

APPENDIX B

International Code of Safety for High-Speed Craft, 2000

2000 HSC Code

Chapter 2 – Buoyancy, Stability and Subdivision

CHAPTER 2

BUOYANCY, STABILITY AND SUBDIVISION

PART A – GENERAL

2.1 General

2.1.1 A craft shall be provided with:

- .1 stability characteristics and stabilization systems adequate for safety when the craft is operated in the non-displacement mode and during the transitional mode;
- .2 buoyancy and stability characteristics adequate for safety where the craft is operated in the displacement mode, both in the intact condition and the damaged condition; and
- .3 stability characteristics in the non-displacement and transitional modes adequate to transfer the craft safely to displacement mode in case of any system malfunction.

2.1.2 Account shall be taken of the effect of icing in the stability calculations. An example of established practice for ice accretion allowances is given in annex 5 for the guidance of the Administration.

2.1.3 For the purpose of this and other chapters, unless expressly defined otherwise, the following definitions apply:

- .1 *Downflooding point* means any opening through which flooding of the spaces which comprise the reserve buoyancy could take place while the craft is in the intact or damaged condition, and inclines to an angle past the angle of equilibrium.
- .2 *Fully submerged foil* means a foil having no lift components piercing the surface of the water in the foil-borne mode.
- .3 *Monohull craft* means any craft which is not a multihull craft.
- .4 *Multihull craft* means a craft which in any normally achievable operating trim or heel angle, has a rigid hull structure which penetrates the surface of the sea over more than one discrete area.
- .5 *Permeability* of a space means the percentage of the volume of that space which can be occupied by water.
- .6 *Skirt* means a downwardly extending, flexible structure used to contain or divide an air cushion.

2.1.4 Other means of demonstrating compliance with the requirements of any part of this Chapter may be accepted, provided that the method chosen can be shown to provide an equivalent level of safety. Such methods may include:

- .1 mathematical simulation of dynamic behaviour;
- .2 scale model testing; and
- .3 full-scale trials.

2.1.5 Model or full-scale tests and/or calculations (as appropriate) shall also include consideration of the following known stability hazards to which high-speed craft are known to be liable, according to craft type:

- .1 directional instability, which is often coupled to roll and pitch instabilities;
- .2 broaching and bow diving in following seas at speeds near to wave speed, applicable to most types;
- .3 bow diving of planing monohulls and catamarans due to dynamic loss of longitudinal stability in relatively calm seas;
- .4 reduction in transverse stability with increasing speed of monohulls;
- .5 porpoising of planing monohulls, being coupled pitch and heave oscillations, which can become violent;
- .6 chine tripping, being a phenomenon of planing monohulls occurring when the immersion of a chine generates a strong capsizing moment;
- .7 plough-in of air-cushion vehicles, either longitudinal or transverse, as a result of bow or side skirt tuck-under or sudden collapse of skirt geometry, which, in extreme cases, can result in capsize;
- .8 pitch instability of SWATH (small waterplane area twin hull) craft due to the hydrodynamic moment developed as a result of the water flow over the submerged lower hulls;
- .9 reduction in effective metacentric height (roll stiffness) of surface effect ship (SES) in high speed turns compared to that on a straight course, which can result in sudden increases in heel angle and/or coupled roll and pitch oscillations; and
- .10 resonant rolling of SES in beam seas, which, in extreme cases, can result in capsize.

2.1.6 Suitable calculations shall be carried out and/or tests conducted to demonstrate that, when operating within approved operational limitations, the craft will, after a disturbance causing roll, pitch, heave or heel due to turning or any combination thereof, return to the original attitude.

2.2 Intact buoyancy and watertight and weathertight integrity

2.2.1 Intact buoyancy

2.2.1.1 All craft shall have a sufficient reserve of buoyancy at the design waterline to meet the intact and damage stability requirements of this chapter. The Administration may require a larger reserve of buoyancy to permit the craft to operate in any of its intended modes. This reserve of buoyancy shall be calculated by including only those compartments that are:

- .1** watertight and situated below the datum, or
- .2** watertight or weathertight and situated above the datum.

In considering the stability after damage, flooding shall be assumed to occur until limited by watertight boundaries in the equilibrium condition, and weathertight boundaries in intermediate stages of flooding and within the range of positive righting lever required to satisfy the residual stability requirements.

Craft built in conformity with the requirements of organizations recognized by the Administration, in accordance with regulation XI/1 of the Convention may be considered to possess adequate strength and integrity.

2.2.1.2 Arrangements shall be provided for checking the watertight or weathertight integrity of those compartments taken into account in 2.2.1.1, and the details incorporated in the Craft Operating Manual required by 18.2.1.

2.2.2 Openings in watertight divisions

2.2.2.1 The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the craft, and all such doors shall be closed prior to departure of the craft from the berth.

2.2.2.2 Doors in watertight bulkheads may be hinged or sliding. They shall be shown by suitable testing to be capable of maintaining the watertight integrity of the bulkhead. Such testing shall be carried out for both sides of the door and shall apply a pressure head 10% greater than that determined from the minimum permissible height of a downflooding opening. Testing may be carried out either before or after the door is fitted into the craft but, where shore testing is adopted, satisfactory installation in the craft shall be verified by inspection and hose testing.

