2018

Guidance for Recreational Crafts

GC-06-E

KR

APPLICATION OF "GUIDANCE FOR RECREATIONAL CRAFT"

1. Unless expressly specified otherwise, the requirements in the Guidance apply to the recreational crafts for which contracts for construction are signed on or after 1 July 2018.

2. The amendments to the rules for 2013 edition and their effective date are as follows;

Effective Date 1 July 2018

- Changed the KS standard to the international standard for overseas customers

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CHAPTER 1 GENERAL

Section 1 General

101. Application

1. This Guidance is to apply to design, construction, exhaust emissions and noise emissions, etc. of maritime recreational craft(hereinafter called "recreational craft") such as leisure boat and yacht of hull length(L_H) from 2.5 m to 24 m.

(1) With regard to design and construction, to:
  (A) recreational craft and partly completed crafts;
  (B) following components.
    (a) ignition-protected equipment for inboard and stern drive engines;
    (b) start-in-gear protection devices for outboard engines;
    (c) steering wheels, steering mechanisms and cable assemblies;
    (d) fuel tanks intended for fixed installations and fuel hoses;
    (e) prefabricated hatches and port-lights.
(2) With regard to exhaust emissions, to:
  (A) propulsion engines which are installed or specifically intended for installation on or in recreational craft;
  (B) propulsion engines installed on or in recreational craft that are subject to a ‘major engine modification'.
(3) With regard to noise emissions, to:
  (A) recreational craft with stern drive engines without integral exhausts or inboard propulsion engine installations;
  (B) recreational craft with stern drive engines without integral exhausts or with inboard propulsion installations which are subject to a major craft conversion
  (C) outboard engines and stern drive engines with integral exhausts intended for installation on recreational craft;
(4) The provisions of (2) and (3) are to apply to only products which are first made.

2. The following are to be excluded from the scope of this Guidance:

(1) With regard to design and construction, to:
  (A) craft intended solely for racing, including rowing racing boats and training rowing boats, labelled as such by the manufacturer;
  (B) canoes and kayaks, gondolas and pedalos;
  (C) sailing surfboards;
  (D) surfboards, including powered surfboards;
  (E) craft specifically intended to be crewed and to carry passengers for commercial purposes, regardless of the number of passengers;
  (F) submersibles;
  (G) air cushion vehicles;
  (H) hydrofoils;
  (I) external combustion steam powered craft, fuelled by oil or gas.
  (J) personal watercraft
  (K) inflatable boat
(2) With regard to exhaust emissions, to:
  (A) propulsion engines installed or specifically intended for installation on the following:
    (a) craft intended solely for racing and labelled as such by the manufacturer,
    (b) craft specifically intended to be crewed and to carry passengers for commercial purposes, regardless of the number of passengers,
    (c) submersibles,
    (d) air cushion vehicles,
    (e) hydrofoils;
    (f) personal watercraft
    (g) inflatable boat
(3) With regard to noise emissions, to:
  all craft referred to (2)

3. Where deemed appropriate by the Society, ISO, KS or internationally recognized standards considered as equivalent may be applied for the items which are not specified in the Guidance. Fire protection and fire extinction are to be complied with the requirements of Flag Administration in addition to the Guidance.

102. Classification

1. Recreational crafts built and surveyed in accordance with this Guidance or with the alternatives equivalent to this Guidance will be assigned a class notation by the Society and registered in the Registration Master.

2. For the classification of recreational craft the requirements, not mentioned in this chapter, are to be in accordance with **Pt 1** of **Rules for the Classification of Steel Ships.**

3. Recreational crafts classed with the Society are, for continuation of the classification, to be subjected to the periodical and other surveys, and are to be maintained in good condition in accordance with the requirements of this Guidance.

103. Class notation

1. The class notations assigned to recreational crafts classed with the Society are to be in accordance with **Pt 1, Ch 1, Sec 2** of **Rules for the Classification of Steel Ships except for the requirements specially specified by this Guidance.**

Hull :

(1)
(2)
(3)

+ KRSA Recreational Craft (Yacht), Catamaran : For catamaran recreational crafts considered as design category of ocean and built under the supervision of the Society

or

(1)
(2)

KRSB Recreational Craft (Leisure Boat) : For monohull recreational crafts considered as design category of offshore and classed as the result of surveys by the Surveyor after construction

Machinery :

(1)

+ KRMA : For recreational crafts with machinery and electrical installations considered as design category of ocean and built under the supervision of the Society

(1)

KRMB : For recreational crafts with machinery and electrical installations considered as design category of offshore and classed as the result of surveys by the Surveyor after construction

(1) Design category notations
A : For recreational crafts with design category of ocean
B : For recreational crafts with design category of offshore
C : For recreational crafts with design category of inshore

D : For recreational crafts with design category of sheltered waters

(2) Ship type notations

Yacht	: Yacht
Leisure Boat	: Leisure Boat

(3) Hull type notations

No symbol	: Monohull craft
Catamaran	: Catamaran
Trimaran	: Trimaran

104. Plans and documents for approval

1. In planning the building of a recreational craft which will comply with Classification requirements 3 copies of the following plans and documents are to be submitted for the approval of the Society prior to commencement of the work.

(1) Midship section
(2) Construction profile
(3) Shell expansion
(4) Watertight and oiltight bulkheads
(5) Deck plans
(6) Structure plans of stem, sternframe and rudder
(7) Superstructure and deckhouse plans
(8) Engine room structure plans
(9) Hatchways, hatch covers and coamings arrangements
(10) Foundations and relevant structure plan of boilers, main engines, thrust bearings, intermediate shaft bearing, generators and other heavy weight auxiliary components
(11) Final stability data
(12) Machinery room arrangement plan
(13) Arrangement and details of propulsion system and stern tube
(14) Attaching method of stern tube, bracket or shaft support
(15) Exhausting piping system with material and cooling system (If cooling method is a water spray type, drainage method is to be included.)
(16) Starting system
(17) Arrangement of bilge pump and bilge piping system
(18) Pipes, sea water and over board scupper pipes arrangement
(19) Contamination product discharge prevention and shore discharge arrangement
(20) Fuel oil system
(21) Fuel oil tanks other than hull structure exceeding 200ℓ in capacity
(22) LPG fuel arrangement for onboard use
(23) Ventilation arrangement for gasoline engine or gasoline fuel tank installation compartment
(24) Fire control plan
(25) Steering gear arrangement
(26) Escape arrangement
(27) Torsional vibration calculation for main engine exceeding 500 PS
(28) Circuits arrangement for electric equipment
(29) Scope and detail of type for electric equipment
(30) Thruster's arrangement and details
(31) Anchor windlass's arrangement and details
(32) Other plans and documents specified by the Society

2. Manufacturers of main engine and shaft arrangement shall submit 3 copies of plans and documents in accordance with **Pt 5, Ch 1** of **Rules for the Classification of Steel Ships** for the approval of the Society prior to commencement of the work.

3. When craft are constructed in FRP, the lay-up procedures, joint details, secondary bondings details and materials list are to be submitted along with the approved plans and documents specified in **Par 1** above.

105. Plans and documents for reference

1. In planning the building of a craft which will comply with Classification requirements, 3 copies of the following plans and documents are to be submitted for reference.

(1) General arrangement
(2) Specifications
(3) Calculation sheets of longitudinal strength
(4) Calculation sheets for midship section modulus and scantlings
(5) Other plans and documents specified by the Society

2. The capacity plans, sea trials records and various test reports are to be submitted before delivery of the craft.

106. Sea Trial

1. The operation tests for windlass(if fitted) and all mechanical system including steering gear are to be carried out after manufacturing of the recreational craft.

2. The propulsion engines are to be carried out sea trial at least one(1) hour with full speed and the condition of operation for starting, stopping and astern etc. are to be of satisfactory.

3. Where the engines are controlled from the deck, the operating tests are to be carried out and the necessary remote indicators are to be installed in control room.

107. Government regulations

1. The Society may require to apply the governmental regulations for items not specified in this Guidance.

2. Where the ships have undergone survey according to relevant governmental regulation and allowed to operate within costal area, the application of this Guidance may be dispensed with.

108. Definitions

For the purposes of this Guidance, the following definitions are to apply:

1. Recreational craft

Any craft of any type intended for sports and leisure purposes of hull length(L_H) from 2.5 m to 24 m, measured according to the 5.2.2 in **ISO 8666**, regardless of the means of propulsion.

2. Propulsion engine

Any spark or compression ignition, internal combustion engine used for propulsion purposes, including two-stroke and four-stroke inboard, stern-drive with or without integral exhaust and outboard engines.

3. Major engine modification

The modification of an engine which :

(1) could potentially cause the engine to exceed the emission limits set out in **Ch 8** excluding routine replacement of engine components that do not alter the emission characteristics, or
(2) increases the rated power of the engine by more than 15 %.

4. Major craft conversion

A conversion of a craft which:

(1) changes the means of propulsion of the craft,
(2) involves a major engine modification, or
(3) alters the craft to such an extent that it is considered a new craft.

5. Means of propulsion

The mechanical method by which the craft is driven, in particular marine propellers or water-jet mechanical drive systems.

6. Engine family

The manufacturer's grouping of engines which, through their design, are expected to have similar exhaust emission characteristics and which comply with the exhaust emissions requirements of this Guidance.

7. Craft identification number

Unique series of numerals, letters and a hyphen, permanently affixed to a craft hull.

8. Builder's plate

Label or plate to display basic user information related to the recreational craft.

9. Graphical symbol

Visually perceptible figure with a particular meaning used to transmit information independently of language.

10. Loaded displacement mass m_{LDC}

Mass of the boat in the loaded displacement condition, including all appendages.

11. Mass of light craft m_{LCC}

Mass of the craft in light craft condition, as defined in **ISO 8666**

12. Nominal sail area (A_S)

Nominal projected profile area of sails, as defined in **ISO 8666** (m^2)

13. Sailing craft

Craft for which the primary means of propulsion is by wind power, having $A_S \geq 0.07(m_{LDC})^{2/3}$

14. Non-sailing craft

Craft for which the primary means of propulsion is other than by wind power, having $A_S < 0.07\,(m_{LDC})^{2/3}$

15. Fully decked craft

Craft in which the horizontal projection of the sheerline area comprises any combination of

(1) watertight deck and superstructure, and/or
(2) quick-draining recesses complying with **Ch 6, Sec 3**, and/or
(3) watertight recesses complying with **Ch 6, Sec 3** with a combined volume of less than $L_H B_H F_M/40$, all closing appliances being watertight in accordance with **Ch 6, Sec 2**.

16. Partially decked craft

Craft in which at least two-thirds of the horizontal projection of the sheerline area is equipped with decking, cabins, shelters or rigid covers which are watertight according to **Ch 6, Sec 2** and designed to shed water overboard, in which area all that within $L_H/3$ from the bow and also the area 100 mm inboard from the periphery of the craft are included.

17. Dimensions, areas and angles

(1) length of hull (L_H)
length of the hull according to **ISO 8666**, (m)
(2) length waterline (L_{WL})
waterline length measured in accordance with **ISO 8666** when the craft is upright in calm water, in the appropriate loading condition and at design trim, (m)
(3) beam of hull (B_H)
maximum beam of the hull according to **ISO 8666**, (m)
- For catamaran and trimaran crafts, B_H shall be measured as the maximum beam across the outer hulls.

(4) beam waterline (B_{WL})
greatest beam measured according to **ISO 8666** at the waterline, which for multihull crafts is the sum of the maximum waterline beams of all hulls, the craft being upright, in the appropriate loading condition and at design trim, (m)
(5) freeboard amidships (F_M)
distance of the sheerline or deck above the waterline at $L_H/2$ according to **ISO 8666**, the craft being upright, in the appropriate loading condition and at design trim, (m)

18. Watertightness degree

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

Section 2 Essential Requirements

201. General

Following essential requirements are to apply to all recreational crafts.

202. Design categories

1. Craft in each category must be designed and constructed to withstand these parameters in respect of stability, buoyancy, and other relevant essential requirements listed in this Section and, **Ch 3** to **Ch 13**, and to have good handling characteristics.

Design category	Wind force (Beaufort scale)	Significant wave height (H 1/3, meters)
A – ‘ocean’	exceeding 8	exceeding 4
B – ‘offshore’	up to, and including, 8	up to, and including, 4
C – ‘inshore’	up to, and including, 6	up to, and including, 2
D – ‘sheltered waters’	up to, and including, 4	up to, and including, 0.3

Remarks :

A. Ocean : Designed for extended voyages where conditions may exceed wind force 8 (Beaufort scale) and significant wave heights of 4 m and above but excluding abnormal conditions, and vessels largely self-sufficient

B. Offshore : Designed for offshore voyages where conditions up to, and including, wind force 8 and significant wave heights up to, and including, 4 m may be experienced.

C. Inshore : Designed for voyages in coastal waters, large bays, estuaries, lakes and rivers where conditions up to, and including, wind force 6 and significant wave heights up to, and including, 2 m may be experienced.

D. Sheltered waters : Designed for voyages on sheltered coastal waters, small bays, small lakes, rivers and canals when conditions up to, and including, wind force 4 and significant wave heights up to, and including, 0.3 m may be experienced, with occasional waves of 0.5 m maximum height, for example from passing vessels.

Note :

1. The Design category parameters are intended to define the physical conditions that might arise in any category for design evaluation, and are not intended for limiting the use of the recreational craft in any geographical areas of operation.

2. For category D, allowance should be made for waves of passing vessels up to a maximum wave height of 0.5 m.

3. For category A, unlimited conditions apply as they reflect that a vessel might incur any conditions during the voyage and should be designed accordingly, excluding abnormal weather conditions e.g. hurricane.

203. Craft identification

1. Each craft is to be marked permanently on the hull with an identification number including the following information:

(1) Manufacturer's code

(2) Country of manufacture
(3) Unique serial number
(4) Year of production
(5) Model year

2. Details of craft identification are to be in accordance with the following.

(1) The craft identification numbers are to be displayed in alphanumerical characters(arabic numerals and upper-case letters) and are to be read from left to right. Composition of the identification numbers is to be in accordance with **ISO 10087**.
(2) The characters are to be at least 6 mm high.
(3) Each identification number is to be carved, burned, stamped, embossed, moulded, or otherwise permanently affixed so that alteration, removal, or replacement will be obvious. If on a plate, the plate is to be fastened, excluding screwing or riveting as sole means of fastening, so that its removal will cause scarring to the surrounding area.
(4) The craft identification numbers are to be visible on the starboard outboard side of the transom or near the stern within 50 mm of the transom top, gunwale, hull/deck joint or its capping,
(5) On craft with a transom, the identification numbers are to be located on the starboard side of the transom.
(6) On craft without a transom or with a transom on which it is impractical to locate the identification numbers, the identification numbers are to be affixed within 300 mm of the stern.
(7) On catamarans the craft identification numbers are to be located as follows.
  (A) Hulls structurally permanently connected : on the starboard hull
  (B) Hulls detachable but regarded as the primary structure : on both hulls
  (C) Hulls readily removable and/or replaceable : on the aft cross-beam within 300 mm of the starboard hull. this also applies to catamaran-type pontoon crafts.
(8) On trimarans the identification numbers are to be located on the centre hull in accordance with (5) or (6).
(9) Rails, fittings or other accessories are not to obscure the identification numbers located as specified above. If the design of the craft would result in this, the identification numbers are to be located as near as possible to the required location to be visible.
(10) If additional information is displayed on the craft within 50 mm of the craft identification numbers, it is to be separated from the craft identification numbers by means of borders or it is to be on a separate label so that it will not be interpreted as a part of the identification numbers.
(11) A duplicate craft identification number is to be affixed to a non-removable part of the craft in a hidden location only known by the manufacturer such as in the interior or beneath a fitting or item of hardware. Catamarans are to have this hidden craft identification number in or on both hulls. The craft identification number are to be located so that it is extremely difficult to reach and modify.
(12) The craft identification number is to be affixed to the craft during the construction or assembly of the craft.

204. Builder's plate

1. Each craft is to carry a permanently affixed plate mounted separately from the craft identification number, containing the following information:

(1) Manufacturer's name
(2) CE marking (if applicable)
(3) Craft design category according to **202.**
(4) Manufacturer's maximum recommended load derived from **Ch 5, Sec 5** excluding the weight of the contents of the fixed tanks when full, with the person symbol and the suitcase symbol(for craft which are powered by outboard engine(s) the mass of the engine(s) is to be included, with the outboard engine symbol).
(5) Maximum number of persons that the craft is designed to carry while underway(with the person symbol).

