BS EN ISO 12217-2:2025

BSI Standards Publication

# Small craft — Stability and buoyancy assessment and categorization

Part 2: Sailing boats of hull length greater than or equal to 6 m

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# National foreword

This British Standard is the UK implementation of EN ISO 12217-2:2025. It is identical to ISO 12217-2:2022. It supersedes BS EN ISO 12217-2:2017, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GME/33, Small craft.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN ISO 12217-2

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English Version

# Small craft - Stability and buoyancy assessment and categorization - Part 2: Sailing boats of hull length greater than or equal to 6 m (ISO 12217-2:2022)

Petits navires - Évaluation et catégorisation de la stabilité et de la flottabilité - Partie 2: Bateaux à voiles d'une longueur de coque supérieure ou égale à 6 m (ISO 12217-2:2022)

Kleine Wasserfahrzeuge - Festlegung und Kategorisierung von Querstabilität und Auftrieb - Teil 2: Segelboote ab 6 m Rumpflänge (ISO 12217-2:2022)

This European Standard was approved by CEN on 15 October 2025.

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## European foreword

This document (EN ISO 12217-2:2025) has been prepared by Technical Committee ISO/TC 188 "Small craft" in collaboration with Technical Committee CEN/TC 464 “Small Craft” the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2026, and conflicting national standards shall be withdrawn at the latest by April 2026.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 12217-2:2017.

Any feedback and questions on this document should be directed to the users’ national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## Endorsement notice

The text of ISO 12217-2:2022 has been approved by CEN as EN ISO 12217-2:2025 without any modification.

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 188, *Small craft*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 464, *Small Craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 12217-2:2015), of which it constitutes a minor revision. The main changes are as follows:

— the Normative references have been updated;

— the "allowance for the maximum mass of optional equipment and fittings not included in the manufacturer's basic outfit" has been moved from 3.5.4 (maximum load) to 3.5.5 (maximum load condition);

— in Clause F.1, the first paragraph has been slightly reworded as a Note, so as to clearly make an informative reference to ISO 10240, which has been moved from Clause 2 to the Bibliography;

— in Annex J, the calculation worksheet No. 1 has been corrected to reflect the changes in 3.5.4 and 3.5.5;

— minor editorial changes throughout the document.

A list of all parts in the ISO 12217 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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# Introduction

This document enables the determination of limiting environmental conditions for which an individual boat has been designed.

It enables the boat to be assigned to a design category appropriate to its design and maximum load. The design categories used align with those in the Recreational Craft Directive of the European Union, EU Directive 2013/53/EU.

Annex J provides worksheets to assist in the systematic assessment of a boat according to this document.


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# Small craft — Stability and buoyancy assessment and categorization —

# Part 2: Sailing boats of hull length greater than or equal to 6 m

**CAUTION — Compliance with this document does not guarantee total safety or total freedom of risk from capsize or sinking.**

**IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.**

## 1 Scope

This document specifies methods for evaluating the stability and buoyancy of intact (i.e. undamaged) boats. The flotation characteristics of boats susceptible to swamping are also encompassed.

The evaluation of stability and buoyancy properties using this document will enable the boat to be assigned to a design category (A, B, C or D) appropriate to its design and maximum load.

This document is principally applicable to boats propelled primarily by sail (even if fitted with an auxiliary engine) of 6 m up to and including 24 m hull length. However, it can also be applied to boats less than 6 m if they are habitable multihulls or can be applied if they do not attain the desired design category specified in ISO 12217-3 and they are decked and have quick-draining recesses which comply with ISO 11812.

In relation to habitable multihulls, this document includes assessment of susceptibility to inversion, definition of viable means of escape and requirements for inverted flotation.

This document excludes:

— inflatable and rigid-inflatable boats covered by the ISO 6185 series, except for references made in the ISO 6185 series to specific clauses of the ISO 12217 series;

— gondolas and pedalos;

— surfboards including sailing surfboards; and

— hydrofoils and foil stabilized boats when not operating in the displacement mode.

NOTE Displacement mode means that the boat is only supported by hydrostatic forces.

It does not include or evaluate the effects on stability of towing, fishing, dredging or lifting operations, which need to be separately considered if appropriate.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2896:2001, *Rigid cellular plastics — Determination of water absorption*

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ISO 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 8666:2020, *Small craft — Principal data*

ISO 9093, *Small craft — Seacocks and through-hull fittings*

ISO 9094, *Small craft — Fire protection*

ISO 11812, *Small craft — Watertight or quick-draining recesses and cockpits*

ISO 12216, *Small craft — Windows, portlights, hatches, deadlights and doors — Strength and watertightness requirements*

ISO 12217-1:2022, *Small craft — Stability and buoyancy assessment and categorization — Part 1: Non-sailing boats of hull length greater than or equal to 6 m*

ISO 14946:2021, *Small craft — Maximum load capacity*

ISO 15083, *Small craft — Bilge-pumping systems*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

NOTE The meanings of certain symbols used in the definitions are given in Clause 4.

### 3.1 Primary

**3.1.1**
**design category**
description of the sea and wind conditions for which a boat is assessed to be suitable

Note 1 to entry: See also 9.2.

**3.1.2**
**sailing boat**
boat for which the primary means of propulsion is by wind power, having *reference sail area* (3.4.8) $A_S \geq 0{,}07(m_{LDC})^{2/3}$

Note 1 to entry: $m_{LDC}$ is the mass of the boat in the maximum load condition, expressed in kilograms.

**3.1.3**
**catamaran**
boat with two main load-bearing hulls

EXAMPLE Boats with a centreline or bridge-deck nacelle which supports less than 30 % of the mass in the maximum load condition are considered to be catamarans. Proas are asymmetric catamarans.

**3.1.4**
**trimaran**
boat with a centre main hull and two sidehulls in which the centre hull, when the boat is upright, supports 30 % or more of the mass in the maximum load condition


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**3.1.5**
**recess**
volume open to the air that might retain water within the range of loading conditions and corresponding trims

EXAMPLE Cockpits, wells, open volumes or areas bounded by bulwarks or coamings.

Note 1 to entry: Cabins, shelters or lockers provided with closures according to the requirements of ISO 12216 are not recesses.

Note 2 to entry: Cockpits that are open aft to the sea are considered to be recesses. Flush decks without bulwarks or coamings are not recesses.

**3.1.6**
**quick-draining recess**
recess fulfilling all the requirements of ISO 11812 for "quick-draining cockpits and recesses"

Note 1 to entry: According to its characteristics, a cockpit may be considered to be quick-draining for one design category, but not for a higher category.

Note 2 to entry: ISO 11812 contains requirements with which most sailing dinghies cannot comply.

**3.1.7**
**watertight recess**
recess fulfilling all the requirements of ISO 11812 for "watertight cockpits and recesses"

Note 1 to entry: This term only implies requirements in respect of watertightness and sill heights, but not those for drainage.

