

Catamaran vessels fitted with arrangements that modify the stability characteristics of the vessel while underway (such as water ballast systems or keels that raise or lower) shall comply with the relevant stability criteria in all intended conditions of operation.

### 6.4.4 **Chapter 6C criteria—Additional comprehensive criteria for catamaran vessels that set sails**

#### 6.4.4.1 **Application**

The criteria in this Clause apply to catamaran vessels that set sails. It is additional to the general criteria in Chapter 4 and Chapter 5 and subject to Clauses 6.4.2 and 6.4.3.

NOTE: Alternative simplified criteria for sheltered water catamarans of length less than 15 m are specified in Clause 8.4.

#### 6.4.4.2 Criteria

A vessel that complies with the criteria listed in Table 17 for all amidships without reefing and over the range of loading conditions during which sail may be set shall be deemed to satisfy the Chapter 6C criteria.

NOTE: The criteria specified within this Subsection do not address the risks of pitching that can arise with some catamaran sailing vessels<sup>1</sup>. Longitudinal stability is likely to become a factor if:

$$\frac{L_H}{B_H} < 2$$

where

$L_H$  = the overall length of each hull, in metres

$B_H$  = The distance between the centre lines of the two hulls, in metres

**Table 17 — Chapter 6C criteria—Additional comprehensive criteria for catamaran vessels that set sail**

Criterion No	Limits to application	Chapter 6C criterion description
6C.1	All vessels within application clause	With all <i>plain sail</i> set and subject to a steady beam wind corresponding to a pressure of 100 Pa (equivalent to 25 knots average), the value of $G_{fZ}$ at the point of intersection of the wind heeling lever curve shall not exceed 25 per cent of the maximum value of $G_{fZ}$ .
6C.2	All vessels within application clause	The maximum permissible steady wind speed specified for combinations of sail other than all <i>plain sail</i> shall be such that the value of $G_{fZ}$ at the point of intersection of the wind heeling lever curve shall not exceed 25 per cent of the maximum value of $G_{fZ}$ .

#### 6.4.4.3 Methods of calculation

The windage area and wind heeling moment under sail shall be determined in accordance with Annex D.

NOTE: Annex D is inaccurate for sailing catamarans operating at large angles of heel because it makes no allowance for the added windage area of the bridging deck as the windward hull emerges. However, the criteria are predicated on the fact that the windward hull is not to emerge in normal operation.

### 6.5 VESSELS ENGAGED IN LIFTING

#### 6.5.1 Application

Clause 6.5 applies to vessels engaged in lifting.

EXAMPLES:

Lifting cargo, catch or stores using a crane, derrick or sheerlegs

Lifting of anchors or moorings over stern rollers of an *offshore supply vessel*

<sup>1</sup> Blythe, A.G. Stability Criteria for Multi-hull Sailing Vessels, RINA conference on Small Craft Regulations, 2004.

Lifting masses from the sea bottom on salvage vessels  
 Operations using a winch to recover a snagged net on trawlers  
 Lifting the cod end on trawlers, purse seiners and other fishing vessels that utilise large nets

### 6.5.2 Exclusions

Unless specifically identified as a potential capsizing hazard, these criteria need not be applied to activities—

- a) involving the lifting of the vessel's own structures or equipment, or  
 EXAMPLES:  
 Ship's anchors  
 Survival craft  
 Accommodation ladders  
 Equipment for man overboard recovery  
 Vehicle ramps
- b) where the maximum heeling moment due to the lift is less than the following:

$$M_L < 0.67 \Delta G_F M_0 \left( \frac{F}{B} \right)$$

where

$M_L$  = the maximum heeling moment due to the lift, in tonne-metres

$\Delta$  = The mass *displacement* of the vessel including the lift load, in tonnes

$G_F M_0$  = Initial metacentric height including the effect of the lift load, in metres

$F$  = Freeboard to the deck edge *amidships*, in metres

$B$  = Breadth of vessel, in metres

### 6.5.3 Vessels engaged in lifting that employ counter ballasting or counterweights

In addition to the Chapter 6D or 6E criteria specified in this Subsection, a vessel that employs counter ballasting or counterweights when lifting shall also comply with the Chapter 6F criteria.

NOTE: The combination of off-centre mass and dynamic effects that arises if a vessel that relies on counter ballasting or counterweights to reduce heel when lifting suddenly loses its load can seriously compromise stability.

### 6.5.4 Chapter 6D criterion—Additional comprehensive criterion for vessels that lift masses

#### 6.5.4.1 Application

Subject to Clause 6.5.2 the criterion in this Clause applies to vessels that lift masses. It is additional to the general criteria in Chapter 4 and Chapter 5 and subject to Clause 6.5.3.

## NOTES:

1. Alternative comprehensive criteria are specified in Clause 6.5.5.
2. Alternative simplified criteria for sheltered water crane barges are specified in Clause 8.5.

**6.5.4.2 Criteria**

A vessel that complies with the criterion listed in Table 18 over the range of loading conditions during which the vessel is engaged in lifting shall be deemed to satisfy the Chapter 6D criterion.

**Table 18 — Chapter 6D criterion—Additional comprehensive criterion for vessels engaged in lifting**

Criterion No	Limits to application	Chapter 6D criterion description
6D.1	All vessels specified in Clause 6.5.1, excluding those in Clause 6.5.2	The residual area $A_R$ beneath the <i>righting lever curve</i> and above the <i>heeling lever curve</i> up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 40 per cent of the total area under the modified <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).
6D.2	All vessels specified in Clause 6.5.1, excluding those in Clause 6.5.2	The angle of heel $\theta_h$ shall not exceed $\theta_s$ degrees (see Table 4) when the load heeling lever is applied.

**6.5.4.3 Methods of calculation**

The loading conditions and heeling lever curve specified in Clause 6.5.4.2 shall be calculated using a heeling moment determined in accordance with Annex E.

**6.5.5 Chapter 6E criteria—Alternative additional comprehensive criteria for vessels that lift masses****6.5.5.1 Application**

Subject to Clause 6.5.2 the criterion in this Clause applies to vessels that lift masses. They are additional to the general criteria specified in Chapter 4 but replace the general criteria in Chapter 5 for the loading conditions during which the vessel is engaged in lifting and are also subject to Clause 6.5.3.

## NOTES:

1. An alternative comprehensive criterion is specified in Clause 6.5.4.
2. Alternative simplified criteria for sheltered water crane barges are specified in Clause 8.5.

**6.5.5.2 Criteria**

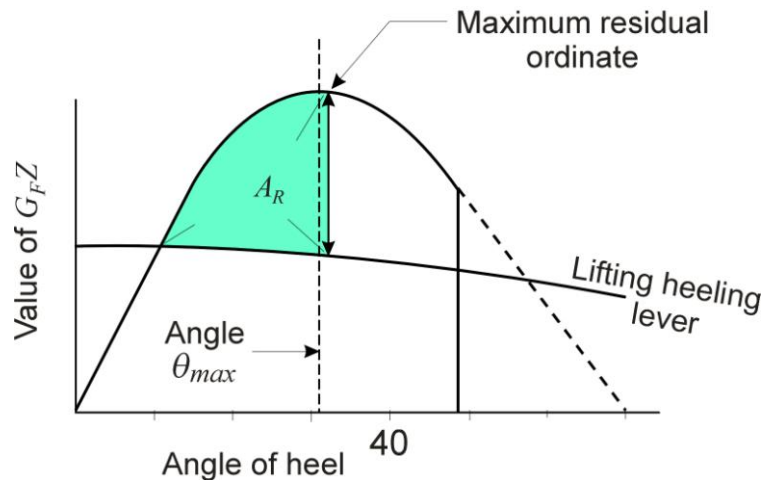
A vessel that complies with the criteria listed in Table 19 over the range of loading conditions during which the vessel is engaged in lifting shall be deemed to satisfy the Chapter 6E criteria.



**Table 19 — Chapter 6E criteria—Additional comprehensive criteria for vessels engaged in lifting**

Criterion No	Limits to application	Chapter 6E criterion description
6E.1	All vessels specified in Clause 6.5.1, excluding those in Clause 6.5.2	The angle of downflooding $\theta_f$ shall not be less than 40 degrees
6E.2a	Seagoing vessels Operational areas A, B, C	The vessel shall have residual area $A_R$ measured beneath the <i>righting lever curve</i> and above the load heeling lever curve to the maximum residual ordinate (see Figure 11), or 40 degrees, whichever is less, not less than 4.58 metre-degrees.
6E.2b	Sheltered water vessels Operational areas D, E	The vessel shall have residual area $A_R$ measured beneath the <i>righting lever curve</i> and above the load heeling lever curve to the maximum residual ordinate (see Figure 11), or 40 degrees, not less than 3.05 metre-degrees.
6E.3	All vessels specified in Clause 6.5.1, excluding those in Clause 6.5.2	The angle of heel $\theta_h$ shall not exceed $\theta_s$ degrees (see Table 4) when the load heeling lever is applied.

NOTE: Where the heeling lever reduces with increasing angle of heel, the maximum residual ordinate occurs at an angle slightly larger than the angle of maximum  $G_{FZ}$ .

**Figure 11 — Residual dynamic stability to the maximum residual ordinate****6.5.5.3 Methods of calculation**

The displacement,  $VCG$  and heeling lever curve specified in Clause 6.5.5.2 shall be calculated in accordance with Annex E.

**6.5.6 Chapter 6F criterion—Additional comprehensive criterion for vessels that employ counter ballasting or counterweights when engaged in lifting**

**6.5.6.1 Application**

The criteria in this Clause apply to vessels that employ counter ballasting or counterweights when lifting masses. They are additional to the Chapter 6D or 6E criteria for vessels lifting masses.

**6.5.6.2 Criteria**

A vessel that complies with the applicable criterion listed in Table 20 over the range of loading conditions during which the vessel is engaged in lifting shall be deemed to satisfy the Chapter 6F criterion.

**Table 20 — Chapter 6F criterion—Additional comprehensive criterion for vessels that employ counter ballasting or counterweights when engaged in lifting**

Criterion No	Limits to application	Chapter 6F criterion description
6F.1a	Seagoing vessels Operational areas A, B, C	The area above the righting lever ( $G_{RZ}$ ) without load curve and below the counter ballast (or counterweight) moment curve up to the angle of downflooding or the point at which positive stability is lost (Area 2) shall be greater than the area below the <i>righting lever curve</i> with load released up to the steady angle of heel before the load was released (Area 1) plus 2.12 metre-degrees, see Figure 12.
6F.1b	Sheltered water vessels Operational areas D, E	The area above the righting lever ( $G_{RZ}$ ) without load curve and below the counter ballast (or counterweight) moment curve up to the angle of downflooding or the point at which positive stability is lost (Area 2) shall be greater than the area below the <i>righting lever curve</i> with load released up to the steady angle of heel before the load was released (Area 1), see Figure 12.

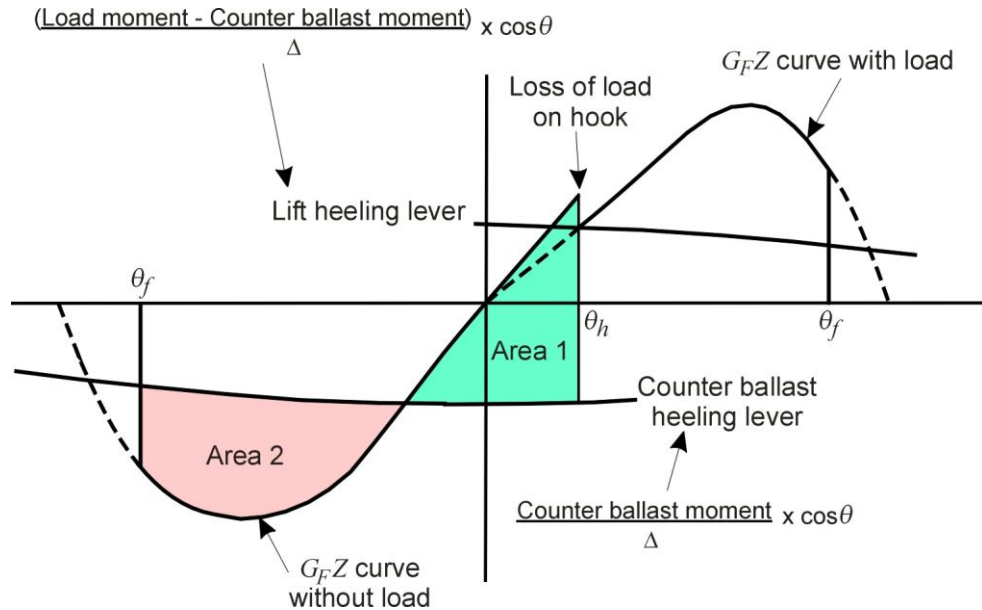


Figure 12 — Criteria for counter balance

### 6.5.6.3 Methods of calculation

The loading conditions and heeling lever curve specified in Clause 6.5.4.2 shall be calculated in accordance with Annex E, but as modified by this Clause.

The righting lever  $G_FZ$  curve used to calculate Area 1 and Area 2 (representative of the righting and heeling energy) is determined at the draft and vertical centre of gravity of the vessel without the load on the derrick or jib, see Figure 12.

The angle  $\theta_h$  is determined from the intersection of the righting lever ( $G_FZ$ ) curve and (jib heel moment—counter ballast moment) curve calculated for the vessel with the load on the jib.

NOTES:

1. The key variables that are considered in this analysis are displacement, maximum vertical moment; crane load radius; and the configuration of the counter ballast or counterweight.
2. The righting lever  $G_FZ$  curve will be discontinuous at the equilibrium angle (hook load side), since displacement and centre of gravity above keel  $KG_F$  change with loss of hook load (See Figure 12).

## 6.6 VESSELS ENGAGED IN TOWING

### 6.6.1 Application

Clause 6.6 applies to vessels engaged in towing by means of a tow-rope where—

- a) the vessel being towed is likely to exceed twice the displacement of the towing vessel; or
- b) the drag of the tow at a speed of 3 knots exceeds the bollard pull of the vessel.

It excludes pushing operations and operations where a vessel tows by being lashed alongside.

NOTE: Many vessels arranged for towing by pushing or being lashed alongside will also, on occasion, tow by means of a tow-rope.

EXAMPLES:

Tugs

*offshore supply vessels*

Rescue and patrol vessels

Aquaculture vessels that tow large fish cages

### 6.6.2 Prerequisites for application of towing criteria

The application of towing criteria specified in Clause 6.6.3 is subject to the following prerequisites:

- a) The arrangements for attachment of the tow-rope on the towing vessel shall be designed to minimise any overturning moment which may occur as a result of the lead of the tow-rope.

NOTES:

1. Locating the point of attachment and leads of the tow-rope as low as possible on the vessel will reduce the magnitude of the tow-rope heeling moment.
2. Restraining the tow line from a vessel engaged in towing at sea by means of towing pins or a gobeye located toward the stern will help limit the magnitude of the yaw angle while underway.

- b) The point of attachment of the tow-rope on the towing vessel shall have a positive, safe and rapid means of quick release. The means of release shall function correctly under all conditions of towing, including when the tow-rope is under full load.

NOTE: Means for quick release include remotely operated release mechanisms on tow hooks, or remote declutching or tension limiting devices on tow winches.

- c) The tow hook on vessels propelled by screws on conventional fixed propeller shafts shall be fitted—
  - i) abaft the longitudinal centre of gravity (*LCG*) of the vessel; and
  - ii) at least 2 per cent of the measured length of the vessel aft of amidships.

### 6.6.3 Chapter 6G criterion—Additional comprehensive criterion for vessels engaged in towing

#### 6.6.3.1 Application

The criterion in this Clause applies to vessels engaged in towing. It is additional to the general criteria in Chapter 4 and Chapter 5 and subject to Clause 6.6.2.

#### 6.6.3.2 Criteria

A vessel that complies with the applicable criterion listed in Table 21 over the range of loading conditions during which the vessel is likely to engage in towing shall be deemed to satisfy the Chapter 6G criterion.

**Table 21 — Chapter 6G criterion—Additional comprehensive criterion  
for vessels engaged in towing**

Criterion No	Limits to application	Chapter 6G criterion description
<b>Vessels with propeller(s) on a conventional fixed propeller shaft</b>		
6G.1a	Seagoing vessels Operational areas A, B, C	Assuming a tow-rope angle of 0 degrees to the horizontal, the residual area ( $A_R$ ) beneath the <i>righting lever curve</i> and above the tow-rope heeling lever curve up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 1.03 metre-degrees plus 20 per cent of the total area under the <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).
6G.1b	Sheltered water vessels Operational areas D, E	Assuming a tow-rope angle of 30 degrees to the horizontal, the residual area ( $A_R$ ) beneath the <i>righting lever curve</i> and above the tow-rope heeling lever curve up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 1.03 metre-degrees plus 20 per cent of the total area under the <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).
<b>Vessels with azimuthing or cycloidal propeller(s)</b>		
6G.1c	Seagoing vessels Operational areas A, B, C	Assuming a tow-rope angle of 0 degrees to the horizontal, the residual area ( $A_R$ ) beneath the <i>righting lever curve</i> and above the tow-rope heeling lever curve up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 40 per cent of the total area under the <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).
6G.1d	Sheltered water vessels Operational areas D, E	Assuming a tow-rope angle of 30 degrees to the horizontal, the residual area ( $A_R$ ) beneath the <i>righting lever curve</i> and above the tow-rope heeling lever curve up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 40 per cent of the total area under the <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).

### 6.6.3.3 **Methods of calculation**

The Chapter 6G criterion specified in Clause 6.6.3.2 shall be calculated using the values of displacement, *VCG* and heeling lever curve using the methods specified in Annex F.

NOTE: The calculation in Annex F does not address the very large overturning levers that can arise from sudden loads on the tow-rope caused when the tow is moving at relatively high speeds. Such loads can occur on escort tugs (tugs that attend large vessels while passing through restricted waters). For escort duties, the magnitude of the overturning load may be as great as the breaking load of the tow-rope (exceeding the bollard pull of the vessel ( $P_{BP}$ ) that is assumed for the purposes of this minimum standard).

## 6.7 **VESSELS ENGAGED IN TRAWLING**

### 6.7.1 **Application**

Clause 6.7 applies to vessels engaged in towing trawl nets.