2. Details of builder's plate is to be in accordance with the following.

(1) The builder's plate is to be a rigid plate or flexible label affixed to the craft in such a way that it can only be removed by the use of tools. Alternatively, the craft shell may be used for the marking.
(2) Characters and other markings on the builder's plate are to be carved, stamped-burned, embossed, moulded, etched, printed, affixed by permanently setting adhesive, or be applied by oth-

er suitable means. Alternatively, the information may be printed or etched on the craft itself. The characters are to contrast or be on a different level to the background so that alterations will be obvious. The colours applied to the label are to be fade resistant.

(3) The required information characters are to be at least 5 mm in height and other characters are to be at least 3 mm in height. And, pictograms and symbols are to be at least 8 mm in height.

(4) The builder's plate is to be readily visible, preferably in the cockpit or near the main steering position.

(5) In any case, the builder's plate is to be separate from the craft identification number.

(6) Where the manufacturer wishes to assign more than one design category to a craft, the display is to be such that the maximum number of persons and the maximum load are clearly identified to belong to a specific design category.

(7) The manufacturer is free to provide additional information in the label. The inclusion of this additional information is not to impair the legibility of the minimum required information and is to be separated from it preferably by a line or similar delimiter.

(8) Design examples of builder's plates are to be referred to Annex A in **ISO 14945**.

205. Owner's manual

1. Each craft shall be provided with an owner's manual in English or languages which may be determined by the Member State in which it is marketed in accordance with the Treaty. This manual should draw particular attention to risks of fire and flooding and shall contain the information of builder's plate, manufacturer's maximum recommended load and handling characteristics as well as the unladen weight of the craft in kilograms.

2. Constitution and format

(1) Description

(A) The owner's manual shall be produced in English or language required in the country of intended use. It may be multilingual.

(B) The owner's manual shall be produced in paper or proper material.

(C) Dimension are not to be regulated, but A4(210 mm × 297 mm), A5(148.5 mm × 210 mm) or B6(128 mm × l82 mm) are to be recommended and folded type paper could be used.

(D) Margins of top, bottom, left and right except the space of bind are not to be less than 7 mm.

(E) Colors could be used to emphasis important descriptions or to specify circuits, drawings and manual. Black letters on the white background to be recommended and printing on both sides of the paper could be used.

(F) Both the corresponding page number and the total page number such as "1(15)" to be marked on page number.

(2) Text

(A) Height of letter to be not less than 1.5 mm.

(B) SI units shall be used in the owner's manual in accordance with **ISO 1000** ; other units may be added between brackets.

3. Content

(1) Description of recreational crafts

(A) Principal dimension

(B) Service area

(C) Mass of the craft

(D) Draft, vertical height

(E) Designed maximum engine rated output (See the information provided by the engine manufacture.)

(F) Usage voltage (alternating or direct current), frequency, constant

(G) Battery capacity

(H) Engine : inboard/outboard engine

(I) Tank capacity/fuel/fresh water/storage tank/gas storage vessel

(J) Maximum recommended load

(K) Maximum number of persons

(L) Strong points for docking and towing

(2) Description for main machinery and equipment

(A) General arrangement

(B) Engine installation
(C) System and circuit diagram

(3) Special manual
Manual for equipment installed or affixed on the crafts to be attached in the owner's manual. In case that this manual is simply attached, the reference about maintenance of engine, refrigerator and heater, etc. to be included.

(4) Information
The following information to be included in the manual.
(A) General information
- Quoted reference standards
- Description for symbols used inboard (See **ISO 8999** and **ISO 11192**.)
- label and warning noticed inboard
- Function of steering installation, valve and handle.
- Function of dial, switch, fuse or circuit isolator
- Handling method for equipment which the owner can handle

(B) Environment protection measures
(C) Maintenance
(D) Recommended items
Warning and/or caution in the manual to be arranged on the introduction of description for corresponding equipment and to be emphasized for the owners by colorful letters or underline, etc.

(5) Additional information
In addition to the above information, the experience, advice, warning and description of builder or seller could be included in the manual to help the maintenance for the optional or later installed equipment. ⚓

CHAPTER 2 PERIODICAL AND OTHER SURVEYS

Section 1 General

101. Application

The Classification Surveys for recreational crafts are to be in accordance with **Pt 1** of **Rules for the Classification of Steel Ships** except those specially specified in this chapter.

Section 2 Kinds and Due Range of Surveys

201. General

Recreational crafts classed with the Society are to be subjected to the Intermediate and Special Surveys for continuation of the classification.

202. Intermediate Survey

The Intermediate Survey is to be carried out within 6 months before or after the anniversary date of the year which is due 2.5 years after the completion date of the initial Classification Survey or the previous Special Survey.

203. Special Survey

The first Special Survey is to be completed within 5 years from the completion date of the initial Classification Survey and thereafter within 5 years form the credited date of the previous Special Survey.

Section 3 Scope of Surveys

301. Intermediate Survey

1. The survey is to be carried out in drydock or on a slipway. The vessel is to be placed at a height enabling its keel and bottom to be thoroughly examined.

2. The surveys are to cover:

(1) External examination of the hull structures, including the deckhouse, inside of engine room and foundations
(2) Watertight closures, such as hatches, skylights, air and sounding pipes, scuppers, discharge lines, doors, etc., including their seals and locking devices.
(3) Rudder and steering gear, including measurement of bearing clearances
(4) Main and auxiliary machinery with pertinent components
(5) Electrical installation, including pertinent machinery, switchboards and cabling
(6) Propeller, including fastening/securing devices
(7) External examination of the entire propeller shaft system(s) without withdrawal of the shaft, including measurement of bearing clearances
(8) Sea valves and all inlet and outlet shell openings
(9) Electric equipment
(10) LPG equipment for onboard use
(11) Fire protection and fighting equipment

302. Special Surveys

1. The Special Survey is to be carried out in drydock or on a slipway. The vessel is to be placed at a height enabling its keel and bottom to be thoroughly examined.

2. In addition to the surveys required in **301.** above, the surveys are to include :

(1) Internal inspection of fresh water, ballast and fuel tanks (If necessary, pressure tests are to be carried out)
(2) Hose testing of all watertight/weathertight closures
(3) Inspection of anchors, chain cables, hawses
(4) Inspection of bilge and ballast lines, including pertinent pumps, with operational trials
(5) Dismounting of sea valves depending of the findings obtained during external inspection, if deemed necessary by the Surveyor
(6) Drawing of propeller shaft if deemed necessary by the Surveyor
(7) Dismounting of individual components of the machinery if deemed necessary by the Surveyor
(8) Partial or complete disassembly of main engines as deemed necessary by the Surveyor, taking into account provable service times recommended by engine manufactures between overhauls and maintenance work performed
(9) Operational trials of the entire machinery and electrical installation, with the ship afloat ⚓

CHAPTER 3 MATERIALS

Section 1 General

101. Application

1. The requirements of this chapter are applied to the metal, wood, FRP materials and it's construction work used for hull construction, superstructure and equipment of recreational crafts. However, the requirements other than those specified in this Chapter are to be in accordance with the related requirements in **Pt 2, Ch 2** of **Rules for the Classification of Steel Ships** and **Rule for the Classification of FRP ships**.

2. Where deemed appropriate by the Society, national standards, internationally recognized Codes or Standards considered as equivalent for those may be applied instead of requirements of this Chapter.

3. Materials not specified in this chapter may be used if adequate suitability and durability for the intended purpose can be demonstrated.

(1) Laboratory tests
(2) Long-term tests with the boat as finished
(3) Reports on similar craft with comparable hull parameters and size, and operating environment.

4. It is the responsibility of the craft's owner to follow the instructions of the recreational craft manufacturer, especially concerning

(1) The possible reduction of mechanical properties by the induction of heat
(2) The use of chemicals and antifouling paints that are incompatible with aluminium

Section 2 Metal Material and Welding

201. Metal material

1. General

(1) The properties of all metal such as steel and aluminium alloy, etc. used in the hull construction and equipment of recreational craft shall be suitable for marine use and the intended methods of construction. However, the requirements not specially provided in this Chapter are to be in accordance with the related requirements in **Pt 2, Ch 2** of **Rules for the Classification of Steel Ships**.
(2) The metal used shall have a suitable finish for the intended application and shall be free from surface defects prejudicial to use for the intended application.
(3) The manufacturer or supplier of the material shall adopt a system of identification, e.g. by colour coding or stamping, that will enable the material to be traced to its original manufacture.

2. Material combinations

(1) When combining metals of different type or composition, the galvanic potential difference must be considered in order to avoid contact corrosion.
(2) The negative effect on certain timber by adjacent metals and vice versa shall be taken into account when selecting the materials to be in contact or shall be neutralized, e.g. by shielding or insulation.

3. Steels for hull structure

(1) The steel used for hull structure of recreational crafts is to be mild or higher strength steel in accordance with requirements in **Pt 2, Ch 1** of **Rules for the Classification of Steel Ships**.
(2) Higher strength steel may be used in the construction of craft provided it is taken into consideration that, when fatigue load is present, the effective fatigue strength of a welded joint may not be greater than a welded joint in normal strength steels. Where higher strength steel is applied to the hull structure, the drawings indicating use extent, location, material property and dimensions to be submitted to the Society for approval.
(3) Classification for steel used in the hull structure is to be complying with **Pt 3, Ch 1, Sec 4** of **Rules for the Classification of Steel Ships**.

4. Stainless steels

(1) Austenitic stainless steels may be used for construction of recreational craft subject to giving consideration to
  (A) the environmental conditions to which the small craft may be subjected,
  (B) any intended combination of different metals, the means of insulation from each other and surface protection or coating, and
  (C) the detail design to reduce the possibility of pitting and/or crevice corrosion.

(2) This group of steels comprises low-carbon austenitic steels which achieve their resistance to corrosion in fresh and sea water by additions of chromium (Cr), nickel (Ni), molybdenum (Mo), and may additionally be stabilized for a stable after welding condition by titanium (Ti) and niobium (Nb).

(3) Alloys suitable for marine use are in general those with a minimum mass fraction of 12 % chromium and a pitting resistance equivalent (W) exceeding 25 (W = % Cr + 3,3 % Mo).

5. Aluminium alloys

(1) Aluminium alloys used for hull structure of recreational crafts is to be 5000 or 6000 series in accordance with requirements in **Pt 2, Ch 1** of **Rules for the Classification of Steel Ships**.

(2) Alloys of the aluminium-copper group(3000 series) and aluminium-zinc group(7000 series) should not be used for the construction of recreational crafts. They may be used for secondary purposes in recreational craft with special protection, e.g. anodizing, painting.

(3) Aluminium-copper alloys(3000 series) may be used without protection for recreational crafts that are intended to be used exclusively in fresh water surroundings. It is preferable that they are not of welded construction.

6. Other metals

Structural members of recreational crafts may be built of other metals, e.g. copper- and nickel-based alloys. Those that are sensitive to crevice corrosion and pitting when not coated shall only be used with cathodic protection when submerged or subject to spray water.

202. Storage and handling

1. Identification and marking

(1) The builder shall establish and maintain a procedure to ensure that material and consumables used in the construction process are identified (by colour-coding and/or marking or any other means, as appropriate) from arrival in the yard through to fabrication in such a way as to enable the type and grade to be readily recognized.

(2) The builder shall maintain purchasing documents containing a clear description of material ordered for hull construction referring to the appropriate standards or specifications.

(3) Non-conforming material shall be separated from the acceptable material.

(4) Where materials are found to be defective, they shall be disposed of in accordance with the builder´s conformity assurance procedure.

2. Storage

(1) Materials shall be stored in accordance with the material manufacturer’ requirements. Storage arrangements shall be such as to prevent deterioration through adverse environmental conditions and poor handling.

(2) Welding consumables shall be stored in suitable conditions to maintain them in accordance with the material manufacturer’ recommendations.

203. Welding

1. General

(1) The welding in the steels or aluminium alloys used for hull structure of recreational crafts are to be suitable for not only **203.** of this rule but **Pt 2, Ch 2** of **Rules for the Classification of Steel Ships.**

(2) Details of welded joints for main structural members are to come under construction plan and/or detail drawing.

(3) The welding is to be carried out in accordance with the procedures previously approved with welding consumables and by the welders qualified by the Society.

2. Preparation

(1) Materials shall be suitably cleaned and cleared of millscale and rust prior to fabrication of the recreational craft.

(2) The preparation of materilas(e.g. cutting, bending and forming) shall follow recognized industry practice and shall be such as to ensure that the mechanical properties of the material are not adversely affected.

3. Welding work

(1) Adequate protection, such as screening, shall be provided where welding is to carried out in wet, windy or cold weather. In cold or very humid conditions, it may be necessary to preheat the work to prevent too rapid cooling of the weld.

(2) The preparation of plate edges shall be accurate and free from harmful defects. Joints shall be properly fitted up, or aligned without using excessive force, before welding. Parts shall be set up and welded in such a way that contraction stresses are kept to be minimum.

(3) The surfaces to be welded shall be clean, dry and free from grease and other contaminants which might adversely affect weld quality. Where a primer has been used after surface preparation and prior to fabrication, the composition of the primer shall have no detrimental effect on the subsequent welding work.

4. Quality of welds

(1) The weld is to have a regular and uniform surface and it to be reasonably free from excessive reinforcements, injurious defects, such as undercuts, overlaps, etc.

(2) Welded structures are to be reasonably free from welding deformation.

(3) Non-destructive inspection is to be carried out for welded joints as the Guidance relating to the Rules specified elsewhere.

(4) The welding defects found in an appropriate non-destructive inspection including the visual inspection or watertight test are to be removed and corrected by rewelding.

5. Repair welding

(1) The removal of weld defects shall be done by gouging, grinding, chipping, etc. with such a manner that the remaining weld metal or base metal is not damaged.

(2) The removed weld defects parts are to be so machined as not to affect repair welding and repair welding shall be carried out with low hydrogen type welding consumables and an electrode preferably smaller than that used for making the original weld.

(3) Members distorted by welding may be straightened by mechanical means or localized heat treatment, however in case of localized heat treatment, the temperature of heated areas is to be so limited as not to affect the mechanical properties of base metal.

204. Steel/aluminium transition joints

1. Explosion-bonded composite transition joints shall be used for connecting aluminium to steel. These assemblies shall be used in strict compliance with the joint manufacturer´s specification.

2. Bimetallic joints, where exposed to sea water or used internally within wet spaces, shall be suitably protected to prevent galvanic corrosion.

205. Adhesive bonding of structure

1. The adhesive manufacturer´s recommendations in respect to the jointing system, comprising surface preparation, the adhesive, bonding, and curing processes and environmental conditions, shall be strictly followed.

2. Where adhesive bonding of any load-bearing structure is used, test samples shall be manufactured under workshop conditions to demonstrate that the bonded connection develops its intended strength.

3. The method used to bond joints shall be documented so that the process is repeatable after the procedure has been verified.

4. Bonded joints shall be designed to avoid tension on the joints which may cause peeling forces tending to open the joint, unless tests and calculations show that the joint has sufficient strength.

5. Glued joints shall be resistant to, or protected against, sunlight (UV, heat, etc.) and environmental effects or cleaning agents normally encountered in the manufacture or the use of the craft.

206. Steel/wood and aluminium/wood connection

1. To minimize corrosion of steel or aluminium in contact with wood in a damp or marine environment, the surfaces in contact shall be protected in accordance with good practice.

2. Surfaces in contact shall be primed and painted, or coated with a substantial thickness of a suitable sealant.

207. Surface coating

Metal shall be given adequate protection for its intended use by an adequate surface treatment and/or coating, as necessary.

208. Aluminium craft production, specific requirements

1. General

(1) Aluminium shall not be welded when damp or wet in order to avoid hydrogen inclusions in the welds.
(2) Aluminium shall be stored in dry places, clear of the ground. Contact with other stored materials shall be avoided.
(3) Where a builder is working with both aluminium and steel, the tools directly in contact with the metal used in aluminium production shall be clearly marked(e.g. by colour) for use with aluminium only.
(4) Where bimetallic connections are made, involving dissimilar metals, measures shall be taken to prevent galvanic action.
(5) Areas of the hull structure that are permanently or temporarily submerged shall be protected by means of coating or cathodic protection.
(6) The welding in the aluminium alloys used for hull structure of recreational crafts are to be in accordance with **2** to **6.** Any contents other than those specified in **2** to **6** are to be in accordance with **Pt 2, Ch 2** of **Rules for the Classification of Steel Ships**.

2. Groove design

(1) The groove design of welded connections, as a rule, is to be in accordance with **Table 3.1.** Grooves and root gaps which differ from these may be subject to special consideration.
(2) To minimize distortion, the X groove with the narrowest root gap practicable is recommended for thick material, instead of single-V groove.