**3.1.8**
**fully enclosed boat**
boat in which the horizontal projection of the sheerline area comprises any combination of

— watertight deck and superstructure, and/or

— quick-draining recesses which comply with ISO 11812, and/or

— watertight recesses complying with ISO 11812 with a combined volume of less than $(L_H B_H F_M)/40$, and

all closing appliances have their degree of watertightness in accordance with ISO 12216

Note 1 to entry: The size of recesses permitted for boats of design category A, B or some boats of design category C is restricted by the requirements of 6.3.

**3.1.9**
**habitable boat**
boat having a fully enclosed cabin with rigid roof fitted with one or more bunks, benches, pipecots, hammocks or similar locations that can be used for sleeping when the boat is under way

Note 1 to entry: A boat is considered to be "habitable" if a fabric closure is used instead of a rigid door, or the cabin has fabric sides.

Note 2 to entry: The following are not considered to render a boat "habitable":

— a cockpit tent, or

— an open-sided cuddy intended to provide limited protection from spray, provided it is not fitted with fabric closures all round.

Note 3 to entry: Locations used for sleeping have minimum dimensions of 1,5 m diagonal length, 0,4 m width at the widest point, and with a minimum headroom of 0,4 m over the length. The cabin sole and compartments designated by the builder to be used exclusively for storage and referenced in the owner's manual are not included.

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**3.1.10**
**habitable part of a boat**
spaces within a habitable boat with rigid roof that are fitted with a toilet or in which there is provision for any of the following activities: sitting, sleeping, cooking, eating, washing, navigation, steering

Note 1 to entry: Compartments designated by the builder to be used exclusively for storage and referenced in the owner's manual are not included.

## 3.2 Hazards

**3.2.1**
**capsize**
event when a boat reaches any heel angle from which it is unable to recover to equilibrium near the upright without intervention

**3.2.2**
**knockdown**
event when a boat reaches a heel angle sufficient to immerse the masthead, and from which it may or may not recover without intervention

**3.2.3**
**inversion**
event when a boat becomes upside down

## 3.3 Downflooding

**3.3.1**
**downflooding opening**
opening in the hull or deck (including the edge of a recess) that might admit water into the interior or bilge of a boat, or a recess, apart from those excluded in 6.2.1.6

**3.3.2**
**downflooding angle**
$\phi_D$
angle of heel at which downflooding openings (apart from those excluded in 6.2.1.6) become immersed, when the boat is in calm water and in the appropriate loading condition at design trim

Note 1 to entry: Where openings are not symmetrical about the centreline of the boat, the case resulting in the smallest angle is used.

Note 2 to entry: The following are specifically considered:

— $\phi_D$ is the downflooding angle to any downflooding opening;

— $\phi_{DA}$ is the angle of heel at which openings which are not marked "KEEP SHUT WHEN UNDER WAY" having a combined total area, expressed in square centimetres ($cm^2$), greater than the number represented by $1{,}2L_H B_H F_M$ first become immersed;

— $\phi_{DC}$ is the downflooding angle at which recesses which are not quick-draining begin to fill with water;

— $\phi_{DH}$ is the downflooding angle at which any main access hatch (i.e. having an opening area greater than 0,18 $m^2$ each) giving direct access to the main open air helm position first begins to become immersed.

Note 3 to entry: Downflooding angle is expressed in degrees.


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**3.3.3**
**downflooding height**
$h_D$
smallest height above the waterline to any downflooding opening, apart from those excluded in 6.2.1.6, when the boat is upright in calm water and in the maximum load condition, measured to the critical downflooding point which might be within pipes or ducts inside the hull

Note 1 to entry: Downflooding height is expressed in metres.

Note 2 to entry: See Figure B.1.

## 3.4 Dimensions, areas and angles

**3.4.1**
**length of hull**
$L_H$
length of the hull measured according to ISO 8666

Note 1 to entry: Length of hull is expressed in metres.

**3.4.2**
**length waterline**
$L_{WL}$
waterline length measured according to ISO 8666 when the boat is upright in calm water, in the appropriate loading condition and at design trim

Note 1 to entry: For multihull boats, $L_{WL}$ relates to that of the longest individual hull.

Note 2 to entry: Length waterline is expressed in metres.

**3.4.3**
**beam of hull**
$B_H$
maximum beam of the hull using the method of ISO 8666; for catamaran and trimaran boats, maximum beam across the outer hulls

Note 1 to entry: Beam of hull is expressed in metres.

**3.4.4**
**beam waterline**
$B_{WL}$
greatest beam measured according to ISO 8666 at the waterline in calm water which, for multihull boats, is the sum of the maximum waterline beams of each of the hulls, the boat being upright, in the appropriate loading condition and at design trim

Note 1 to entry: Beam waterline is expressed in metres.

**3.4.5**
**beam between hull centres**
$B_{CB}$
on catamaran and trimaran boats, the transverse distance between the centres of buoyancy of the outer hulls

Note 1 to entry: Beam between hull centres is expressed in metres.

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**3.4.6**
**freeboard amidships**
$F_M$
distance of the sheerline or deck above the waterline at $L_{WL}/2$ measured according to ISO 8666, the boat being upright, in the appropriate loading condition and at design trim

Note 1 to entry: Freeboard amidships is expressed in metres.

Note 2 to entry: Where no loading condition is specified, maximum load condition should be assumed.

**3.4.7**
**draught of canoe body**
$T_C$
draught of the main buoyant part of the hull(s) below the waterline, as defined in ISO 8666, the boat being upright in the appropriate loading condition and at design trim

Note 1 to entry: Draught of canoe body excludes appendages such as rudders or skegs, and is expressed in metres.

**3.4.8**
**reference sail area**
$A_S$
actual profile area of sails set abaft a mast, plus the maximum profile areas of all masts, plus reference triangle area(s) forward of each mast as defined in ISO 8666

Note 1 to entry: Sail area is expressed in square metres.

**3.4.9**
**standard sail area**
$A'_S$
actual profile area of the largest sail plan suitable for windward sailing in true winds of 10–12 kn (5,1–6,2 m/s), including overlaps, and supplied or recommended by the builder as standard

Note 1 to entry: Sail area is expressed in square metres.

**3.4.10**
**angle of vanishing stability**
$\phi_V$
angle of heel nearest the upright (other than upright) in the appropriate loading condition at which the transverse stability righting moment is zero

Note 1 to entry: This is determined assuming that there is no offset load, and that all potential downflooding openings are considered to be watertight.

Note 2 to entry: Where a boat has recesses which are not quick-draining, $\phi_V$ is to be taken as the downflooding angle to these recesses, unless the loss of buoyancy due to such recesses is fully accounted for in determining $\phi_V$.

Note 3 to entry: Angle of vanishing stability is expressed in degrees.