2.2.2.3 Type approval may be accepted in lieu of testing individual doors, provided the approval process includes pressure testing to a head equal to, or greater, than the required head (refer to 2.2.2.2).

2.2.2.4 All watertight doors shall be capable of being operated when the craft is inclined up to 15°, and shall be fitted with means of indication in the operating compartment showing whether they are open or closed. All such doors shall be capable of being opened and closed locally from each side of the bulkhead.

2.2.2.5 Watertight doors shall remain closed when the craft is at sea, except that they may be opened for access. A notice shall be attached to each door to the effect that it is not to be left open.

2.2.2.6 Watertight doors shall be capable of being closed by remote control from the operating compartment in not less than 20 s and not more than 40 s, and shall be provided with an audible alarm, distinct from other alarms in the area, which will sound for at least 5 s but no more than 10 s before the doors begin to move whenever the door is closed remotely by power, and continue sounding until the door is completely closed. The power, control and indicators shall be operable in the event of main power failure, as required by regulation II-1/15.7.3 of the Convention. In passenger areas and areas where the ambient noise exceeds 85 dB(A) the audible alarm shall be supplemented by an intermittent visual signal at the door. If the Administration is satisfied that such doors are essential for the safe work of the craft, hinged watertight doors having only local control may be permitted for areas to which crew only have access, provided they are fitted with remote indicators as required by 2.2.2.4.

2.2.2.7 Where pipes, scuppers, electric cables, etc. are carried through watertight divisions, the arrangements for creating a watertight penetration shall be of a type which has been prototype tested under hydrostatic pressure equal to or greater than that required to be withstood for the actual location in the craft in which they are to be installed. The test pressure shall be maintained for at least 30 min and there must be no leakage through the penetration arrangement during this period. The test pressure head shall be 10% greater than that determined from the minimum permissible height of a downflooding opening. Watertight bulkhead penetrations which are effected by continuous welding do not require prototype testing. Valves on scuppers from weathertight compartments, included in the stability calculations, shall have arrangements for remote closing from the operating station.

2.2.2.8 Where a ventilation trunk forms part of a watertight boundary, the trunk shall be capable of withstanding the water pressure that may be present taking into account the maximum inclination angle allowable during all stages of flooding.

2.2.3 *Inner bow doors*

2.2.3.1 Where ro-ro craft are fitted with bow loading openings, an inner bow door shall be fitted abaft such openings, to restrict the extent of flooding in the event of failure of the outer closure. This inner bow door, where fitted, shall be:

- .1** weathertight to the deck above, which deck shall itself be weathertight forward to the bow loading opening;
- .2** so arranged as to preclude the possibility of a bow loading door causing damage to it in the case of damage to, or detachment of, the bow loading door;
- .3** forward of all positions on the vehicle deck in which vehicles are intended to be carried; and
- .4** part of a boundary designed to prevent flooding into the remainder of the craft.

2.2.3.2 A craft shall be exempted from the requirement for such an inner bow door where one of the following applies:

- .1** the vehicle loading deck at the inner bow door position is above the design waterline by a height more than the significant wave height corresponding to the worst intended conditions;
- .2** it can be demonstrated using model tests or mathematical simulations that when the craft is proceeding at a range of speeds up to the maximum attainable speed in the loaded condition at all headings in long crested seas of the greatest significant wave height corresponding to the worst intended conditions, either:
 - .2.1** the bow loading door is not reached by waves; or
 - .2.2** having been tested with the bow loading door open to determine the maximum steady state volume of water which accumulates, it can be shown by static analysis that, with the same volume of water on the vehicle deck(s) the residual stability requirements of 2.6.11 and 2.13 or 2.15 are satisfied. If the model tests or mathematical simulations are unable to show that the volume of water accumulated reaches a steady state, the craft shall be considered not to have satisfied the conditions of this exemption.

Where mathematical simulations are employed they shall already have been verified against full-scale or model testing;

- .3** bow loading openings lead to open ro-ro spaces provided with guard-rails or having freeing ports complying with 2.2.3.2.4;
- .4** the deck of the lowest ro-ro space above the design waterline is fitted on each side of the deck with freeing ports evenly distributed along the sides of the compartment. These shall either be proven to be acceptable using tests according to 2.2.3.2.2 above or comply with the following:
 - .4.1** $A \geq 0.3 l$
where:
 A = the total area of freeing ports on each side of the deck in m^2 ; and
 l = the length of the compartment in m;
 - .4.2** the craft shall maintain a residual freeboard to the deck of the ro-ro space of at least 1 m in the worst condition;
 - .4.3** such freeing ports shall be located within the height of 0.6 m above the deck of the ro-ro space, and the lower edge of the ports shall be within 0.02 m above the deck of the ro-ro space; and
 - .4.4** such freeing ports shall be fitted with closing devices or flaps to prevent water entering the deck of the ro-ro space whilst allowing water which may accumulate on the deck of the ro-ro space to drain.