3. Welding consumables

Welding consumables used for aluminium alloys is to be applied in accordance with **Table 3.2.**

Table 3.1 Groove Design of TIG and MIG Welding

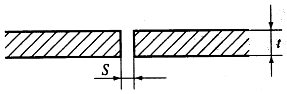
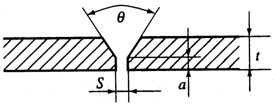
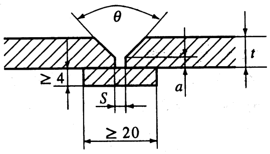
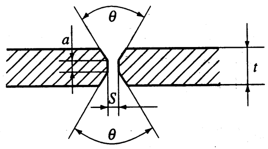
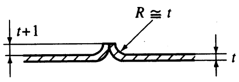
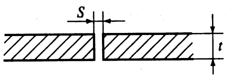
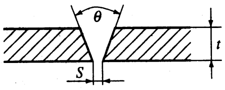
Groove design		Dimension	Remarks
MIG		t = 1.5 ~ 5 s = 0 ~ 2	Welding from one side. Backing may be used.
		t = 5 ~ 25 s = 0 ~ 3 a = 1.5 ~ 3 θ = 60 ~ 100°	Largest angle is recommended for under-up position. Back chipping and rewelding should be carried out.
		t = 8 ~ 25 s = 3 ~ 7 a = 2 ~ 4 θ = 40 ~ 60°	Smallest joint angle may be used up to 15 mm and with the largest root gap. Position vertical, under-up and side-in require large root gap.
		t = 12 ~ 25 s = 0 ~ 2 a = 3 ~ 5 θ = 50 ~ 70°	Allowed specially for automatic welding. Semiautomatic processes may be used in all positions, and shall be back chipped before welding from backside.
TIG		t ≤ 2	
		t ≤ 4 s = 0 ~ 2	Welding from one side.
		t = 4 ~ 10 s = 0 ~ 2 θ = 60 ~ 70°	Backing may be used in horizontal position
t = material thickness (mm) a = root face (mm) s = root gap (mm) θ = joint angle			

Table 3.2 Application of Welding Consumables used for Aluminium Alloy

Kind and grade of aluminium alloys to be welded		Grade of applicable welding consumables
5000 series[(1)]	5754 *P*	*RAlRA, RAlRB, RAlRC* *RAlWA, RAlWB, RAlWC*
	5086 *P*, 5086 *S*	*RAlRB, RAlRC* *RAlWB, RAlWC*
	5083 *P*, 5083 *S*	*RAlRC, RAlWC*
6000 series[(1)]	6005 *AS*	*RAlRD, RAlWD*
	6061 *P*, 6061 *S*	*RAlRD, RAlWD*
	6082 *S*	*RAlRD, RAlWD*
(NOTES) (1) For welded joint of 5000 series alloys and 6000 series, the welding consumables corresponding to 5000 series alloys specified in this table may be used.		

4. Preparation for welding

(1) **Edge preparation**

(A) Proper edge preparation is to be employed.

(B) Joint edge may be prepared by mechanical cutting, such as band sawing, and by plasma (TIG) arc cutting.

(2) **Cleanliness**

(A) All oil or other hydrocarbons, paint and loose particles from the sawed edges must be removed prior to welding.

(B) Oil or grease films may be removed chemically by dipping, spraying or wiping the aluminium plate with solvents. Mildly alkaline solutions may be used for cleaning and all welding surfaces shall be thoroughly dried before welding.

(C) Oxide films, which will prevent fusion between the filler metal and the parent material are to be removed from the weld bevels and a minimum of 75 mm to any side, prior to assembly. Mechanical means, such as a power-driven clean, stainless steel brush, or suitable chemical means are to be used. Welding is to take place immediately after cleaning, and the welding site is to be protected against draft, wind and moisture.

(3) **Backing**

(A) When backing is used, the joint angle is to be large enough to provide accessibility for the root runs.

(B) Besides aluminium alloys, stainless steel and copper may be used as backing bar material.

(C) When copper backing is used, copper pickup is to be prevented because local deposition can result in corrosion service.

(D) Temporary aluminium backing is to be removed by chipping after welding. If the butt weld is not completely fused to the temporary aluminium backing, the root pass is to be back chipped to sound metal after the backing bar has been removed.

(E) When permanent aluminium backing is used, it is necessary to obtain complete fusion between the backing, the root faces and the root layer of the weld. Permanent backing is not recommended where crevice corrosion is of a concern. In these conditions, all edges of the backing bars are to be completely welded.

5. Main welding

(1) The welding process may be manual, semi-automatic or automatic according to welding procedure specifications.

(2) TIG-welding is a recommended process for welding of thinner gages and precision weldments. MIG-welding is recommended for thicker gages.

(3) For MIG fillet welds, back stepping is recommended to fully fill the end crater and thereby eliminate cracking problems that usually accompany the crater.

(4) Other welding methods such as resistance, spot, seam, stud or electron beam welding may be approved by the Society after consideration in each separate case.

6. Preheating

(1) Preheating of parts to be welded is to be carried out when the temperature of the parts is below 5 ℃ or when the mass of the parts is such that the heat is conducted away from the joint faster than the welding process can supply it. Use of preheat is required when welding is performed under high humidity conditions.

(2) The preheating temperature must be limited to maximum 60 ℃, due to the increased susceptibility of stress corrosion cracking for 5000 series alloys above this temperature.

7. Acceptance criteria fabrication

(1) **Visual inspection**

(A) All welds are to show good workmanship with smooth transition to the base material without sharp edges. An overlap or deficient weld is not acceptable.

(B) For butt welds, weld reinforcement or excessive penetration is not to exceed 2 mm.

(C) For fillet and partial penetration welds, weld reinforcement is not to exceed 3 mm.

(D) For throat thickness, a negative deviation from that which is specified is not allowed.

(E) The difference in leg lengths of a fillet weld is not to exceed 3 mm.

(2) **Non-destructive examination**

(A) Requirements for non-destructive examination to be complying with **Pt 2, Annex 2-7** of **Guidance for the Classification of Steel Ships**.

(B) Cracks, incomplete penetration and lack of fusion are not acceptable.

Section 3 Wood

301. General

1. Requirements specified in this Chapter are applied to structural wood and plywood used in the hull structure of recreational crafts.

2. Wood and plywood used for hull structure of recreational crafts are to be approved by Society.

302. Wood

1. Timber shall be suitable for use in the intended marine environment and shall be of durability classes 1, 2 or 3, (see **Table 3.3**) except where otherwise specified in this section.

Table 3.3 Designation of durability of wood

Durability class	Endurance (years)	Resistance
1	〉 25	high resistance
2	15 ~ 25	resistant
3	10 ~ 15	moderate resistance
4	〈 10	non-resistant

2. A selection of such wood species is given in **Table 3.4**. Wood of lower durability classes may be used, as listed in **Table 3.4**, provided the mechanical properties are sufficient for scantlings, and suitable preservations are applied.

Table 3.4 Wood designation and durability classes (selection)

Trade name	Botanical designation	Durability class
Teak	Tectona grandis	1
Iroko	Chlorophora excelsa	1
Macore	Tieghemelia heckelii	1
Sipo, Utile	Entandophragma utile	2
Mahogany	Swietenia macrophylla	2
Oak, European	Quercus robur	2
Red cedar, Western	Thuja plicata	2
Khaya, Benin mahogany	Khaya ivorensis	2, 3
Agba	Gossweilerodendron balsamife-rum	2, 3
Douglas fit, Oregon pine	Pseudotsuga menziesii	3
Larch	Larix decidua	3
Pine	Pinus sylvestris	3
Fir	Abies alba	4
Fir, Spruce	Picea abies	4
Spruce	Picea glauca	4

3. Timber for structural parts shall be free from defects that might impair the strength or durability of the craft, e.g. bluing, brittleness, rot, cracks, knots and sapwood.

4. Timber used for planking of the hull shall be cut with consideration of warping, shrinkage and swelling in the as-assembled condition. Timber intended to be used for planking of the hull should be quarter sawn (rift sawn), with an angle of the annular rings to the lower cut edge less than 45° for single-skin carvel construction, except for strip plank construction with small strip width.

5. The moisture content of the wood shall be within the limits required by the method of joining the parts (gluing, laminating, sheathing) and consideration of the dimensional stability of the structure. Timber for structural purposes where encapsulated or over-laminated shall have an average moisture content not greater than 15 %.

303. Plywood

1. Plywood intended to be used for external structural members, e.g. hull, weather deck not sheathed by fibre reinforced plastics (FRP) laminate or similar, superstructures and deckhouses, shall be marine-grade plywood. Where a craft is intended to be only temporarily used in the water and the hull is protected by a wood-penetrating medium (e.g. epoxy resin) other waterproof and boilproof external-grade plywood may be used.

2. Other members inside the hull may be made of waterproof and boilproof plywood which does not fully comply with marine-grade plywood. It shall be durable.

304. Veneers for moulded construction

Veneers used in the construction of the hull, deck and superstructure shall in general be of durability class 1 or 2. Exception: veneers of durability less than 2 may be used if adequately preserved by resin penetration or FRP sheathing.

305. Wood composite structures

1. Composite structures are wooden, generally of moulded construction and made of layers of veneers or strip planking with cove-and-bead or tongue-nd-groove edge joints with one or more layers of synthetic fibres incorporated taking a significant part of the stress. The synthetic fibres are generally used in the form of fabrics, for example glass, aramid, carbon fibres, or a combination of these.

2. When selecting wood and fibre fabrics for the purpose of composite construction, the resin used for saturating the fibres shall be capable of achieving a good penetration into the surface of the wood and a structurally sound bond between wood and fabric.

3. Where composite construction is used, account shall be taken of the different properties of the materials being used and the way in which applied loads will be shared.

306. Workshop conditions

1. The premises used for production and storage shall be suitable, and equipped to provide the conditions necessary for fault-free bonding by adhesives.

2. This shall enable the builder to monitor, and if necessary control, temperature, humidity and other environmental conditions during manufacturing so as to avoid changes during manufacture.

3. The workshop and equipment shall be maintained in a clean and efficient condition.

307. Storage and handling for material

1. Timber shall be stored in dry and well-ventilated premises where it is protected from direct sunlight and excessive moisture. It shall be stored horizontally, each plank or layer being separated from the other to achieve air circulation.

2. Adhesives shall be suitable for the intended purpose. The bond's mechanical properties and life shall exceed that of the glued wood. Adhesives shall be stored as specified by the manufacturer of these materials in their original containers. They must not be used after their expiry date.

3. Fastening elements for load-bearing parts of the construction, e.g. nails, screws and bolts shall be corrosion resistant or hot-dipped galvanized.

308. Manufacturing for wooden crafts

1. Manufacturing shall take place in an environment that takes into account the requirements and limitations specified by the manufacturer of the material (e.g. glue, resin or paint).
2. The moisture content of the wood shall be checked before gluing. The moisture content shall not exceed that which permits full joint strength. Areas to be glued shall be free from any contamination that might impair the strength of the bond.
3. Wooden craft shall be constructed in such a way that water cannot collect in areas where it cannot be drained. They shall also be constructed in such a way that natural ventilation is promoted to all areas of the craft.
4. A protective coating or surface treatment shall be applied to finished surfaces not intended to be left bare, for example teak decks. Any coating or treatment shall not adversely react with the adhesives, reduce the mechanical property of the joint or have a detrimental effect on the wood itself.

Section 4 FRP Material and Moulding

401. General

1. The requirements in this section are applied to FRP materials and moulding used for hull construction of recreational crafts. However, the requirements other than those specified in this section are to be in accordance with the related requirements in **Pt 2** of **Rules for the Classification of Steel Ships** and **Rules for the Classification for FRP ships**.
2. Resins, gelcoats, fibre reinforcement, core for sandwich structure (Expanded plastics foam and End-grain balsa) and core for moulding used for FRP raw materials are to be approved by Society in accordance with the requirement of **Guidance for Approval of Manufacturing Process and Type Approval, Etc**.
3. Type Approval for FRP materials other than those specified in this section may be applied to recognized Standards. Where deemed appropriate by the Society, National Standards, internationally recognized Codes or Standards considered as equivalent for those may be applied instead of requirements of this Guidance.

402. FRP Material

1. **Reinforcement fibres**
   (1) The reinforcement used as a reference for this chapter shall be E-glass in accordance with **ISO 2078**. Other types of glass fibres may be used if the minimum properties of E-glass are met or surpassed and the laminate itself is of equal or higher mechanical property.
   (2) The finish and binder of glass fibres shall be compatible with the matrix material used.
   (3) Fibres made of material other than glass may be used, provided that their properties are suitable for the intended purpose.
   (4) The material upon delivery complies with **Table 3.5**.
2. **Resin**
   (1) **Properties**
   The properties of liquid gelcoat, topcoat and laminating resins shall comply with the requirements of **Table 3.6**, as applicable.
   (2) **Gelcoat resins**
   (A) Gelcoat base resins when cured shall meet the requirements of Type A in **Table 3.7**.
   (B) For specific applications, in order to achieve superior properties as to elongation and/or reduced water absorption, resins used for gelcoats and skin coats may deviate as to their minimum properties from the requirements of Type A resin in **Table 3.7**.

Table 3.5 Properties of fibre reinforcement

Property	Test method	Requirement
Moisture content on delivery % max. Roving Chopped strand mat Fabrics	ISO 3344	0.2 0.5 0.2
Mass per unit, tolerance on nominal value % Roving (length) Chopped strand mat (area) Woven roving (area)	ISO 1889 ISO 3374 ISO 3374	-5~+10 -5~+10 -5~+10
Loss on ignition, nominal value % max.	ISO 1887	+20
(NOTE) Equivalent methods for determining moisture content and mass including permissible tolerances should be used for materials other than glass fibre.		

Table 3.6 Properties of liquid resins

Property	Test method	Requirement (Tolerance on nominal value specified by the manufacturer %)
Viscosity	(1) Brookfield, ISO 2555, or (2) Cone/plate, ISO 2884-1	±20
Monomer content	ISO 4901	±5
Gel time	ISO 2535	±20
Density	ISO 1675 or ISO 2811-1	±5
Mineral content (laminating resins only)	DIN 16945	±5

Table 3.7 Properties of cured resins (after a postcure schedule of 24h at 50℃)

Property	Test method	Requirement		
		Resin type		
		A	B(1)	C(1)
Ultimate tensile strength (Min. MPa)	ISO 527-1/527-4	55	45	45
Elongation at break (Min. %)	ISO 527-1/527-4	2.5	1.5	1.2
Ultimate bending strength (Min. MPa)	ISO 178	100	80	80
Ultimate flexural strength (Min. MPa)	ISO 178	2700	2700	2700
Heat deflection temperature (Min. ℃)	ISO 75-1/75-2, method A	60	60	53
Water absorption (Max. mg)	ISO 62(2)	80	100	100
Overall volume shrinkage	ISO 3521	Nominal value specified by the manufacturer +5 %		
Barcol hardness(3) (Min.)	EN 59	35	35	35

(NOTES)

(1) The requirements for laminating resins Types B and C are minima of different applica- tions of determining required scantlings.

(2) Test sample : $50^{+1}_{0}\,\mathrm{mm} \times 50^{+1}_{0}\,\mathrm{mm} \times 4^{+0.2}_{0}\,\mathrm{mm}$, Distill water. Exposure time 28 day at 23 ℃

(3) Resin systems may deviate from these values, provided a minimum value of 30 is ach- ieved and adequate cure can be demonstrated by the manufacturer.

(3) **Topcoat resins**
The formulation of a topcoat resin as to its physical properties shall consider the specific applications for which it is intended and shall meet the respective requirements for Type A, B or C, for instance
(A) exposure to weathering;
(B) oily bilge water;
(C) tack-free surface only;
(D) suitability as a paint.
(4) **Laminating resins**
Laminating resins, including resin blends with permissible amounts of fillers and other additives when cured shall meet the respective requirements specified in **Table 3.7**.
(5) **Fillers, additives**
Quantities and types of fillers and/or additives shall allow sufficient wet out of reinforcement fibres within the resin manufacturer's specified gel time.
(6) **Catalysts, accelerators**
The use of catalysts and accelerators shall be as specified or recommended by the resin manufacturer.
(7) **Declaration**
(A) The resin manufacturer shall declare in writing that the material upon delivery complies with **Tables 3.6** and **3.7** appropriate to the manufacturer's specified Type A, B or C resin.
(B) If the resin manufacturer claims for exemption according to **Table 3.7**, i.e. that the requirements are not applicable to resins used in the formulations of fillers and putties, he shall state the mechanical properties achieved and shall provide information on the intended application of the resin.
(C) The manufacturer of the resin, catalyst, accelerator, filler or other substances used in the laminate shall each provide written information on
(a) the compatibility or incompatibility (if known) of the material supplied with other materials used in the laminate;
(b) the shelf life of the material;
(c) the specific requirements concerning storage;
(d) the specific requirements concerning use.
(D) The boat manufacturer shall keep this information with the documentation established for the small craft.