## 3.5 Condition, mass and volume

**3.5.1**
**empty craft condition**
empty boat including fittings and equipment as listed below but excluding all optional equipment and fittings not included in the manufacturer's basic outfit:

a) structure: comprising all the structural parts, including any fixed ballast keel and/or drop keel/centreboard/daggerboard(s) and rudder(s);

b) ballast: any fixed ballast installed;


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c) internal structure and accommodation: bulkheads and partitions, insulation, lining, built-in furniture, flotation material, windows, hatches and doors, permanently installed mattresses and upholstery materials;

d) permanently installed engine(s) and fuel system: comprising inboard engine(s), including all supplies and controls as needed for their operation, permanently installed fuel systems, including tanks;

e) fluids in permanently installed systems: residual working fluids as needed for their operation (see examples below), but excluding contents of fluid ballast systems and tanks, and main storage tanks (which are included in maximum load);

EXAMPLE Fluids in hot or cold water, fuel, lubricating or hydraulic oil systems.

f) internal equipment, including:

— all items of equipment permanently attached to the craft, e.g. tanks, toilet system(s), water transfer equipment;

— bilge pumping system(s), cooking and heating devices, cooling equipment, ventilation system(s);

— electrical installation and equipment, including permanently installed batteries mounted in the position intended by the builder;

— fixed navigational and electronic equipment;

— fixed firefighting equipment, where fitted;

g) external equipment, including:

— all permanently attached standard or specified deck fittings, e.g. guardrails, pulpits and pushpits, bowsprits and their attachments, bathing platforms, boarding ladders, steering equipment, winches, sprayhood(s);

— awning(s), cockpit tables, gratings, signal mast(s), where fitted;

— mast(s), boom(s), spinnaker poles and other pole(s), standing and running rigging, in the stowed position ready for use; all standing and running rigging in place

Note 1 to entry: The mass in the empty craft condition is denoted by $m_{EC}$ and is expressed in kilograms.

**3.5.2**
**light craft condition**
empty craft condition plus standard equipment (3.6.12) plus removable ballast (whether solid or liquid) when supplied and/or intended by the manufacturer to be carried when the boat is afloat, with elements positioned as follows:

a) where provision is made for propulsion by outboard engine(s) of more than 3 kW, the heaviest engine(s) recommended for the boat by the manufacturer is(are) mounted in the working position(s);

b) where batteries are fitted, they are mounted in the position intended by the builder, and if there is no specific stowage provided for batteries, the mass of one battery for each engine over 7 kW is allowed for, and located within 1,0 m of the engine location;

c) all upwind sails supplied or recommended by the builder as standard, onboard and rigged ready for use, but not hoisted, e.g. mainsail on boom, roller furling sails furled, hanked foresails on stay stowed on foredeck

Note 1 to entry: For the minimum mass of outboard engines and batteries, refer to ISO 12217-3:2022, Tables C.1 and C.2.

Note 2 to entry: The mass in the light craft condition is denoted by $m_{LC}$ and is expressed in kilograms.

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**3.5.3**
**minimum operating condition**
boat in the light craft condition with the following additions:

a) mass to represent the crew, positioned on the centreline near the main control position of

— 75 kg where $L_H \leq 8$ m,

— 150 kg where 8 m < $L_H \leq 16$ m,

— 225 kg where 16 m < $L_H \leq 24$ m;

b) non-edible stores and equipment normally carried on the boat and not included in the manufacturer's list of standard equipment

EXAMPLE Loose internal equipment and tools, spare parts, dishes, kitchenware and cutlery, additional anchors or sails, dinghy and outboard if carried aboard.

Note 1 to entry: Liquids in main storage tanks (e.g. fuel, drinking water, black and grey water, live wells, bait tanks, etc.) are excluded.

Note 2 to entry: Water ballast in tanks which are symmetrical about the centreline and which are intended by the builder to be used for variable asymmetric ballasting while under way is excluded.

Note 3 to entry: Elements with transversally variable position (e.g. canting keels, movable solid ballast, tilting masts) are positioned symmetrically about the centreline of the boat. Elements with longitudinally variable position (e.g. tilting masts or keels) are positioned so that the VCG is maximized.

Note 4 to entry: Any centreboard or keel is in the raised position unless it can be fixed in the lowered position and an appropriate instruction is given in the owner's manual.

Note 5 to entry: The mass in the minimum operating condition is denoted by $m_{MO}$ and is expressed in kilograms.

**3.5.4**
**maximum load**
load which the boat is designed to carry in addition to the light craft condition, comprising:

— the crew limit at 75 kg each;

— the personal effects of the crew;

— stores and cargo (if any), dry provisions, consumable liquids;

— contents of all permanently installed storage tanks filled to 95 % of their maximum capacity, including fuel, drinking water, black water, grey water, lubricating and hydraulic oil, bait tanks and/or live wells; plus ballast water at 100 % capacity;

— consumable liquids in portable tanks (drinking water, fuel) filled to 95 % of the maximum capacity;

— dinghy or other small craft intended to be carried aboard, and any outboard motor associated with them;

— liferaft(s) if carried in excess of the minimum required in essential safety equipment;

— non-edible stores and equipment normally carried on the boat and not included in the manufacturer's list of standard equipment, e.g. loose internal equipment and tools, spare parts, additional anchors or sails, dinghy and outboard if carried aboard;

Note 1 to entry: Liferafts are not included in essential safety equipment for Categories C and D.

Note 2 to entry: As a guide, not less than 20 kg per person should be allowed for personal effects on habitable boats.


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Note 3 to entry: As a guide, the mass of yachting liferafts varies from approximately 12 + 2CL (kg) to double this, according to specification.

Note 4 to entry: Unless otherwise required, variable position elements (e.g. canting keels, movable solid ballast, tilting masts) are positioned symmetrically about the centreline of the boat.

Note 5 to entry: Any centreboard or keel is in the raised position unless it can be fixed in the lowered position and an appropriate instruction is given in the owner's manual.

Note 6 to entry: The mass of maximum load is denoted by $m_{ML}$ and is expressed in kilograms.

**3.5.5**
**maximum load condition**
boat in the light craft condition with the maximum load added and an allowance for the maximum mass of optional equipment and fittings not included in the manufacturer's basic outfit so as to produce the design trim, the crew corresponding to the minimum operating condition being located at the main control position, the remainder positioned at sheerline height at the mid-length of $L_H$

Note 1 to entry: The mass in the maximum load condition is denoted by $m_{LDC}$ and is expressed in kilograms.

**3.5.6**
**loaded arrival condition**
boat in the maximum load condition minus 85 % of the maximum capacity of fixed or portable storage tanks for fuel, oils and drinking water, and minus 90 % of edible stores, but including the worst combination of optional fittings or equipment with respect to stability

Note 1 to entry: In this condition, tanks have 10 % of their maximum capacity remaining.

Note 2 to entry: The mass in the loaded arrival condition is denoted by $m_{LA}$ and is expressed in kilograms.

Note 3 to entry: Unless otherwise required, variable position elements (e.g. canting keels, movable solid ballast, tilting masts) are positioned symmetrically about the centreline of the boat.

**3.5.7**
**displacement volume**
$V_D$
volume of displacement of the boat that corresponds to the appropriate loading condition, taking the density of water as 1 025 kg/m$^3$

Note 1 to entry: Displacement volume is expressed in cubic metres.

