INTERNATIONAL STANDARD

ISO 12217-2

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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

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

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 12217 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12217-2 was prepared by Technical Committee ISO/TC 188, *Small craft*.

ISO 12217 consists of the following parts, under the general title *Small craft — Stability and buoyancy assessment and categorization*:

— *Part 1: Non-sailing boats of hull length greater than or equal to 6 m*

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

— *Part 3: Boats of hull length less than 6 m*

Annexes A, B, C, D, E and F form a normative part of this part of ISO 12217. Annexes G, H and I are for information only.

Introduction

This part of ISO 12217 enables the determination of limiting environmental conditions for which an individual boat has been designed.

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 part of ISO 12217 does not guarantee total safety or total freedom of risk from capsize or sinking.

1 Scope

This part of ISO 12217 specifies methods for evaluating the stability and buoyancy of intact (i.e. undamaged) boats. The flotation characteristics of boats vulnerable to swamping are also encompassed.

The evaluation of stability and buoyancy properties using this part of ISO 12217 will enable the boat to be assigned to a design category (A, B, C or D) appropriate to its design and maximum load.

This part of ISO 12217 is 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 may also be applied to boats of under 6 m if they are habitable multihulls or 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.

This part of ISO 12217 excludes

— inflatable and rigid-inflatable boats up to 8 m covered by ISO 6185,

— canoes, kayaks or other boats with a beam of less than 1,1 m.

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12217. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12217 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 8666:—[1)], *Small craft — Principal data*

ISO 9093-1:1994, *Small craft — Seacocks and through-hull fittings — Part 1: Metallic*

1) To be published.

ISO 9093-2:—[1], *Small craft — Seacocks and through-hull fittings — Part 2: Non-metallic*

ISO 9094-1:—[1], *Small craft — Fire protection — Part 1: Craft with a hull length of up to and including 15 m*

ISO 9094-2:—[1], *Small craft — Fire protection — Part 2: Craft with a hull length of over 15 m*

ISO 10240:1995[2], *Small craft — Owner's manual*

ISO 11812:2001, *Small craft — Watertight cockpits and quick-draining cockpits*

ISO 12216:—[1], *Small craft — Windows, portlights, hatches, deadlights and doors — Strength and tightness requirements*

ISO 14946:2001, *Small craft — Maximum load capacity*

IMO Resolution MSC.81(70) — *Revised Recommendation on Testing of Life-Saving Appliances*

3 Terms and definitions

For the purposes of this part of ISO 12217, the following terms and definitions apply. 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 by this part of ISO 12217

NOTE See also 8.2.

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

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 total loaded displacement mass 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 total loaded displacement mass

3.1.5
recess
any volume open to the sky that may retain water

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

NOTE Cabins, shelters or lockers provided with closures according to the requirements of ISO 12216 are not recesses.

2) Undergoing revision.

3.1.6
quick-draining recess
recess fulfilling all the requirements of ISO 11812 for “quick-draining cockpits and recesses”.

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

NOTE 2 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 This term only implies requirements in respect of watertightness and sill heights, but not those for drainage.

3.1.8
fully decked 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 $L_H B_H F_M/40$,

all closing appliances being watertight in accordance with ISO 12216.

NOTE The plan area of recesses permitted for boats of design category A or B is restricted by the requirements of 6.1.5.

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
any opening (including the edge of a recess) that may admit water into the interior or bilge of a boat, or a recess, apart from those excluded in 6.2.1.1

3.3.2
downflooding angle
ϕ_D
angle of heel at which the downflooding openings described in 6.2.1.1 become immersed, when the boat is in calm water and in the appropriate loading condition at design trim

NOTE 1 Where openings are not symmetrical about the centreline of the boat, the case resulting in the smallest angle is used. The following are specifically considered:

— ϕ_{DA} is the downflooding angle to any downflooding opening;

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

— ϕ_{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 2 Downflooding angle is expressed in degrees.

3.3.3
downflooding height
h_D
smallest height above the waterline to any downflooding opening, apart from those excluded in 6.2.1.1 when the boat is upright in calm water and at loaded displacement mass and design trim

NOTE Downflooding height is expressed in metres.