## EXAMPLES:

Prawn trawlers and other boom trawlers

Stern trawlers

Side trawlers

Research vessels

**6.7.2 Prerequisites for application of trawling criteria**

The application of trawling criteria specified in Clause 6.7.3 shall be subject to the owner of the vessel providing a declaration that either—

- a) confirms that the the effect on the vessel's stability of the intended trawling operations would be no worse than the loading conditions analysed against the minimum requirements of the relevant criteria; or
- b) describes in detail the trawling operations that could foreseeably have an effect on the vessel's stability that is worse than the minimum requirements specified in the relevant criteria.

NOTE: In the case of b) above, to meet the broader safety obligations listed in NSCV Part A, additional loading conditions showing compliance with the relevant criteria in the worst case scenario would be necessary.

**6.7.3 Chapter 6H criteria—Additional comprehensive criteria for vessels engaged in trawling****6.7.3.1 Application**

The criteria in this Clause apply to loading conditions where the vessel is engaged in trawling. They are additional to the general criteria in Chapter 4 and Chapter 5 and are subject to Clause 6.7.2.

**6.7.3.2 Criteria**

A vessel that complies with the criteria listed in Table 22 over the range of loading conditions during which the vessel is likely to engage in trawling shall be deemed to satisfy the Chapter 6H criteria.

**Table 22 — Chapter 6H criteria—Additional comprehensive criteria for vessels engaged in trawling**

Criterion No	Limits to application	Chapter 6H criterion description
6H.1	All vessels within application	<b>Snagged net:</b> The residual area $A_R$ beneath the <i>righting lever curve</i> and above the heeling lever curve from a snagged net up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 40 per cent of the total area under the modified <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).
6H.2	All vessels within application	<b>Attempted retrieval of a snagged net (stalled winch condition):</b> The residual area $A_R$ beneath the <i>righting lever curve</i> and above the heeling lever curve from attempting to retrieve a snagged net up to 40 degrees angle of heel (or up to the angle of downflooding, $\theta_f$ degrees, if this angle is less than 40 degrees) shall not be less than 40 per cent of the total area under the modified <i>righting lever curve</i> from 0 degrees to 40 degrees (or from 0 degrees to $\theta_f$ degrees).

### 6.7.3.3 **Methods of calculation**

The criterion specified for 6H.1 (Clause 6.7.3.2) shall be calculated using the values of displacement,  $VCG$  and heeling moment of a snagged fishing net calculated using the methods specified in Annex G.

Loading conditions shall include the effects of fish on deck, fish on a sorting table and/or the lifting of the cod end on deck (see Clause 6.5) where such operations may be carried out while the vessel is engaged in trawling operations. Such effects shall include an allowance for the 'free surface' of fish where fish would be free to slide as the vessel heels.

The criterion specified for 6H.2 (Clause 6.7.3.2) shall be calculated using the values of displacement,  $V_CG$  and heeling moment determined at the moment the trawl winch stalls while attempting to retrieve a snagged fishing net calculated using the methods specified in Annex E.

Where there is a high likelihood of downflooding of fish holds or brine tanks, the loading conditions shall include an investigation of the effect on compliance with the criteria of such spaces assumed full of sea water and with free surface. Spaces shall be deemed to be subject to such risks where —

- a) the opening to the particular fish hold or brine tank is likely to be left open for periods of time while the vessel is engaged in fishing; and
- b) that opening immerses at angles of heel that are less than the lesser of 40 degrees or angle of downflooding  $\theta_f$ .

## 6.8 **ADDITIONAL CRITERIA FOR SHELTERED WATER CRANE BARGES WHILE ON TRANSFER VOYAGES AT SEA**

### 6.8.1 **Application**

The criteria in Clause 6.8 apply to sheltered water *crane barges* while engaged in transfer voyages at sea. They are additional to the relevant criteria in Chapter 4 to Chapter 8 that apply when the vessel is engaged in sheltered waters operations.

#### NOTES:

1. These criteria do not replace the applicable criteria for a crane barge that is intended for operation at sea.
2. As an alternative to these criteria, the crane barge may comply with the relevant seagoing criteria of general application.

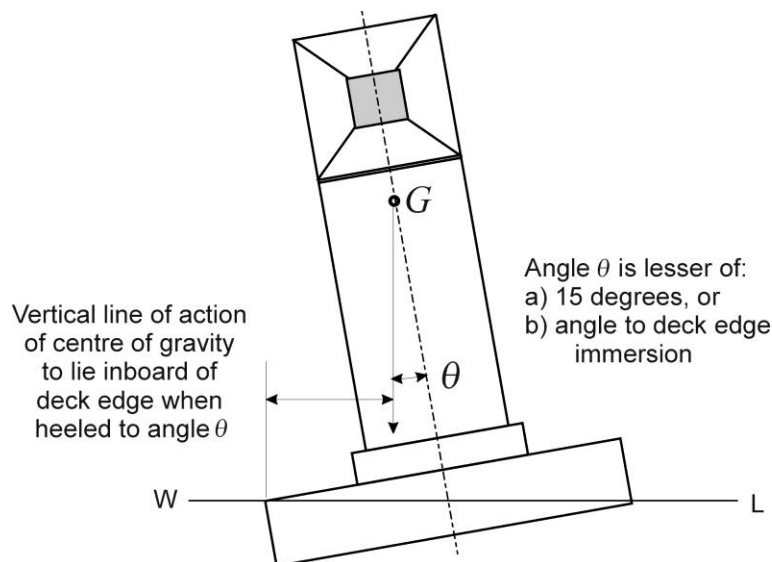
### 6.8.2 **Chapter 6J Criteria— Additional comprehensive criteria for sheltered water crane barges while on transfer voyages at sea**

A vessel that, for the range of loading conditions representative of transfer voyages at sea, complies with the criteria listed in Table 23 shall be deemed to satisfy the Chapter 6J criteria.

**Table 23 — Chapter 6J criteria—Additional comprehensive criteria for sheltered water crane barges while on transfer voyages at sea**

Criterion No	Limits to application	Chapter 6J criterion description
6J.1	All vessels within application clause	<p>The ratio between the minimum capsizing moment <math>M_C</math> and the wind heeling moment <math>M_W</math> when applied to the lateral profile area shall not be less than 1.75, i.e.</p> $\frac{M_{C0}}{M_{W0}} \geq 1.75$ <p>where</p> <p><math>M_{C0}</math> = the minimum straight line (i.e.; constant as at the value at 0° heel) capsizing moment, in tonne-metres</p> <p><math>M_{W0}</math> = the wind heeling moment at 0° heel determined in accordance with Annex B, in tonne-metres</p>
6J.2	All vessels within application clause	<p>When subjected to the wind moment <math>M_W</math>, the craft shall not heel to an angle where a vertical line through the centre of gravity would lie beyond the deck edge or to an angle of 15 degrees whichever is the lesser, see Figure 13 and Note.</p>

NOTE: To meet this criterion, it may be necessary that the crane structure be partially dismantled and lowered and/or additional ballast be provided.



**Figure 13 — Heeled crane barge showing line of centre of gravity within deck edge of barge**

**6.8.2.1 Methods of calculation**

The minimum capsizing moment,  $M_C$  shall be obtained using the following procedure (see also Figure 14):



- Determine the dynamic stability curve being the integral of the *righting lever curve*  $G_F Z$  (i.e.  $\int G_F Z d\theta$ ).
- On the dynamic stability curve, draw a line  $AC$  tangential to the dynamic stability curve.
- Draw a vertical line  $BC$  at 57.3 degrees (one radian) from the origin point  $A$ .
- Calculate the minimum capsizing moment  $M_{C0}$  from the following formula:

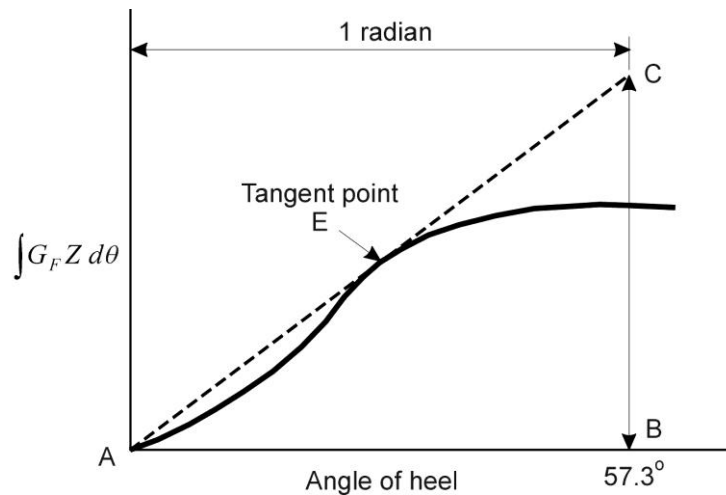
$$M_{C0} = \Delta \times BC$$

where

$M_{C0}$  = the minimum capsizing moment at 0 degrees of heel, in tonne- metres

$\Delta$  = vessel displacement, in tonnes

$BC$  = the vertical dimension measured from Figure 14, in metres



**Figure 14 — Curve of dynamic stability**

## 6.9 ADDITIONAL CRITERIA FOR SHELTERED WATER BUCKET DREDGERS WHILE ON TRANSFER VOYAGES AT SEA

### 6.9.1 Application

The criteria in Clause 6.9 apply to sheltered water bucket *dredgers* while engaged in transfer voyages at sea. They are additional to the relevant criteria in Chapter 4 to Chapter 8 that apply when the vessel is engaged in sheltered waters operations.

NOTES:

- These criteria do not replace the applicable criteria for a bucket dredger that is intended for operation at sea.
- As an alternative to these criteria, the bucket dredger may comply with the relevant seagoing criteria of general application.

### 6.9.2 Chapter 6K Criteria— Additional criteria for sheltered water bucket dredgers while on transfer voyages at sea

A vessel that, for the range of conditions of loading representing transfer voyages at sea, complies with the criteria listed in Table 24 shall be deemed to satisfy the Chapter 6K criteria.

**Table 24 — Chapter 6K criteria—Additional criteria for sheltered water bucket dredgers while on transfer voyages at sea**

Criterion No	Limits to application	Chapter 6K criterion description
6K.1	All vessels within application clause	The freeboard shall be sufficient to prevent the <i>freeboard deck</i> edge becoming immersed at an angle of heel of less than 12.5 degrees.
6K.2	All vessels within application clause	The range of stability to the <i>downflooding angle</i> $\theta_f$ shall be at least 45 degrees.
6K.3	All vessels within application clause	The maximum $G_{FZ}$ value shall be at least 0.61 metres.
6K.4	All vessels within application clause	The metacentric height $G_{FM_0}$ shall be at least 1.22 metres.

NOTE: To meet this criterion, it may be necessary that the ladder on the bucket dredger be partially dismantled and lowered and/or additional ballast be provided.

## CHAPTER 7 SIMPLIFIED CRITERIA OF GENERAL APPLICATION

### 7.1 SCOPE

This Chapter specifies simplified criteria of general application that, if applicable, may be substituted instead of the comprehensive criteria of general application specified in Chapter 5.

#### NOTES:

1. Simplified criteria provide alternative means to verify compliance with the deemed-to-satisfy standard of intact stability that are simpler to apply than comprehensive criteria.
2. Simplified criteria are based upon assumptions and approximations and so are not suited to vessels that fall outside the parameters of form and/or operation specified in the application of those criteria.
3. A failure of a vessel to be able to apply or comply with simplified criteria does not necessarily mean that the vessel would fail comprehensive criteria. The vessel can still be assessed against the relevant comprehensive criteria.

### 7.2 APPLICATION

This Chapter applies to the vessels specified in Table 25, subject to the applicable limits of application specified for the particular suite of simplified stability.

**Table 25 — Simplified stability of general application**

Area of operation	Limitations on length	Other conditions	Suite of criteria	Applicable clause
C	Less than 20 m	As per Clause 7.3.2	Ch. 7A	7.3
		As per Clause 7.4.2	Ch. 7B	7.4
	Less than 12 m	collared vessels as per Clause 7.5.2	Ch. 7C	7.5
D, E	Less than 35 m	As per Clause 7.3.2	Ch. 7A	7.3
		As per Clause 7.4.2	Ch. 7B	7.4
	Less than 12 m	collared vessels as per Clause 7.5.2	Ch. 7C	7.5
	Less than 7.5 m	As per Clause 7.6.2	Ch. 7D	7.6
	Less than 20 m	Catamarans, as per Clause 7.7.2	Ch. 7E	7.7
	Less than 50 m	Dumb barges	Ch. 7F	7.8

### 7.3 CHAPTER 7A CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION IN OPERATIONAL AREAS C, D AND E

#### 7.3.1 Scope

Clause 7.3 provides an alternate means of verifying compliance with the intact stability requirements of this Standard by specifying criteria that allow the application of a practical inclining experiment, without the need to

determine  $KN$  data, analyse loading conditions and also, in many cases, determine hydrostatic data.

NOTE: The procedure for undertaking a practical inclining experiment is specified in Subsection 6C.

### 7.3.2 Application

Clause 7.3 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel—

- a) operates within operational areas C, D or E;
- b) has a measured length less than—
  - i) 20 m in operational area C, or
  - ii) 35 m in operational areas D or E;
- c) carries not more than 49 passengers;
- d) has not more than one deck above the freeboard deck, exclusive of a wheelhouse; and
- e) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

NOTE: There is no benefit to applying simplified intact criteria on vessels that require comprehensive analysis to verify compliance with the damaged stability standards specified in Subsection 6C.

### 7.3.3 Prerequisites for application of Chapter 7A criteria

#### 7.3.3.1 No sudden changes in waterplane area

The waterplane of the vessel over the range of loading conditions shall not significantly reduce in area or moment of inertia as the vessel heels.

A vessel shall be deemed to satisfy this requirement if the deck edge does not immerse and the chine does not emerge when the vessel is heeled to angles  $2\theta_R$  and  $\theta_R$  respectively, see Clause 7.3.5.4. A vessel that is unable to satisfy this requirement may also be deemed to satisfy provided conservative factors of safety are applied, see Clause 7.3.5.5.

NOTE: Chapter 7A criteria are based on the assumption that a vessel's stability characteristics in the upright condition reflect the stability characteristics over the relevant range of heel angles. This assumption is only valid provided the shape of the waterplane area does not significantly alter. The criteria are best suited to displacement vessels of round bilge or deep chine hull form.

#### 7.3.3.2 Decks on seagoing vessels that carry passengers

##### 7.3.3.2.1 Drainage of water

Vessels that carry passengers within operational area C shall have means to drain the decks of water, without assistance of propulsive power and forward motion.

##### 7.3.3.2.2 Minimum freeboard

The minimum freeboard on vessels that carry passengers within operational area C measured to the lowest weathertight deck shall not be less than the value specified in Table 26.

**Table 26 — Minimum freeboard prerequisite for Chapter 7A criteria for vessels that carry passengers to sea**

Measured length $L_m$ (m)	Minimum freeboard (mm)	
	All vessels within application except for specified vessels that carry passengers that are all divers	Alternative for vessels that carry passengers not more than 5 nm to sea where the passengers are all divers
Less than 6 m	150	150
6 m to 10 m	$150 + \frac{(L_m - 6) \times 100}{4}$	150
More than 10 m	250	150

**7.3.4 Criteria**

A vessel that complies with the criteria listed in Table 27 shall be deemed to satisfy the Chapter 7A criteria.

**Table 27 — Chapter 7A criteria—Alternative simplified criteria of general application in operational areas C, D and E**

Criterion No	Limits to application	Chapter 7A criterion description
7A.1	All vessels within application clause	<p>The vessel at the relevant <i>displacement</i> shall have an initial metacentric height <math>G_F M_o</math>, not less than the largest of the values calculated from the following formulae:</p> $G_F M_o = F_S \frac{M_P}{\Delta \tan \theta_R}$ $G_F M_o = F_S \frac{M_W}{\Delta \tan \theta_R}$ $G_F M_o = F_S \frac{M_T}{\Delta \tan \theta_R}$ <p>where</p> <ul style="list-style-type: none"> <li><math>G_F M_o</math> = the required net initial metacentric height, in metres</li> <li><math>F_S</math> = factor of safety determined in accordance with Clause 7.3.5.5</li> <li><math>M_P</math> = the persons crowding moment in the upright condition (<math>\theta = 0</math>), in tonne-metres</li> <li><math>M_W</math> = the wind heeling moment in the upright condition (<math>\theta = 0</math>), in tonne-metres</li> <li><math>M_T</math> = turning moment in the upright position (<math>\theta = 0</math>), in tonne-metres</li> <li><math>\Delta</math> = the vessel <i>displacement</i>, determined in accordance with Clause 7.3.5.2, in tonnes</li> <li><math>\theta_R</math> = an angle representing the maximum reliable angle of heel, calculated from the geometry of the vessel in accordance with Clause 7.3.5.4, in degrees</li> </ul>

### 7.3.5 Methods of testing and calculation

#### 7.3.5.1 Standard tests and calculations

The parameters specified in Clause 7.3.4 shall be determined in accordance with Table 28.

**Table 28 — Standard tests and calculations for Chapter 7A criteria**

<i>Parameter</i>	<i>Test</i>	<i>Magnitude</i>
$G_F M_0$	Practical inclining experiment see Subsection 6C	Clause 7.3.5.3
$\Delta$	Practical inclining experiment see Subsection 6C	Clause 7.3.5.2
$M_P$	N/A	Annex A
$M_W$	N/A	Annex B
$M_T$	N/A	Annex C

#### 7.3.5.2 Displacement $\Delta$

The displacement shall represent the vessel in the worst of the following two conditions of loading for intact stability—

- a near light condition, but with all persons on board and tanks 25 per cent full (to provide free surface); and
- a near laden condition, but with all tanks 75 per cent full (to provide free surface).

Where the worst condition of loading is not evident, then compliance shall be determined in both conditions.

NOTE: Either two simplified inclining tests are carried out or the result of a single test is used to determine by calculation compliance of the second condition by working through a loading condition and applying hydrostatic data.

#### 7.3.5.3 Metacentric height $G_F M_0$

The metacentric height shall be determined assuming any persons are distributed to give the maximum height of the centre of gravity. On vessels having a deck above the freeboard deck that is accessible to passengers, the mass of passengers on the upper deck for the purposes of determining  $G_F M_0$  shall be increased by 33 per cent. The mass of passengers on the freeboard deck shall be the total mass of passengers less the assumed mass of passengers on the upper deck for the purposes of determining  $G_F M_0$ .