## 3.6 Other terms and definitions

**3.6.1**
**calculation wind speed**
$v_W$
wind speed used in calculations

Note 1 to entry: Calculation wind speed is expressed in metres per second or in knots.

**3.6.2**
**crew**
collective description of all persons onboard a boat

**3.6.3**
**crew limit**
**CL**
maximum number of persons (with a mass of 75 kg each) used when assessing the design category

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**3.6.4**
**design trim**
longitudinal attitude of a boat when upright, with crew, fluids, stores and equipment in the positions designated by the designer or builder

Note 1 to entry: Crew are assumed to be in positions designated by the builder. In the absence of builder's instructions, crew and gear are assumed to be positioned in a manner most likely to provide a favourable test result, provided that such positions are consistent with the proper operation of the boat, and that crew are assumed to be either standing at designated positions fitted with handholds, or seated.

**3.6.5**
**essential safety equipment**
loose equipment considered essential to the safe operation of the boat, which may include distress flares and rockets, lifebuoy with light and battery, first aid box, wire cutters for standing rigging, lifejackets, safety harnesses and lines, portable firefighting equipment, flashlight, binoculars, radio (e.g. VHF), ball and cone visual signals, charts, navigational publications and for design categories A and B, liferaft(s) sufficient for the crew limit in the corresponding design category

Note 1 to entry: Quantities carried may vary according to the size of boat, design category and crew limit.

Note 2 to entry: As a guide, the mass allowed for essential safety equipment but excluding any liferaft(s) should not be less than $3L_H$ (kg).

Note 3 to entry: The mass of yachting liferafts varies from approximately 12 + 2CL (kg) to double this, according to specification.

Note 4 to entry: Liferafts are not considered to be essential safety equipment in design categories C and D.

**3.6.6**
**flotation element**
element which provides buoyancy to the boat and thus influences the flotation characteristics

**3.6.6.1**
**air tank**
tank made of hull construction material, and integral with hull or deck structure

**3.6.6.2**
**air container**
container made of stiff material, and not integral with the hull or deck structure

**3.6.6.3**
**low density material**
material with a specific gravity of less than 1,0 primarily incorporated into the boat to enhance the buoyancy when swamped

**3.6.6.4**
**inflated bag**
bag made of flexible material, not integral with hull or deck, accessible for visual inspection and intended always to be inflated when the boat is being used

Note 1 to entry: Bags intended to be inflated automatically when immersed (e.g. at the masthead as a means to prevent inversion) are not regarded as flotation elements.

**3.6.7**
**inclining experiment**
method by which the vertical position of the centre of gravity (VCG) of a boat can be determined

Note 1 to entry: The VCG, together with a knowledge of the shape of the hull (the lines plan) and the position of the waterline in a known loading condition, enable all the intact stability parameters to be calculated.

Note 2 to entry: A full description of how to conduct an inclining experiment is given in standard naval architecture textbooks, e.g. References [6] and [8].


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**3.6.8**
**righting lever**
**GZ**
at a specific heel (or trim) angle in calm water, the distance in both the horizontal and transverse (or horizontal and longitudinal) planes between the centre of buoyancy and the centre of gravity

Note 1 to entry: Righting lever usually refers to the transverse plane, but may be in the longitudinal plane where longitudinal stability is concerned.

Note 2 to entry: Righting lever is equal to the righting moment divided by the product of mass, expressed in kilograms, and acceleration due to gravity (9,806 m/s$^2$) and is expressed in metres.

**3.6.9**
**righting moment**
**RM**
at a specific heel (or trim) angle in calm water, the restoring moment generated by the transverse (or longitudinal) offset of the centre of buoyancy of the submerged part of the hull from the centre of gravity of the boat

Note 1 to entry: Righting moment usually refers to the transverse plane, but may be in the longitudinal plane where longitudinal stability is concerned.

Note 2 to entry: The righting moment varies with heel (or trim) angle and is usually plotted graphically against heel (or trim) angle. Righting moments are most accurately derived by computer from a knowledge of the hull shape and the location of the centre of gravity. Other more approximate methods are also available. The righting moment varies substantially with hull form, centre of gravity position, boat mass and trim attitude.

Note 3 to entry: Righting moment is expressed in newton metres or kilonewton metres.

**3.6.10**
**loaded waterline**
waterline of the boat when upright in the maximum load condition

**3.6.11**
**recess retention level**
level of water in recesses, when the boat is at design trim, at which 20 % of the uppermost periphery of the surrounding coaming (measured in horizontal plane parallel to waterline at design trim) would be covered by water, assuming that all gates, doors or drainage openings are considered to be sealed

Note 1 to entry: This definition is illustrated in Annex K.

**3.6.12**
**standard equipment**
devices including outboard motors (excluding those for tenders), loose furniture and furnishings such as tables, chairs, non-permanently installed mattresses, curtains, etc., portable bilge pumping equipment anchors, chain, warps, sails, loose external equipment such as fenders, boathook and boarding ladder, oars (if appropriate), and essential safety equipment

Note 1 to entry: Where outboard engine(s) are fitted, the heaviest engine(s) recommended for the boat by the manufacturer is(are) included, the mass allowed for outboard engines and their batteries (if not permanently installed) not being less than that given in ISO 12217-1:2022, Tables F.1 and F.2, columns 1 and 3, or ISO 12217-3:2022, Tables C.1 and C.2.

Note 2 to entry: As a guide, the mass allowed for anchors, anchor chain, warps and fenders should not be less than about $0{,}25 L_H^{2,2}$ (kg). In some cases, up to double this mass may be appropriate.

**3.6.13**
**watertightness degree**
degree of watertightness as specified in ISO 11812 and ISO 12216

Note 1 to entry: The degree of watertightness is summarized as follows:

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— Degree 1: Degree of tightness providing protection against effects of continuous immersion in water.
— Degree 2: Degree of tightness providing protection against effects of temporary immersion in water.
— Degree 3: Degree of tightness providing protection against splashing water.
— Degree 4: Degree of tightness providing protection against water drops falling at an angle of up to 15° from the vertical.

**3.6.14**
**under way**
not at anchor, or made fast to the shore, or aground

## 4 Symbols

For the purposes of this document, the symbols and associated units in Table 1 apply.