3. FRP laminate

(1) The mechanical properties of the reference laminate as listed in **Table 3.8** shall be achieved by any manufacturing process.

Table 3.8 Minimum mechanical properties of reference laminate

Property	Test method	Requirement (MPa)
Ultimate tensile strength	ISO 527-1, ISO 527-4	80
Tensile modulus	ISO 527-1, ISO 527-4	6,350
Ultimate flexural strength	ISO 178	135
Flexural modulus	ISO 178	5,200
In-plane shear	ASTM D 4255	50
Apparent interlaminar shear strength (short-beam shear)	ISO 14130	15

(2) The resin manufacturer shall declare in writing that the mechanical properties of **Table 3.8** are capable of being fulfilled. The resin manufacturer shall provide detailed information with respect to other substances (e.g. catalyst, accelerator, fillers, additives, etc.) used in the fabrication process of the reference laminate.

4. Core for sandwich structure

(1) **Structural requirements**

(A) Core materials for sandwich construction of small craft shall only be used if the following requirements of the final structure are fulfilled. The material shall have adequate properties to enable the sandwich structure to fulfil the requirements specified in **Ch 4** for a normal service life in a marine environment, with special regard to

(a) in-plane forces, acting in the direction of the sandwich layers, e.g. tension, compression, shear;

(b) out-of-plane forces, acting transversely to the sandwich layers, e.g. compression, tension, shear.

(B) Fatigue performance must be considered when choosing the core material.

(2) **General requirements**

(A) Core materials shall have stable mechanical properties consistent with the designated use of the craft.

(B) Resin applied to the core material or its protective sheathing/coating shall be compatible with its surface.

(C) Core materials forming part of a sandwich structure shall

(a) limit the penetration of water beyond the area of a possible fracture of the skin laminate. This requirement does not apply for core materials that consist of a three-dimensional open structure bonded to both skin laminates, e.g. honeycomb or three-dimensional fabrics.

(b) not emit significant amounts of gases that would compromise the bond or laminate.

(D) Core materials shall be capable of transferring the shear loads specified in **Ch 4**.

(E) The core material manufacturer shall provide written information on the mechanical and other properties relevant for the intended application, as well as their variation in temperature and thermal limit of application where relevant.

(F) Where the core material used for structural parts may limit the mechanical properties of the sandwich panel due to extreme thermal conditions, the temperature range for safe operation of the craft shall be stated in the owner' manual.

(3) **End-grain balsa**

(A) Where used as a structural core material of the hull, end-grain balsa wood shall fulfil the following requirements.

(a) be free from living organisms that may cause degradation when enclosed in a boat structure sandwich panel;

(b) have been homogenized;

(c) have an average moisture content of 12 % to 15 %, when packaged.

(B) The mechanical properties as delivered shall comply with Grade I or II of **Table 3.9**.

(4) **Special requirement for Expanded foam**

(A) Expanded foam plastics used in structural sandwich cores of the craft shall be of a closed cell type.

(B) The mechanical properties of PVC (polyvinyl chloride) and SAN (styrene acrylic nitrile) type foam cores, intended to be used in the structural laminate of hull, deck and first tier of the superstructure, if this is open to the atmosphere, shall at least comply with the properties of Grade I of **Table 3.10**.

(C) The mechanical properties as delivered, intended to be used for other parts of the craft, shall comply at least with the properties of Grade II of **Table 3.10**.

5. Embedded materials—inserts

(1) The properties of expansion and contraction of inserts shall be similar to those of the laminate so that the overall performance of the structural laminate is not impaired.

(2) Embedded plywood shall be of the waterproof and boilproof type and shall have a surface that bonds easily to the resin or adhesive. Solid timber inserts between layers of laminate are not recommended.

Table 3.9 Minimum mechanical properties of end-grain balsa wood as delivered

Property	Test method[5]	Required minimum values		Unit
		Grade I	Grade II	
Density	ISO 3131, ISO 845	Manufacturer' specified min. value		
Tensile strength: longitudinal perpendicular	ISO 3345(KS F 2207)[1][2] ISO 3346(KS F 2207)	16 0.64	9 0.44	N/mm^2
Compressive strength: longitudinal perpendicular	ASTM C365[1][2], 23℃ ISO 3132(KS F 2206), 23℃	10 0.6	5 0.35	N/mm^2
Compressive modulus: longitudinal perpendicular	ASTM C365, 23℃ ISO 3132(KS F 2206)[1][2][3], 23℃	4,300 73	2,275 35	N/mm^2
Shear strength[4]	ISO 1922	1.84	1.1	N/mm^2
Shear modulus[4]	ISO 1922	150	105	N/mm^2

(NOTES)
(1) Max. speed of deformation, mm/min: 10 % of the measured initial thickness.
(2) Dimensions of specimen: 50 mm × 50 mm × product thickness in millimetres.
(3) Core material to be tested with and without a longitudinal adhesive joint. Joint at mid-plane of specimen, parallel to steel supports and at an equal distance from supports.
(4) Test to be carried out on samples with a layer of suitable resin to stabilize the core cell walls at the loaded surfaces.
(5) Moisture content of the specimens shall be between 12 % and 15 %.

Table 3.10 Minimum mechanical properties of foam core materials as delivered

Property	Test method[5]	Required minimum values		Unit
		Grade I	Grade II	
Tensile strength	ISO 1926[1][2]	1.0	0.6	N/mm^2
Tensile modulus	ISO 1926	60	30	N/mm^2
Compressive strength	ISO 844[1][2][3], 23°C	1.0	0.6	N/mm^2
Compressive modulus	ISO 844[1][2][3], 23°C	40	40	N/mm^2
Compressive strength	ISO 844[1][2][3], 45°C	60% of value obtained at 23°C	50% of value obtained at 23°C	N/mm^2
Compressive modulus	ISO 844[1][2][3], 45°C	70% of value obtained at 23°C	50% of value obtained at 23°C	N/mm^2
Shear strength[4]	ISO 1922	0.6	0.4	N/mm^2
Shear modulus[4]	ISO 1922	18	9	N/mm^2
Shear elongation[5]	ISO 1922	Manufacturer' specified min. value		
Water absorption	ISO 2896, 40°C,1 week, in water	1.5 max.	1.5 max.	%(V/V)
Water resistance	Percentage retention of compressive and tensile strength after 4 weeks in water (ISO 2896) at 23°C	75	70	%
Density	ISO 845	Manufacturer' specified min. value		kg/m^3
Oxygen index	ISO 4589-1,2,3	Stated value		

(NOTES)
(1) Maximum speed of deformation, mm/min: 10 % of the measured initial thickness.
(2) Dimensions of specimen: 50 mm x 50 mm x product thickness in millimetres.
(3) Test to be carried out on samples with a layer of suitable resin to stabilize the core cell walls at the loaded surfaces.
(4) Core material to be tested with and without a longitudinal adhesive joint. Joint at mid-plane of specimen, parallel to steel supports and at an equal distance from supports.
(5) Elongation at break or at the point where the load has decreased to 80 % of its maximum value.

403. Workshop conditions

1. General

(1) The buildings used for production and storage shall be of suitable construction, and equipped to provide the environment specified by the material manufacturer or supplier.
(2) To minimize contamination or impairment of the laminate, the production area shall be separate from the storage area and, wherever practicable, the various manufacturing processes shall be carried out in separate sections.
(3) The workshop and equipment shall be properly maintained and kept in a clean condition, substantially free from debris, surplus material, and equipment that is not essential for the production process.

2. Temperature and humidity

(1) Where a conventional manual lay-up or spray-up process is used, the moulding shop temperature shall be maintained within the limits specified by the resin manufacturer during lay-up and curing periods.
(2) Should the temperature vary outside the specified limits, the boat builder shall establish with the resin manufacturer that the resulting laminate will meet the requirements upon which scantlings and design are based.

3. Ventilation

(1) Adequate ventilation shall be provided in the laminating area, in order to minimize accumulation of monomer fumes in the mould.
(2) The ventilation shall not significantly reduce the surface temperature of the mould or laminate.
(3) The design of the ventilation system shall take account of the size of the laminating shop, possible subdivision and the amount of resin under cure.
(4) The ventilation arrangements shall not cause excessive evaporation of the resin monomer.
(5) Precautions shall be taken to ensure freedom from draughts.

4. Dust control

Provisions shall be made to minimize harmful accumulation of dust on moulds and laminates.

5. Illumination

Provisions shall be made to avoid any harmful effects on the resin cure due to direct sunlight or artificial lighting.

404. Material storage and handling

1. General requirements

(1) Storage areas shall be arranged and equipped in such a way that the material manufacturer' requirements for storage and handling can be followed.
(2) The procedures for the reception, verification against certificates of conformity, storage and handling of materials shall be detailed in the conformity assurance procedures provided by the boat builder (see clause 10) to ensure that the materials suffer no contamination or degradation and carry adequate identification at all times.
(3) Storage shall be arranged so that wherever possible materials are used in order of receipt.
(4) Structural parts shall be manufactured from materials that have not passed the material manufacturers'date of expiry.
(5) Materials found to be defective or not in compliance with the specifications of raw-material supplier(s) shall be rejected unless treated in accordance with the conformity assurance procedure, provided by the boat builder.
(6) Unused resin and ancillary materials exposed to the workshop atmosphere shall not be returned to the parent stock or bulk storage.

2. Resin

(1) Resins shall be stored under controlled conditions in accordance with the resin manufacturer's requirements.
(2) Where a resin contains an ingredient that can settle within the resin system, it is the builder's responsibility to ensure that the resin manufacturer's recommendations for mixing and conditioning are complied with prior to use.

3. Catalysts and accelerators

Catalysts and accelerators shall be stored according to the material manufacturer's requirements.

4. Fillers and additives

Fillers and additives used in the moulding process shall be stored in closed containers to protect them from dust and humidity.

5. Reinforcing and core materials

Reinforcing and core materials shall be stored in clean and dry conditions, in accordance with the material manufacturer's recommendations.

405. Moulds

1. Construction

(1) Moulds shall be constructed of a suitable material and adequately stiffened to maintain their shape and fairness of form.
(2) The materials used in the construction of moulds shall not adversely affect the resin cure.

2. Preparation

(1) Moulds shall be cleaned, dried and in place so that they stabilize at the workshop temperature before the release agent is applied.
(2) The release agent shall be compatible with the mould surface, the resins applied in the laminating process and with mould release films used previously. Release agents containing silicon shall not be used.

406. Resin preparation

1. The requirements of the resin manufacturer shall be followed.

2. Where blended resins are used, test specimen(s) shall be made to ensure that the blended resin is suitable for the laminating process.

3. Where the boat builder wishes to modify resin with additives outside the resin manufacturer' specification, the boat builder shall conduct tests to verify compliance with **Table 3.7**.

407. Laminating process

1. General

(1) The resins are to be scrubbed by rollers till they are permeated completely. In the laminations for structures, the glass/resins ratio is to be the minimum quantities of the resins to permeate the glass completely. In the chopped strand mat moulded by the manual lay-up process, the weight of the glass/resins is to be 2.5:1 to 3:1.
(2) The hull lamination and other hull structural members are to be tested in glass fiber content ratio, aperture content ratio, hardening degree and mechanical strength etc. if it is necessary by surveyor.
(3) The laminations are to be free from defects such as blister, delamination, excessive resin etc.
(4) The overlapping breadths at butts and seams of mats which are composed of reinforcement layer are not to be less than 40 mm. The centre lines of overlaps of two adjacent plies are not be less than 100 mm apart from each other.
(5) In case where heavy mats and fibers are used, special attention is to be taken to permeate completely.
(6) When the dough materials with resin and glass fiber are used to increase the thickness of lamination, they are to be same with main lamination. And the content of fiberglass is not to be less than 25 % of resin and the length of fiberglass is not to be less than 25 mm.
(7) Where thickness of lamination are shifted, it is changed slowly and gradually. The change of weight for the hull lamination is not to be more than 1200 g per 25 mm as weight of glass fiber reinforcement.

2. Manual lay-up

(1) The material type and unit weight of the first fibre reinforcement layer shall be chosen to provide for adequate penetration of the reinforcement layer by the resin system used and reduce the effect of hydrolytic attack.
(2) The lay-up sequence and degree of resin cure between plies shall be in accordance with the resin manufacturer's recommendation. Where the degree of cure exceeds these recommendations, the surface shall be treated.
(3) Moulds shall be arranged or access provided so that each part of the mould can be reached with the tools used to ensure consolidation and de-aeration of the laminate during lay-up.

3. Spray lay-up

(1) Spray lay-up of resin and/or reinforcement fibres shall be limited to applications where, in gen-

eral, a specified even thickness of the sprayed laminate can be achieved. Consideration shall be given to
- exothermic heat by excessive wet laminate thickness,
- sagging or drainage of the laminate, and
- de-aereation

(2) The weight of glass reinforcement to be deposited between resin/glass consolidation depends upon the complexity of the mould. In general, this shall not be more than 1,150 g/m^2 of glass fibres, unless it can be demonstrated that a satisfactory laminate can be achieved with a greater glass reinforcement weight.
(3) The uniformity of the laminate and glass content shall be checked at regular intervals.
(4) Where the back-up layer behind the gelcoat is sprayed-up, the type and length of the fibres shall ensure that no wicking effect can occur.
(5) The spray equipment shall be calibrated and shall be checked for the desired setting for the resin/catalyst and resin/reinforcement fibre ratios at the beginning of each working day.
(6) To ensure that the lay-up is within tolerances, the settings shall be monitored.

4. Closed moulding

When closed moulding is applied, the system shall be designed to ensure the correct distribution of resin in the laminate.

5. Pre-impregnated laminates

Pre-impregnated laminates shall be stored, used and cured in accordance with the material manufacturer' requirements.

408. Surface coating

1. Coating material

(1) Gelcoat or another suitable coating, which may be the laminating resin when designed for this purpose, shall be applied to provide some protection from solar radiation, hydrolytic attack and abrasion.
(2) Where gelcoat is used, the first layer of reinforcement shall be applied according to the resin manufacturer's specification and as soon as the gelcoat has adequately cured.

2. Spray surface coating

The spray equipment shall be calibrated and shall be checked for the desired settings for the resin/catalyst ratios and the spray pattern at the beginning of each working day or prior to the start of single-part work to ensure consistent application.

409. Manufacturing requirements, sandwich construction

1. Sandwich construction using female moulds

(1) Core surface cavities and other irregularities shall be removed or coated with filler, resin or sandwich adhesive according to the material manufacturer' specification and depending on the following skin lay-up. When using scored core material, a sufficient amount of resin or adhesive shall be used in the bond to fill the gaps.
(2) When bonding core material to a wet laminate, sufficient resin shall be in or on the laminate to achieve a bond between the laminate and core material without resin deficiency of the laminate.
(3) The materials shall be kept in contact while curing to ensure a structurally sufficient bond and to avoid air entrapment.
(4) Deviations from these procedures may be made, provided that the structural requirements of **Ch 4** are met.

2. Sandwich construction with male moulds

(1) Joints, scores and voids in the core material shall be filled or fixed to each other before the skin laminate is applied.
(2) When laying the core material, it shall not be bent or deformed to such an extent that the properties of the core are adversely affected.
(3) Irregularities on the core surface and the joints shall be removed.
(4) The core surface shall be primed where required before the laminate is applied.

410. Laminate curing

1. Open-mould process

(1) The laminate cure schedule shall follow the resin manufacturer's requirements and shall be documented.
(2) The curing schedule for sandwich laminates shall take into account the thermal influence of the core material and the possible slower initiation of the cure due to thin laminates.
(3) If the resin requires higher post-cure temperatures than ambient temperature, this process shall be documented.
(4) Post-curing at an elevated temperature shall not commence until the laminate has stabilized.
(5) The post-cure temperature shall be compatible with the temperature limits of the release agent and shall not adversely effect the gelcoat, the single skin or sandwich laminate.

2. Closed-mould process

The curing schedule for the closed-mould technique shall take into account the thermal influence of material, mass and construction of the mould.

411. Bonding

1. The required surface treatment for the laminate subject to the bonding are to be in accordance with manufacturer's specification.

2. If a laminate subject to secondary bonding has cured for more than 5 days the surface should be ground. If resin containing wax is used grinding is required if the curing time exceeds 24 hours.

3. If peel strips are used in the bonding surface the required surface treatment may be dispensed with. ⚓

CHAPTER 4 HULL STRUCTURES

Section 1 General

101. Scope

This chapter applies to the determination of design pressures and stresses, and to the determination of the scantlings, including internal structural members of monohull small craft constructed from fi-bre-reinforced plastics, aluminium or steel alloys, glued wood or other suitable craft building materi-al, with a length of hull, L_H, between 2.5 m and 24 m. It only applies to crafts in the intact condition. And it only applies to craft with a maximum speed ≤ 50 knots in m_{LDC} conditions.