2.2.4 *Other provisions for ro-ro craft*

2.2.4.1 All accesses in the ro-ro space that lead to spaces below the deck shall have a lowest point which is not less than the height required from the tests conducted according to 2.2.3.2.2 or 3 m above the design waterline.

2.2.4.2 Where vehicle ramps are installed to give access to spaces below the deck of the ro-ro space, their openings shall be capable of being closed weathertight to prevent ingress of water below.

2.2.4.3 Accesses in the ro-ro space that lead to spaces below the ro-ro deck and having a lowest point which is less than the height required from the tests conducted according to 2.2.3.2.2 or 3 m above the design waterline may be permitted provided they are watertight and are closed before the craft leaves the berth on any voyage and remain closed until the craft is at its next berth.

2.2.4.4 The accesses referred to in 2.2.4.2 and 2.2.4.3 above shall be fitted with alarm indicators in the operating compartment.

2.2.4.5 Special category spaces and ro-ro spaces shall be patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the craft is underway (refer to 7.8.3.1).

2.2.5 *Indicators and surveillance*

2.2.5.1 Indicators

Indicators shall be provided in the operating compartment for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could lead to major flooding in the intact and damage conditions. The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked, and by audible alarms if such door or closing appliance becomes open or the securing arrangements become unsecured. The indicator panel in the operating compartment shall be equipped with a mode selection function 'harbour/sea voyage' so arranged that an audible alarm is given in the operating compartment if the craft leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator systems shall be independent of the power supply for operating and securing the doors.

2.2.5.2 Television surveillance

Television surveillance and a water leakage detection system shall be arranged to provide an indication to the operating compartment and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to major flooding.

2.2.6 *Integrity of superstructure*

2.2.6.1 Where entry of water into structures above the datum would significantly influence the stability and buoyancy of the craft, such structures shall be:

- .1** of adequate strength to maintain the weathertight integrity and fitted with weathertight closing appliances; or
- .2** provided with adequate drainage arrangements; or
- .3** an equivalent combination of both measures.

2.2.6.2 Weathertight superstructures and deckhouses located above the datum shall in the outside boundaries have means of closing openings with sufficient strength such as to maintain weathertight integrity in all damage conditions where the space in question is not damaged. Furthermore, the means of closing shall be such as to maintain weathertight integrity in all operational conditions.

2.2.7 *Doors, windows, etc., in boundaries of weathertight spaces*

2.2.7.1 Doors, windows, etc., and any associated frames and mullions in weathertight superstructures and deckhouses shall be weathertight and shall not leak or fail at a uniformly applied pressure less than that at which adjacent structure would experience permanent set or fail. Conformity with the requirements of organizations recognized by the Administration in accordance with regulation XI/1 of the Convention may be considered to possess adequate strength.

2.2.7.2 For doors in weathertight superstructures, hose tests shall be carried out with a water pressure from the outside in accordance with specifications at least equivalent to those acceptable to the Organization*.

2.2.7.3 The height above the deck of sills to doorways leading to exposed decks shall be as high above the deck as is reasonable and practicable, particularly those located in exposed positions. Such sill heights shall in general not be less than 100 mm for doors to weathertight spaces on decks above the datum, and 250 mm elsewhere. For craft of 30 m in length and under, sill heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.2.7.4 Windows shall not be permitted in the boundaries of special category spaces or ro-ro spaces or below the datum. If required by restrictions in the Permit to Operate, forward facing windows, or windows which may be submerged at any stage of flooding shall be fitted with hinged or sliding storm shutters ready for immediate use.

2.2.7.5 Side scuttles to spaces below the datum shall be fitted with efficient hinged deadlights arranged inside so that they can be effectively closed and secured watertight.

* Refer to ISO 6042 - *Ships and Marine Technology - Weathertight single-leaf steel doors*, or a similar standard.

2.2.7.6 No side scuttle shall be fitted in a position so that its sill is below a line drawn parallel to and one metre above the design waterline.

2.2.8 *Hatchways and other openings*

2.2.8.1 Hatchways closed by weathertight covers

The construction and the means for securing the weathertightness of cargo and other hatchways shall comply with the following:

- .1** coaming heights shall in general not be less than 100 mm for hatches to weathertight spaces on decks above the datum, and 250 mm elsewhere. For craft of 30 m in length and under, coaming heights may be reduced to the maximum which is consistent with the safe working of the craft;
- .2** the height of these coamings may be reduced, or the coamings omitted entirely, on condition that the Administration is satisfied that the safety of the ship is not thereby impaired in any sea conditions up to the worst intended conditions. Where coamings are provided, they shall be of substantial construction; and
- .3** the arrangements for securing and maintaining weathertightness shall ensure that the tightness can be maintained in any sea conditions up to the worst intended conditions.

2.2.8.2 Machinery space openings

2.2.8.2.1 Machinery space openings shall be properly framed and efficiently enclosed by casings of ample strength and, where the casings are not protected by other structures, their strength shall be specially considered. Access openings in such casings shall be fitted with weathertight doors.