#### 7.3.5.4 Maximum reliable angle of heel $\theta_R$

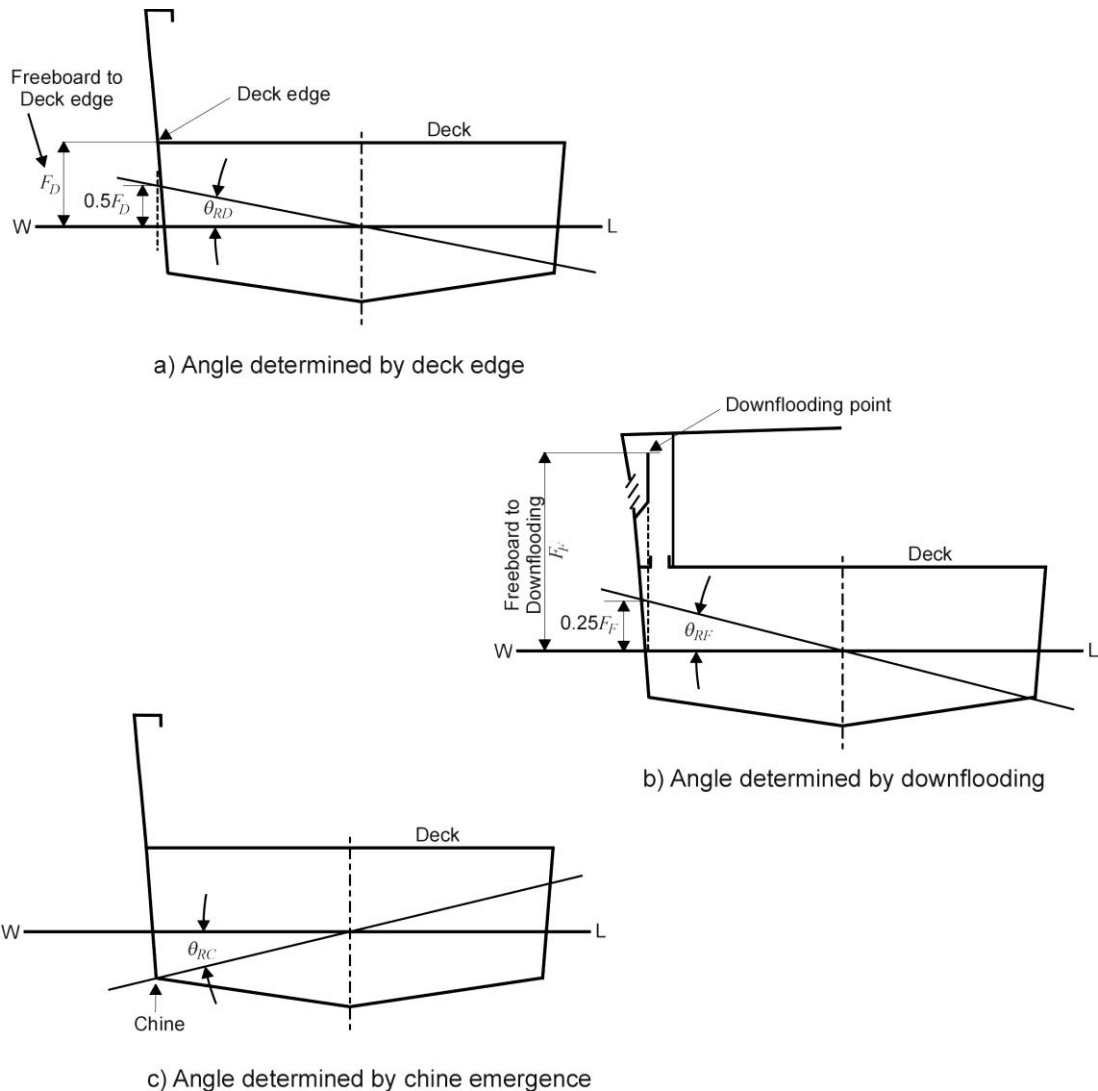
The maximum reliable angle of heel shall be determined by the least value of the angle of heel  $\theta_R$ , in degrees at—

- 50 per cent of the freeboard to the deck edge, see  $\theta_{RF}$  in Figure 15 a);
- 25 per cent of the freeboard to the first point of downflooding, see  $\theta_{RD}$  in Figure 15 b);

NOTE: Part C Section 2 specifies requirements for openings that prevent or significantly reduce the ingress of water from transient immersion. A dorade box, labyrinth or similar device is used to provide such protection for ventilation openings in the exposed topsides of a seagoing vessel.

- c) the angle of heel in degrees at which the chine of a vessel having only a single hard chine emerges, see  $\theta_{RC}$  in Figure 15 c); and
- d) the maximum allowable angle of heel from a single heeling moment  $\theta_S$  degrees (see Table 4).

NOTE: Methods for determining freeboard are provided in Subsection 6C, including adjustments for decked vessels having a discontinuous sheer.



**Figure 15 — Determination of maximum reliable angle of heel  $\theta_R$**

### 7.3.5.5 Correction factor $F_S$

NOTE: The Chapter 7A criteria assume that the vessel's stability characteristics in the upright position are representative of the stability over a range of angles of heel. This assumption may become invalid if parts of the deck edge immerses or chine emerges at relatively small angles of heel. The correction factor  $F_S$  allows the criteria to apply to vessels notwithstanding likely early changes in waterplane area as the vessel heels. A factor of safety is determined that assumes that the waterplane area is reduced in direct proportion to the change in immersed deck or emerged chine length.

Where a portion of the length of chine emerges or deck immerses before the maximum reliable angle of heel, an adjustment to the required value of  $G_{FM_0}$  may be applied determined by a factor  $F_s$ , calculated as follows:

$$F_s = F_C F_D$$

where

$F_C$  = a factor to compensate for chine emergence

= the greater of  $L_{CU}/L_{CH}$  and 1

where

$L_{CU}$  = the length of the immersed hard chine when upright, in metres, see Figure 16

$L_{CH}$  = the length of the immersed hard chine on the emerging side of the hull when heeled to an angle  $\theta_R$ , in metres, see Figure 16

$F_D$  = a factor to compensate for deck immersion

= the greater of  $L_{DU}/L_{DH}$  and 1

where

$L_{DU}$  = the length of the emerged deck when upright, in metres, see Figure 16

$L_{DH}$  = the length of the emerged deck on the immersing side of the hull when heeled to an angle  $2\theta_R$ , in metres, see Figure 16

Chapter 7A criteria shall not be applied to a vessel if either  $F_C$  or  $F_D$  exceeds 1.33.

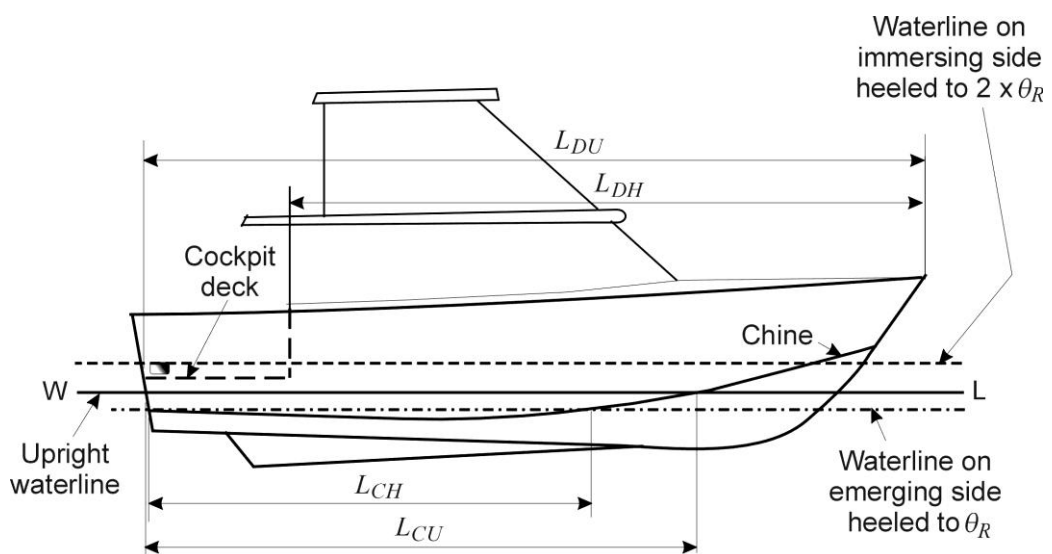


Figure 16 — Lengths used in calculation of correction factor



## **7.4 CHAPTER 7B CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION IN OPERATIONAL AREAS C, D AND E**

### **7.4.1 Scope**

Clause 7.4 provides a simplified means of verifying compliance with the intact stability requirements of this Standard by specifying criteria that allow the application of a stability proof test without the need to determine lightship particulars, loading conditions, *KN* data and hydrostatic data.

NOTE: The procedure for undertaking a stability proof test is specified in Subsection 6C.

### **7.4.2 Application**

Clause 7.4 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel—

- a) operates within operational areas C, D or E;
- b) has a measured length less than—
  - i) 20 m in operational area C, or
  - ii) 35 m in operational areas D or E;
- c) carries not more than 49 passengers;
- d) has not more than one deck above the freeboard deck, exclusive of a wheelhouse; and
- e) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

NOTE: There is no benefit to applying simplified intact criteria on vessels that require comprehensive analysis to verify compliance with the damaged stability standards specified in Subsection 6C.

### **7.4.3 Prerequisites for application of Chapter 7B criteria**

#### **7.4.3.1 General characteristics**

Chapter 7B criteria shall only be applied to a vessel that meets the following assumptions: (also in 7.3.3)

- a) The stability characteristics of the vessel over the normal range of loading conditions do not alter significantly.
- b) The waterplane of the vessel does not alter significantly in area or moment of inertia as the vessel heels. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to deck or gunwale remains within the maximum values specified during a stability proof test.
- c) Downflooding of buoyant spaces does not occur at relatively small angles of heel. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to downflooding of buoyant spaces remains within the maximum values specified during a stability proof test.

NOTE: Chapter 7B criteria are based on the assumption that the vessel has a reserve of stability beyond the angle attained during the stability proof test.

### 7.4.3.2 Decks on seagoing vessels that carry passengers

#### 7.4.3.2.1 Minimum freeboard

Vessels that carry passengers within operational area C shall have a minimum freeboard to the lowest weathertight deck in accordance with Table 29.

**Table 29 — Minimum freeboard prerequisite for application of Chapter 7B criteria for vessels that carry passengers to sea**

Measured length $L_m$ (m)	Minimum freeboard (mm)	
	All vessels within application except for specified vessels that carry passengers that are all divers	Alternative for vessels that carry passengers not more than 5 nm to sea where the passengers are all divers
Less than 6 m	150	150
6 m to 10 m	$150 + \frac{(L_m - 6)}{4} \times 100$	150
More than 10 m	250	150

#### 7.4.3.2.2 Drainage of water

Vessels that carry passengers within operational area C shall have means to drain the decks of water, without assistance of propulsive power and forward motion, see NSCV Part C Section 2.

### 7.4.4 Testing

#### 7.4.4.1 Loading condition

The conduct of the stability proof test shall comply with the following:

- The vessel shall be tested in a loading condition representative of normal trim and most unfavourable vertical centre of gravity (*VCG*) likely to occur in normal service (see also Clause 7.4.4.2).

NOTE: The loading condition may include dive bottles and racks, fishing equipment, stores, and tanks nearly full or nearly empty.

- Non-return closures on freeing ports or scuppers shall be held in the open position to allow entry of water on the cockpit or well deck.
- The stability proof test shall be undertaken with masses representing any persons distributed to give the maximum height of the centre of gravity.
- On vessels having a deck above the freeboard deck that is accessible to passengers, the total mass of passengers on the upper deck for the purposes of the stability proof test shall be increased by 33 per cent, and the total mass of passengers on the main decks reduced by the same amount.

#### 7.4.4.2 Displacement $\Delta$

The vessel shall be tested when in the worst of the following two conditions of loading for intact stability—

- a) a near light condition, but with all persons on board and tanks 25 per cent full (to provide free surface); and
- b) a near laden condition, but with all tanks 75 per cent full (to provide free surface).

Where the worst condition of loading is not evident, then compliance shall be determined in both conditions.

NOTE: Either two simplified inclining tests are carried out or the result of a single test is used to determine by calculation compliance of the second condition by working through a loading condition and applying hydrostatic data.

#### 7.4.5 Criteria

A vessel that complies with the criteria listed in Table 30 shall be deemed to satisfy the Chapter 7B criteria.

**Table 30 — Chapter 7B criteria—Alternative simplified criteria of general application in operational areas C, D and E**

Criterion No	Limits to application	Chapter 7B criterion description
7B.1	All vessels within Application Clause	The angle of heel shall not exceed $\theta_s$ degrees (see Table 4) when the most severe of the individual heeling moments due to person crowding, wind or turning is applied.
7B.2a	<i>flush decked vessel</i>	The inclined freeboard <sup>(A)</sup> when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than 50 per cent of the minimum upright freeboard $F_D$ measured from the waterline to the deck, (see Figure 17a)).
7B.2b	<i>well deck vessel</i> Operational area C	The inclined freeboard <sup>(A)</sup> when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than 50 per cent of the minimum upright freeboard $F_D$ measured from the waterline to the well deck (see Figure 17b)).
7B.2c	<i>well deck vessel</i> Operational areas D and E	On vessels with scuppers, or with <i>freeing ports</i> fitted with non-return closures, as an alternative to criterion 7B.2.b, the inclined freeboard <sup>(A)</sup> when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than 75 per cent of the minimum upright freeboard $F_G$ measured from the waterline to the top of the gunwale, (see Figure 17c)).
7B.2d	<i>cockpit vessel</i> Operational area C	The inclined freeboard <sup>(A)</sup> when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than the minimum upright freeboard measured from the waterline to the top of the gunwale $F_G$ less the maximum allowable loss of freeboard $\delta_f$ . The value of $\delta_f$ shall be calculated by the following formula (see Figure 17d)):

(Continued)

Table 30 (Continued)

Criterion No	Limits to application	Chapter 7B criterion description
7B.2d	<i>cockpit vessel</i> Operational area C	$\delta_f \leq \frac{F_G (2L - 1.5C)}{4L}$ <p>where</p> <p><math>\delta_f</math> = the maximum allowable loss of freeboard, in metres</p> <p><math>F_G</math> = the freeboard, in metres, measured from the waterline to the top of the gunwale when vessel is upright</p> <p><math>L</math> = the measured length of vessel in metres</p> <p><math>C</math> = the length of cockpit in metres</p>
7B.2e	<i>cockpit vessel</i> Operational areas D and E	<p>The inclined freeboard(A) when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than the minimum upright freeboard measured from the waterline to the top of the gunwale FG less the maximum allowable loss of freeboard <math>\delta_f</math>. The value of <math>\delta_f</math> shall be calculated by the following formula (see Figure 17d):</p> $\delta_f \leq \frac{F_G (2L - C)}{4L}$ <p>where</p> <p><math>\delta_f</math> = the maximum allowable loss of freeboard, in metres</p> <p><math>F_G</math> = the freeboard, in metres, measured from the waterline to the top of the gunwale when vessel is upright</p> <p><math>L</math> = the measured length of vessel in metres</p> <p><math>C</math> = the length of cockpit in metres</p>
7B.2f	<i>open vessel</i>	The inclined freeboard(A) when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than 75 per cent of the upright freeboard FG measured from the waterline to the top of the gunwale (see Figure 17e)).
7B.3	All vessels	The inclined freeboard(A) when any of the individual heeling moments due to person crowding, wind or turning is applied shall not be less than 75 per cent of the upright freeboard FF measured from the waterline to the point of downflooding (see Figure 18).

## KEY:

(A) Methods for determining freeboard are provided in Subsection 6C, including adjustments for decked vessels having a discontinuous sheer.