102. Terms and definitions

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

1. Displacement craft

Craft whose maximum speed in flat water and m_{LDC} conditions, declared by its manufacturer, is such that

$$\frac{V}{(\sqrt{L_{WL}})} < 5$$

2. Displacement mode

Mode of running of a craft in the sea such that its mass is mainly supported by buoyancy forces

3. Planing craft

Craft whose maximum speed in flat water and m_{LDC} conditions, declared by its manufacturer, is such that

$$\frac{V}{(\sqrt{L_{WL}})} \geq 5$$

4. Planing mode

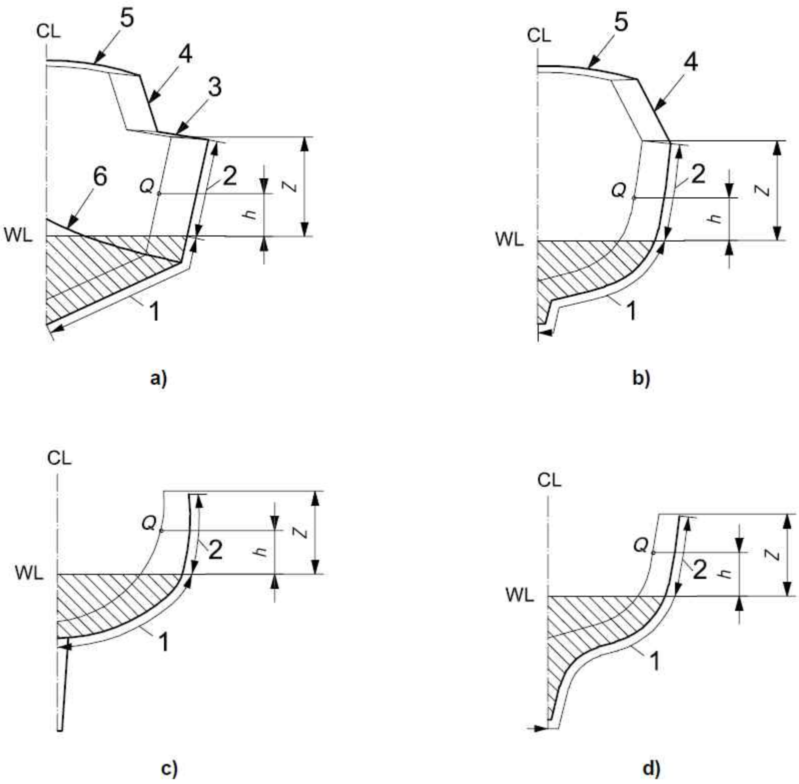
Mode of running of a craft in the sea such that its mass is significantly supported by forces coming from dynamic lift due to speed in the water

103. Areas

1. General

The hull, deck and superstructure are divided into various areas: bottom, side, decks and super-structures (see **Fig 4.1**).

(1) Bottom areas
For all craft, bottom pressure applies up to waterline (see **Fig 4.1**). The part of the transom fol-lowing the above definition is considered as bottom.



1. bottom (hatched area)
2. side
3. deck
4. superstructures
5. superstructure top
6. hard chine

Fig 4.1 Definitions of areas, and panel height above waterline

(2) Side areas
The extent of the side pressure area, which includes the transom, is the part of the hull not considered as belonging to the bottom area.

(3) Decks and superstructures
Deck areas are parts of the deck exposed to weather and where persons are liable to walk. Cockpit bottom and top of benches and seating areas are included.
Superstructure areas include all areas above deck level. **Table 4.3** lists the different super-structure types.

(4) Panel fully in one area or across two areas
The general situation is as follows:
(A) Where the plate panel or stiffener is fully within a specified design area, e.g. bottom, side, deck, superstructures, etc., its design pressure shall be determined at the middle of the panel or at mid-length of the stiffener;
(B) Where the plate panel or stiffener extends over both bottom area and side area, its design pressure shall be determined as a constant pressure over the entire design area, calculated as a weighted average between the two pressures.

Section 2 Pressure Adjusting Factors

201. General

Final design pressure is adjusted by a set of factors according to design, craft type and location, etc.

202. Design category factor, k_{DC}

The design category factor k_{DC}, defined in **Table 4.1**, takes into account the variation of pressure loads due to sea with design category.

Table 4.1 Values of k_{DC} according to design category

Design category	A	B	C	D
k_{DC}	1	0.8	0.6	0.4

203. Dynamic load factor, n_{CG}

1. General

The dynamic load factor n_{CG} is considered to be close to the single amplitude acceleration measured at the craft centre of gravity at the relevant frequency for a certain period of time. This factor is the negative acceleration supported by the craft, either while slamming in an encountered wave at speed or falling from the crest of a wave into its trough. n_{CG} is expressed in gs where 1 g is the acceleration due to gravity (9.81 $\mathrm{m/s^2}$).

2. Dynamic load factor n_{CG} for planing non-sailing craft in planing mode

The dynamic load factor for planing craft running in planing mode shall be determined from Equation (1) or Equation (2).

$$n_{cg} = 0.32\left(\frac{L_{WL}}{10 \times B_C} + 0.084\right) \times (50 - \beta_{0.4}) \times \frac{V^2 \times B_C^2}{m_{LDC}} \qquad (1)$$

where,

V : for non-sailing craft, the maximum speed in calm water declared by the manufacturer, with the craft in m_{LDC} conditions. This speed shall not be taken as 〈 $2.36\sqrt{L_{WL}}$.

B_C : the chine beam, measured at $0.4\sqrt{L_{WL}}$ forward of its aft end, in metres (See **ISO 12215-5** Fig 1)

$\beta_{0.4}$: the deadrise angle at $0.4\sqrt{L_{WL}}$ forward of its aft end (See **ISO 12215-5** Fig 1), not to be taken 〈 10°, nor 〉 30°, in degrees,

Where Equation (1) gives an n_{CG} value ≤ 3.0, the value given by Equation (1) shall be used. Where Equation (1) gives an n_{CG} value 〉3.0, that value or the value from Equation (2) shall be used.

$$n_{CG} = \frac{0.5 \times V}{m_{LDC}^{0.17}} \qquad (2)$$

In any case, n_{CG} need not be taken 〉7.

3. Dynamic load factor n_{CG} for sailing craft and displacement non-sailing craft

For sailing craft, n_{CG} is not used for pressure determination. It is only used in the calculation of k_L for which purpose the value of n_{CG} shall be taken as 3. For non-sailing craft where n_{CG}, determined using Equation (1), is 〈3.0 from Equation (1), a value of 3.0 shall still be used for calculation of k_L.

4. Longitudinal pressure distribution factor k_L

The longitudinal pressure distribution factor k_L takes into account the variation of pressure loads due to location on the craft. It shall be taken from **Fig 4.2** or calculated from Equation (3).

k_L is a function of the dynamic load factor defined below for non-sailing craft.

$$k_L = \frac{1 - 0.167 \times n_{CG}}{0.6} \frac{x}{L_{WL}} + 0.167 \times n_{CG} \text{ but not taken } \rangle\ 1 \quad \text{for } \frac{x}{L_{WL}} \leq 0.6$$

(3)

$$k_L = 1 \quad \text{for } \frac{x}{L_{WL}} > 0.6$$

where

n_{CG} is determined in accordance with **1 to 3**, but for the purposes of determination of k_L, n_{CG} shall not be taken 〈 3 nor 〉 6;

$\frac{x}{L_{WL}}$ is the position of the centre of the panel or middle of stiffener analysed proportional to L_{WL}, where $\frac{x}{L_{WL}}$ = 0 and 1 are respectively the aft end and fore end of L_{WL}.

where

x is the longitudinal position of the centre of the panel or middle of stiffener forward of aft end of L_{WL} in m_{LDC} conditions, in metres.

The overhangs fore and aft shall have the same value of k_L as their respective end of the waterline.

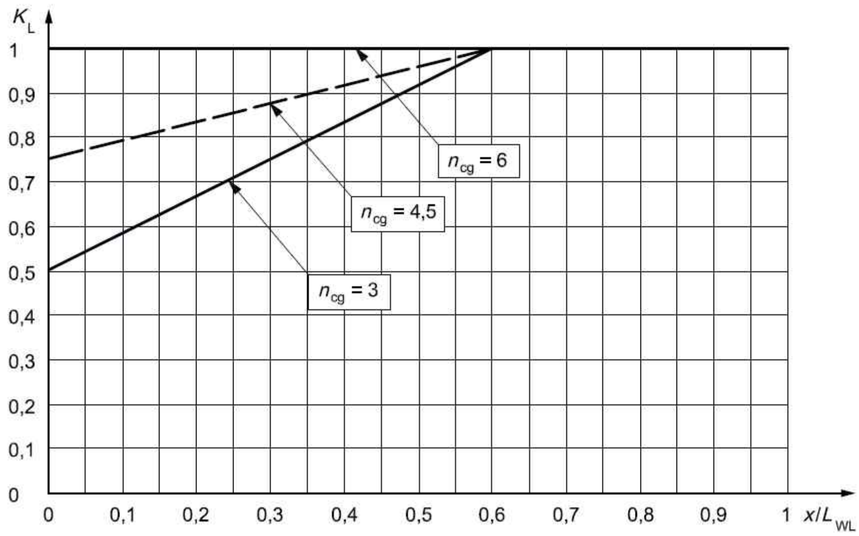


Fig 4.2 Longitudinal pressure distribution factor k_L

204. Area pressure reduction factor k_{AR}

1. General

The area pressure reduction factor k_{AR} takes into account the variation of pressure loads due to panel or stiffener size.

$$k_{AR} = \frac{k_R \times 0.1 \times {m_{LDC}}^{0.15}}{{A_D}^{0.3}} \quad (4)$$

where

k_R is the structural component and craft type factor:

- $k_R = 1.0$ for bottom side and deck panels and stiffeners of planing non-sailing craft operating in planing mode;
- $k_R = 1.5 - 3 \times 10^{-4} \times b$ for bottom side and deck panels of sailing craft, displacement non-sailing craft and planing non-sailing craft operating in displacement mode;
- $k_R = 1 - 2 \times 10^{-4} \times l_u$ for bottom side and deck stiffeners of sailing craft, displacement non-sailing craft and planing non-sailing craft operating in displacement mode;

A_D is the design area, in square metres:

- $A_D = (l \times b) \times 10^{-6}$ for plating, but shall not be taken 〉 $2.5 \times b^2 \times 10^{-6}$;
- $A_D = (l_u \times s) \times 10^{-6}$ for stiffeners but need not be taken 〈 $0.33 \times l_u^2 \times 10^{-6}$;

b is the shorter dimension of the panel, in millimetres;

l is the longer dimension of the panel, in millimetres;

s is the stiffener spacing, in millimetres;

l_u is the unsupported span of a stiffener, in millimetres.

2. Maximum and minimum value of k_{AR}

k_{AR} shall not be taken 〉 1 and at less than the values given in **Table 4.2**.

Table 4.2 Minimum values of k_{AR}

<table>
<tr><td rowspan="2">Design category</td><td rowspan="2">Side and bottom single-skin panels and stiffeners

Deck and superstructures sandwich and single-skin panels and stiffeners</td><td colspan="3">Side and bottom sandwich panels [a]</td></tr>
<tr><td>$\frac{x}{L_{WL}} \leq 0.4$</td><td>$0.4 < \frac{x}{L_{WL}} < 0.6$</td><td>$\frac{x}{L_{WL}} \geq 0.6$</td></tr>
<tr><td>A</td><td>0.25
any craft
hull and deck</td><td>0.4</td><td rowspan="2">Interpolation between values at $\frac{x}{L_{WL}}$ = 0.4 and 0.6</td><td>0.5 sail bottom and topside
0.5 non-sailing bottom
0.4 non-sailing topside</td></tr>
<tr><td>B</td><td>0.25
any craft
hull and deck</td><td>0.4</td><td>0.4</td></tr>
<tr><td>C & D</td><td>0.25
any craft
hull and deck</td><td colspan="3">0.4</td></tr>
<tr><td colspan="5">[a] Minimum k_{AR} applies to bending or shear strength and deflection requirement.</td></tr>
</table>

205. Hull side pressure reduction factor k_Z

The side pressure reduction factor k_Z interpolates the pressure of the hull side between the (bottom) pressure at waterline and deck pressure at the top edge (see **Fig 4.1**).

$$k_Z = \frac{Z-h}{Z} \tag{5}$$

where

Z is the height of top of hull or hull/deck limit above the fully loaded waterline, in metres;

h is the height of centre of panel or middle of stiffener above the fully loaded waterline, in metres.

206. Superstructure and deckhouse pressure reduction factor k

The superstructure and deckhouse pressure reduction factor k is defined according to location and craft type by **Table 4.3**.

Table 4.3 Values of k for superstructures and deckhouses

Position of panel	k non-sailing and sail	Application
Front	1	Any area
Side	0.67	Walking area
Side	0.5	Non-walking area
Aft end	0.5	Any area
Top, ≤ 800 mm above deck	0.5	Walking area
Top, 〉800 mm above deck and upper tiers	0.35	Walking area
Upper tiers [a]	Minimum deck pressure 5 $\mathrm{kN/m^3}$	Non-walking area
[a] Elements not exposed to weather shall be considered as upper tiers.		

207. Light and stable sailing craft pressure correcting factor for slamming k_{SLS}

The light and stable sailing craft pressure correcting factor k_{SLS} takes into account higher slamming pressures encountered on light and stable sailing craft when sailing upwind (i.e at an angle of up to 90° off true wind). It is defined below.

- In design category C and D: $k_{SLS}=1$
- In design category A and B:
  - $k_{SLS}=1$ if $m_{LDC} > 5{L_{WL}}^3$
  - $k_{SLS}=\left(\dfrac{10\,GZ_{MAX<60}\times {L_{WL}}^{0.5}}{{m_{LDC}}^{0.33}}\right)^{0.5}$ if $m_{LDC} \le 5{L_{WL}}^3$ but shall not be taken 〈 1 (6)

where

$GZ_{MAX<60}$ is the maximum righting moment lever taken at a heel angle not 〉 60°, with all stability increasing devices such as canting keels or water ballast at their most effective position, in fully loaded condition, measured in metres.

If the maximum righting lever occurs at a heel angle 〉 60°, the value at 60° shall be taken. The crew shall be considered in upwind hiking position in the calculation of the above $GZ_{MAX<60}$.

Section 3 Design Pressure

301. Non-sailing craft design pressure

1. General

The bottom pressure of non-sailing craft shall be the greater of (see NOTE 1)

- the displacement mode bottom pressure P_{BMD} defined in **2** or
- the planing mode bottom pressure P_{BMP} defined in **3**

For non-sailing craft of design categories A and B, the side pressure shall be the greater of

- the displacement mode side pressure P_{SMD} defined in **4** or
- the planing mode side pressure P_{SMP} defined in **5**

For non-sailing craft of design categories C and D, the side pressure shall be the one corresponding to planing or displacement mode: the "mode" to consider is the one where the bottom pressure, planing or displacement is the greater.

2. Non-sailing craft bottom pressure in displacement mode P_{BMD}

The bottom design pressure for non-sailing craft in displacement mode P_{BMD} is the greater of

$$P_{BMD} = P_{BMDBASE} \times k_{AR} \times k_{DC} \times k_L \ \ \mathrm{kN/m^2} \text{ or} \tag{7}$$

$$P_{BMMIN} = 0.45 m_{LDC}^{0.33} + (0.9 \times L_{WL} \times k_{DC}) \ \ \mathrm{kN/m^2} \tag{8}$$

where

$$P_{BMDBASE} = 2.4 m_{LDC}^{0.33} + 20 \ \ \mathrm{kN/m^2} \tag{9}$$

3. Non-sailing craft bottom pressure in planing mode P_{BMP}

The bottom design pressure for planing non-sailing craft P_{BMP} is the greater of

$$P_{BMP} = P_{BMPBASE} \times k_{AR} \times k_L \ \ \mathrm{kN/m^2} \text{ or} \tag{10}$$

$$P_{BMMIN} = 0.45 m_{LDC}^{0.33} + (0.9 \times L_{WL} \times k_{DC}) \ \ \mathrm{kN/m^2} \tag{11}$$

where

$$P_{BMPBASE} = \frac{0.1 m_{LDC}}{L_{WL} \times B_C} \times (1 + k_{DC}^{0.5} \times n_{CG}) \ \ \mathrm{kN/m^2}$$

4. Non-sailing craft side pressure in displacement mode P_{SMD}

The side design pressure for non-sailing craft in displacement mode P_{SMD} is the greater of

$$P_{SMD} = [P_{DMBASE} + k_Z \times (P_{BMDBASE} - P_{DMBASE})] \times k_{AR} \times k_{DC} \times k_L \ \ \mathrm{kN/m^2} \text{ or} \tag{12}$$

$$P_{SMMIN} = 0.9 L_{WL} \times k_{DC} \ \ \mathrm{kN/m^2} \tag{13}$$

For decked crafts, those parts of the side above hull-deck limit (e.g. bulwark) shall be assessed using P_{SMMIN}.