2.2.8.2.2 Heights of sills and coaming shall, in general, not be less than 100 mm for openings to weathertight spaces on decks above the datum, and 380 mm elsewhere. For craft of 30 m in length and under, these heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.2.8.2.3 Machinery space ventilator openings shall comply with the requirements of 2.2.8.4.2.

2.2.8.3 Miscellaneous openings in exposed decks

2.2.8.3.1 Manholes and flush scuttles on the datum or within superstructures other than enclosed superstructures shall be closed by substantial covers capable of being made watertight. Unless secured by closely spaced bolts, the covers shall be permanently attached.

2.2.8.3.2 Service hatches to machinery, etc. may be arranged as flush hatches provided that the covers are secured by closely spaced bolts, are kept closed at sea, and are equipped with arrangements for portable guardrails.

2.2.8.3.3 Openings in exposed decks leading to spaces below the datum or enclosed superstructures other than hatchways, machinery space openings, manholes and flush scuttles shall be protected by an enclosed superstructure, or by a deckhouse or companionway of equivalent strength and weathertightness.

2.2.8.3.4 The height above the deck of sills to the doorways in companionways shall, in general, not be less than 100 mm for doors to weathertight spaces on decks above the datum, and 250 mm elsewhere. For craft of 30 m in length and under sill heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.2.8.4 Ventilators

2.2.8.4.1 Ventilators to spaces below the datum or decks of enclosed superstructures shall have substantially constructed coamings efficiently connected to the deck. Coaming heights shall in general not be less than 100 mm for ventilators to weathertight spaces on decks above the datum, and 380 mm elsewhere. For craft of 30 m in length and under, coaming heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.2.8.4.2 Ventilators the coamings of which extend to more than one metre above the deck or which are fitted to decks above the datum need not be fitted with closing arrangements unless they face forward or are specifically required by the Administration.

2.2.8.4.3 Except as provided in 2.2.8.4.2, ventilator openings shall be provided with efficient weathertight closing appliances.

2.2.8.4.3 Ventilator openings shall face aft or athwartships wherever practicable.

2.2.9 Scuppers, inlets and discharges

2.2.9.1 Discharges led through the shell either from spaces below the datum or from within superstructures and deckhouses fitted above the datum shall be fitted with efficient and accessible means for preventing water from passing inboard. Normally each separate discharge shall have one automatic non-return valve with a positive means of closing it from a position above the datum. Where, however, the vertical distance from the design waterline to the inboard end of the discharge pipe exceeds 0.01 L, the discharge may have two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions. Where that vertical distance exceeds 0.02 L, a single automatic non-return valve without positive means of closing may be accepted. The means for operating the positive action valve shall be readily accessible and provided with an indicator showing whether the valve is open or closed.

2.2.9.2 Valves on scuppers from weathertight compartments included in the stability calculations shall be operable from the operating compartment.

2.2.9.3 In manned machinery spaces, main and auxiliary sea inlets and discharges in connection with the operation of machinery may be controlled locally. Such controls shall be readily accessible and shall be provided with indicators showing whether the valves are open or closed. In unmanned machinery spaces, main and auxiliary sea inlets and discharges in connection with the operation of machinery shall be operable from the operating compartment.

2.2.9.4 Scuppers leading from superstructures or deckhouses not fitted with weathertight doors shall be led overboard.

2.2.9.5 All shell fittings and the valves required by this Code shall be of a suitable ductile material. Valves of ordinary cast iron or similar material shall not be acceptable.

2.2.10 *Air pipes*

2.2.10.1 Main storage tanks containing flammable liquids or tanks which can be pumped or filled from the sea shall have air pipes which do not terminate in enclosed spaces.

2.2.10.2 All air pipes extending to exposed decks shall have a height from the deck to the point where water may have access below of at least 300 mm where the deck is less than 0.05L above the design waterline, and 150 mm on all other decks.

2.2.10.3 Air pipes may discharge through the side of the superstructure provided that this is at a height of at least 0.02L above any waterline when the intact craft is heeled to an angle of 15°, or 0.02L above the highest waterline at all stages of flooding as determined by the damaged stability calculations, whichever is higher.

2.2.10.4 All air pipes shall be equipped with weathertight closing devices that close automatically.

2.2.11 *Freeing ports*

2.2.11.1 Where bulwarks on weather decks form wells, ample provision shall be made for rapidly freeing the decks of water and for draining them. The minimum freeing port area (A) on each side of the craft for each well on the weather deck of the main hull(s) shall be:

- .1** where the length of bulwark (l) in the well is 20 m or less:
 $A = 0.7 + 0.035 l \text{ (m}^2\text{)}$; and
- .2** where l exceeds 20 m:
 $A = 0.07 l \text{ (m}^2\text{)}$,

and, in no case, l need be taken as greater than 0.7 L.

If the bulwark is more than 1.2 m in average height, the required area shall be increased by 0.004 m² per metre of length of well for each 0.1 metre difference in height. If the bulwark is less than 0.9 m in average height, the required area shall be decreased by 0.004 m² per metre of length of well for each 0.1 metre difference in height.

2.2.11.2 Such freeing ports shall be located within the height of 0.6 m above the deck and the lower edge shall be within 0.02 m above the deck.