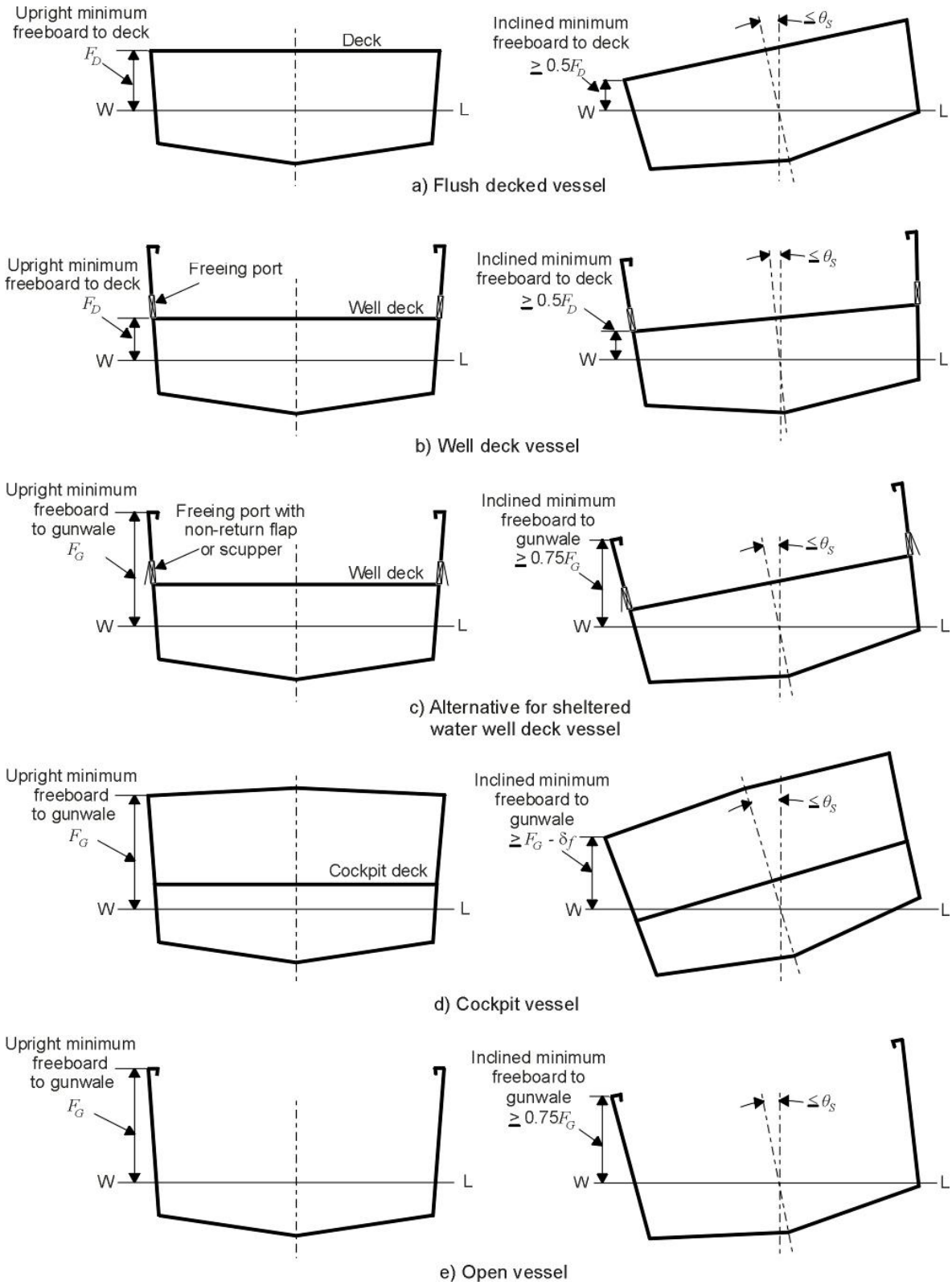
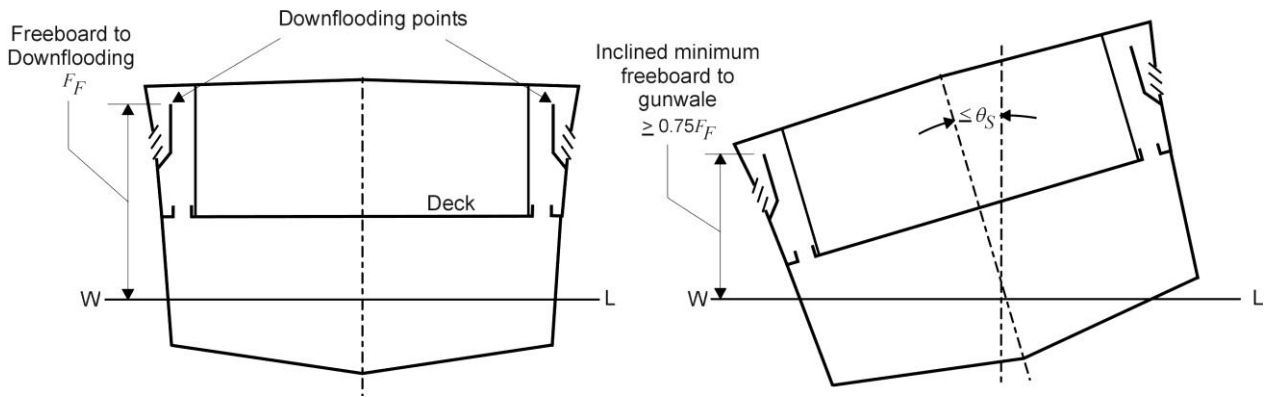


Figure 17 — Chapter 7B criteria—allowable loss of freeboard



**Figure 18 — Chapter 7B criteria—minimum angle to downflooding**

**7.4.6 Methods of calculation**

**7.4.6.1 Heeling moments**

The individual heeling moments due to person crowding, wind or turning specified in Clause 7.4.5 shall be determined in accordance with Table 31.

**Table 31 — Standard calculations for Chapter 7B criteria**

<i>Parameter</i>	<i>Magnitude</i>
$M_P$	Annex A
$M_W$	Annex B
$M_T$	Clause 7.4.6.2

**7.4.6.2 Turning moment**

The calculation of turning moment specified in Annex C requires a value for the distance  $d$ . Because the location of the  $VCG$  is not ascertained as part of a stability proof test, either the value of  $d$  may be determined by conservative estimate; or alternatively, the angle of outward heel resulting from turning may be determined by measurement of the vessel while turning underway at a speed the lesser value, in knots, of the maximum speed of the vessel or  $4\sqrt{L_{WL}}$ .

When the angle is determined by means of a practical test, the loss of freeboard may be calculated from the measured angle of heel.

Where the location of the  $VCG$  is to be determined by estimate—

- a) on decked vessels, the  $VCG$  shall be assumed not lower than the deck level amidships, and
- b) on cockpit, well deck or open vessels, the  $VCG$  shall be assumed not lower than the level of the gunwale amidships.

## **7.5 CHAPTER 7C CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION TO COLLARED VESSELS IN OPERATIONAL AREAS C, D AND E**

### **7.5.1 Scope**

Clause 7.5 provides an alternative simplified method to the Chapter 7B criteria that are better suited to the hull characteristics of collared vessels.

### **7.5.2 Application**

Clause 7.5 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel—

- a) operates within operational areas C, D or E;
- b) has a measured length less than 12 m;
- c) carries not more than 49 passengers;
- d) has not more than one deck above the freeboard deck, exclusive of a wheelhouse; and
- e) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

### **7.5.3 Prerequisites for application of Chapter 7C criteria**

#### **7.5.3.1 General characteristics**

Chapter 7C criteria shall only be applied to a vessel that meets the following assumptions:

- a) The stability characteristics of the vessel over the normal range of loading conditions do not alter significantly.
- b) The waterplane of the vessel does not alter significantly in moment of inertia as the vessel heels by virtue of the size and location of buoyant collars. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to deck or gunwale remains within the maximum values specified during a stability proof test.
- c) Downflooding of buoyant spaces does not occur at relatively small angles of heel. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to downflooding of buoyant spaces remains within the maximum values specified during a stability proof test.
- d) The vessel complies with the specific requirements for collared vessels in Subsection 6B.

NOTE: Chapter 7C criteria are based on the assumption that the vessel has a reserve of stability beyond the angle attained during the stability proof test and that a reserve of stability will remain in the event of a chamber of the collar losing its watertight integrity.

#### **7.5.3.2 Minimum Freeboard**

The minimum freeboard of the collared vessel in all normal conditions of loading shall not be less than—

- a) 300 mm measured from the upper surface of the buoyancy collars at their lowest point; and
- b) 250 mm at the lowest part of the transom.

NOTE: For the purposes of establishing compliance with this Clause, drainage socks, if fitted, may be tied closed.

### 7.5.3.3 Decks on seagoing vessels that carry passengers

Vessels carrying passengers in operational area C shall satisfy the following additional requirements for freeboard in all normal conditions of loading:

- a) The mean freeboard to the main watertight deck when the vessel is at rest shall not be less than the following value:

$$F_{bd} = 0.01L_m$$

where

$F_{bd}$  = the freeboard to the well or cockpit deck, in metres

$L_m$  = the measured length of the collared vessel, in metres

- b) The portion of a well deck within the forward half length of the vessel shall, at all points, have positive freeboard.
- c) The immersion (if any) of the lowest point of the well deck or cockpit deck, excluding a drainage sump, shall not exceed 0.01  $L_m$ .

NOTES:

- For the purposes of establishing compliance with this Clause, drainage socks, if fitted, may be tied closed.
- Negative or low freeboards to the cockpit or well deck may not be conducive to passenger or crew comfort.
- Negative freeboard will require mechanical means to achieve the criteria for drainage of water, seen NSCV Part C Section 2.

### 7.5.4 Testing

The conduct of the stability proof test shall be as per Clause 7.4.4.

### 7.5.5 Criteria

A collared vessel that complies with the criteria listed in Table 32 shall be deemed to satisfy the Chapter 7C criteria.

**Table 32 — Chapter 7C criteria—Alternative simplified criteria of general application in operational areas C, D and E for collared vessels**

Criterion No	Limits to application	Chapter 7C criterion description
7C.1	All vessels within Application Clause	The angle of heel shall not exceed $\theta_s$ degrees (see Table 4) when the most severe of the individual heeling moments due to person crowding, wind or turning is applied.
7C.2a	<i>collared</i> vessel, well deck or <i>cockpit</i> vessel vessel Operational area C	The loss of freeboard $\delta_f$ when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be more than 25 per cent of the freeboard to the top of the collar or transom
7C.2b	<i>collared</i> vessel, well deck, <i>cockpit</i> vessel or <i>open</i> vessel vessel Operational area D or E	The loss of freeboard $\delta_f$ when the most severe of the individual heeling moments due to person crowding, wind or turning is applied shall not be more than 50 per cent of the freeboard to the top of the collar or transom



### 7.5.6 Methods of calculation

Methods of calculation shall be as per Clause 7.4.6.

## 7.6 CHAPTER 7D CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION TO SPECIFIED SMALL VESSELS IN OPERATIONAL AREAS D AND E

### 7.6.1 Scope

Clause 7.6 provides a simplified means of verifying compliance with the intact stability requirements of this Standard by adopting criteria specified in AS 1799.1 that allow the application of a stability proof test without the need to determine lightship particulars, loading conditions, *KN* data and hydrostatic data.

### 7.6.2 Application

Clause 7.6 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel—

- a) has a measured length less than 7.5 m;
- b) operates within operational areas D or E;
- c) carries not more than 12 persons;
- d) is fitted with enclosed buoyancy in accordance with Subsection 6B;
- e) does not have a deck above the freeboard deck or gunwale that is accessible to persons; and
- f) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

NOTE: There is no benefit to applying simplified intact criteria on vessels that require comprehensive analysis to verify compliance with the damaged stability criteria specified in Subsection 6B.

### 7.6.3 Prerequisites for application of the Chapter 7D criteria

#### 7.6.3.1 Assumptions

The Chapter 7D criteria shall be applied to a vessel that meets the following assumptions:

- a) The stability characteristics of the vessel over the normal range of loading conditions do not alter significantly.
- b) The waterplane of the vessel does not alter significantly in area or moment of inertia as the vessel heels. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to deck or gunwale remains within the maximum values specified during a stability proof test.
- c) Downflooding of buoyant spaces does not occur at relatively small angles of heel. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to downflooding of buoyant spaces remains within the maximum values specified during a stability proof test.

NOTE: The Chapter 7D criteria is based on the assumption that the vessel has a reserve of stability beyond the angle attained during the stability proof test.

### 7.6.3.2 Testing

The conduct of the stability proof test shall comply with the following:

- a) The vessel shall be loaded to its maximum capacity based on a standard person mass of 80 kg plus an allowance of 10 kg per person for ancillary equipment.

NOTE: The masses specified above differ from the 75 kg per person and allowance for 15 kg per person specified in AS 1799.1.

- b) The vessel shall be tested in a loading condition representative of normal trim and most unfavourable vertical centre of gravity (*VCG*) likely to occur in normal service.

NOTE: The loading condition may include dive bottles and racks, fishing equipment, stores, and tanks nearly full or nearly empty.

- c) Non-return closures on freeing ports or scuppers shall be held in the open position to allow entry of water on the cockpit or well deck.
- d) The stability proof test shall be undertaken with masses distributed to give a realistic simulation of the *VCG* when persons are on board.

### 7.6.4 Criteria

The vessel shall comply with the stability criteria applicable to boats up to 7.5 m operating in protected waters specified in AS 1799.1.

## 7.7 CHAPTER 7E CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION TO CATAMARAN VESSELS OPERATING IN OPERATIONAL AREAS D AND E

### 7.7.1 Scope

Clause 7.7 provides an alternative means of verifying compliance with the intact stability requirements of this Standard by specifying criteria that allow the application of a stability proof test without the need to determine lightship particulars, loading conditions, *KN* data and hydrostatic data.

### 7.7.2 Application

Clause 7.7 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel is a catamaran and—

- a) has a measured length less than 20 m;
- b) operates within operational areas D or E;
- c) carries not more than 12 persons;
- d) is fitted with internal buoyancy or subdivision in accordance with Subsection 6B;
- e) does not have more than one deck above the freeboard deck or gunwale that is accessible to persons; and
- f) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

### 7.7.3 Prerequisites for application of Chapter 7E criteria

#### 7.7.3.1 Assumptions

Chapter 7E criteria shall be applied to a vessel that meets the following assumptions:

- a) There is no point of downflooding to spaces within the hulls.
- b) The waterplane of the vessel does not alter significantly in area or moment of inertia as the vessel heels. A vessel shall be deemed to satisfy this requirement if the loss of freeboard to the top of the buoyant portion of hull remains within the maximum values specified during a stability proof test.

#### 7.7.3.2 Testing

The conduct of the stability proof test shall comply with the following:

- a) The vessel shall be loaded to its maximum capacity based on a standard person mass of 80 kg plus an allowance of 10 kg per person for ancillary equipment.

NOTE: The masses specified above differ from the 75 kg per person and allowance for 15 kg per person specified in AS 1799.1.

- b) The vessel shall be tested in a loading condition representative of normal trim and most unfavourable vertical centre of gravity (*VCG*) likely to occur in normal service.

NOTE: The loading condition may include dive bottles and racks, fishing equipment, stores, and tanks nearly full or nearly empty.

- c) Non-return closures on freeing ports or scuppers shall be held in the open position to allow entry of water on the cockpit or well deck.
- d) The stability proof test shall be undertaken with masses distributed to give a realistic simulation of the *VCG* when persons are on board.

#### 7.7.3.3 Freeboard resulting from persons crowding

The minimum freeboard shall be determined as follows:

- a) With the vessel loaded to maximum capacity and the passengers evenly distributed throughout the vessel, the freeboard shall be measured at the lowest point of the deck.
- b) With all persons crowded into the worst position with regard to heel and trim, the resultant minimum freeboard is to be measured.

#### 7.7.4 Criteria

The vessel shall comply with the stability criteria for multihull boats specified in AS 1799.1.

### 7.8 CHAPTER 7F CRITERIA—ALTERNATIVE SIMPLIFIED CRITERIA OF GENERAL APPLICATION FOR DUMB BARGES IN OPERATIONAL AREAS D AND E

#### 7.8.1 Scope

Clause 7.8 provides a simplified means of verifying compliance with the intact stability requirements of this Standard by adopting criteria that are

based on the geometrical characteristics of the vessel without the need to undertake a physical stability test.

### 7.8.2 Application

Clause 7.8 may be applied as an alternative to comprehensive criteria of general application specified in Chapter 5 provided the vessel—

- a) is a dumb barge of measured length not exceeding 50 m;
- b) operates within operational areas D or E;
- c) has a block coefficient of 0.9 or more;
- d) has ratio of vessel beam to vessel depth between 3 and 6;
- e) carries not more than 12 persons;
- f) is fitted with a weather deck that is watertight; and
- g) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

### 7.8.3 Criteria

A vessel that complies with the criteria listed in Table 33 shall be deemed to satisfy the Chapter 7F criteria.

**Table 33 — Chapter 7F criteria—Alternative simplified criteria of general application for dumb barges in operational areas D and E**

Criterion No	Limits to application	Chapter 7F criterion description
7F.1a	The ratio beam to depth is between 3.00 to less than 3.75	The ratio of draft to depth shall be equal to or less than 0.70
7F.1b	The ratio beam to depth is between 3.75 to less than 4.00	The ratio of draft to depth shall be equal to or less than 0.72
7F.1c	The ratio beam to depth is between 4.00 to less than 4.50	The ratio of draft to depth shall be equal to or less than 0.76
7F.1d	The ratio beam to depth is between 4.50 to 6.00	The ratio of draft to depth shall be equal to or less than 0.80
7F.2	All barges within application	The maximum height of deck cargo height shall not be greater than the depth of the <i>barge amidships</i> .

## CHAPTER 8 SIMPLIFIED CRITERIA FOR VESSELS ENGAGED IN SPECIAL OPERATIONS

### 8.1 SCOPE

This Chapter specifies simplified criteria for special operations that may be substituted—

- a) for the relevant additional comprehensive criteria for special operations contained in Chapter 6; and
- b) if specified for the particular criteria, instead of the comprehensive criteria of general application specified in Chapter 5.

#### NOTES:

1. Simplified criteria provide alternative means to verify compliance with the deemed-to-satisfy standard of stability at a reduced cost compared to comprehensive criteria.
2. Simplified criteria are based upon assumptions and approximations and so are not suited to vessels that fall outside the parameters of form and/or operation specified in the application of those criteria.
3. A failure of a vessel to meet simplified criteria does not necessarily mean that the vessel would fail comprehensive criteria. The vessel can still be assessed against the comprehensive criteria.
4. There is no benefit to applying simplified intact criteria on vessels that require comprehensive analysis to verify compliance with the damaged stability criteria specified in Subsection 6B.

### 8.2 APPLICATION

This Chapter applies to the vessels specified in Table 34, subject to the applicable limits of application specified for the particular suite of simplified stability criteria.

**Table 34 — Simplified stability criteria for special operations**

Type of operation	Area of operation	Limitations on length	Other conditions	Suite of criteria	Applicable clause
Vessels that set sail	D, E	Less than 15 m	Monohulls as per Clause 8.3.2	Ch. 8A	8.3
			Catamarans as per Clause 8.4.2	Ch. 8B	8.4
Vessels engaged in lifting	D, E	Less than 50 m	As per Clause 8.5.2	Ch. 8C	8.5
	D, E	Less than 50 m	Within proportions as per Clause 8.6.2	Ch.8D	8.6

### 8.3 CHAPTER 8A CRITERION—ALTERNATIVE SIMPLIFIED CRITERION FOR MONOHULL SAILING VESSELS IN OPERATIONAL AREAS D AND E

#### 8.3.1 Scope

Clause 8.3 provides a simplified means of verifying compliance with the intact stability requirements of this Standard by specifying criteria that allow the use of a stability proof test, without the need to determine  $KN$  data and hydrostatic data.

### **8.3.2 Application**

Clause 8.3 may be applied as an alternative to the sailing criteria in Chapter 6 provided the vessel—

- a) is a monohull sailing vessel;
- b) has a measured length less than 15 m;
- c) is not intended for the carriage of cargoes;
- d) operates within operational areas D or E; and
- e) is not engaged in special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

Clause 8.3 may be applied as an alternative to the criteria of general application in Chapter 5 as well as the sailing criteria in Chapter 6 provided the vessel carries not more than 12 persons.

### **8.3.3 Prerequisites for application of the Chapter 8A criterion**

#### **8.3.3.1 Hull configuration**

The vessel shall be of conventional yacht configuration having the majority of ballast located external to the hull within or beneath the level of the keel. The ballast shall be fixed relative to the vessel.