5. Non-sailing craft side pressure in planing mode P_{SMP}

For side areas located at or above waterline, the side design pressure P_{SMP} for non-sailing craft in planing mode is the greater of

$P_{SMP} = [P_{DMBASE} + k_Z \times (0.25P_{BMPBASE} - P_{DMBASE})] \times k_{AR} \times k_{DC} \times k_L$ kN/m² or (14)

$P_{SMMIN} = 0.9L_{WL} \times k_{DC}$ kN/m² (15)

For decked crafts, those parts of the side above hull-deck limit (e.g. bulwark) shall be assessed using P_{SMMIN}.

6. Non-sailing craft deck pressure P_{DM}

The design pressure P_{DM} for the non-sailing craft weather deck is the greater of

$P_{DM} = P_{DMBASE} \times k_{AR} \times k_{DC} \times k_L$ kN/m² or (16)

$P_{DMMIN} = 5$ kN/m²

where

$P_{DMBASE} = 0.35L_{WL} + 14.6$ kN/m² (17)

7. Non-sailing craft pressure for superstructures and deckhouses P

The design pressure P for superstructures and deckhouses exposed to weather of non-sailing craft is proportional to the deck pressure, but not to be taken less than P_{DMMIN} in walking areas:

P kN/m² (18)

302. Sailing craft design pressure

1. Sailing craft bottom pressure

The bottom design pressure P_{BS} for sailing craft is the greater of

$P_{BS} = P_{BSBASE} \times k_{AR} \times k_{DC} \times k_L$ kN/m² or (19)

$P_{BSMIN} = 0.35m_{LDC}^{0.33} + 1.4L_{WL} \times k_{DC}$ kN/m² (20)

where

$P_{BSBASE} = (2m_{LDC}^{0.33} + 18) \times k_{SLS}$ kN/m² (21)

2. Sailing craft side pressure P_{SS}

The side pressure for sailing craft P_{SS} is the greater of

$P_{SS} = [P_{DSBASE} + k_Z \times (P_{BSBASE} - P_{DSBASE})] \times k_{AR} \times k_{DC} \times k_L$ kN/m² or (22)

$P_{SSMIN} = 1.4L_{WL} \times k_{DC}$ but shall not be taken 〈 5 kN/m²
(23)

where

P_{BSBASE} is the base sailing craft bottom pressure defined in **3** ;

P_{DSBASE} is the base sailing craft deck pressure.

3. Sailing craft deck pressure P_{DS}

The design pressure for the weather deck of sailing craft P_{DS} is the greater of

$$P_{DS} = P_{DSBASE} \times k_{DC} \times k_{AR} \times k_L \ \text{kN/m}^2 \qquad (24)$$

$$P_{DSMIN} = 5 \ \text{kN/m}^2$$

where

$$P_{DSBASE} = 0.5 m_{LDC}{}^{0.33} + 12 \ \text{kN/m}^2 \qquad (25)$$

4. Sailing craft superstructure pressure P

The design pressure P for superstructures and deckhouses exposed to weather on sailing craft is proportional to the deck pressure, but not to be taken less than P_{DSMIN} in walking areas.

$$P \ \text{kN/m}^2 \qquad (26)$$

303. Watertight bulkheads and integral tank boundaries design pressure

1. Watertight bulkheads pressure P_{WB}

The design pressure P_{WB} on watertight bulkheads is

$$P_{WB} = 7 h_B \ \text{kN/m}^2$$

where

h_B is the water head, in metres, measured as follows (see **Fig 4.3**):

- for plating, the distance from a point 2/3 of the depth of the panel below the top of bulkhead;
- for vertical stiffeners, the distance from a point 2/3 of the depth of the stiff- ener below top of bulkhead;
- for horizontal stiffeners, the height measured from the stiffener to the top of bulkhead.

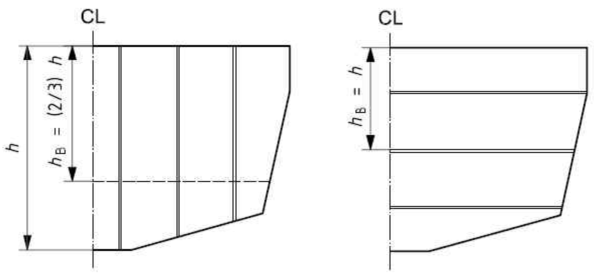


Fig 4.3 Watertight bulkheads

2. Integral tank bulkheads and boundaries P_{TB}

The design pressure P_{TB} on integral tank bulkheads and boundaries is:

$$P_{TB} = 10 h_B \ \text{kN/m}^2$$

where

h_B is the water head, in metres, measured as follows (see **Fig 4.4**):

- for plating, the distance from a point 2/3 of the depth of the panel below top of tank or top of overflow, whichever is the greater;
- for vertical stiffeners, the distance from a point 2/3 of the depth of the stiff-ener below top of tank or top of the overflow, whichever is the greater;
- for horizontal stiffeners, the height measured from the stiffener to top of tank or top of overflow, whichever is the greater.

Where there are plates of different thicknesses or scantlings, h_B for each plate panel shall be measured to the lowest point of the panel.

For determination of the design pressure, the top of the overflow shall not be taken 〈 2 m above the top of the tank.

Where the tanks form part of the deck, this has to be assessed according to the requirements of this section.

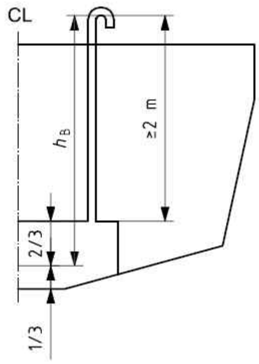


Fig 4.4 Measurement of dimensions for integral tank scantling calculation

3. Wash plates

(1) Tanks shall be subdivided as necessary by internal baffles or wash plates. Baffles or wash plates that support hull framing shall have scantlings equivalent to stiffeners located in the same position.
(2) Wash plates and wash bulkheads shall, in general, have an area of perforation not 〈 50 % of the total area of the bulkhead. The perforations shall be so arranged that the efficiency of the bulk-heads as a support is not impaired.
(3) The general stiffener requirement for both minimum section modulus and second moment of area may be 50 % of that required for stiffener members of integral tanks.

4. Collision bulkheads

The scantlings of collision bulkheads, where fitted, shall not be less than required for integral tank bulkheads.

5. Non-watertight or partial bulkheads

Where a bulkhead is structural but non-watertight, the scantlings shall be as required in **507**.

6. Transmission of pillar loads

Bulkheads that are required to act as pillars in the way of under-deck girders subjected to con-centrated loads and other structures that carry heavy loads shall be dimensioned according to these loads.

304. Design pressures for structural components where k_{AR} would be ≤ 0.25

1. The dynamic effect reduces as the structural component size increases. For very large structural components, the design pressure should be based on the hydrostatic pressure, since it is this load that can be reasonably taken as being distributed over the whole area of the component.

2. “Very large” components are defined as panels or stiffeners for which the product of the shorter and longer panel sides (panels) or the span and spacing (stiffeners) exceeds the following areas:

- for bottom structure, 30 % of the $L_{WL} \times B_{WL}$ product;
- for side structure, 30 % of the $L_{WL} \times D$ product, where D is the hull total depth;
- for deck structure, 30 % of the $L_{WL} \times B_{WL}$ product.

In such cases, irrespective of the pressure loads obtained from **301.** and **302.**, the design pressures need not be taken greater than:

- for bottom structure, $0.45 {m_{LDC}}^{0.33}$, but not 〈 5 $\mathrm{kN/m^2}$;
- for side structure, $0.3 {m_{LDC}}^{0.33}$, but not 〈 5 $\mathrm{kN/m^2}$;
- for deck structure, 5 $\mathrm{kN/m^2}$.

Section 4 Scantling of Plating

401. Plating – Scantling equations

1. Thickness adjustment factors for plating

(1) Bending deflection factor k_1 for sandwich plating
k_1 = 0.017

(2) Panel aspect ratio factor for strength k_2 and for stiffness k_3
The panel aspect ratio factors for strength k_2 and for stiffness k_3 are given in **Table 4.4**.

Table 4.4 Values of k_2 and k_3 in function of aspect ratio l/b for isotropic panels

Panel aspect ratio l/b	Factor k_2 k_2 to be taken = 0.5 for laminated wood plating	Factor k_3
〉 2.0	0.500	0.028
2.0	0.497	0.028
1.9	0.493	0.027
1.8	0.487	0.027
1.7	0.479	0.026
1.6	0.468	0.025
1.5	0.454	0.024
1.4	0.436	0.023
1.3	0.412	0.021
1.2	0.383	0.019
1.1	0.349	0.016
1.0	0.308	0.014
	k_2 can be evaluated by the formula below, keeping 0.308 〈 k_2 〈 0.5	k_3 can be evaluated by the formula below, keeping 0.014 〈 k_3 〈 0.028
	$k_2 = \dfrac{0.271(l/b)^2 + 0.910(l/b) - 0.554}{(l/b)^2 - 0.313(l/b) + 1.351}$	$k_3 = \dfrac{0.027(l/b)^2 - 0.029(l/b) + 0.011}{(l/b)^2 - 1.463(l/b) + 1.108}$

(3) Curvature correction factor k_C for curved plates
The curvature correction factor k_C is given by **Table 4.5**, where c is the crown of the panel, as defined in **Fig 4.5**. k_C shall not be taken 〈 0.5 nor 〉1.

Table 4.5 Curvature correction factor k_C

c/b	k_C
0 to 0.03	1.0
0.03 to 0.18	$1.1-\frac{3.33c}{b}$
〉0.18	0.5

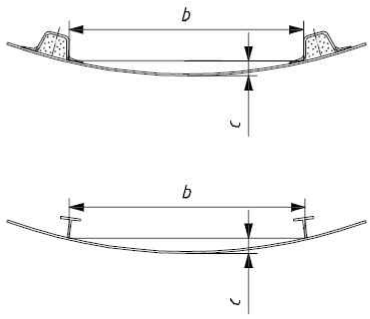


Fig 4.5 Measurement of convex curvature

(4) Shear force and bending moment on a panel
In the case on non-homogenous or non-isotropic material, the shear force and bending moment on panel are complying with following equations.

$F_d = \sqrt{k_C} \times k_{SHC} \times P \times b \times 10^{-3}$ is the shear force in the middle of the b dimension in N/mm (27)

$M_d = 83.33 \times {k_C}^2 \times 2k_2 \times P \times b^2 \times 10^{-6}$ is the bending moment in the b direction in N/mm (28)

Where the panel stiffness is not similar in the two principal panel directions, see **ISO 12215-5** Annex H.

402. FRP single-skin plating

1. Design stress for FRP single-skin plating

Table 4.6 Design stresses for FRP single-skin plating

Material	Structural element	Design stress σ_d $\mathrm{N/mm^2}$
FRP single skin	All elements	0.5 σ_{uf}

where σ_{uf} is the minimum ultimate flexural strength, in newtons per square millimetre.

2. Required thickness for FRP single-skin plating

The following equation is only valid if the mechanical properties in both directions differ by 〈 25 %; otherwise the panel shall be analysed in accordance with **ISO 12215-5** Annex H.

The minimum required single-skin plating thickness t is

$$t = b \times k_C \times \sqrt{\frac{P \times k_2}{1000 \times \sigma_d}} \text{ mm} \tag{29}$$

where

- b is the short dimension of the panel in millimetres;
- k_C is the curvature correction factor for curved panels given in **Table 4.5**;
- P is the design pressure (bottom, side, deck and superstructure, etc.) of the panel in accordance with **Ch.3**, in kilonewtons per square metre;
- k_2 is the panel aspect ratio factor for bending strength given in **Table 4.4**;
- σ_d is the design stress for FRP plating given in **Table 4.6**, in newtons per square millimetre.

For FRP, it shall be translated into a mass of dry fibre reinforcement w_f (in kilograms per square metre) using the fibre mass content Ψ according to the methods of **ISO 12215-5** Annex C,

3. Use of bulking material

(1) General

A bulking material is a core material (thick fabric, resin-rich felt, syntactic foam, etc.) intended to increase the thickness of a laminate. The bulking material functions either as an element only carrying shear (like in a sandwich) or as an elemnet of the laminate working both in shear transmission and flexure.

(2) Resin-saturated foam or felt

Bulking materials having a strength 〉 3 $\mathrm{N/mm^2}$ may be substituted for the central layers of a single-skin FRP laminate, providing the total thickness t of single skin determined by Equation (29) according to the following requirements ;

(A) if the total thickness is 1.15t, the bulking material thickness shall be 0.33 time the total laminate thhickness, i.e. a bulking thickness 0.383t and each skin 0.383t ;

(B) if the total thickness is 1.30t, the bulking material thickness shall be 0.50 time the total laminate thhickness, i.e. a bulking thickness 0.65t and each skin 0.325t ;

For a total thickness between 1.15t and 1.30t, bulking thickness may be interpolated.

403. Metal plating - Steel and aluminium alloy

1. Design stress for metal plating

Table 4.7 Design stresses for metal plating

Material	Structual element	Design stress σ_d $(\mathrm{N/mm^2})$
Aluminium alloys	All elements	$0.6\sigma_{uw}^{a}$ or $0.9\,\sigma_{yw}$
Steel	All elements	$0.6\sigma_{u}^{a}$ or $0.9\,\sigma_{y}$
[a] The lesser value applies.		

where

for steel : σ_y - Minimum tensile yield strength, $(\mathrm{N/mm^2})$
σ_{ut} - Minimum ultimate tensile strength, $(\mathrm{N/mm^2})$

for welded aluminium : σ_{yw} - Minimum tensile yield strength in the welded condition, $(\mathrm{N/mm^2})$

σ_{utw} - Minimum ultimate tensile strength in the welded condition ($\mathrm{N/mm^2}$)

For aluminium adhesively bonded or mechanically fastened, σ_y and σ_{ut} are in the unwelded state.

2. Required thickness for metal plating

The thickness of metal required by the following does not take into account any corrosion margin or the effect of fabrication techniques. Coating is considered to be used where needed.

The minimum required thickness of the plating t is

$$t = b \times k_C \times \sqrt{\frac{P \times k_2}{1000 \times \sigma_d}} \quad \text{(mm)} \qquad (30)$$

where

b : the short dimension of the panel (mm)

k_C : the curvaure correction factor for curved panels given in **Table 4.5**.

P : the design pressure in accordance with **Ch.3** (bottom, side, deck, etc.) ($\mathrm{kN/m^2}$)

k_2 : the panel aspect ratio factor for bending strength given in **Table 4.4**.

σ_d : the design stress for metal plating given in **Table 4.7**.

404. Laminated wood or plywood single-skin plating

See **ISO 12215-5** Annex E for Laminated wood or plywood single-skin plating.

405. FRP sandwich plating

1. General

This section applies to sandwich panels where the outer and inner skins are similar in layout, in strength and in elastic properties. The skin laminates are considered similar when the ratio of their mechanical properties is within 25 percent of each other.

If this is not the case, the sandwich shall be analysed in accordance with **ISO 12215-5** Annex H. In any case, the thickness requirement from the shear load capacity of **4.** shall be followed.

2. Design stress for sandwich plating

Table 4.8 Design stresses for FRP sandwich plating

Material	Structural element	Design stress σ_{dt} or σ_{dc} ($\mathrm{N/mm^2}$)
FRP sandwich	Hull, deck, superstructures, structural and watertight bulkheads and tanks	In outer skin $0.5\sigma_{ut}$ In inner skin $0.5\sigma_{uc}$ or $0.3\sqrt[3]{E_C \times E_{CO} \times G_C}$ [a]
[a] See **3.** and Equation (34).		

where

for FRP sandwich: σ_{ut} is the minimum ultimate tensile strength of the skin, in newtons per square millimetre;

σ_{uc} is the minimum ultimate compressive strength of the skin, in newtons per square millimetre.

3. Minimum section modulus and second moment

The required minimum section modulus about the neutral axis of a strip of sandwich panel shall not be less than the values given by Equations (31) and (32).