**Table 1 — Symbols**

| Symbol | Unit | Meaning |
|---|---|---|
| $\phi$ | degree (°) | Angle of heel |
| $\phi_D$ | degree (°) | Actual downflooding angle of any downflooding opening, see 3.3.2 |
| $\phi_{D(R)}$ | degree (°) | Required downflooding angle, see 6.2.3 |
| $\phi_{DA}$ | degree (°) | Downflooding angle at which a certain total area of openings is submerged, see 3.3.2 |
| $\phi_{DC}$ | degree (°) | Downflooding angle to cockpits that are not quick-draining according to ISO 11812, see 3.3.2 |
| $\phi_{DH}$ | degree (°) | Downflooding angle to any main access hatchway, see 3.3.2 |
| $\phi_{GZmax}$ | degree (°) | Angle of heel at which maximum righting moment or lever occurs |
| $\phi_V$ | degree (°) | Angle of vanishing stability, see 3.4.10 |
| $\phi_{V(R)}$ | degree (°) | Required angle of vanishing stability, see 6.5 |
| $A_{GZ}$ | m · degree | Positive area under righting lever curve, see 6.4 and 6.6.2 |
| $A_S$ | $m^2$ | Reference sail area according to ISO 8666 and 3.4.8 |
| $A'_S$ | $m^2$ | Standard sail area, see 3.4.9 |
| $B_{CB}$ | m | Beam between centres of buoyancy of sidehulls, see 3.4.5 |
| $B_H$ | m | Beam of hull according to ISO 8666 |
| $B_{WL}$ | m | Beam waterline in the appropriate loading condition according to ISO 8666 and 3.4.4. In the case of multihulls, it is the sum of the maximum waterline beams of each of the hulls. |
| CL | | Crew limit = maximum number of persons on board, see 3.6.3 |
| $F_M$ | m | Freeboard amidships at the appropriate loading condition according to 3.4.6 |
| $GM_T$ | m | Transverse metacentric height, see 6.3 |
| GZ | m | Righting lever = righting moment (N·m)/[mass (kg) × 9,806 ($m/s^{-2}$)], see 3.6.8 |
| $GZ_{90}$ | m | Righting lever at 90° heel |
| $h_{CE}$ | m | Height of centre of area of $A_S$ above waterline at the appropriate loading condition, see 6.8 |
| $h'_{CE}$ | m | Height of centre of area of $A'_S$ above waterline at the appropriate loading condition, see 6.8 |
| $h_D$ | m | Actual downflooding height, see 3.3.3 |
| $h_{D(R)}$ | m | Required downflooding height, see 6.2.2 |
| $h_{LP}$ | m | Height of waterline at the appropriate loading condition above centre of area of immersed profile area including keel(s) and rudder(s), see 6.8.2 and 6.8.3 |
| $L_{BS}$ | m | Length base size = $(2L_{WL} + L_H)/3$ |


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**Table 1** *(continued)*

| Symbol | Unit | Meaning |
|---|---|---|
| LCG | m | Longitudinal position of the centre of gravity from a chosen datum |
| $L_H$ | m | Length of hull according to ISO 8666 |
| $L_{WL}$ | m | Length of waterline at the appropriate loading condition according to ISO 8666 |
| $m$ | kg | Mass of the boat, used where more than one loading condition is considered |
| $m_{EC}$ | kg | Mass of the boat in the empty craft condition, see 3.5.1 |
| $m_{LA}$ | kg | Mass of the boat in the loaded arrival condition, see 3.5.6 |
| $m_{LC}$ | kg | Mass of the boat in light craft condition, see 3.5.2 |
| $m_{LDC}$ | kg | Mass of the boat in maximum load condition, see 3.5.5 |
| $m_{ML}$ | kg | Mass of the maximum load, see 3.5.4 |
| $m_{MO}$ | kg | Mass of the boat in the minimum operating condition, see 3.5.3 |
| RM | N·m | Righting moment, see 3.6.9 |
| STIX | — | Actual stability index value at the appropriate loading condition according to 6.6 |
| $STIX_{(R)}$ | — | Required stability index value, see Table 6 |
| $T_C$ | m | Draught of canoe body at the appropriate loading condition according to ISO 8666 |
| VCG | m | Vertical position of the centre of gravity from a chosen datum |
| $V_D$ | $m^3$ | Displacement volume, see 3.5.7 |
| $V_R$ | $m^3$ | Volume of a non-quick-draining recess, see Annex A |
| $v_W$ | m/s | Calculation wind speed, see 3.6.1 |
| $x_D$ | m | Longitudinal distance of downflooding opening from nearest extremity of $L_H$ |
| $x'_D$ | m | Longitudinal distance of downflooding opening from forward end of $L_H$ |
| $y_D$ | m | Transverse distance of downflooding opening from periphery of boat |
| $y'_D$ | m | Transverse distance of downflooding opening off centreline |
| $z_D$ | m | Height above waterline of downflooding opening |

# 5 Procedure

## 5.1 Maximum load

Decide on the crew limit and the maximum load that the boat is intended to carry in accordance with the definitions. The crew limit shall not exceed that determined by the seating or standing space requirements of ISO 14946:2021.

**IMPORTANT — Ensure that the maximum load is not underestimated.**

NOTE If a boat is assessed with different amounts of maximum load, different design categories may be assigned according to the load.

## 5.2 Sailing or non-sailing

Confirm that the boat is defined as sailing. Sailing boats are those where $A_S \geq 0{,}07 \times (m_{LDC})^{2/3}$, where $A_S$ is the reference sail area according to 3.4.8 and ISO 8666:2020 and $m_{LDC}$ is the mass of the boat in the maximum load condition, as defined in 3.5.5 and expressed in kilograms.

Other boats are non-sailing boats and shall be assessed using ISO 12217-1:2022.

## 5.3 Tests, calculations and requirements to be applied

Clause 6 shall be applied to monohull sailing boats.

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Clause 7 shall be applied to catamaran or trimaran sailing boats.

NOTE Monohulls applying 6.5.3 (form-stable monohulls) are required to comply with some requirements of Clause 7.

All the requirements of the option chosen from Clause 6 or 7 shall be satisfied.

### 5.4 Variation in input parameters

Users of this document shall consider the effect on compliance of variations in the empty craft mass within the builder's manufacturing tolerances.

## 6 Requirements for monohull boats

### 6.1 Requirements to be applied

**6.1.1** Monohull sailing boats shall comply with all the requirements of any one of seven options according to amount of flotation and decking, and whether the boat is fitted with suitable recesses. These options and the tests to be applied are given in Table 2.

NOTE For any given test, the requirements may vary according to the chosen option, e.g. for downflooding height.

**6.1.2** The design category finally given is that for which the boat satisfies all the relevant requirements of any one of these options. See Annex I.

**6.1.3** For boats using option 1 or 2, each of the requirements shall be satisfied in the minimum operating condition and in the loaded arrival condition unless otherwise specifically noted. In calculating the position of the overall centre of gravity in the loaded arrival condition, the following shall be observed:

— fluids shall be located in the fixed tanks;

— provisions shall be stowed in an appropriate location;

— the mass of additional crew (crew limit less those required for $m_{MO}$) shall be added at sheerline height at the mid-length of $L_H$.

**6.1.4** Boats fitted with provision for asymmetric ballasting while under way (whether liquid or solid) shall

a) comply with all the requirements of the selected option as indicated in Table 2, and

b) comply with the requirements of 6.2.3, 6.4 (if appropriate), 6.5 and 6.6 considering that the movable ballast is of whichever amount and position that gives the most adverse result when considering each individual stability requirement.