NOTE: The simplified Category 8A criterion relies on the vessel being of a type that has a range of stability approaching 90 degrees or more.

#### **8.3.3.2 Ready and rapid handling of sail**

The vessel shall be arranged to allow ready and rapid handling of all sails by the crew over the anticipated range of wind and weather conditions, and without assistance from other persons on board. Sails shall be arranged so that they can be effectively and quickly—

- a) eased to spill wind in gusting or squall conditions; and
- b) reefed and/or furled to avoid excessive heeling moments in high wind or squall conditions, or in anticipation of such conditions.

#### **8.3.3.3 Auxiliary means of propulsive power**

The vessel shall be provided with an auxiliary means of propulsive power sufficient to control and manoeuvre the vessel when under bare poles.

#### **8.3.3.4 Deck openings**

Deck openings on the vessel shall be—

- a) fitted with weathertight closures;
- b) arranged to minimise the possibility of flooding the hull at large angles of heel by being located on or near the centre line of the vessel; and
- c) arranged to ensure that, apart from air pipes to tanks, no opening regardless of size which may lead to progressive flooding shall be immersed at an angle of heel of less than 70 degrees.

### 8.3.4 Criteria

A vessel under all plain sail without reefing that complies with the applicable criterion listed in Table 35 shall be deemed to satisfy the Chapter 8A criterion.

**Table 35 — Chapter 8A criterion—Alternative simplified criterion for monohull vessels that set sail in operational areas D and E**

Criterion No	Limits to application	Chapter 8A criterion description
8A.1a	Vessels of operational area D within the application of Clause 8.3.2	The vessel shall not heel to an angle greater than 25 degrees when a wind heeling moment ( $M_W$ ) is applied to the vessel under full sail with the wind pressure of 60 Pa.
8A.1b	Vessels of operational area E within the application of Clause 8.3.2	The vessel shall not heel to an angle greater than 25 degrees when a wind heeling moment ( $M_W$ ) is applied to the vessel under full sail with the wind pressure of 50 Pa.

NOTES:

1. A pressure of 60 Pa equates to a wind speed of approximately 20 knots.
2. A pressure of 50 Pa equates to a wind speed of approximately 18 knots.

### 8.3.5 Methods of testing and calculation

#### 8.3.5.1 Standard tests and calculations

The parameters specified in Clause 8.3.4 shall be determined in accordance with Table 36.

**Table 36 — Standard tests and calculations for the Ch.8A criterion**

Parameter	Test	Magnitude
Heel	Subsection 6C	As per criteria
Moment	Subsection 6C	Annex D

#### 8.3.5.2 Displacement $\Delta$

The displacement shall represent the vessel in the worst case condition of loading for intact stability. For the purposes of this Clause, the vessel shall be tested in a fully laden condition, but with all tanks 75 per cent full (to provide free surface).

## 8.4 CHAPTER 8B CRITERION—ALTERNATIVE SIMPLIFIED CRITERION FOR CATAMARAN VESSELS THAT CARRY SAIL IN OPERATIONAL AREAS D AND E

### 8.4.1 Scope

Clause 8.4 provides an alternative means of verifying compliance with the intact stability requirements of this Standard for catamaran vessels that carry sail by specifying criteria that dispense with the need for physical testing,  $KN$  data and hydrostatic data.

### 8.4.2 Application

Clause 8.4 may be applied as an alternative to the sailing criteria in Chapter 6 provided the vessel—

- a) is a catamaran sailing vessel;
- b) has a measured length less than 15 m;
- c) is not intended for the carriage of cargoes;
- d) operates within operational areas D or E; and
- e) is not engaged in other special operations which are required to meet the additional comprehensive criteria specified in Chapter 6, and for which no simplified alternative is provided in Chapter 8.

Clause 8.4 may be applied as an alternative to the criteria of general application in Chapter 5 as well as the sailing criteria in Chapter 6 provided the vessel carries not more than 12 persons.

NOTE: There is no benefit to applying simplified intact criteria on vessels that require comprehensive analysis to verify compliance with the damaged stability criteria specified in Subsection 6C.

### 8.4.3 Criteria

A catamaran sailing vessel under all plain sail without reefing that complies with the criterion listed in Table 37 shall be deemed to satisfy the Chapter 8B criterion.

**Table 37 — Chapter 8B criterion—Alternative simplified criterion for catamaran sailing vessels in operational areas D and E**

Criterion No	Limits to application	Chapter 8B criterion description
8B.1	Vessels within the application of Clause 8.4.2	<p>The vessel's stability shall comply with the following equation:</p> $\frac{2940 \Delta B_H}{A H} > 47.8 \text{ Pa}$ <p>where</p> <p><math>B_H</math> = the distance between hull centre lines, in metres</p> <p><math>A</math> = the profile area subject to wind as defined in Annex D, in square metres.</p> <p><math>H</math> = the mast height above the deck, in metres</p> <p><math>\Delta</math> = the fully laden <i>displacement</i> of the vessel, in tonnes</p>

## 8.5 CHAPTER 8C CRITERION—ALTERNATIVE SIMPLIFIED CRITERION FOR VESSELS LIFTING HEAVY LOADS IN OPERATIONAL AREAS D AND E

### 8.5.1 Scope

Clause 8.5 provides an alternative means of verifying compliance with the intact stability requirements of this Standard applicable to vessels engaged



in lifting by specifying criteria that permit testing by a stability proof test without the need for  $KN$  data and hydrostatic data.

### 8.5.2 Application

Clause 8.5 may be applied as an alternative to the additional comprehensive lifting criteria in Chapter 6 provided the vessel—

- a) operates within operational areas D or E; and
- b) has a measured length less than 50 m.

### 8.5.3 Prerequisites for application of the Chapter 8C criterion

The waterplane of the vessel over the range of loading conditions shall not significantly reduce in area or moment of inertia as the vessel heels or trims.

The Chapter 8C criterion shall not be applied to a vessel if, while lifting longitudinally or transversely, or slewed positions anywhere in between, the bilge or chines at the opposite end, side or corner of the vessel emerge or the deck edges immerse.

### 8.5.4 Criteria

A vessel that complies with the criteria listed in Table 38 shall be deemed to satisfy the Chapter 8C criterion.

**Table 38 — Chapter 8C criterion—Alternative simplified criteria for vessels lifting heavy loads in operational areas D and E**

Criterion No	Limits to application	Chapter 8C criterion description
8C.1	Vessels within the application clause	<p>The angle of heel <math>\theta_h</math> resulting from the worst case combination of loading condition and heeling moment due to lifting shall not exceed the lesser of—</p> <ol style="list-style-type: none"> <li>a) 5 degrees;</li> <li>b) the angle corresponding to a loss of half the freeboard to the deck; or</li> <li>c) the angle of bilge emersion.</li> </ol>

### 8.5.5 Loading conditions

#### 8.5.5.1 Displacement $\Delta$

The displacement shall represent the vessel in the worst of the following two conditions of loading for intact stability—

- a) a near light condition, but with all persons on board and tanks 25 per cent full (to provide free surface); and
- b) a fully laden condition, but with tanks 75 per cent full (to provide free surface).

Where the worst condition of loading is not evident, then compliance shall be determined in both conditions.

### 8.5.5.2 **Vertical centre of gravity (VCG)**

The distribution of mass on the vessel shall be simulated to give the maximum height of the centre of gravity at the particular condition of loading including the effect of lifting. The effect on the *VCG* of lifting may be superimposed directly during the course of the stability proof test.

### 8.5.5.3 **Moment due to lifting**

The moment due to lifting  $M_L$  shall be simulated by applying a moment of magnitude in accordance with Annex E. Where the mass being lifted, height of the lift and/or the lifting lever arm is variable, then the worst case scenario shall be applied.

NOTE: The worst case scenario may need to be established by trial and error if necessary.

## 8.6 **CHAPTER 8D CRITERION—ALTERNATIVE SIMPLIFIED CRITERION FOR DUMB BARGE LIFTING HEAVY LOADS**

### 8.6.1 **Scope**

Clause 8.6 provides an alternative means of verifying compliance with the intact stability requirements of this Standard applicable to vessels engaged in lifting by specifying criteria that permit testing by a stability proof test without the need for *KN* data and hydrostatic data.

### 8.6.2 **Application**

Clause 8.6 may be applied as an alternative to the additional comprehensive lifting criteria in Chapter 6 provided the vessel—

- a) is a dumb barge carrying no more than 12 persons;
- b) has a measured length less than 50 m;
- c) has a ratio of beam to depth from 3.40 to 4.75;
- d) has a ratio of length to beam from 3.20 to 4.50; and
- e) has a ratio of deepest fully laden draft to depth of 0.60 to 0.85.

### 8.6.3 **Prerequisites for application of the Chapter 8D criterion**

The waterplane of the vessel over the range of loading conditions shall not significantly reduce in area or moment of inertia as the vessel heels or trims.

The Chapter 8D criterion shall not be applied to a vessel if, while lifting longitudinally or transversely, or slewed positions anywhere in between, the bilge or chines at the opposite end, side or corner of the vessel emerge or the deck edges immerse.

### 8.6.4 **Criteria**

A vessel that complies with the criteria listed in Table 39 shall be deemed to satisfy the Chapter 8D criterion.

**Table 39 — Chapter 8D criterion—Alternative simplified criteria for dumb barges lifting heavy loads**

Criterion No	Limits to application	Chapter 8D criterion description
8D.1a	Operational areas A, B or C	The angle of heel $\theta_h$ resulting from the worst case combination of loading condition and heeling moment due to lifting shall not exceed the lesser of— a) 5 degrees; b) the angle corresponding to a loss of 50 per cent of the freeboard to the deck; or c) the angle of bilge emersion.
8D.1b	Operational areas D or E	The angle of heel $\theta_h$ resulting from the worst case combination of loading condition and heeling moment due to lifting shall not exceed the lesser of— a) 5 degrees; b) the angle corresponding to a loss of 100 per cent of the freeboard to the deck; or c) the angle of bilge emersion.

**8.6.5 Loading conditions****8.6.5.1 Displacement  $\Delta$** 

The displacement shall represent the vessel in the worst of the following two conditions of loading for intact stability—

- a near light condition, but with all persons on board and tanks 25 per cent full (to provide free surface); and
- a fully laden condition, but with tanks 75 per cent full (to provide free surface).

Where the worst condition of loading is not evident, then compliance shall be determined in both conditions.

**8.6.5.2 Vertical centre of gravity (VCG)**

The distribution of mass on the vessel shall be simulated to give the maximum height of the centre of gravity at the particular condition of loading including the effect of lifting. The effect on the VCG of lifting may be superimposed directly during the course of the stability proof test.

**8.6.6 Moment due to lifting**

The moment due to lifting  $M_L$  shall be simulated by applying a moment of magnitude in accordance with Annex E. Where the mass being lifted, height of the lift and/or the lifting lever arm is variable, then the worst case scenario shall be applied.

NOTE: The worst case scenario may need to be established by trial and error if necessary.

## ANNEX A HEEL DUE TO PERSON CROWDING

### A1 SCOPE

This Annex specifies the calculations for determining the heeling moment and other effects that arise from person crowding for the purposes of verifying compliance under the relevant stability criteria.

### A2 APPLICATION

This Annex is normative and applies to all vessels for which a person crowding moment is required. It is referenced in Clauses 5.3.2, 5.5.3, 7.3.5.1 and 7.4.6.1.

### A3 PERSON CROWDING, ITS LEVER AND VCG FOR DIFFERENT TYPES OF OPERATIONS

#### A3.1 Minimum assumed mass of persons and their effects

The minimum values for the mass of each person and their effects assumed for the purposes of determining compliance with the criteria contained in this Standard shall not be less than the values specified in Table 40.

**Table 40 — Minimum values for mass of persons and their effects**

Person type	Minimum assumed mass per person Kg per person ( <i>w</i> )	Minimum allowance for baggage Kg per person	Minimum allowance for additional diving equipment Kg per person
Passenger or crew day only	80	Nil	Nil
Passenger or crew overnight	80	15	Nil
Diver day only	116	Nil	17
Diver overnight	116	15	17

NOTES:

1. The mass of 80 kg in Table 40 represents a mean value for the Australian adult population as of 2005 including an allowance of 5 kg for clothing and personal effects.
2. The additional 15 kg for overnight persons is for luggage.
3. The additional 53 kg for divers includes the mass diving suit, flippers, mask, wet suit, regulator and 2 filled gas bottles. Of the total additional mass, 36 kg is included in the minimum assumed mass of the diver and the other 17 kg is the minimum allowance for the second gas bottle as additional diving equipment.
4. Nothing in this Standard precludes adopting a larger assumed mass of persons and their effects where heavier persons, additional baggage or additional diving equipment are anticipated, provided that this represents a more onerous condition of loading.

**A3.2 Vertical centre of gravity of persons**

The vertical centre of gravity of a standing person shall be 1 m above the deck. The vertical centre of gravity of a seated person shall be 300 mm above the seat.

**A3.3 Person crowding**

The assumed distribution of passengers or crew when crowded shall be four (4) persons per square metre. Each person in the crowded distribution shall be considered to occupy a deck area measuring 625 mm x 400 mm.

The assumed distribution of divers when crowded shall be three (3) divers per square metre. Each diver in the crowded distribution shall be considered to occupy a deck area measuring 625 mm x 533 mm.

**A4 PERSON HEELING MOMENTS**

The minimum required persons crowding moment for the purposes of verifying compliance with the stability criteria shall be determined in accordance with the following:

- a) On vessels of length 6 m or more, the persons crowding moment shall be calculated taking into account the transverse movement of all passengers.
- b) On vessels of length less than 6 m, the persons crowding moment shall be calculated taking into account the transverse movement of all persons on board (passengers and crew).

The persons of mass specified in Table 40 shall be assumed as crowded (as per Clause A3.3) along one side of the vessel to produce the most unfavourable combination of person heeling moment and height of the aggregate centre of gravity of the person mass.

## NOTES:

1. Analysis may be required to determine the worst case distribution of crowded persons, e.g., in some cases persons having a lesser person crowding moment on a higher deck could still result in a greater heel than the same number of persons having a greater person crowding moment on a lower deck.
2. The mass of baggage and additional diving equipment need not be included in the determination of the maximum person crowding moment.

**A5 PERSON CROWDING MOMENT CALCULATION**

The heeling moment due to persons crowding shall be calculated using the following formula:

$$M_p = \frac{Nwb}{1000} \cos \theta$$

where

$M_p$  = person crowding moment at angle of heel  $\theta$  in tonne-metres

$N$  = for vessels less than 6 m in measured length, the number of persons on the vessel

= for vessels 6 m and more in measured length, the number of passengers on the vessel

$w$  = the mass per person in kilograms

$b$  = the distance in metres from the vessel's centreline to the transverse centre of gravity of the persons when crowded

$\theta$  = the transverse angle of heel of the vessel in degrees

The corresponding person crowding heeling lever when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_p = \frac{M_p}{\Delta} = \frac{Nwb}{1000\Delta} \cos \theta$$

where

$HZ_p$  = the heeling lever due to person crowding in metres

$\Delta$  = displacement including the mass of persons and their effects, in tonnes

## ANNEX B HEEL DUE TO WIND

### B1 SCOPE

This Annex specifies the calculations for determining the heeling moment that arises from a beam wind acting on the windage profile of the vessel for the purposes of verifying compliance under the relevant stability criteria.

### B2 APPLICATION

This Annex is normative and applies to all vessels for which a wind heeling moment is required, other than for the purposes of compliance with sailing criteria. It is referenced in Clauses 5.3.2, 6.3.2, 6.4.2, 7.3.5.1 and 7.4.6.1.

### B3 WIND PRESSURE, WINDAGE AREA AND WIND LEVER FOR DIFFERENT TYPES OF OPERATIONS

#### B3.1 Wind pressures

The minimum wind pressure to be used in the wind heeling moment calculation shall be as specified in Table 41.

**Table 41 — Wind pressure**

Operational Area	Gusting wind pressure (Pa)	Gusting wind speed (knots)	Equivalent average wind speed (knots)
A & B	600	61	44
C	450	53	38
D	360	47	34
E	300	43	31

#### B3.2 Vessel windage area and centroid

The windage area and its centroid shall be determined including the projected profile area of all bulwarks, deck fittings, masts, spars, deck cargo, safety equipment, seating, cranes, other fixtures mounted on the vessel, awnings and screens.

Where vessels are fitted with portable side screens or other similar fittings that add to the profile area, they shall be included in the calculations.

Where deck cargo is carried, the windage area and centroid shall be determined assuming the deck cargo is a solid mass extending over the length of the cargo deck and to an assumed height above the deck.

NOTE: Sails may be excluded from the calculation of windage profile under this Annex where, with sails set, a vessel also complies with the applicable criteria for vessels that set sails specified in Clauses 6.3, 6.4, 8.3 or 8.4.

### B4 HEELING MOMENT CALCULATION

The heeling moment due to a beam wind shall be calculated using the following formula:

$$M_w = \frac{P_w A_w h}{1000 g} \cos \theta$$

where

$M_w$  = the wind heeling moment at an angle of heel  $\theta$  in tonne-metres

$P_w$  = the applicable wind pressure for the vessel's area of operation, in Pascals from Table 41

$A_w$  = the windage area of the vessel above the design waterline, in square metres, see Clause B3.2

$h$  = the vertical distance from the centre of area  $A$  to the centre of the lateral underwater area, in metres, see Clause B3.2

$g$  = the acceleration due to gravity, 9.81 m/s<sup>2</sup>

$\theta$  = the transverse angle of heel of the vessel in degrees

The corresponding wind heeling lever when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_w = \frac{M_w}{\Delta} = \frac{P_w A_w h}{1000 g \Delta} \cos \theta$$

where

$HZ_w$  = the heeling lever due to wind, in metres

$\Delta$  = displacement of the vessel, in tonnes



## ANNEX C HEEL DUE TO TURNING

### C1 SCOPE

This Annex specifies the calculations for determining the heeling moment that arises from turning of the vessel for the purposes of verifying compliance under the relevant stability criteria.

### C2 APPLICATION

This Annex is normative and applies to all vessels for which a turning moment is required. It is referenced in Clauses 5.3.2, 5.5.3, 7.3.5.1 and 7.4.6.2.