3.4 Dimensions, areas and angles

3.4.1
length of hull
L_H
length of the hull according to ISO 8666

NOTE Length of hull is expressed in metres.

3.4.2
length waterline
L_{WL}

waterline length measured in accordance with ISO 8666 when the boat is upright in calm water, in the appropriate loading condition and at design trim

NOTE 1 For multihull boats, this length relates to that of the longest individual hull.

NOTE 2 Length waterline is expressed in metres.

3.4.3
beam of hull
B_H
maximum beam of the hull according to ISO 8666

NOTE 1 For catamaran and trimaran boats, B_H shall be measured as the maximum beam across the outer hulls.

NOTE 2 Beam of hull is expressed in metres.

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

NOTE 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 sidehulls

NOTE Beam between hull centres is expressed in metres.

3.4.6
freeboard amidships
F_M
distance of the sheerline or deck above the waterline at L_H /2 according to ISO 8666, the boat being upright, in the appropriate loading condition and at design trim

NOTE Freeboard amidships is expressed in metres.

3.4.7
draught of the 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 Draught of canoe body is expressed in metres.

3.4.8
nominal sail area
A_S

nominal projected profile area of sails, as defined in ISO 8666

NOTE Sail area is expressed in square metres.

3.4.9
actual sail area
A'_S
actual profile projected area of a specific combination of sails

NOTE 1 Sail area is expressed in square metres.

NOTE 2 This area will vary according to the individual sail combination being considered.

3.4.10
angle of vanishing stability
ϕ_V
angle of heel nearest the upright (other than upright) in the appropriate loading condition at which the transverse stability righting moment is zero; determined assuming that there is no offset load, and that all potential downflooding openings are considered to be watertight

NOTE 1 Where a boat has recesses which are not quick-draining, ϕ_V is to be taken as ϕ_{DC}, unless such recesses are fully accounted for in determining ϕ_V.

NOTE 2 Angle of vanishing stability is expressed in degrees.

3.5 Condition, mass and volume

3.5.1
light craft condition
boat equipped as the light craft mass according to ISO 8666 with the following added as appropriate:

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, mounted in the working position(s);

b) where batteries are fitted, they shall be mounted in the position intended by the builder;

c) mast(s), boom(s), and other spar(s) on board and rigged in the stowed position ready for use, but not set; all standing and running rigging in place;

d) any sails supplied by the builder, 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 In item b), if there is no specific stowage provided for batteries, the mass of one battery for each engine over 7 kW shall be allowed for, and located within 1,0 m of the engine location.

3.5.2
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 $L_H \leqslant 8$ m;

— 150 kg where 8 m < $L_H \leqslant 16$ m;

— 225 kg where 16 m < $L_H \leqslant 24$ m.

b) essential safety equipment with a mass of not less than $(L_H - 2{,}5)^2$ kg;

c) non-consumable stores and equipment normally carried on the boat;

d) water ballast in tanks which are symmetrical about the centreline and which are notified in the owner's manual to be filled whenever the boat is afloat, but no liquid being in ballast tanks which are intended by the builder to be used for variable asymmetric ballasting whilst under way;

e) a liferaft (where appropriate) fitted in the stowage provided.

Variable position elements (e.g. canting keels, movable solid ballast, tilting masts) shall be positioned symmetrically about the centreline of the boat;

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

3.5.3
minimum operating mass
m_{MOC}
mass of the boat in the minimum operating condition

NOTE Minimum operating mass is expressed in kilograms.

3.5.4
maximum total load
m_{MTL}
maximum load which the boat is designed to carry in addition to the light craft condition, comprising the manufacturer's maximum recommended load as defined in ISO 14946, including all liquids (e.g. fuel, oils, fresh water, water in ballast or bait tanks and live wells) to the maximum capacity of fixed or portable tanks

NOTE Maximum total load is expressed in kilograms.

3.5.5
loaded displacement condition
boat in the light craft condition with the maximum total load added so as to produce the design trim, the vertical distribution of crew mass being that described in C.2.2

3.5.6
loaded displacement mass
m_{LDC}
mass of the boat in the loaded displacement condition

NOTE Loaded displacement mass is expressed in kilograms.