2.2.11.3 All such openings in the bulwarks shall be protected by rails or bars spaced approximately 230 mm apart. If shutters are fitted to freeing ports, ample clearance shall be provided to prevent jamming. Hinges shall have pins or bearings of non-corrodible material.

If shutters are fitted with securing appliances, these appliances shall be of approved construction.

2.2.11.4 Craft, having superstructures which are open in front or both ends, shall comply with the provisions of 2.2.11.1.

2.2.11.5 In craft, having superstructures which are open at the aft end, the minimum freeing port area shall be:

$$A = 0.3 b \text{ (m}^2\text{)}$$

where:

b = the breadth of the craft at the exposed deck (m).

2.2.11.6 Ro-ro craft fitted with bow loading openings leading to open vehicle spaces shall comply with the provisions of 2.2.3.

2.3 Intact stability in the displacement mode

2.3.1 Hydrofoil craft fitted with surface-piercing foils and/or fully submerged foils shall have sufficient stability under all permitted cases of loading to comply with the relevant provisions of annex 6 and specifically maintain a heel angle of less than 10° when subjected to the greater of the heeling moments in 1.1.2 and 1.1.4 of that annex.

2.3.2 Subject to 2.3.4, multihull craft other than hydrofoil craft shall meet the relevant requirements of annex 7 in all permitted cases of loading.

2.3.3 Subject to 2.3.4, monohull craft other than hydrofoil craft shall meet the relevant requirements of annex 8 in all permitted conditions of loading.

2.3.4 Where the characteristics of multihull craft are inappropriate for application of annex 7 or the characteristics of monohull craft are inappropriate for application of annex 8, the Administration may accept alternative criteria equivalent to those stipulated, as appropriate to the type of craft and area of operation. The requirements of annexes 7 and 8 may be applied as indicated in the table below.

Table 2.3.4 – Application of annexes 7 and 8 to monohull and multihull craft

GM _T	$\frac{B_{WL} \cdot A_{WL}}{\nabla}$	
	≤ 7	> 7
≤ 3.0	annex 8	annex 8 or annex 7
> 3.0	annex 8 or annex 7	annex 7

where:

B_{WL} = maximum waterline beam at the design waterline (m); for multihull, this shall be taken to the outside of sidehulls

- A_{WP} = waterplane area at the design waterline (m^2)
- ∇ = volume of displacement at the design waterline (m^3)
- GMT = transverse metacentric height in the loading condition corresponding to the design waterline, corrected for free surface effects (m)

2.4 Intact stability in the non-displacement mode

2.4.1 The requirements of this section and section 2.12 shall be applied on the assumption that any stabilisation systems fitted are fully operational.

2.4.2 The roll and pitch stability on the first and/or any other craft of a series shall be qualitatively assessed during operational safety trials as required by chapter 18 and annex 9. The results of such trials may indicate the need to impose operational limitations.

2.4.3 Where craft are fitted with surface-piercing structure or appendages, precautions shall be taken against dangerous attitudes or inclinations and loss of stability subsequent to a collision with a submerged or floating object.

2.4.4 In designs where periodic use of cushion deformation is employed as a means of assisting craft control, or periodic use of cushion air exhausting to atmosphere for purposes of craft manoeuvring, the effects upon cushion-borne stability shall be determined, and the limitations on the use by virtue of craft speed or attitude shall be established.

2.4.5 In the case of an air cushion vehicle fitted with flexible skirts, it shall be demonstrated that the skirts remain stable under operational conditions.

2.5 Intact stability in the transitional mode

2.5.1 Under weather conditions up to the worst intended conditions, the time to pass from the displacement mode to the non-displacement mode and vice versa shall be minimised unless it is demonstrated that no substantial reduction of stability occurs during this transition.

2.5.2 Hydrofoil craft shall comply with the relevant provisions of annex 6.

2.6 Buoyancy and stability in the displacement mode following damage

2.6.1 The requirements of this section apply to all permitted conditions of loading.

2.6.2 For the purpose of making damage stability calculations, the volume and surface permeabilities shall be, in general, as follows:

Spaces	Permeability
Appropriated to cargo or stores	60
Occupied by accommodation	95
Occupied by machinery	85
Intended for liquids	0 or 95*
Appropriated for cargo vehicles	90
Void spaces	95

* whichever results in the more severe requirements.

2.6.3 Notwithstanding 2.6.2, permeability determined by direct calculation shall be used where a more onerous condition results, and may be used where a less onerous condition results from that provided according to 2.6.2.

2.6.4 The Administration may permit the use of low-density foam or other media to provide buoyancy in void spaces, provided that satisfactory evidence is provided that any such proposed medium is the most suitable alternative and is:

- .1 of closed-cell form if foam, or otherwise impervious to water absorption;
- .2 structurally stable under service conditions;
- .3 chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact (reference is made to 7.4.3.7); and
- .4 properly secured in place and easily removable for inspection of the void spaces.