### C3 CALCULATION OF HEELING MOMENT FROM TURNING

The heeling moment resulting from a vessel turning shall be calculated using the following formula:

$$M_T = \frac{0.0053 V^2 \Delta h}{L_{WL}} \cos \theta$$

where

$M_T$  = the heeling moment of a turning vessel at angle  $\theta$ , in tonne-metres

$V$  = the lesser value, in knots, of—  
 a) the maximum speed of the vessel, and  
 b)  $4\sqrt{L_{WL}}$ .

$\Delta$  = the vessel displacement, in tonnes

$h$  = the vertical distance between the vertical centre of gravity of the vessel (*VCG*) and the centre of the projected lateral underwater area, in metres

$L_{WL}$  = the waterline length of the vessel in metres.

$\theta$  = the transverse angle of heel of the vessel in degrees

The corresponding lever due to turning when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_T = \frac{M_T}{\Delta} = \frac{0.0053 V^2 h}{L_{WL}} \cos \theta$$

where

$HZ_T$  = the heeling lever due to turning, in metres

## ANNEX D HEEL DUE TO WIND ON A VESSEL UNDER SAIL

### D1 SCOPE

This Annex specifies the calculations for determining the wind heeling moment on a vessel under sail for the purposes of verifying compliance under the sail criteria.

### D2 APPLICATION

This Annex is normative. It is referenced in Clauses 6.3.4.3, 6.3.5.3, 6.4.4.3, 8.3.5.1 and 8.4.3.

### D3 PROFILE AREA SUBJECT TO WIND

The profile area ( $A_S$ ) subject to wind shall be calculated as per Clause B3.2 for windage area of the hull, superstructures, deck houses and fittings but with the addition of all plain sails set and trimmed flat, see Figure D.1 a).

Where the total area of the headsails is in excess of the fore triangle area the 100 per cent fore triangle area and centre may be used in lieu of those of the individual headsails, see Figure D.1 b), c) and d).

The windage lever ( $h_S$ ), shall be the vertical distance, in metres, from the centre of the profile area ( $A_S$ ) to the centre of the projected lateral underwater area, see Figure D.1 a).

### D4 HEELING MOMENT CALCULATION

The heeling moment due to a beam wind shall be calculated using the following formula:

$$M_w = \frac{P_S A_S h_S}{1000 g} \cos^{1.3} \theta$$

where

$M_w$  = the wind heeling moment at an angle of heel  $\theta$  in tonne-metres

$P_S$  = the applicable wind pressure determined from the relevant sailing criteria, in Pascals

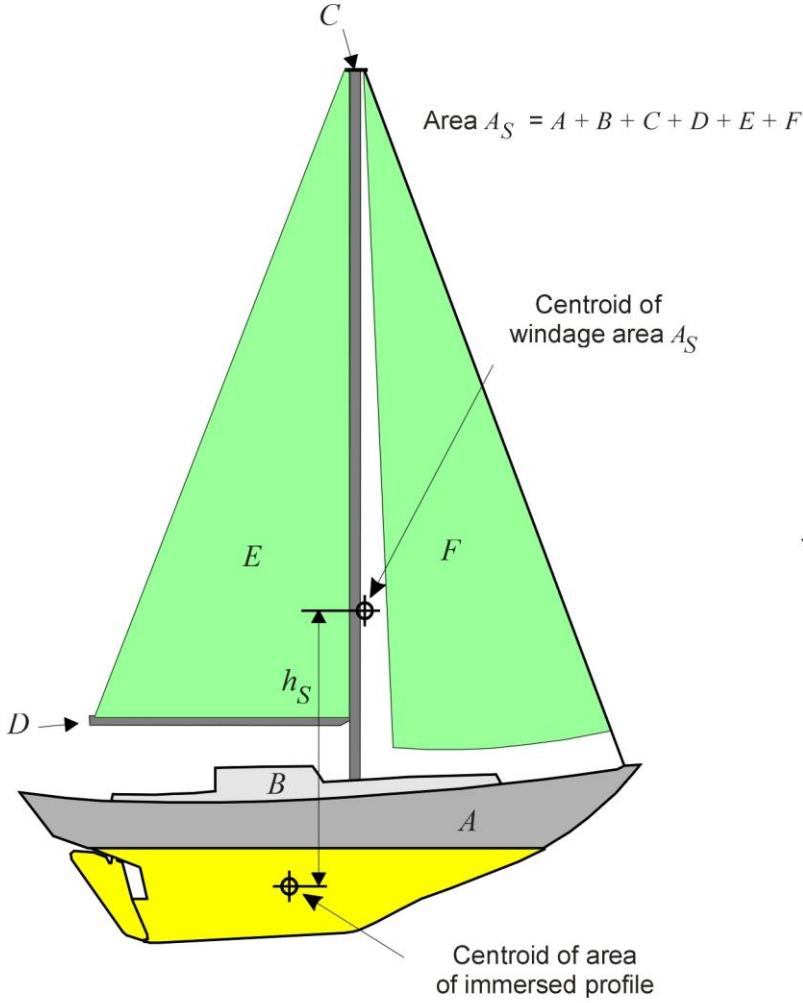
$A_S$  = the lateral profile area of the vessel above the design waterline, in square metres

$h_S$  = the vertical distance from the centre of area  $A_S$  to the centre of the projected lateral underwater area, in metres

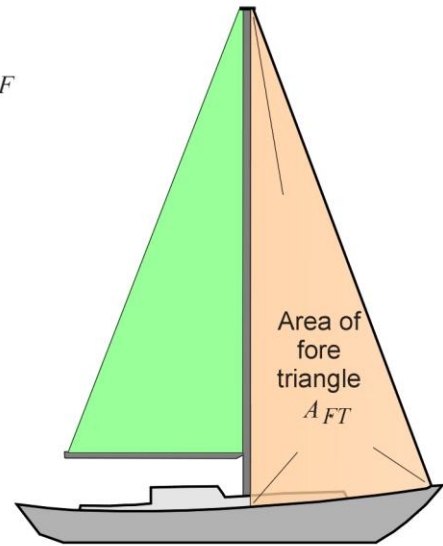
$g$  = the acceleration due to gravity, 9.81 m/s<sup>2</sup>

$\theta$  = the transverse angle of heel of the vessel, in degrees

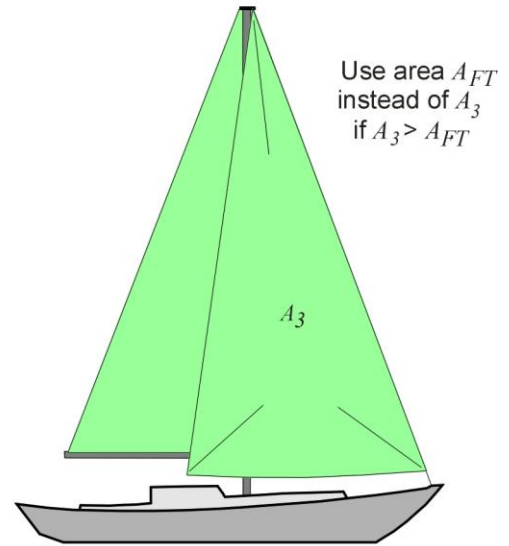
NOTE: Annex D is inaccurate for sailing catamarans operating at large angles of heel because it makes no allowance for the added windage area of the bridging deck as the windward hull emerges.



a) Typical calculation

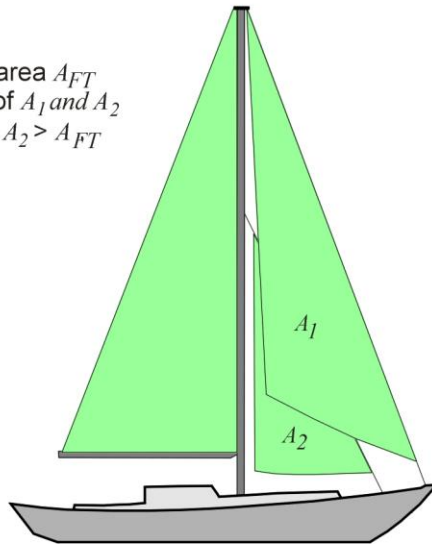


b) Area of fore triangle



c) Sail area on vessels with a headsail that overlaps the main

Use area  $A_{FT}$  instead of  $A_1$  and  $A_2$  if  $A_1 + A_2 > A_{FT}$



d) Sail area on vessels with overlapping headsails

**Figure D.1— Determination of windage area and windage lever for vessels that set sail**

## ANNEX E CALCULATIONS FOR THE HEELING EFFECT OF LIFTING

### E1 SCOPE

This Annex specifies the calculations for determining the heeling moment and other effects that arise from lifting for the purposes of verifying compliance under the relevant stability criteria.

### E2 APPLICATION

This Annex is normative and applies to operations involving lifting. It is referenced in Clauses 6.5.4.3, 6.5.6.3, 6.7.3.3 and 8.5.

#### EXAMPLES:

Lifting cargo, catch or other heavy masses using a crane, derrick or boom

Lifting the cod end on trawlers, purse seiners and other fishing vessels that utilise large nets

Lifting anchors over the stern of an *offshore supply vessel*

Salvage operations

Attempting a recovery of a snagged net

### E3 LOAD, ITS LEVER AND VCG FOR DIFFERENT TYPES OF LIFTING OPERATIONS

For the purposes of undertaking calculations as to the effects of lifting on the stability of a vessel, the values specified in Table 42 shall apply.

**Table 42 — Values of load, its lever and VCG for different types of lifting operations**

Lifting operation	Magnitude of vertical pull	Value of transverse distance	Vertical height of load
Crane or cod end lift (including derrick or sheerlegs)	Maximum allowed static hook load at a given outreach of crane	Transverse distance between top block and the vessel centre line in the upright position (see Figure E.1)	Point of attachment of the top block to the crane (see Figure E.1)
Anchor handling or salvage	Stalled winch load	Transverse distance between point of contact on fixed sheave or roller and the vessel centre line in the upright position (see Figure E.2)	Top of fixed sheave or roller or point of attachment of block (see Figure E.2)
Snagged fishing gear recovery (1)	Stalled winch load	Transverse distance between quarter block and the vessel centre line in the upright position (see Figure E.3)	Point of attachment of quarter block (see Figure E.3)

#### KEY:

(1) Significant risk of capsize will result if an attempt is made to retrieve snagged fishing gear by using the trawl winch to haul the trawl warp via the block on a side boom (see Figure G.1). The heeling moment will be significantly reduced by leading the trawl warp through a quarter block close to the vessel's side (see Figure E.3), or over the stern before applying high line pull.

**E4      LOADING CONDITION CALCULATION**

Loading conditions for the vessel when lifting shall take into account—

- a) the magnitude of the vertical component of the load lifted in the total displacement of the vessel; and
- b) the vertical height of the load lifted when determining the *VCG* of the vessel.

**E5      HEELING MOMENT CALCULATION**

The heeling moment due to lifting shall be calculated using the following formula:

$$M_L = P_L y \cos \theta$$

where

$M_L$  = the heeling moment due to lifting at an angle of heel  $\theta$  in tonne-metres.

$P_L$  = the vertical pull of the load; in tonnes

$y$  = the transverse distance of the line of action of the load from the vessel's centre line in the upright condition; in metres (see Table 42)

$\theta$  = the transverse angle of heel of the vessel, in degrees

The corresponding heeling lever when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_L = \frac{M_L}{\Delta + P_L} = \frac{P_L y}{\Delta + P_L} \cos \theta$$

where

$HZ_L$  = the heeling lever due to lifting in metres

$\Delta$  = displacement excluding the lifting load, in tonnes

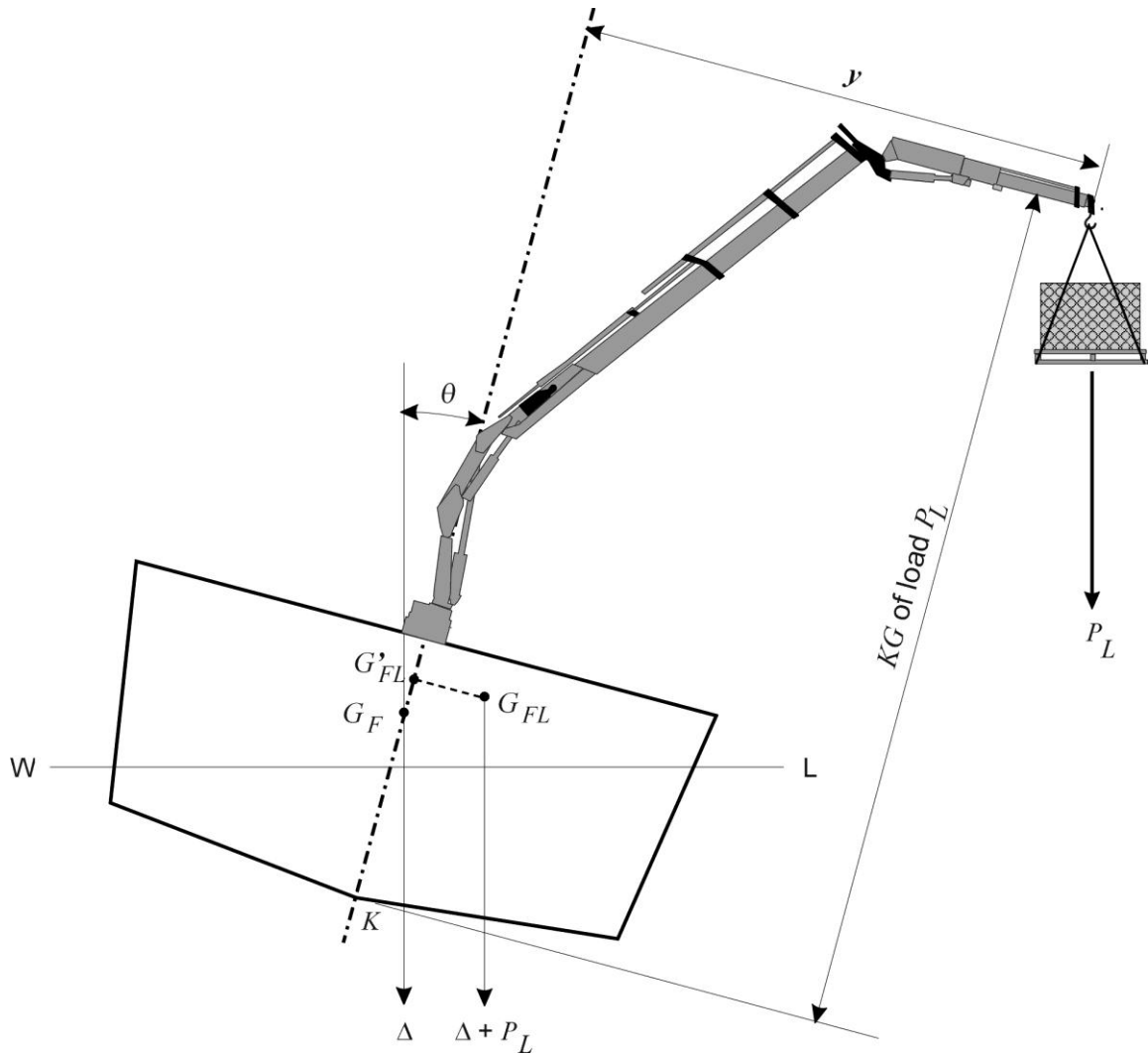


Figure E.1— Heeling effect of lifting by crane

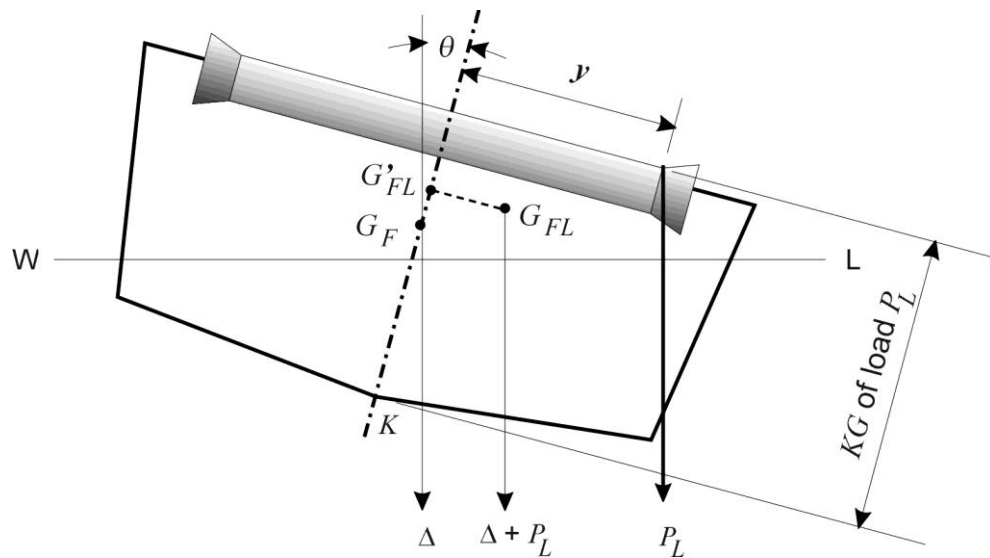


Figure E.2— Heeling effect of lifting over a roller

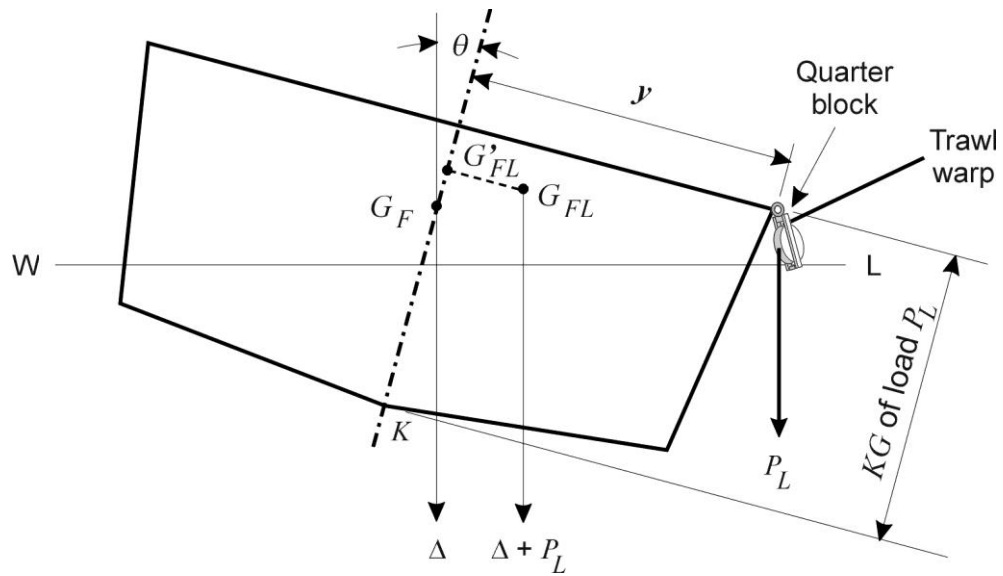


Figure E.3— Heeling effect of lifting snagged fishing gear

## E6 WORST CASE SCENARIOS

The combinations of loading and heeling moment used to verify compliance against the relevant criteria in this Standard shall represent the worst case scenario. Where there is uncertainty as to what represents the worst case scenario of lifting, multiple combinations of loading and heeling shall be analysed.