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 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 Calculation wind speed is expressed in metres per second.

3.6.2
crew
collective description of all persons onboard a boat

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

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

3.6.5
flotation element
element which provides buoyancy to the boat and thus influences the flotation characteristics

3.6.5.1
air tank
tank made of hull construction material, integral with hull or deck structure

3.6.5.2
air container
container made of stiff material, not integral with the hull or deck structure

3.6.5.3
low density material
material with a specific gravity of less than 1,0 primarily incorporated into the boat to enhance the buoyancy when swamped

3.6.5.4
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 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.

3.6.6
inclining experiment
method by which the vertical position of the centre of gravity (VCG) of a boat can be determined

NOTE 1 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 For a full description of how to conduct an inclining experiment, standard naval architecture textbooks should be consulted (e.g. *Principles of Naval Architecture*, published by S.N.A.M.E) or refer to American Society for Testing and Materials *Standard Guide for Conducting a Stability* Test (ASTM F-1321-90).

3.6.7
righting moment
RM
at a specific heel angle in calm water, the restoring moment generated by the transverse offset of the centre of gravity of the boat from the centre of buoyancy of the submerged part of the hull

NOTE 1 The righting moment varies with heel angle and is usually plotted graphically against heel 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 2 Righting moment is expressed in newton metres.

3.6.8
righting lever
GZ
distance in both the horizontal and transverse planes between the centre of buoyancy and the centre of gravity

NOTE 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
loaded waterline
waterline of the boat when upright at loaded displacement mass and design trim

3.6.10
watertightness degree
degree of watertightness as specified in ISO 11812 and ISO 12216

NOTE The degree of watertightness is summarized as follows.

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.

4 Symbols

For the purposes of this part of ISO 12217, symbols and associated units in Table 1 apply.

Table 1 — Symbols

Symbol	Unit	Meaning
ϕ	degree (°)	Angle of heel
ϕ_{D}	degree (°)	Actual downflooding angle, see 3.3.2
$\phi_{\mathrm{D(R)}}$	degree (°)	Required downflooding angle, see 6.2.3
ϕ_{DA}	degree (°)	Downflooding angle to any downflooding opening
ϕ_{DC}	degree (°)	Downflooding angle to cockpits that are not quick-draining according to ISO 11812
ϕ_{DH}	degree (°)	Downflooding angle to any main access hatchway
ϕ_{GZmax}	degree (°)	Angle of heel at which maximum righting moment or lever occurs
ϕ_{V}	degree (°)	Angle of vanishing stability, see 3.4.10
$\phi_{\mathrm{V(R)}}$	degree (°)	Required angle of vanishing stability, see 6.3
A_{GZ}	m·degree	Positive area under righting lever curve, see 6.4.2
A_{S}	m^2	Nominal sail area according to ISO 8666, see 3.4.8
A'_{S}	m^2	Actual profile projected area of a specific combination of sails, 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, this is the sum of the waterline beam 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 ISO 8666
GM	m	Transverse metacentric height
GZ	m	Righting lever = righting moment (N·m)/[mass (kg) × 9,806], 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
h_{D}	m	Actual downflooding height, see 3.3.3
$h_{\mathrm{D(R)}}$	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 including keel and rudder(s)
L_{BS}	m	Length base size = $(2L_{\mathrm{WL}} + L_{\mathrm{H}})/3$
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 in the appropriate loading condition
m_{LCC}	kg	Mass in light craft condition, see 3.5.1
m_{LDC}	kg	Loaded displacement mass, see 3.5.5 and 3.5.6
m_{MOC}	kg	Mass in the minimum operating condition, see 3.5.2
m_{MTL}	kg	Mass of the maximum total load, see 3.5.4
RM	N·m	Righting moment, see 3.6.7
STIX	—	Actual stability index value at the appropriate loading condition according to 6.4
$\mathrm{STIX}_{\mathrm{(R)}}$	—	Required stability index value, see 6.4.9