2.6.5 The Administration may permit void bottom spaces to be fitted within the watertight envelope of the hull without the provision of a bilge system or air pipes provided that:

- .1 the structure is capable of withstanding the pressure head after any of the damages required by this section;
- .2 when carrying out a damage stability calculation in accordance with the requirements of this section, any void space adjacent to the damaged zone shall be included in the calculation and the criteria in 2.6, 2.13 and 2.15 complied with;
- .3 the means by which water which has leaked into the void space is to be removed shall be included in the craft operating manual required by chapter 18; and
- .4 adequate ventilation is provided for inspection of the space under consideration as required by 2.2.1.2.

2.6.6 Any damage of a lesser extent than that postulated in 2.6.7 to 2.6.10, as applicable, which would result in a more severe condition shall also be investigated. The shape of the damage shall be assumed to be a parallelepiped.

2.6.7 *Extent of side damage*

The following side damages shall be assumed anywhere on the periphery of the craft:

- .1 the longitudinal extent of damage shall be $0.75 \nabla^{1/3}$, or $(3 \text{ m} + 0.225 \nabla^{1/3})$, or 11 m, whichever is the least;

- .2 the transverse extent of penetration into the craft shall be $0.2 \nabla^{1/3}$. However, where the craft is fitted with inflated skirts or with non-buoyant side structures, the transverse extent of penetration shall be at least $0.12 \nabla^{1/3}$ into the main buoyancy hull or tank structure; and
- .3 the vertical extent of damage shall be taken for the full vertical extent of the craft,

where:

∇ = volume of displacement corresponding to the design waterline (m^3).

2.6.8 Extent of bottom damage in areas vulnerable to raking damage

2.6.8.1 Application

- .1 Any part of the surface of the hull(s) is considered to be vulnerable to raking damage if:
 - .1.1 it is in contact with the water at operational speed in smooth water, and
 - .1.2 it also lies below two planes which are perpendicular to the craft centreline plane and at heights as shown in figure 2.6.8.1.

For multihulls, individual hulls shall be considered separately.

- .2 Raking damage shall be assumed to occur along any fore-and-aft line on the surface of the hull(s) between the keel and the upper limit defined in the figure below:

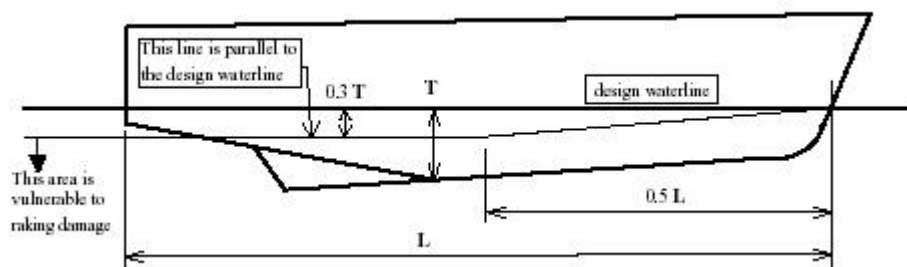


Figure 2.6.8.1

where: T = maximum draught of the hull (each hull considered individually in the case of multihulls) to the design waterline, excluding any nonbuoyant structure

- .3 Damage shall not be applied at the same time as that defined in 2.6.7 or 2.6.9.

2.6.8.2 Extent

2.6.8.2.1 Two different longitudinal extents shall be considered separately:

- .1 55% of the length L, measured from the most forward point of the underwater buoyant volume of each hull; and
- .2 a percentage of the length L, applied anywhere in the length of the craft, equal to 35% for craft where L = 50m and over and equal to (L/2 + 10)% for craft where L is less than 50m.

2.6.8.2.2 Except as provided below, the penetration normal to the shell shall be $0.04 \nabla^{1/3}$ or 0.5 m, whichever is the lesser, in association with a girth along the shell equal to $0.1 \nabla^{1/3}$, where ∇ is the volume of displacement corresponding to the design waterline (m^3). However this penetration or girth shall under no circumstances extend above the vertical extent of the vulnerable area as specified in 2.6.8.1.1.

2.6.9 *Extent of bottom damage in areas not vulnerable to raking damage*

2.6.9.1 Application

This applies to all parts of the hull(s) which are not defined as vulnerable to raking damage in 2.6.8.1. Damage shall not be applied at the same time as that defined in 2.6.7 or 2.6.8.

2.6.9.2 Extent

The following extent of damage shall be assumed:

- .1 the length of damage in the fore-and-aft direction shall be $0.75 \nabla^{1/3}$, or (3 m + $0.225 \nabla^{1/3}$), or 11 m whichever is the least;
- .2 the athwartships girth of damage shall be $0.2 \nabla^{1/3}$; and
- .3 the depth of penetration normal to the shell shall be $0.02 \nabla^{1/3}$,

where:

∇ = volume of displacement corresponding to the design waterline (m^3).

2.6.10 In applying 2.6.8 and 2.6.9 to multihull craft, an obstruction at or below the design waterline of up to 7 m width shall be considered in determining the number of hulls damaged at any one time. The requirement of 2.6.6 shall also be applied.