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**Table 2 — Requirements to be applied to monohull sailing boats**

| Option | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Categories possible** | **A and B** | **C and D** | **C and D** | **C and D** | **C and D** | **C and D** | **C and D** |
| **Decking or covering** | **Fully enclosed boat[a]** | **Fully enclosed boat[a]** | **Any boat except fully enclosed boat[b]** | **Any boat except fully enclosed boat[b]** | **Any boat** | **Any boat** | **Any boat except fully enclosed boat[b]** |
| Downflooding openings | 6.2.1 | 6.2.1 | 6.2.1 | 6.2.1 | 6.2.1 | 6.2.1 | — |
| Downflooding-height test | 6.2.2 | 6.2.2 | 6.2.2 | — | 6.2.2 | — | — |
| Downflooding angle | 6.2.3 | 6.2.3 | — | — | — | — | — |
| Recess size | 6.3[c] | — | — | — | 6.3[d] | 6.3[d] | — |
| Minimum righting energy | 6.4 | — | — | — | — | — | — |
| Angle of vanishing stability | 6.5 | 6.5 | — | — | — | — | — |
| Stability index | 6.6 | 6.6 | — | — | — | — | — |
| Knockdown-recovery test | — | — | 6.7 | 6.7 | — | — | — |
| Wind stiffness test | — | — | — | — | 6.8 | 6.8 | — |
| Flotation requirements | — | — | — | 6.9 | — | 6.9 | — |
| Capsize recovery test | — | — | — | — | — | — | 6.10 |
| Detection and removal of water | 6.11 | 6.11 | 6.11 | 6.11 | 6.11 | 6.11 | 6.11 |

[a] This term is defined in 3.1.8.

[b] That is, any boat that is not "fully enclosed", thus including boats without any decking.

[c] Only applicable to boats using 6.5.3 and having $\phi_V < 90°$.

[d] This requirement only applies to boats of design category C that are fully enclosed.

## 6.2 Downflooding

NOTE These requirements are to ensure that a level of watertight integrity appropriate to the design category is maintained.

### 6.2.1 Downflooding openings

**6.2.1.1** All closing appliances (as defined in ISO 12216) such as windows, portlights, hatches, deadlights and doors shall comply with ISO 12216, according to design category and appliance location area.

Openings to centreboard or drop keel casings fitted to habitable sailing boats shall comply with the watertightness degree 3 if their height is less than that corresponding to Area I (as defined in ISO 12216).

**6.2.1.2** No hatches or opening type windows shall be fitted in the hull with the lowest part of the opening less than 0,2 m (design category A, B or C) or 0,1 m (design category D) above the loaded waterline, except for emergency escape hatches on design category C boats, where 0,1 m is allowable.

**6.2.1.3** Seacocks complying with ISO 9093 together with means of preventing flow into the boat when the seacock is open, shall be fitted to through-hull pipe fittings located with any part of the opening below either the heeled or upright waterline when fully loaded, apart from:

a) engine exhausts, or

b) drains forming an integral part of the hull and of equal strength and tightness extending from the outlet to above the fully loaded upright waterline at least 0,12 m for design category A, 0,08 m for

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design category B, 0,06 m for design category C or 0,04 m for design category D, and also above the heeled waterline defined as follows:

1) 7° for sailing multihulls, or

2) 30° or immersion of the sheerline, whichever occurs first, for monohull sailing boats.

NOTE 1 Means of preventing flow into the boat may comprise:

— a pipe or hose extending above the heeled waterline, or

— a pipe or hose leading to a downflooding point above the heeled waterline, or

— a non-return valve, or

— a pipe or hose connected to a system that cannot flood the interior of the boat, or

— for seacocks not connected internally, a permanent cap or means of securing the seacock in the closed position.

Instructions for the correct and safe operation of seacocks shall be included in the owner's manual.

NOTE 2 Special requirements for seacocks on bilge system discharges are given in ISO 15083.

**6.2.1.4** Openings within the boat, such as outboard engine trunks or openings in centreboard casings, shall be considered as possible downflooding openings.

**6.2.1.5** For boats to be given design category A or B, downflooding openings not fitted with any form of closing appliance shall only be permitted if they are not in Area I (as defined in ISO 12216) and are essential for cabin or engine ventilation requirements, but these shall at least comply with tightness degree 3.

**6.2.1.6** The requirements given in 6.2.2 and 6.2.3 apply to all downflooding openings except:

a) watertight recesses with a combined volume less than $(L_H B_H F_M)/40$, or quick-draining recesses;

b) drains from:

1) quick-draining recesses, or

2) watertight recesses which, if filled, would not lead to downflooding or capsize when the boat is upright,

and which:

i) are freeing ports fitted with non-return flap closures which are watertight from the exterior to degree 3 of ISO 12216, or

ii) have a combined cross-sectional area smaller than three times the minimum area required to comply with ISO 11812 for quick-draining cockpits;

c) non-opening appliances which comply with ISO 12216;

d) opening appliances located in the topsides which comply with ISO 12216 which are:

1) referenced in the owner's manual as watertight closure to be kept shut when under way, and

2) clearly marked on the inboard side "KEEP SHUT WHEN UNDER WAY" in upper case letters not less than 4,8 mm high, and

3) positioned so that the lowest part of the opening is above the loaded waterline by at least 50 % of the minimum downflooding height required by 6.2.2, or in the case of means of escape fitted to habitable multihulls considered to be susceptible to inversion (see 7.11 and 7.13) positioned


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with the bottom of the clear opening not less than 0,2 m (design category A or B) or 0,1 m (design category C or D) above the loaded waterline when the boat is upright;

e) opening appliances which are fitted in a compartment of such restricted volume that, even if flooded, the boat satisfies all the requirements;

f) opening appliances located other than in the topsides which comply with ISO 12216 to tightness degree 2 and which are referenced in the owner's manual as being "KEEP SHUT WHEN UNDER WAY" and clearly marked as such on the appliance on the inboard side in upper case letters not less than 4,8 mm high;

g) engine exhausts or other openings that are only connected to watertight systems;

h) discharge pipes fitted with non-return valves;

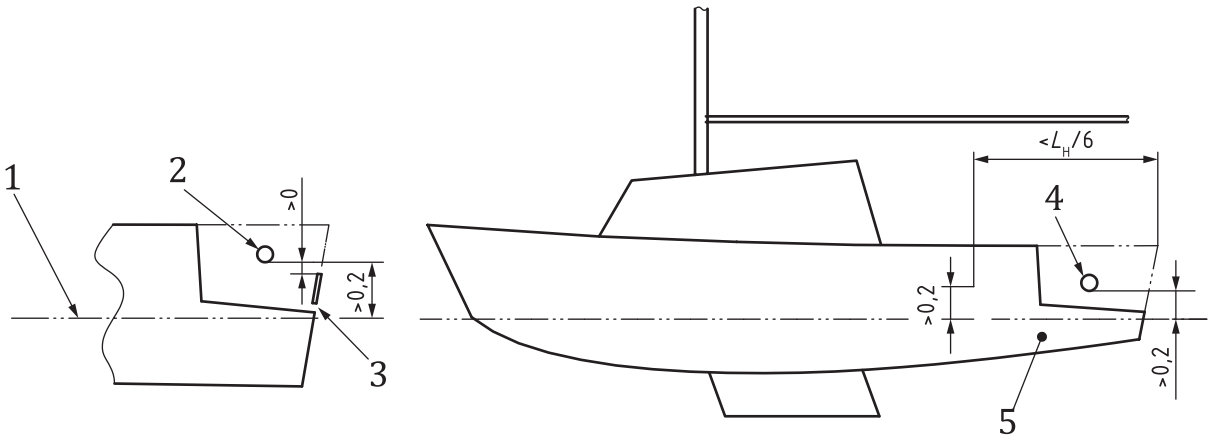
i) openings in the sides of outboard engine wells which are of