### EXAMPLE:

The worst case scenario for a crane might occur when carrying rated maximum crane load at maximum transverse outreach or when carrying rated maximum crane load at maximum elevation or at some other combination of rated maximum crane load, elevation and outreach.

## ANNEX F HEEL DUE TO TOWING

### F1 SCOPE

This Annex specifies the calculations for determining the heeling moment and other effects that can arise when a vessel is engaged in towing, for the purposes of verifying compliance under the relevant stability criteria.

This Annex is referenced in Clause 6.6.3.3 of this Subsection.

### F2 APPLICATION

This Annex is normative for vessels that engage in towing operations where the displacement of the towed vessel exceeds twice the displacement of the towing vessel.

### F3 HEELING MOMENT CALCULATION

The minimum required towrope heeling moment shall be calculated using the following formula:

$$M_T = P_{BP} \times [AD \cos(\alpha + \theta) - AC \sin(\alpha + \theta)]$$

where

$M_T$  = the tow rope heeling moment at an angle of heel  $\theta$  in tonne-metres

$P_{BP}$  = the maximum bollard pull of the towing vessel; in tonnes

$AD$  = the vertical distance between the centre of lateral resistance of the immersed hull profile and the point of attachment of the tow rope when the vessel is in the upright condition, in metres (see Figure F.1 and Figure F.2)

$AC$  = The horizontal distance between the point of attachment of the tow rope and the vessel's centre line, in metres (see Figure F.1 and Figure F.2).

NOTE: This distance is normally taken as the radius of the towing quadrant.

$\theta$  = the transverse angle of heel of the vessel, in degrees

$\alpha$  = the angle of the tow line above the horizontal, in degrees

= 0 degrees if operational area A, B or C; see Figure F.2

= 30 degrees if operational area D or E; see Figure F.1

The corresponding heeling lever when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_T = \frac{M_T}{\Delta} = P_{BP} \times \frac{AD \cos(\alpha + \theta) - AC \sin(\alpha + \theta)}{\Delta}$$

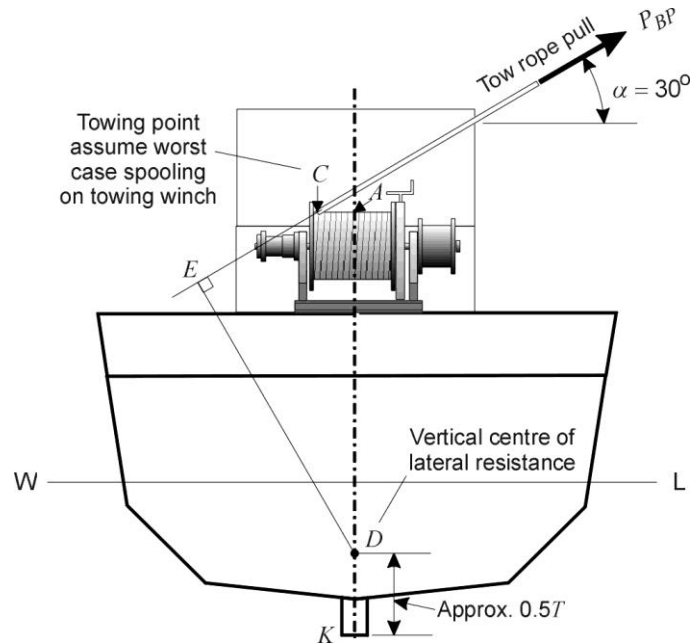
where

$HZ_T$  = The tow rope heeling lever, in metres

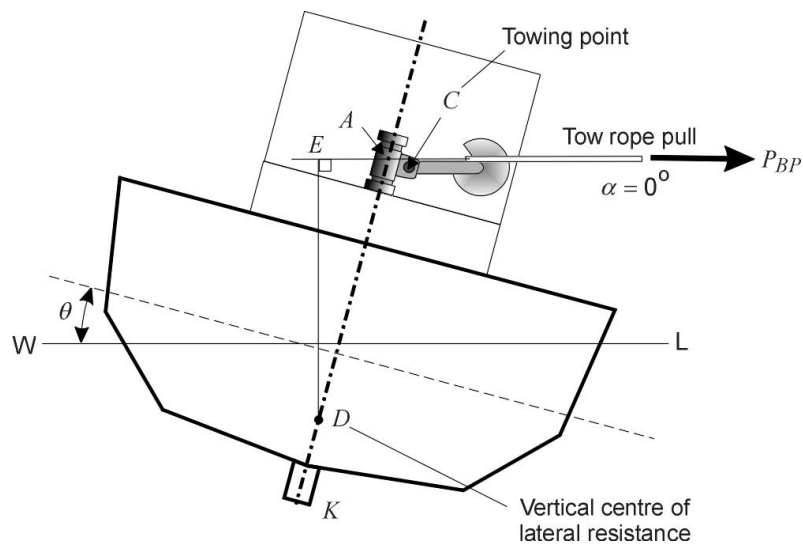


$\Delta$  = vessel displacement, in tonnes

NOTE: The above formula neglects the reduction in displacement due to the vertical component of  $P_{BP}$ .



**Figure F.1—Typical towing vessel with towing winch—  $\alpha = 30^\circ$  for determining tow rope heeling lever in sheltered waters (vessel shown upright)**



**Figure F.2—Typical towing vessel with tow hook—  $\alpha = 0^\circ$  for determining tow rope heeling lever at sea (vessel shown inclined at an angle  $\theta$  degrees)**

#### F4 LOADING CONDITION CALCULATION

Loading conditions for the vessel when towing need not take into account the effect of the vertical pull when determining the displacement and *VCG* of the vessel.

## ANNEX G CALCULATIONS FOR THE HEELING EFFECT OF A TRAWL NET SNAGGING

### G1 SCOPE

This Annex specifies the calculations for determining the heeling moment and other effects that arise when a trawl net snags for the purposes of verifying compliance under the relevant stability criteria.

### G2 APPLICATION

This Annex is normative for vessels that engage in trawling operations. It is referenced in Clause 6.7.3.3.

### G3 SNAGGED NET LOAD, ITS LEVER AND VCG

For the purposes of undertaking calculations as to the effects of a snagged net on the stability of a vessel, the values specified in Table 43 shall apply.

**Table 43 — Values of load, its lever and VCG for different types of lifting operations**

Magnitude of vertical pull	Value of transverse distance	Vertical height of load
Vertical component of the least value of— 1. the breaking load of the weakest link in the trawl wire; or 2. the breaking load of the connection of the trawl wire to the trawl net	Transverse distance between the block at the head of the trawl wire and the vessel's centre line (see Figure G.1)	The point of attachment of the block at the head of the trawl wire to the boom, gantry or other structural component of the vessel. (see Figure G.1)

### G4 DEPTH AND SCOPE OF TRAWL

For the purposes of verifying the stability characteristics when engaged in trawling, the vertical component of the net snagging load shall be determined assuming the ratio of depth to scope of trawl is not less than one to four (corresponding to an angle  $\Phi$  of 14.5 degrees), see Figure G.2.

NOTE: The vertical component could exceed this value on a vessel trawling to greater depths. It is the responsibility of the operator to verify the stability remains acceptable if the vessel is to operate with a larger ratio of depth to scope of trawl.

### G5 LOADING CONDITION CALCULATION

Loading conditions for the vessel when lifting shall include—

- the magnitude of the vertical pull arising from the net snagging in the total displacement of the vessel; and
- the vertical height of the load when determining  $KG$  of the vessel.

### G6 HEELING MOMENT CALCULATION

The minimum heeling moment due to a snagged net shall be calculated using the following formula:

$$M_{SN} = (P_B \sin \Phi)(y \cos \theta)$$

where

$M_{SN}$  = the heeling moment due to the snagged net at an angle of heel  $\theta$ , in tonne-metres

$P_B$  = the breaking load of the weakest link in the trawl wire or its connection to the trawl net, in tonnes

$y$  = the transverse distance of the line of action of the trawl wire from the vessel's centreline in the upright condition, in metres (see Figure G.1)

$\theta$  = the transverse angle of heel of the vessel, in degrees

$\Phi$  = the greater value of—

$$\text{Arcsin}\left(\frac{\text{Trawl depth}}{\text{Trawl scope}}\right) \text{ or } 14.5^\circ$$

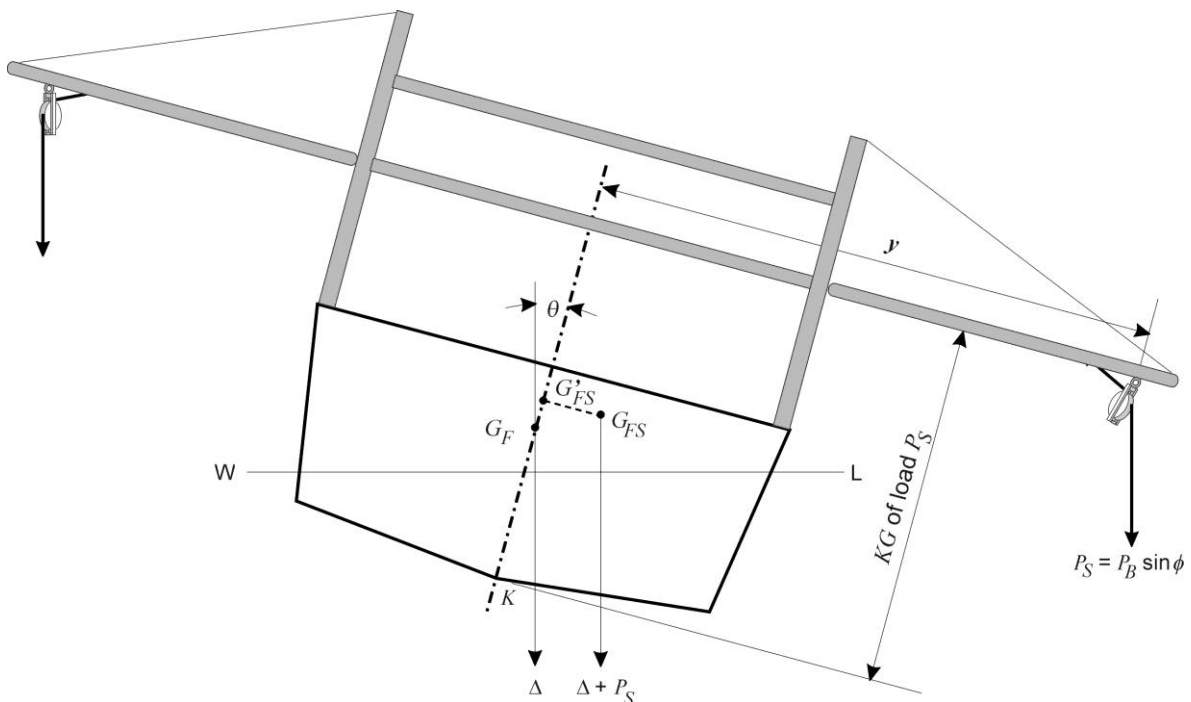
The corresponding heeling lever when the vessel is inclined at an angle of heel  $\theta$  shall be calculated from the following formula:

$$HZ_{SN} = \frac{M_{SN}}{\Delta + P_B \sin \phi} = \frac{P_B \sin \phi y}{\Delta + P_B \sin \phi} \cos \theta$$

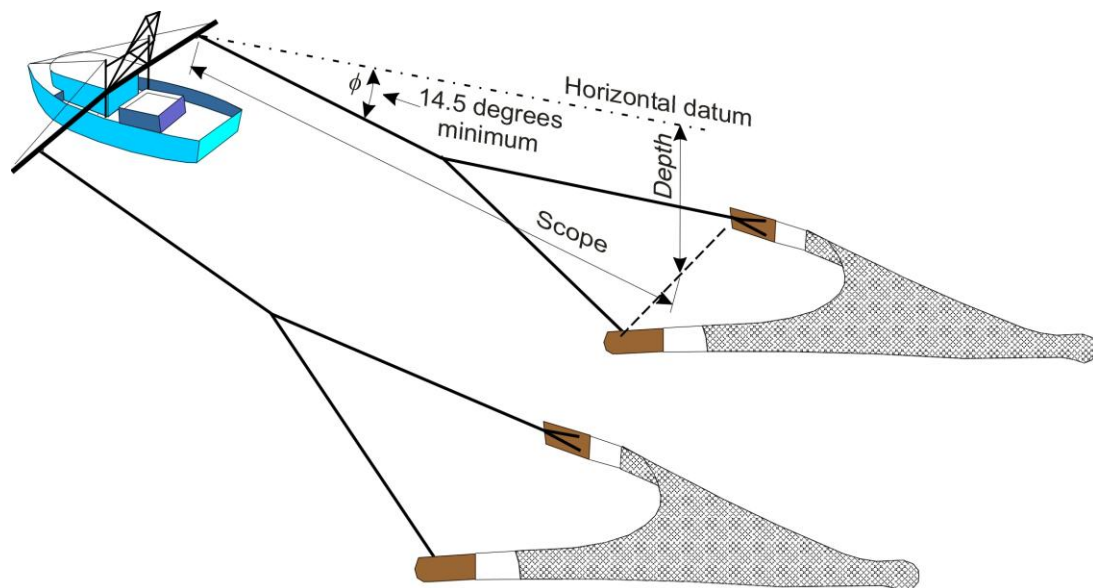
where

$HZ_{SN}$  = the heeling lever due to a snagged net in metres

$\Delta$  = vessel displacement, in tonnes



**Figure G.1—Heeling effect of a snagged net on a vessel engaged in trawling**



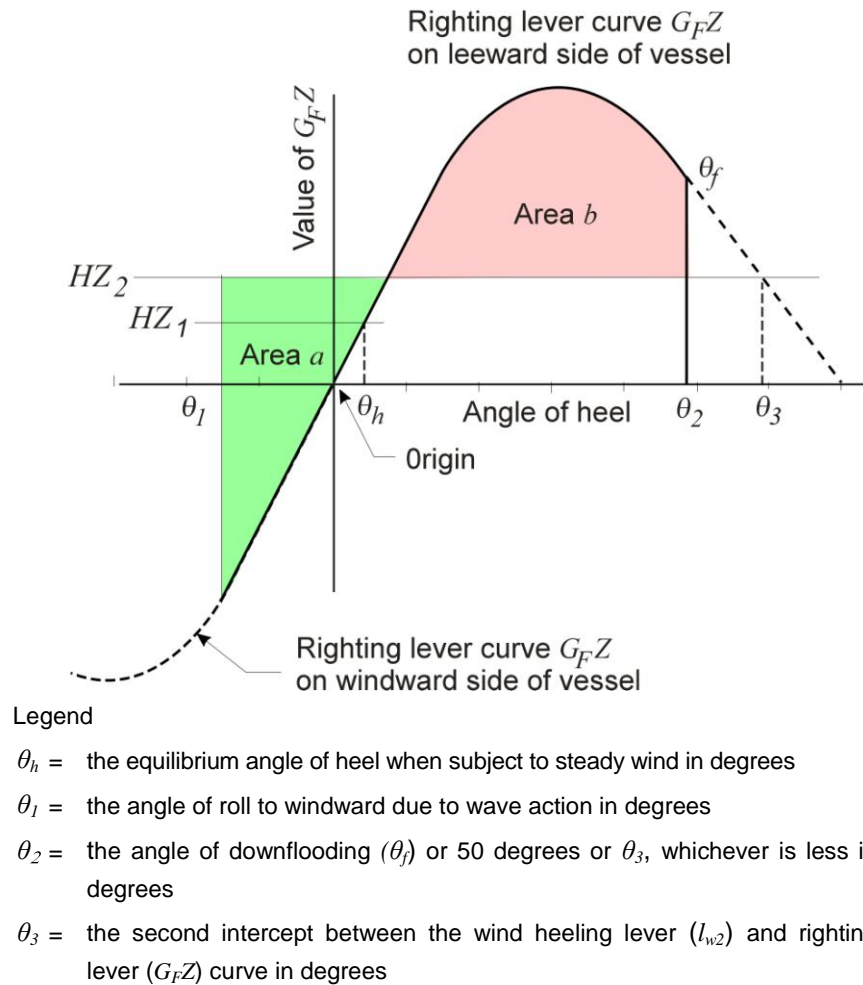
**Figure G.2—Twin rig trawler showing minimum angle for determining trawl net snagging load**

## ANNEX H CALCULATIONS FOR SEVERE WIND AND ROLLING CRITERIA (WEATHER CRITERIA)

### H1 SCOPE

This Annex specifies the calculations for the severe wind and rolling criteria applicable to power vessels. It forms a normative part of this Subsection.

This Annex is referenced in Clause 5.4.2 of this Subsection.



**Figure H.1— Severe wind and rolling analysis**

### H2 SEVERE WIND AND ROLLING SCENARIO

The severe wind and rolling criteria investigate the vessel's capacity to withstand the combined effects of severe wind and rolling that are described in the following, with reference to Figure H.1:

- The vessel is initially subjected to a steady wind pressure acting perpendicular to the vessel's centre line which results in a steady wind heeling lever ( $HZ_1$ ).
- From the resultant equilibrium angle of heel ( $\theta_h$ ), the vessel is assumed to roll due to wave action to an angle of roll ( $\theta_1$ ) to windward.

- c) The vessel is then subjected to a gust wind pressure which results in a gust wind heeling lever ( $HZ_2$ ).
- d) The vessel's motion to windward takes it beyond the equilibrium value of heel until the energy represented by the area beneath the  $HZ_2$  line is balanced by the work needed to heel the vessel beyond equilibrium represented by the area above the  $HZ_2$  line.