2.6.11 Following any of the postulated damages detailed in 2.6.6 to 2.6.10, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that:

- .1 for all craft other than amphibious air-cushion vehicles, after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 50% of the significant wave height corresponding to the worst intended conditions;

- .2 for amphibious air-cushion vehicles, after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 25% of the significant wave height corresponding to the worst intended conditions;
- .3 there is a positive freeboard from the damage waterline to survival craft embarkation positions;
- .4 essential emergency equipment, emergency radios, power supplies and public address systems needed for organizing the evacuation remain accessible and operational;
- .5 the residual stability of craft meets the appropriate criteria as laid out in annexes 7 and 8 according to table 2.3.4. Within the range of positive stability governed by the criteria of annexes 7 or 8, no unprotected opening shall be submerged.

2.6.12 Downflooding openings referred to in 2.6.11.1 and 2.6.11.2 shall include doors and hatches which are used for damage control or evacuation procedures, but may exclude those which are closed by means of weathertight doors and hatch covers and not used for damage control or evacuation procedures.

2.7 Inclining and stability information

2.7.1 Every craft, on completion of build, shall be inclined and the elements of its stability determined. When an accurate inclining is not practical, the lightweight displacement and centre of gravity shall be determined by a lightweight survey and accurate calculation.

2.7.2 The master shall be supplied by the owner with reliable information relating to the stability of the craft in accordance with the following provisions of this paragraph. The information relating to stability shall, before issued to the master, be submitted to the Administration for approval, together with a copy thereof for their retention, and shall incorporate such additions and amendments as the Administration may in any particular case require.

2.7.3 Where any alterations are made to a craft so as significantly to affect the stability information supplied to the master, amended stability information shall be provided. If necessary the craft shall be re-inclined.

2.7.4 A report of each inclining or lightweight survey carried out in accordance with this chapter and of the calculation therefrom of the lightweight condition particulars shall be submitted to the Administration for approval, together with a copy for their retention. The approved report shall be placed on board the craft by the owner in the custody of the master and shall incorporate such additions and amendments as the Administration may in any particular case require. The amended lightweight condition particulars so obtained from time to time shall be used by the master in substitution for such previously approved particulars when calculating the craft's stability.

2.7.5 Following any inclining or lightweight survey, the master shall be supplied with amended stability information if the Administration so requires. The information so supplied

shall be submitted to the Administration for approval, together with a copy thereof for their retention, and shall incorporate such additions and amendments as the Administration may in any particular case require.

2.7.6 Stability information demonstrating compliance with this chapter shall be furnished in the form of a stability information book which shall be kept on board the craft at all times in the custody of the master. The information shall include particulars appropriate to the craft and shall reflect the craft loading conditions and mode of operation. Any enclosed superstructures or deck-houses included in the cross curves of stability and the critical downflooding points and angles shall be identified. At the operating station there shall be plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with their means of closure and position of any controls thereof.

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

2.7.8 The owner or builder, as appropriate, shall ensure that the positions of the draught marks are accurately determined and that the marks are located on the hull in a permanent manner. Accuracy of the draught marks shall be demonstrated to the Administration prior to the inclining experiment.

2.8 Loading and stability assessment

On completion of loading of the craft and prior to its departure on a voyage, the master shall determine the trim and stability of the craft and also ascertain and record that the craft is in compliance with stability criteria of the relevant requirements. The Administration may accept the use of an electronic loading and stability computer or equivalent means for this purpose.

2.9 Marking and recording of the design waterline

2.9.1 The design waterline shall be clearly and permanently marked on the craft's outer sides by the load line mark described below. This and the reference line described in 2.9.2.2 below shall be recorded in the High-Speed Craft Safety Certificate. For craft where this is not practical, e.g. amphibious air-cushion vehicles fitted with peripheral skirts, defined deck reference points shall be provided, from which the freeboard can be measured, and hence the draughts obtained.

2.9.2 Load line mark

2.9.2.1 The load line mark shall consist of a ring with an outside diameter of 300 mm and width of 25 mm which is intersected by a horizontal line of length 450 mm and having a breadth of 25 mm, the upper edge of which passes through the centre of the ring. The centre of the ring shall be placed at the longitudinal centre of flotation in the displacement mode and at a height corresponding to the design waterline.

2.9.2.2 To assist in verifying the position of the load line mark, a reference line shall be marked on the hull at the longitudinal centre of flotation by a horizontal bar having a length of 300 mm and a breadth of 25 mm and having the upper edge corresponding to the reference line.

2.9.2.3 Where practicable, the reference line should be related to the uppermost deck at side. Where it is not possible, the position of the reference line should be defined from the underside of keel at the longitudinal centre of flotation.

2.9.2.4 The mark of the Authority by whom the load lines are assigned may be indicated alongside the load line ring above the horizontal line which passes through the centre of the ring, or above and below it. This mark shall consist of not more than four initials to identify the Authority's name, each measuring approximately 115 mm in height, and 75 mm in width.

2.9.2.5 The ring, lines and letters shall be painted in white or yellow on a dark ground or in black on a light ground, and permanently marked. The marks shall be plainly visible.