1) watertightness degree 2 and having the lowest point of downflooding more than 0,1 m above the loaded waterline, or

2) watertightness degree 3 and having the lowest point of downflooding more than 0,2 m above the loaded waterline and also above the top of the transom in way of the engine mounting, provided that well drain holes are fitted, see Figure 1, or

3) watertightness degree 4 and having the lowest point of downflooding more than 0,2 m above the loaded waterline and also above the top of the transom in way of the engine mounting, provided that well drain holes are fitted, and that the part of the interior or non-quick-draining spaces into which water may be admitted has a length less than $L_H/6$ and from which water up to 0,2 m above the loaded waterline cannot drain into other parts of the interior or non-quick-draining spaces of the boat, see Figure 1.

Dimensions in metres




**Key**

1 waterline
2 watertightness degree 3 or 4
3 drain
4 watertightness degree 4
5 non-quick-draining space

**Figure 1 — Openings in outboard engine wells**

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### 6.2.2 Downflooding height

#### 6.2.2.1 Test

This test is to demonstrate sufficient margins of freeboard for the boat in the maximum load condition before water is shipped aboard.

This test shall be performed using people as described below, or test weights to represent people (at 75 kg per person), or by calculation (using a lines plan and displacement derived by a weighing or measured freeboards).

a) Select a number of people equal to the crew limit, having an average mass of not less than 75 kg.

b) In calm water, load the boat with all items of maximum load, with the people positioned so as to achieve the design trim.

c) Measure the height from the waterline to the points at which water could first begin to enter any downflooding opening except those excluded in 6.2.1.6. Where a downflooding opening is fully protected by a higher coaming around the recess from which it leads, the downflooding height shall be measured to the lowest point of that coaming, see Figure B.1. Where an opening in the hull is permanently attached to a watertight pipe or trunk rising to a higher level within the boat, the downflooding height is taken to the critical height within that pipe or trunk.

Downflooding height to downflooding points within quick-draining or watertight recesses shall be measured as though the following openings are closed:

— freeing ports fitted with non-return flap closures which are watertight from the exterior to degree 3 of ISO 12216, or

— drains having a combined cross-sectional area smaller than three times the minimum area required to comply with ISO 11812 for quick-draining cockpits.

#### 6.2.2.2 Requirements

a) Determine the design category by comparing the measurements with the requirements for minimum downflooding height, as modified by b) and c) below, using either

   1) the method of Annex A, which generally gives the lowest requirement, or

   2) Figure 2, which is based only on boat length.

b) Boats assessed using Figure 2 shall be permitted openings having a combined clear area, expressed in square millimetres (mm$^2$), of not more than $50L_H{}^2$ within the aft quarter of $L_H$, provided that the downflooding height to these openings is not less than 75 % of that required by Figure 2.

c) The required downflooding height for centreboard, drop keel or dagger-board casings on the centreline shall be half of that determined by a) above.


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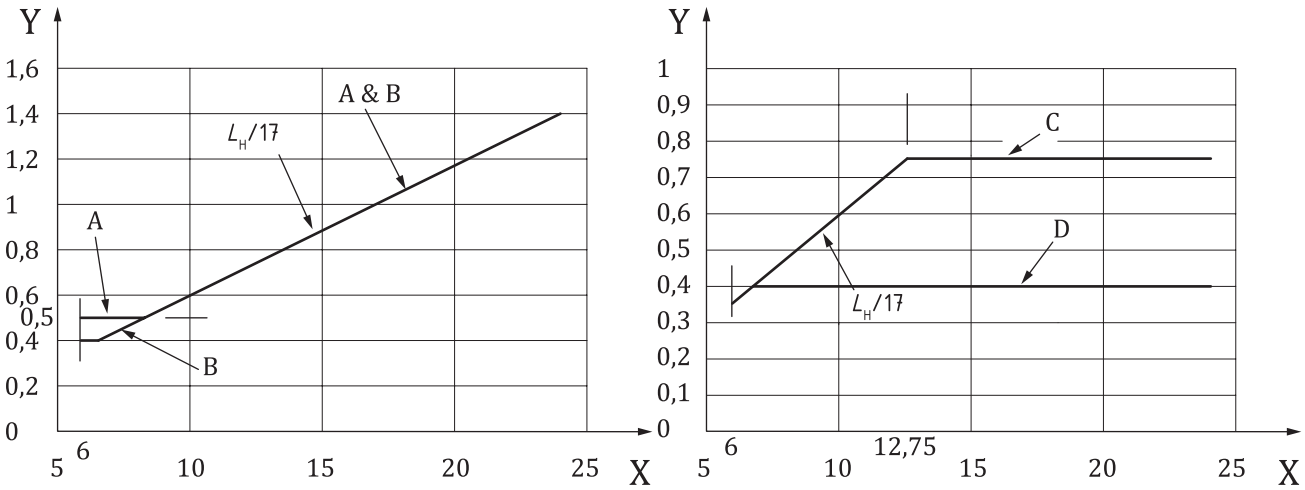


**a) Design categories A and B** **b) Design categories C and D**

**Key**

X length of hull (m)

Y required downflooding height (m)

**Figure 2 — Required downflooding height**

### 6.2.3 Downflooding angle

This requirement is to show that there is sufficient margin of heel angle before significant quantities of water can enter the boat.

The downflooding angle to any downflooding opening ($\phi_D$) (apart from those excluded by 6.2.1.6), determined using either of the methods in Annex B, shall exceed the required downflooding angle ($\phi_{D(R)}$) as shown in Table 3.

Where a downflooding opening is protected by a higher coaming around the recess from which it opens, the downflooding angle shall be determined to the lowest point of that coaming, see Figure B.1.

Where an opening in the hull is permanently attached to a watertight pipe or trunk rising to a higher level inboard, the downflooding angle is taken to the critical location within that pipe or trunk.

**Table 3 — Required minimum downflooding angle**

| Design category | A and B | C | D |
|---|---|---|---|
| Required downflooding angle, $\phi_{D(R)}$ | 40° | 35° | 30° |

## 6.3 Recess size

### 6.3.1 Application

This requirement is applicable only to:

— boats of design category B assessed using 6.5.3 and having $\phi_V < 90°$,

— fully-enclosed monohull boats of design category C using options 5 or 6, or

— fully enclosed multihulls of design categories A, B or C.