### H3 CRITERIA

A vessel that complies with the criteria listed in Table H.1 over the range of normal loading conditions shall be deemed to satisfy the severe wind and rolling criteria.

**Table H.1 — Severe wind and rolling criteria**

Criterion No	Limits to application	Annex H criterion description
Annex H.1	All vessels within application	The angle of heel $\theta_h$ resulting from the application of a steady wind heeling lever $HZ_1$ shall not exceed the lesser of: a) the angle corresponding to 80 per cent of the angle of deck edge immersion; or b) 16 degrees.
Annex H.2	All vessels within application	Referring to Figure H.1, Area $b$ shall be equal to or greater than Area $a$ .

### H4 METHODS OF CALCULATION

#### H4.1 Wind heeling levers

The wind heeling levers ( $HZ_1$ ) and ( $HZ_2$ ) referred to in Clause H3 are constant values at all angles of heel and shall be calculated as follows:

$$HZ_1 = \frac{P_w A_w h}{1000 g \Delta}$$

$$HZ_2 = 1.5 HZ_1$$

where

$HZ_1$  = the wind heel lever due to steady wind in metres

$HZ_2$  = the wind heel lever due to wind gusting in metres

$P_w$  = a wind pressure of 504 Pa

$A_w$  = The projected lateral area of the portion of the vessel and deck cargo above the waterline in square metres

$h$  = the vertical distance from the centre of  $A_w$  to the centre of the underwater lateral area or alternatively to a point at one half the mean draft in metres

$\Delta$  = the displacement in tonnes

$g$  = the acceleration due to gravity, 9.81 m/s<sup>2</sup>

**H4.2 Angle of roll**

The angle of roll ( $\theta_1$ ) referred to in Clause H2 and Figure H.1 shall be:

$$\theta_1 = 109k X_1 X_2 \sqrt{rs} \text{ degrees}$$

where

$X_1$  = a factor as specified in Table H.2

$X_2$  = a factor as specified in Table H.3

$k$  = a factor:

where

$k = 1.0$  for a round bilge vessel having no bilge or bar keels

$k = 0.7$  for a vessel having sharp bilges

$k =$  as specified in Table H.4 for a vessel having bilge keels, a bar keel or both.

$$r = 0.73 + 0.6 \frac{OG}{d}$$

where

$OG$  = the distance between the centre of gravity and the waterline, in metres

NOTE: The value of  $OG$  shall be positive if the centre of gravity is above the waterline, and negative if the centre of gravity is below the waterline

$d$  = the mean moulded draft of the vessel, in metres

$s$  = a factor as specified in Table H.5

**Table H.2 – Values for factor  $X_1$**

$B/d$	$X_1$
$\leq 2.4$	1.00
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 H.3 – Values of factor  $X_2$**

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

Table H.4 – Values of factor  $k$ 

$\frac{100A_k}{LB}$	$k$
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
$\geq 4.0$	0.70

Table H.5 – Values of factor  $s$ 

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

NOTE: Intermediate values in Table H.2 to Table H.5 shall be obtained by linear interpolation

where

$L$  = the length of the vessel at the waterline in metres

$B$  = the moulded breadth of the vessel in metres

$d$  = the mean moulded draft of the vessel in metres

$A_K$  = the total overall area of bilge keels, or area of the lateral projection of the bar keel, or the sum of these areas, in square metres

$T$  = the rolling period in seconds

$$= \frac{2CB}{\sqrt{G_F M_0}}$$

where

$$C = 0.373 + 0.023 \left( \frac{B}{d} \right) - 0.043 \left( \frac{L}{100} \right)$$

$G_F M_0$  = The metacentric height corrected for free surface effect in metres



## ANNEX J CALCULATION AND EVALUATION OF CHAPTER 6A CRITERIA APPLICABLE TO MONOHULL VESSELS THAT SET SAILS

### J1 SCOPE

This Annex specifies the method of verifying the adequacy of the vessel's righting lever ( $G_FZ$ ) curve as related to the sail area. It forms a normative part of this document.

This Annex is referenced in Clause 6.3.4.3 of this Subsection.

### J2 PLOTTING THE RIGHTING LEVER ( $G_FZ$ ) CURVE

The righting lever ( $G_FZ$ ) curve for the vessel shall be plotted for each operating condition up to an angle of heel of—

- 90 degrees, if the angle of vanishing positive stability is equal to or less than 90 degrees; or
- the angle of vanishing positive stability, if that angle exceeds 90 degrees but is less than 120 degrees; or
- 120 degrees, if the angle of vanishing positive stability exceeds 120 degrees.

If the angle of heel at which the maximum righting lever ( $G_FZ$ ) occurs is less than 35 degrees, then the curve shall be truncated so that the maximum value of  $G_FZ$  is no more than the value at 35 degrees, as shown in Figure J.1

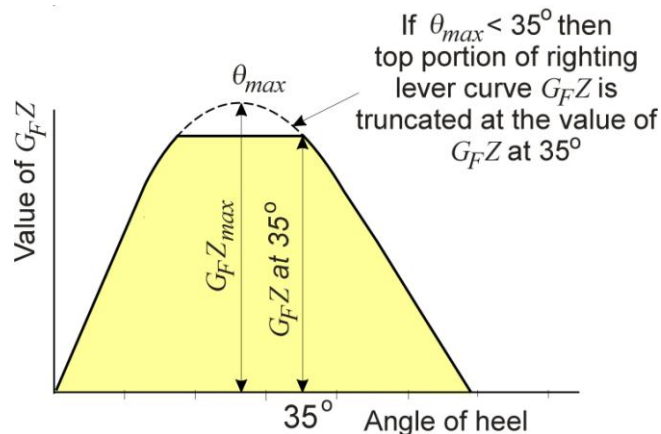


Figure J.1— Truncation of  $G_FZ$  Curve at 35 degrees

### J3 ASSUMED WIND HEELING LEVER

The wind heeling lever curve shall be calculated as follows:

$$HZ_{\theta} = HZ \cos^{1.3} \theta$$

where

$HZ$  = the heeling lever at zero degrees angle of heel in metres

$\theta$  = the angle of heel in degrees

$HZ_\theta$  = the heeling lever in metres at  $\theta$  degrees angle of heel in metres

#### J4 HEELING LEVER TO DECK EDGE IMMERSION

The heeling lever ( $HZ_A$ ) to achieve static balance at the deck edge immersion angle  $\theta_{DE}$  shall be calculated by the following formula, see also Figure J.2.

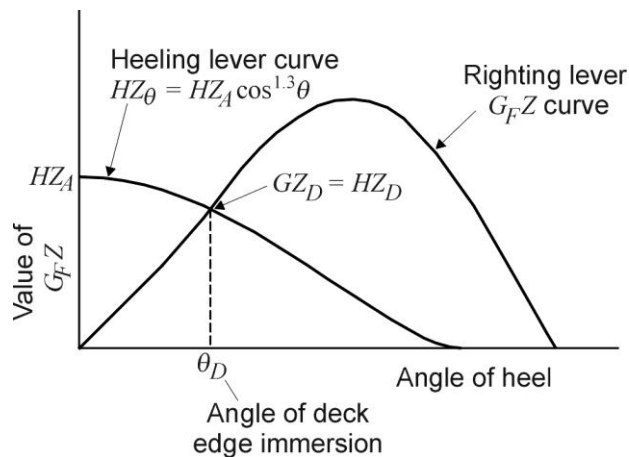
$$HZ_A = \frac{HZ_D}{\cos^{1.3}\theta_D}$$

where

$HZ_A$  = the heeling lever at zero degrees angle of heel in metres

$HZ_D$  = the heeling lever at angle of deck edge immersion in metres  
=  $G_F Z_D$

$\theta_D$  = the angle of heel to deck edge immersion in degrees



**Figure J.2— Heeling lever curve set to intersect the  $G_F Z$  curve at deck edge immersion**

#### J5 DYNAMIC BALANCE TO DOWNFLOODING

The heeling lever ( $HZ_B$ ) to achieve dynamic balance to the downflooding angle shall be calculated by equating the Area B + Area C under the righting lever ( $G_F Z$ ) curve to the Area A + Area C under the heeling lever ( $HZ_\theta$ ) curve, see Figure J.3. Both are calculated to the downflooding angle or 60 degrees whichever is the lesser.

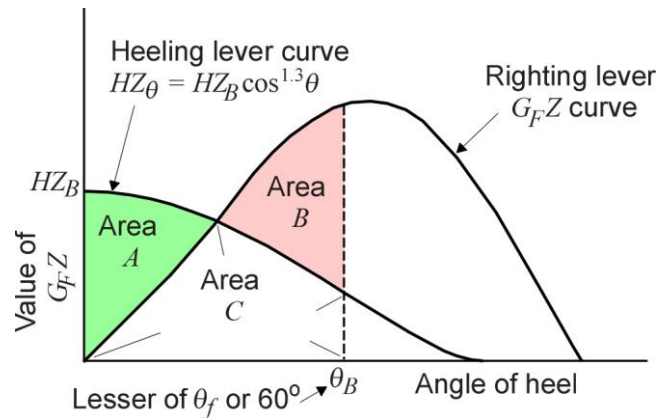
As shown in Figure J.3, for Area A + Area C to be equal to Area B + Area C the heeling lever shall be determined from the following formula:

$$HZ_B = \frac{A_f}{-0.00003\theta_B^3 + 0.0025\theta_B^2 - 1.042\theta_B}$$

where

$HZ_B$  = the heeling lever in metres

- $A_f$  = the area under the righting lever ( $G_FZ$ ) curve to the angle  $\theta_B$  in metre-degrees  
 = Area B + Area C  
 $\theta_B$  = the angle of downflooding  $\theta_f$  or 60 degrees, whichever is less.



**Figure J.3— Heeling lever curve set to balance areas to the downflooding angle  $\theta_B$**

## J6 DYNAMIC BALANCE TO CAPSIZE ON VESSELS THAT HAVE A RANGE OF STABILITY OF 90 DEGREES OR MORE

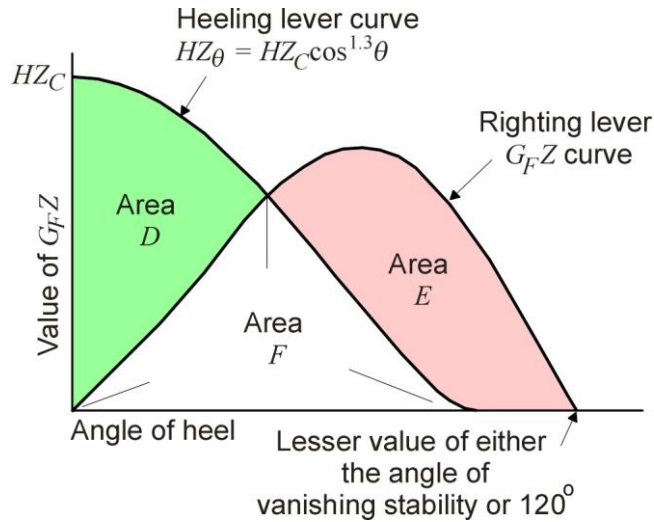
The heeling lever ( $HZ_C$ ) to achieve dynamic balance throughout the range of stability shall be calculated by equating the area under the *righting lever curve* ( $G_FZ$ ) Area E + Area F to the area under the *heeling lever* ( $HZ_C$ ) curve Area D + Area F, see Figure J.4. The areas are to be calculated to the angle of vanishing positive stability but not greater than 120 degrees.

For Area E + Area F to be equal to Area D + Area F the heeling lever shall be determined from the following formula:

$$HZ_B = \frac{A_C}{-0.00003\theta_v^3 + 0.0025\theta_v^2 - 1.042\theta_v}$$

where

- $HZ_C$  = the heeling lever in metres  
 $A_C$  = the area under the righting lever ( $G_FZ$ ) curve to the angle  $\theta_v$  in metre-degrees  
 = Area E + Area F  
 $\theta_v$  = the angle of vanishing positive stability but not less than 90 degrees or greater than 120 degrees

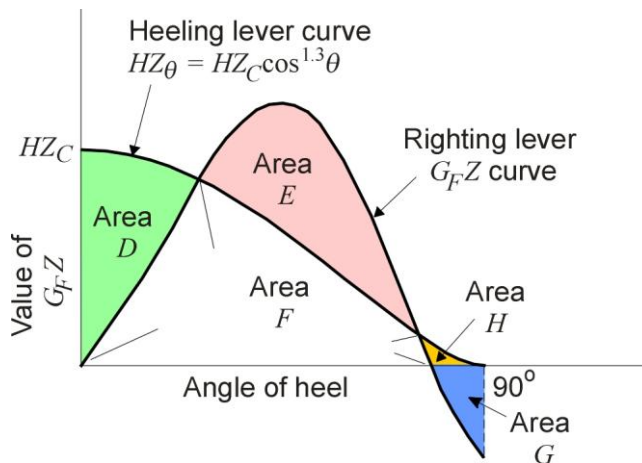


**Figure J.4 — Heeling lever curve set to balance areas to capsize for vessels having an angle of vanishing stability 90 degrees or more**

**J7 DYNAMIC BALANCE TO CAPSIZE ON VESSELS THAT HAVE A RANGE OF STABILITY OF LESS THAN 90 DEGREES**

Where the angle of vanishing positive stability is less than 90 degrees, a safety margin (Area G and Area H) shall be included to reduce the likelihood of heel angles approaching those of capsize. The heeling lever  $HZ_C$  for dynamic balance shall be calculated using the formula specified in Clause J6 except that the value of angle  $\theta_v$  shall be taken to be 90 degrees and the value of  $A_C$  (the area under the righting lever ( $G_F Z$ ) curve to the angle  $\theta_v$ ) shall be reduced by the Area G in Figure J.5; i.e. .

$$A_C = \text{Area } E + \text{Area } F - \text{Area } G$$



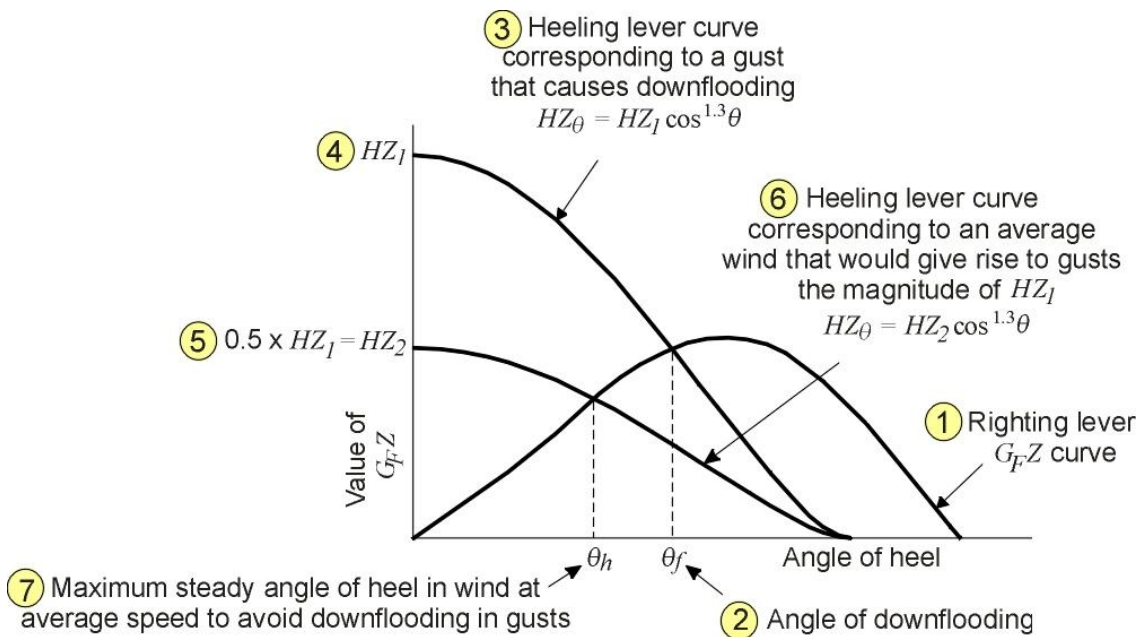
**Figure J.5—Heeling lever curve set to balance areas to capsize for vessels having an angle of vanishing stability less than 90 degrees**

## ANNEX K CHAPTER 6B CRITERIA—DERIVATION OF THE MAXIMUM STEADY HEEL ANGLE TO PREVENT DOWN FLOODING IN GUSTING WINDS

### K1 SCOPE

This Annex provides the method of calculation for the derivation of the maximum steady heel angle  $\theta_h$  to prevent downflooding in gusts. It forms a normative part of this document.

This Annex is referenced in Clause 6.3.5.3 of this Subsection.



**Figure K.1— Method for determining the maximum steady angle of heel in average winds to avoid downflooding in gusts**

### K2 METHOD

The maximum steady heel angle  $\theta_h$  to prevent downflooding in gusts shall be calculated using the steps illustrated in Figure K.1. The heeling levers due to an actual wind gust  $HZ_1$  and the mean wind  $HZ_2$  shall be calculated using the following formulas:

$$HZ_1 = \frac{G_F Z_f}{\cos^{1.3}\theta_f}$$

$$HZ_2 = 0.5 HZ_1 \cos^{1.3}\theta$$

where

$HZ_1$  = the actual wind heeling lever at 0 degrees which would cause the vessel to heel to the downflooding angle  $\theta_f$  or 60 degrees whichever is least.

$G_f Z_f$  = the righting lever derived from the vessel's  $G_f Z$  curve at the downflooding angle  $\theta_f$  or 60 degrees whichever is least

$\theta_f$  = the downflooding angle in degrees

$HZ_2$  = the corresponding average wind heeling lever at any angle  $\theta$  in degrees

$\theta$  = the heel angle in degrees

### K3 DOWNFLOODING ANGLE

The downflooding angle  $\theta_f$  may be determined as the point at which openings having an aggregate area calculated in accordance with the following formula are immersed:

$$A_f = \frac{\Delta}{1500}$$

where

$A_f$  = the area of openings immersed; in square metres

$\Delta$  = the vessel displacement; in tonnes

The following shall be taken into account when establishing the downflooding angle  $\theta_f$ :

- a) All openings regularly used for crew access and for ventilation shall be considered.
- b) The angle shall be determined at the point at which the lower edge of the actual opening that results in critical flooding becomes immersed.