Minimum required section modulus of the outer skin of sandwich 1 cm wide:

$$SM_0/1\text{ cm width} = \frac{b^2 \times k_C{}^2 \times P \times k_2}{6 \times 10^5 \times \sigma_{dto}} \text{ outer skin } \mathrm{cm^3/cm} \tag{31}$$

Minimum required section modulus of the inner skin of sandwich 1 cm wide:

$$SM_i/1\text{ cm width} = \frac{b^2 \times k_C{}^2 \times P \times k_2}{6 \times 10^5 \times \sigma_{dci}} \text{ inner skin } \mathrm{cm^3/cm} \tag{32}$$

Minimum required second moment (moment of inertia) for a strip of sandwich 1 cm wide:

$$I/1\text{ cm width} = \frac{b^3 \times k_C{}^3 \times P \times k_3}{12 \times 10^6 \times k_1 \times E_{io}} \ \mathrm{cm^4/cm} \tag{33}$$

where

b is the shorter dimension of the panel, but shall not be taken 〉330 L_H, in millimetres;

k_C is the curvature correction factor for curved panels given in **Table 4.5**;

P is the pressure (bottom, side, deck, etc.) for the panel in accordance with Clause 8, in kilonewtons per square metre;

k_2 is the panel aspect ratio factor for bending strength given in **Table 4.4**;

k_3 is the panel aspect ratio factor for bending stiffness given in **Table 4.4**;

k_1 = 0,017 is the sandwich bending deflection factor;

E_{io} is the mean of the inner and outer face moduli, in newtons per square millimetre (see Annex C); this approach is suitable when the inner and outer faces are similar, i.e. differ by not 〉25 %.

Design tensile stress on the outer skin:

σ_{dto} is the tensile design stress of the outer skin given in **Table 4.8**, i.e. 0.5 σ_{ut}, in newtons per square millimetre

Design compressive stress on the inner skin:

σ_{dci} is the compression design stress of the inner skin which is the lesser of

$$0.5\,\sigma_{uc} \text{ or } 0.3\sqrt[3]{E_c \times E_{co} \times G_c} \tag{34}$$

where

E_C is the compressive E modulus of inner skin in 0°/90° in-plane axis of panel (see **ISO 12215-5** Annex C), in newtons per square millimetre,

E_{CO} is the compressive E modulus of core, perpendicular to skins (see **ISO 12215-5** Annex D), in newtons per square millimetre;

G_C is the core shear modulus in the direction parallel to load (see **ISO 12215-5** Annex

D), in newtons per square millimetre.

Equation (33) may also be written as

$$EI \text{ per mm width} = \frac{b^3 \times k_c^{\,3} \times P \times k_3}{12 \times 10^3 \times k_1} \ \mathrm{N/mm^2/mm} \qquad (35)$$

4. Thickness required by shear load capabilities

In order to transmit the shear load, the effective thickness of sandwich laminate t_s shall not be less than given by Equation (36):

$$t_s \geq \sqrt{k_C}\frac{k_{SHC} \times P \times b}{1000 \times \tau_d} \ \text{mm} \qquad (36)$$

where

$t_s = t_c + 0.5(t_i + t_o)$ is the distance between mid-thickness of the skins of the sandwich, in millimetres;

k_C is the curvature correction factor defined in **Table 4.5**;

t_o is the thickness of the sandwich outer skin, excluding gel coat, in millimetres;

t_i is the thickness of the sandwich inner skin, in millimetres;

t_c is the thickness of the core, in millimetres;

k_{SHC} is the shear strength aspect ratio factor, given in **Table 4.10**;
Where the elastic properties of the skins are different by 〉25 % in the principal axes, k_{SHC} shall not be taken 〈 0.465;

P is the pressure (bottom, side, deck, etc.) for the panel in accordance with **Ch. 3**, in kilonewtons per square metre;

b is the short dimension of the panel in millimetres;

τ_d is the design shear stress of the core, according to **Table 4.9**, in newtons per square millimetre.

Table 4.9 Design shear strength of sandwich cores

Material	Core design shear stress τ_d $(\mathrm{N/mm^2})$
End grain balsa	0.5 τ_u
Core having shear elongation at break 〈 35 % (cross-linked PVC, etc.)	0.55 τ_u
Core having shear elongation at break 〉35 % (linear PVC, SAN, etc.)	0.65 τ_u
Honeycomb cores (to be compatible with marine application)	0.5 τ_u

τ_u is the minimum ultimate core shear strength, in newtons per square millimetre.

Table 4.10 Shear strength aspect ratio factor k_{SHC}

l/b	〉4.0	3.0	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0
k_{SHC} [a]	0.500	0.493	0.463	0.459	0.453	0.445	0.435	0.424	0.410	0.395	0.378	0.360	0.339

[a] The values of k_{SHC} may be calculated by the equation $k_{SHC} = 0.035 + 0.394 \times \left(\frac{l}{b}\right) - 0.99 \times \left(\frac{l}{b}\right)^2$ for $l/b < 2$

5. Minimum core shear strength

For bottom laminate, the value of the design shear strength of the core, as used in **4**, shall be at least in accordance with to **Table 4.11**.

Table 4.11 Minimum design core shear according to craft length

L_H (m)	〈 10	10 to 15	15 to 24
τ_d min $(\mathrm{N/mm^2})$	0.25	0.25 + 0.03(L_H −10)	0.40

6. Minimum sandwich skin fibre mass requirements

In order to reduce the risk of skin puncture or damage, the required minimal fibre mass in kilo-grams per square metre is given by

$$w_{os} = k_{DC} \times k_4 \times k_5 \times k_6 \times (0.1 L_{WL} + 0.15) \ \ \mathrm{kg/m^2} \qquad (37)$$

$$w_{is} = 0.7 \times w_{os} \ \ \mathrm{kg/m^2} \qquad (38)$$

where

w_{os} is the fibre mass per square metre of the outer skin, in kilograms per square metre;

w_{is} is the fibre mass per square metre of the inner skin, in kilograms per square metre;

k_4 is the sandwich minimum skin location factor where

k_4 = 1 for hull bottom,

k_4 = 0.9 for side shell,

k_4 = 0.7 for deck,

k_5 is the sandwich minimum skin fibre type factor where

k_5 = 1.0 for E-glass reinforcement containing up to 50 % of chopped strand mat by mass,

k_5 = 0.9 for continuous glass reinforcement (i.e. bi-axials, woven roving, unidirectionals, double bias or multiaxial),

k_5 = 0.7 for continuous reinforcement using aramid or carbon or hybrids thereof,

k_6 is the sandwich minimum skin care factor where

k_6 = 0.9 for craft where the sandwich outer skin is expected to be punctured after hitting a sharp object;

k_6 = 1 for other craft.

If k_6 = 0.9, a statement warning that the craft may be punctured after hitting a sharp object and that this damage shall be quickly repaired shall be inserted in the owner's manual.

406. Single-skin plating minimum thickness

1. Minimum thickness or mass of reinforcement for the hull

For metal or plywood $t_{MIN} = k_5 \times (A + k_7 \times V + k_8 \times m_{LDC}{}^{0.33})$ mm (39)

For FRP, minimal dry fibre weight $w_{MIN} = 0.43 \times k_5 \times (A + k_7 \times V + k_8 \times m_{LDC}{}^{0.33})$ $\mathrm{kg/m^2}$ (40)

where

A, k_5, k_7 and k_8 are defined in **Table 4.12**. For sailing craft V shall be taken as $2.36\sqrt{L_{WL}}$.

Table 4.12 Minimum thickness factors

Material	Position	A	k_5	k_7	k_8
FRP	Bottom	1.5	As defined in **405. 6.**	0.03	0.15
	Side/transom	1.5		0	0.15
Aluminium	Bottom	1.0	$\sqrt{125/\sigma_y}$	0.02	0.1
	Side/transom	1.0		0	0.1
Steel	Bottom	1.0	$\sqrt{240/\sigma_y}$	0.015	0.08
	Side/transom	1.0		0	0.08
Plywood	Bottom	3.0	$\sqrt{30/\sigma_{uf}}$	0.05	0.3
	Side/transom	3.0		0	0.3

2. Minimum deck thickness

The values of minimum deck thickness shall be derived from **Table 4.13**.

Table 4.13 Minimum deck thickness

Location	Deck minimum required thickness t_{MIN} mm			
	FRP	Aluminium	Steel	Wood, plywood
Deck	$k_5(1.45 + 0.14L_{WL})$	$1.35 + 0.06L_{WL}$	$1.5 + 0.07L_{WL}$	$3.8 + 0.17L_{WL}$

Section 5 Requirements for Stiffening

501. Stiffening members requirements

1. General

Plating shall be supported by an arrangement of stiffening members. The relative stiffness of primary and secondary stiffening members shall be such that loads are effectively transferred from secondary to primary, then to shell and bulkheads.

502. Properties adjustment factors for stiffeners

1. Curvature factor for stiffeners k_{CS}

The curvature factor k_{CS} shall be taken as listed in **Table 4.14**.

Table 4.14 Values of curvature factor for stiffeners k_{CS}

$\frac{c_u}{l_u}$	k_{CS}
0 to 0.03	1
0.03 to 0.18	1.1−3.33(c_u/l_u)
〉0.18	0.5

where

c_u is the crown of a curved stiffener, in millimetres;

k_{CS} applies to convex or concave stiffeners; it shall not be taken 〈0.5 nor 〉1.

2. Stiffener shear area factor k_{SA}

The stiffener shear area factor k_{SA} shall be taken as listed in **Table 4.15**.

Table 4.15 Values of shear area factor k_{SA}

Stiffener arrangements	k_{SA}
Attached to the plating	5
Other arrangements (floating)	7.5

503. Design stresses for stiffeners

Table 4.16 Design stresses for stiffeners

Material	Tensile and compressive design stress σ_d $\mathrm{N/mm^2}$	Design shear stress τ_d $\mathrm{N/mm^2}$
FRP	0.5 σ_{ut} and 0.5 σ_{uc} [a]	0.5 τ_u
Aluminium alloys	0.7 σ_{yw} [b]	0.4 σ_{yw} [b]
Steel	0.8 σ_y	0.45 σ_y
Laminated wooden frames	0.45 σ_{uf} [c]	0.45 τ_u
Solid stock wooden frames	0.4 σ_{uf} [c]	0.4 τ_u
Plywood on edge frames	0.45 σ_{uf} [c]	0.45 τ_u
NOTE These design stresses also apply for the attached plating of the stiffener, according to its material.		
[a] σ_c is considered where stressed in compression (usually the stiffener top flange) and σ_t is considered where stressed in tension (usually the plating); both verifications need to be calculated. [b] For welded stiffeners. If aluminium stiffeners are not welded, i.e. riveted, glued, etc., the non-welded properties shall be used. [c] σ_{uf} for laminated wooded stiffeners and σ_{uf} for solid stock shall be taken from **ISO 12215-5 Table E.1**. For plywood, σ_{uf} shall not be taken from **Table E.2** but from **Tables E.3** or **E.6**.		

τ_u is the minimum ultimate in-plane shear strength of the stiffener material, in newtons per square millimetre.

504. Requirements for stiffeners made with similar materials

1. For any material: minimum section modulus and shear area

The web area A_W and minimum section modulus SM of stiffening members, including the effective plating of the stiffening members, shall be not less than the values given by Equations (41) and (42) :

$$A_W = \frac{k_{SA} \times P \times s \times l_u}{\tau_d} 10^{-6} \ \mathrm{cm^2} \tag{41}$$

$$SM = \frac{83.33 \times k_{CS} \times P \times s \times {l_u}^2}{\sigma_d} 10^{-9} \ \mathrm{cm^3} \tag{42}$$

where

k_{CS} is the curvature factor for stiffeners given in **Table 4.14**;

k_{SA} is the stiffener shear area factor given in **Table 4.15**;

P is the pressure (bottom, side, deck and superstructure, etc.) for the panel, in kilonewtons per square metre;

s is the spacing of stiffeners, in millimetres;

l_u is the length of the stiffener, in millimetres;

σ_d is the design stress for stiffeners given in **Table 4.16**, in newtons per square millimetre;

A_W is the shear area (cross-sectional area of stiffener shear web), in square centimetres;

τ_d is the design shear stress of the shear web as defined in **Table 4.16**, in newtons per square millimetre.

2. Supplementary stiffness requirements for FRP

For FRP stiffeners, the second moment of area, including the effective plating, shall not be less than given by the following formula.

$$I = \frac{26 \times k_{CS}^{1.5} \times P \times s \times l_u^{3}}{k_{1S} \times E_{tc}} 10^{-11} \ \mathrm{cm}^4 \qquad (43)$$

where

E_{tc} is the mean of compressive/tensile modulus of the material (see **ISO 12215-5** Annex C), in newtons per square millimetre;

k_{1S} = 0.05 is the deflection factor for stiffeners (allowable relative deflection y/l_u).

505. Requirements for stiffeners made with dissimilar materials

In case that dissimilar materials which mechanical properties differ by 〉25 % from each other are used, see **ISO 12215-5** 11.5.

506. Effective plating

The lower flange of stiffening members working in bending is a band of plating called “effective plating” as shown in **Fig 4.6**. The effective extent of plating be shall be calculated according to **Table 4.17**, but shall not be taken greater than the actual stiffener spacing.

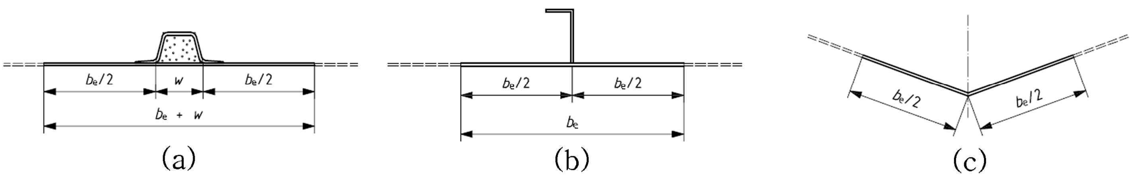


Fig 4.6 Sketch showing the effective extent of plating around a stiffener (top hat, L and chine)

Table 4.17 Values of b_e

Material	Steel	Aluminium	FRP single skin	FRP sandwich	Wood, plywood
b_e	80 t	60 t	20 t	$20(t_o + t_i)$[a]	15 t
[a] The attached plating is 20 times both inner and outer skins, separated by the core, which is considered ineffective, i.e $E_{core} = 0$.					

Where the stiffener has a significant width it may be added to be [see **Fig 4.6** a)].
The above equations are valid for any stiffener: stringer, frame, bulkhead, etc.
For stiffeners along an opening, the effective extent shall be taken as 50 % of the extent as given above.

507. Structural bulkheads

1. Plywood bulkheads

The thickness of unstiffened solid plywood bulkheads shall be not less than

$$t_b = 7.0\,D_b \text{ mm} \tag{44}$$

where

D_b is the depth of the bulkhead from bottom of canoe body to deck at side, in metres.

2. Sandwich bulkheads

(1) Core

In addition to the requirements of (2) and (3)

- the core shear strength shall be in accordance with to **405. 5.** and **Table 4.11**,
- the core thickness shall be at least five times the thickness of the thinnest skin.

(2) Sandwich bulkheads with identical plywood skins

The thickness of skins t_s and of core t_c shall be such that

$$t_s \times t_c \geq \frac{t_b^{\,2}}{6}\ \mathrm{mm}^2 \quad \text{and} \quad t_s \times \frac{t_c^{\,2}}{2} \geq \frac{t_b^{\,3}}{12}\ \mathrm{mm}^3 \tag{45}$$

where

t_b is the solid plywood bulkhead thickness defined by Equation (54);

t_s and t_c are as defined in **405. 4.**

(3) Sandwich bulkheads with identical FRP skins

The thickness of skins ts and of core tc shall be such that

$$t_s \times t_c \geq \frac{t_b^{\,2}}{6}\left(\frac{25}{\sigma_d}\right) \text{ mm} \quad \text{and} \quad t_s \times \frac{t_c^{\,2}}{2} \geq \frac{t_b^{\,3}}{12}\left(\frac{4000}{E_{io}}\right) \text{ mm} \tag{46}$$

where

t_b is the solid plywood bulkhead thickness

3. Metal bulkheads

They shall be calculated as watertight bulkheads.

Section 6 Structural Arrangement

601. Stiffening

1. General

(1) The hull, deck and deckhouse plating shall be stiffened as necessary, by any combination of longitudinal and transverse conventional stiffeners, structural bulkheads, internal furniture such as berths and shelves, and internal tray mouldings, providing these may be considered as “load bearing”. The arrangement is usually made with stiffeners supported by deeper and stronger stiffeners, crossing perpendicularly.