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Boats shall be assessed in the loaded arrival condition. The requirements of either 6.3.2 or 6.3.3 apply to recesses except those:

a) fitted to boats with an angle of vanishing stability greater than 90°, or

b) where the depth of the recess is less than 3 % of the maximum breadth of the recess over at least 35 % of the periphery, or

EXAMPLE Toe rails, low bulwarks.

c) formed by a bulwark provided with at least 5 % of its area providing overboard drainage positioned within the lowest 25 % of its height, and where the height of the bulwark is less than 12,5 % of the maximum breadth of the recess, or

d) where it can be shown that the unobstructed drainage area from the recess on each side of the boat centreline exceeds $K$ multiplied by the volume of the recess to the recess retention level defined in 3.6.11, where $K$ is:

1) 0,09 where the drainage openings are within the lowest 25 % of the recess depth;

2) 0,16 where the drainage openings are within the lowest 50 % of the recess depth;

3) 0,30 where the drainage openings are the full depth of the recess.

To qualify under 6.3.1 c) and d):

— the lower edge of all drainage openings shall be not more than 10 mm above recess sole height for at least 70 % of the width of each opening, and

— where drainage area is provided by an open or partially open transom, openings shall extend to the outboard sides of the recess sole on both sides.

NOTE The area of drainage openings is expressed in square metres and the volume is expressed in cubic metres.

Recesses completely or partially located within any third of the length must be considered to be swamped simultaneously.

Linked recesses shall be treated as being separate if more than 80 % of the volume of each one cannot drain into an adjacent linked recess. Where two recesses are linked by side decks, the total open cross-sectional area linking the forward and aft recesses must be greater than (open area at transom) × (volume of forward recess) / (volume of all linked recesses).

### 6.3.2 Simplified methods

**6.3.2.1** The percentage loss in initial metacentric height ($GM_T$) due to free-surface effect when the recess is filled to the retention level defined in 3.6.11 and the boat is in the loaded arrival condition shall be not more than:

— $250\ F_R / L_H$ for boats of design category A;

— $550\ F_R / L_H$ for boats of design category B;

— $1\ 200\ F_R / L_H$ for boats of design category C;

where

$F_R$ is the average freeboard to the waterline of the periphery of the recess

$= (F_A + 2F_S + F_F) / 4$


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$F_A$ is the average of highest and lowest freeboard to the waterline across aft end of recess;

$F_S$ is the average of highest and lowest freeboard to the waterline along the sides of recess;

$F_F$ is the average of highest and lowest freeboard to the waterline across forward end of recess.

Compliance with this requirement may be demonstrated by any of the methods given in 6.3.2.2, 6.3.2.3, or 6.3.2.4 for monohulls, or 6.3.2.2 or 6.3.2.3 for multihulls.

Alternatively, the direct calculation method of 6.3.3 may be used.

NOTE Each method given below is increasingly approximate, but in some cases 6.3.2.3 or 6.3.2.4 may be slightly more advantageous than 6.3.2.2.

**6.3.2.2** The percentage loss in initial metacentric height ($GM_T$) due to free-surface effect may be calculated from:

$$\%\ \text{loss}\ GM_T = \frac{102\ 500 \times SMA_{RECESS}}{m_{LA} \times GM_T} \tag{1}$$

where $SMA_{RECESS}$ is the second moment of area of free-surface of recess at retention level as defined in 3.6.11, about the longitudinal axis through the centre of area, expressed in $m^4$.

Where multiple recesses have to be considered swamped simultaneously, $SMA_{RECESS}$ should include all such recesses.

**6.3.2.3** The percentage loss in initial metacentric height ($GM_T$) due to free-surface effect may be estimated from:

$$\%\ \text{loss}\ GM_T = \frac{245 \times SMA_{RECESS}}{SMA_{WP}} \tag{2}$$

where

$SMA_{RECESS}$ is the second moment of area of free-surface of recess at retention level as defined in 3.6.11, about the longitudinal axis through the centre of area, expressed in $m^4$;

$SMA_{WP}$ is the second moment of area of waterplane of boat at $m_{LA}$.

Both second moments of area are about the longitudinal axis through the respective centre of area, expressed in $m^4$.

Where multiple recesses have to be considered swamped simultaneously, $SMA_{RECESS}$ should include all such recesses.

**6.3.2.4** The percentage loss in initial metacentric height ($GM_T$) due to free-surface effect may alternatively be estimated more approximately, and therefore more conservatively, from:

$$\%\ \text{loss}\ GM_T = 270\left(\frac{l \times b^3}{L_H \times B_H{}^3}\right)^{0,7} \tag{3}$$

where

$l$ is the maximum length of recess at the retention level as defined in 3.6.11, expressed in metres;

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*b* is the maximum breadth of recess at the retention level as defined in 3.6.11, expressed in metres.

Where multiple recesses have to be considered swamped simultaneously, *l* shall be the sum of the length of individual recesses and *b* shall be the maximum value of any recesses considered swamped at the same time.

NOTE This method is not appropriate for multihull boats.

### 6.3.3 Direct calculation method

a) Calculate the righting moment curve (N·m) for the boat in the loaded arrival condition in calm water using computer modelling which correctly represents (in calm water) the roll, heave and pitch of the boat, and with water in the recess allowed to flow in or out over gunwales or coamings according to the attitude of the boat in calm water, assuming that no flow through drains occurs. When the boat is upright, the recess shall be assumed to be filled to the following percentage of the capacity at the recess retention level:

$$(60 - 240\ F/L_H)\ \% \tag{4}$$

where *F* is the minimum freeboard to the waterline of the coaming of the recess in question.

b) In the range from the steady equilibrium heel angle to the least of the downflooding angle, $\phi_{DA}$, the angle of vanishing stability, $\phi_V$, and 90°, the righting moment (N·m) shall attain a value of at least:

1) $3{,}6m_{LA}$ for design category A;

2) $2{,}6m_{LA}$ for design category B;

3) $2{,}1m_{LA}$ for design category C;

where

$m_{LA}$ is the mass of the boat in the loaded arrival condition without any swamp water;

$\phi_{DA}$ is the angle of heel at which openings (except those listed in 6.2.1.6) not marked "KEEP SHUT WHEN UNDER WAY" and having a total combined area, expressed in square centimetres
(cm$^2$), greater than the number represented by $1{,}2L_HB_HF_M$, first become immersed.

## 6.4 Minimum righting energy

Boats to be assigned to design category A or B shall comply with the requirements given in Table 4.

**Table 4 — Required minimum righting energy**

| Design category | Required minimum righting energy<br>kg·m·deg |
|---|---|
| A | $m_{MO} \times A_{GZ} > 172\ 000$ |
| B | $m_{MO} \times A_{GZ} > 57\ 000$ |
| NOTE $A_{GZ}$ is the positive area under the righting lever curve in the minimum operating condition, expressed in metre degrees from upright to $\phi_V$. | |


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