2.9.3 *Verification*

The High-Speed Craft Safety Certificate shall not be delivered until the Administration has verified that the marks are correctly and permanently indicated on the sides of the craft.

PART B - REQUIREMENTS FOR PASSENGER CRAFT

2.10 **General**

Where compliance with this chapter requires consideration of the effects of passenger weight, the following information shall be used:

- .1** The distribution of passengers is 4 persons per square metre.
- .2** Each passenger has a mass of 75 kg.
- .3** Vertical centre of gravity of seated passengers is 0.3 m above seat.
- .4** Vertical centre of gravity of standing passengers is 1.0 m above deck.
- .5** Passengers and luggage shall be considered to be in the space normally at their disposal.
- .6** Passengers shall be distributed on available deck areas towards one side of the craft on the decks where assembly stations are located and in such a way that they produce the most adverse heeling moment.

2.11 **Intact stability in the displacement mode**

The craft shall have sufficient intact stability that, when in still water conditions, the inclination of the craft from the horizontal would not exceed 10° (under all permitted cases of loading and uncontrolled passenger movements as may occur).

2.12 Intact stability in the non-displacement mode

2.12.1 The total heel angle in still water due to the effect of passenger movements or due to beam wind pressure as per 1.1.4 of annex 6 shall not to exceed 10°. Passenger movement need not be considered where passengers are required to be seated whenever the craft is operating in the non-displacement mode.

2.12.2 In all loading conditions, the outward heel due to turning shall not exceed 8°, and the total heel due to beam wind pressure as per 1.1.4 of annex 6 and due to turning shall not exceed 12° outward.

2.13 Buoyancy and stability in the displacement mode following damage

2.13.1 Following any of the postulated damages detailed in 2.6.6 to 2.6.10, in addition to satisfying the requirements of 2.6.11 and 2.6.12, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that:

- .1 the angle of inclination of the craft from the horizontal does not normally exceed 10° in any direction. However, where this is clearly impractical, angles of inclination up to 15° immediately after damage but reducing to 10° within 15 min shall be permitted provided that efficient non-slip deck surfaces and suitable holding points, e.g., holes, bars, etc., are provided; and
- .2 any flooding of passenger compartments or escape routes which might occur will not significantly impede the evacuation of passengers.

2.13.2 In addition to the requirements in 2.13.1, category B craft shall also satisfy the following criteria after sustaining raking damage of 100% of length L, having the girth and penetration given in 2.6.8.2.2, to any part of the surface of the hull(s) defined in 2.6.8.1:

- .1 the angle of inclination of the craft from the horizontal shall not exceed 20° in the equilibrium condition;
- .2 the range of positive righting lever shall be at least 15° in the equilibrium condition;
- .3 the positive area under the righting lever curve shall be at least 0.015 mrad in the equilibrium condition;
- .4 the requirements of 2.6.11.3 and 2.13.1.2 are satisfied; and
- .5 in intermediate stages of flooding, the maximum righting lever shall be at least 0.05 m and the range of positive righting lever shall be at least 7°.

In complying with the above, the righting lever curve shall be terminated at the angle of downflooding, and only one free surface need be assumed.

2.14 Inclining and stability information

2.14.1 At periodical intervals not exceeding 5 years, a lightweight survey shall be carried out on all passenger craft to verify any changes in lightweight displacement and longitudinal centre of gravity. The passenger craft shall be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightweight displacement exceeding 2%, or a deviation of the longitudinal centre of gravity exceeding 1% of L is found or anticipated.

2.14.2 A report of each inclining or lightweight survey carried out in accordance with paragraph 2.7.1 and of the calculation therefrom of the lightweight condition particulars shall be submitted to the Administration for approval, together with a copy for their retention. The approved report shall be placed on board the craft by the owner in the custody of the master and shall incorporate such additions and amendments as the Administration may in any particular case require. The amended lightweight condition particulars so obtained from time to time shall be used by the master in substitution for such previously approved particulars when calculating the craft's stability.

2.14.3 Following any inclining or lightweight survey, the master shall be supplied with amended stability information if the Administration so requires. The information so supplied shall be submitted to the Administration for approval, together with a copy thereof for their retention, and shall incorporate such additions and amendments as the Administration may in any particular case require.

PART C - REQUIREMENTS FOR CARGO CRAFT

2.15 Buoyancy and stability in the displacement mode following damage

Following any of the postulated damages detailed in 2.6.6 to 2.6.10, in addition to satisfying the requirements of 2.6.11 and 2.6.12, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that the angle of inclination of the craft from the horizontal does not normally exceed 15° in any direction. However, where this is clearly impractical, angles of inclination up to 20° immediately after damage but reducing to 15° within 15 minutes may be permitted provided that efficient non-slip deck surfaces and suitable holding points are provided.

2.16 Inclining

Where it is satisfied by lightweight survey, weighing or other demonstration that the lightweight of a craft is closely similar to that of another craft of the series to which 2.7.1 has been applied, the Administration may waive the requirement of 2.7.1 for craft to be inclined. In this regard, a craft which lies within the parameters of 2.14.1, when compared with a craft of the series which has been inclined, shall be regarded as being closely similar to that craft.