(2) **Fig 4.7, 4.8** and **4.9** illustrate characteristic arrangements that comply with good practice. These figures apply to both sailing and non-sailing craft, and combinations of arrangement within a single craft are acceptable. Small crafts (generally those of hull length less than about 9 m in length) employ natural stiffeners such as deck edge, round bilges, hard chines, keel, etc. to define panels and then need no further stiffening.

(3) Equivalence criteria

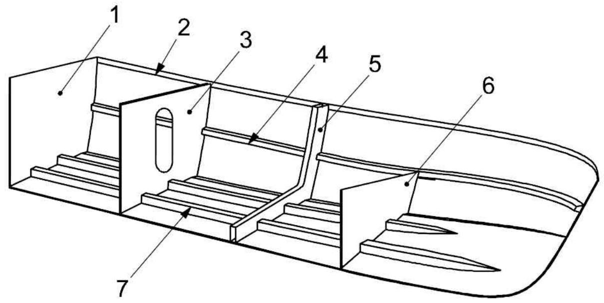
Other arrangements are possible, but these shall follow good practice principles (as illustrated by **Fig 4.7, 4.8** and **4.9**) of effective and smooth transmission of stresses due to pressure loads and concentrated loads (mast, keel, rudder, etc) from the load point into the supporting structure (see **603.** and **604.**).

(4) Longitudinally framed craft
In the example in **Fig 4.7**, the hull shell is stiffened by longitudinal secondary stiffeners supported by transverse primary stiffeners, such as web frames, bulkheads and deep floors. The example given is typical for an FRP craft.

(5) Transversally framed craft
In the example in **Fig 4.8**, the hull shell is stiffened by transverse frames (secondary stiffeners) that are typically supported at the centreline, at the chines or turn of bilge and at deck level. In larger crafts, girders (primary stiffeners) may be fitted, which support these frames and also assist in carrying hull girder loads.

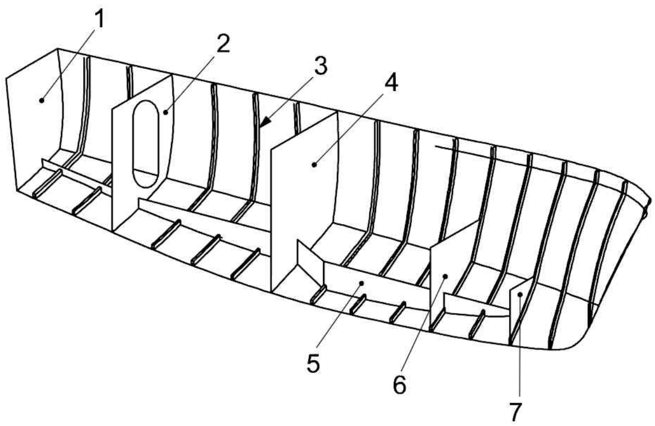
(6) Small, slow craft stiffened by keel, gunwale stringer, structural sole and thwarts
It is common for small craft (i.e. those of hull length less than 6 m) to have no specific stiffeners. However, components not primarily intended to be stiffeners, such as internal partitions may act as such. These components may need to be reinforced for this other role as "stiffeners". In **Fig 4.9**, the thwarts, front and aft locker, cockpit sole and gunwale are used in this way.

(7) Load bearing elements
To be considered as "load bearing", the supporting member shall be effectively attached to the plating by any combination of welding (continuous or intermittent), bonding with structural quality adhesive (e.g. use of epoxy fillets) or fibre reinforced bonding angles or other methods appropriate to the materials. In addition, the member in question shall be constructed of material acceptable for hull construction in accordance with **Ch 4**, and shall be able to carry the forces and moments associated with the effective support assumption as defined there.



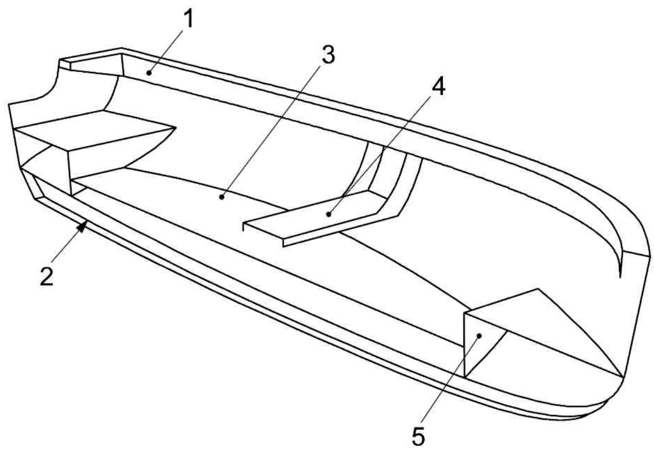
1 transom 2 gunwale stringer 3 bulkhead
4 side longitudinal stiffener (stringer) 5 web frame 6 deep floor
7 bottom longitudinal stiffener (girder or stringer)
NOTE 1, 3, 5 and 6 are primary stiffeners; 2, 4 and 7 are secondary stiffeners.

Fig 4.7 Longitudinally framed small craft



1 transom 2 bulkhead 3 frame
4 bulkhead 5 bottom girder 6 deep floor
7 deep floor

Fig 4.8 Transversally framed small craft



1 gunwale stringer 2 keel 3 structural sole
4 thwarts 5 deep floor

Fig 4.9 Small, slow craft stiffened by keel, gunwale stringer, structural sole and thwarts

602. Hull girder strength

This section is based on the assumption that hull and deck scantlings are governed by local loads, which is usually the case for craft of normal proportions and is especially so for longitudinally framed craft.

For the following craft, an explicit longitudinal strength and buckling assessment is recommended:

- transversely framed non-sailing craft where $\frac{V_{\max}}{\sqrt{L_{WL}}} > 6$;
- transversely framed sailing crafts experiencing large rig loads;
- craft with large deck openings or craft with $\frac{L_H}{D_{\max}} > 12$

603. Load transfer

1. General

The structural geometry shall be so arranged and detailed as to ensure a smooth transfer of loads throughout the structure. Concentrated loads (e.g. mast step for a keel stepped mast, mast pillar for a deck stepped mast) shall be transmitted into the surrounding structure by a series of stiff supporting members. In no case shall concentrated load points be landed on unsupported plating. In general, concentrated loads shall be introduced into the adjacent structural elements by shear load carrying brackets, flanges or floors. Knife edge load crossing shall be avoided (see **5**).

2 gives examples of good practice load transfer arrangements. Other arrangements need to be specifically engineered.

2. Examples of good practice load transfer arrangements

The list below gives examples of good practice load transfer arrangements.

(1) Stiffeners (generally angle bar, tee section, top hats or flat bars, etc.) and girders (including engine girders) do not terminate abruptly, but are suitably terminated to develop their bending strength and shear strength at the supporting member, with brackets or without brackets, but with structurally effective attachment of web and flange to the supporting member (see **Fig 4.10**). Where stiffeners are lightly loaded, they may have tapered (sniped) ends, provided the slope of the taper is at least 30 % and that the plating between the end of the stiffener and the supporting structure is designed or able to transmit the shear force and bending moment of the tapered stiffener [see **Fig 4.10** c)].

(2) Floors smoothly taper in depth towards that of the attached transverse frame. Where no transverse frames are fitted, the floor is attached to the side shell over a sufficient length to ensure that the shear force (due to keel moment or bottom pressure) can be adequately transferred to

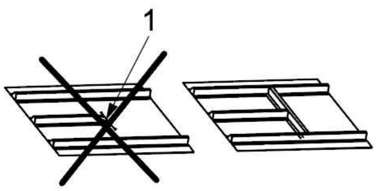
the side shell (see **Fig 4.11**).

(3) Cut-outs and sharp corners are avoided in load-carrying structures such as shell, deck, primary and secondary stiffening members. Where cut-outs cannot be avoided, the depth of any cut-out does not exceed 50 % of the depth of the web of the member, and the length of the cut-out does not exceed 75 % of the depth of the web of the member, unless effectively engineered. Cut-outs shall have radius corners not less than 12 % of the cut-out depth or 30 mm, whichever is the greater. Cut-outs are avoided within 20 % of the span from the support points and by way of concentrated loads on the member.

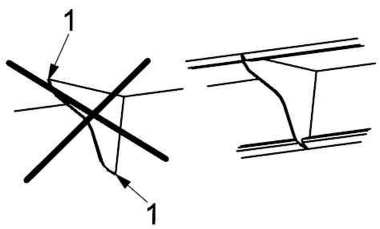
3. Openings in deck and shell according to good practise

Openings in decks and shell have radius corners not less than 12 % of the width of opening, but need not exceed 300 mm and are not less than 50 mm. This does not apply where the edges are reinforced by a structural flat bar or equivalent (see **Fig 4.12**).

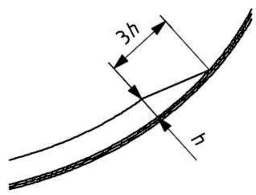
It is also good practice to minimize sharp cut-outs in structurally loaded panels and stiffeners, unless accordingly reinforced.



a) Stiffener ending in panel, poor practice and good practice solution



b) Bracket, poor practice and good practice solution



c) Tapered ends acceptable provided the vertical load can be taken by the shell

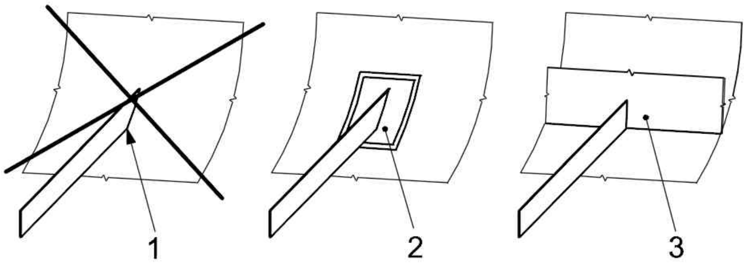
1 risk of crack
h height of stiffener

Fig 4.10 Detail of stringer and bracket end

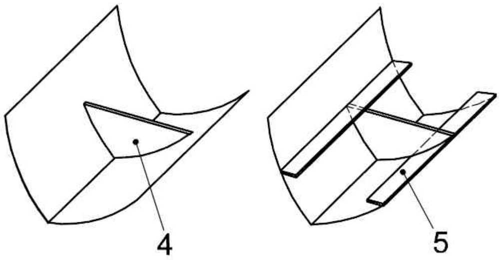
4. Floating frame systems

Floating frame systems (see **Fig 4.13**) are those where one set of stiffeners (the “floated” stiff-eners) effectively sits on top of another set without being directly attached to the hull plating. Only the second set (the “attached” stiffener) is directly attached to the plating. When analysing such floating frames, the effective plating of the floating frame is to be taken as zero.

For all materials, particular metal crafts or wooden crafts that use plywood frames, these “floating” frames are normally I beams “attached” to a T, L or U stringer. Attention shall be given to the strength of the weld or glued area between the “floating” frame and stringer, torsional (tripping) or shear buckling of the stringer and the frame transverse web and knife edge load crossing (see **5.**), which requires explicit calculation. By way of Guidance, the weld or glue area shall generally not be less than the stiffener web area, A_W, Equation (41).



a) Stiffener ending in shell, poor practice and good practice

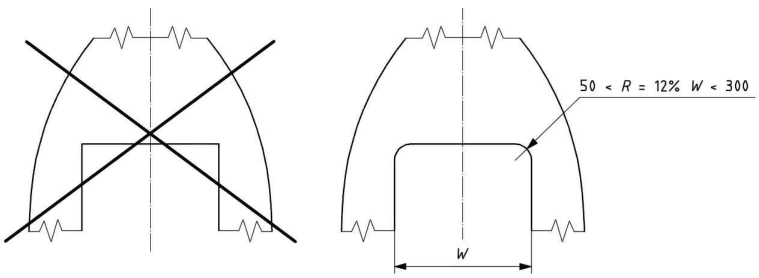


b) Deep floor/partial bulkhead

1 hard spot, risk of crack, poor practice
2 reinforced plating, acceptable practice
3 transverse floor or bulkhead, good practice
4 no longitudinal structure at top end of deep floor, acceptable practice
5 cabin sole, deck or longitudinal stiffener on top of floor, good practice

Fig 4.11 Detail of stiffener ending on the plating

Dimensions in millimetres



R radius corner
W width of opening

Fig 4.12 Deck and shell openings corner radius

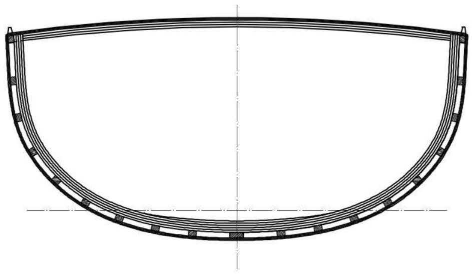
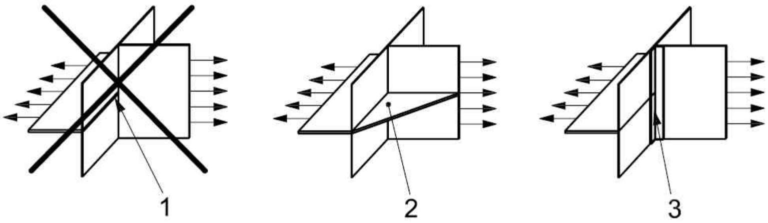


Fig 4.13 Section of a wooden craft with floating frame

5. Knife edge load crossing

Knife edge load crossing happens when two load carrying members cross at a right angle. This shall be avoided as there is a high stress concentration at the point of connection of the two members. In the case of knife edge load crossing, at least one of the members shall be reinforced as shown in **Fig 4.14**.



1 stress concentration (knife edge load crossing), poor practice
2 bracket transferring the load from the horizontal plate to the vertical plate, good practice
3 reinforcement with an L shaped stiffener or tabbing (for use in lightly loaded areas only), acceptable practice

Fig 4.14 Knife edge load crossing

6. Equivalent criteria

Other arrangements are possible but these shall follow good practice principles (as illustrated by **Fig 4.10** to **4.14**) of effective and smooth transmission of stresses, generous radii, use of connecting brackets, gentle tapering of material, avoidance of stress concentration features and careful placement of any lightening holes.

604. Determination of stiffener spans

1. General

In order to establish whether a stiffener complies with the requirements of the **Ch.6** series, the spacing and span of the stiffener being considered shall be established.

The spacing is the distance between successive stiffeners, measured perpendicular to the stiffener axis. The span is the distance between support points. It is important to appreciate that span exercises a very strong influence on the bending strength and deflection of any stiffener.

In order to simplify the calculations, this chapter considers stiffeners as isolated beams under a uniformly distributed pressure load. ISO 12215-5 provides Guidance on locating support points for isolated stiffeners.

In reality, small craft structures often comprise a set of transverse stiffeners that intersect a set of longitudinal stiffeners. This may be termed a “grid”. Each point where a transverse member crosses a longitudinal member is termed an “intersection point”.

In some cases, it is correct to take the stiffener span as the distance between adjacent intersection points, but in other cases this is too optimistic. The support which one set of crossing members offers to the other set is a complex function of the relative flexural rigidity (EI) and the grid dimensions between well defined supports such as bulkheads, side shell, partitions and other very deep members. This subclause provides procedures for determination of stiffener spans.

2. Deep stiffeners crossing shallow stiffeners

Where one set of members have a depth of at least twice that of the other set, these deeper stiffeners are called “primary members” and the shallower stiffeners are called “secondary members”.

The span of primary members, l_u, is the grid dimension in the direction of the primary member.

The span of secondary members, l_u, is the spacing of the primary member.

3. Stiffeners crossing similar depth stiffeners

(1) General
This arrangement is commonly found in small craft as a tray moulding (see **Fig 4.15**) and is often referred to as “egg-box” style. Neither set of members can be categorized as primary or secondary as the degree to which one set supports the other is indeterminate by simple means of assessment.

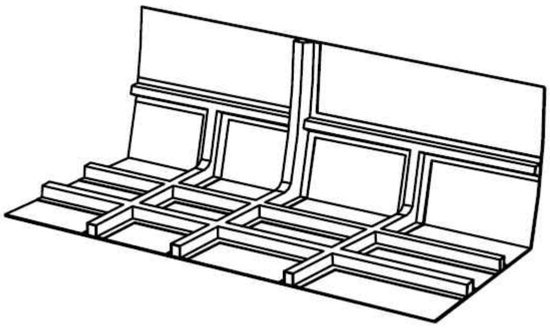


Fig 4.15 “Egg-box” style tray mouldings

In such cases, the procedure described in (2) and (3) shall be adopted.

(2) Stiffeners running in the shorter of the grid dimensions
The span used to determine the design bending moment and shear force shall be taken as 60 % of the grid dimension.
The design pressure shall be obtained using a design area, A_D, based on the stiffener spacing and 60 % of the grid dimension.

(3) Stiffeners running in the longer of the grid dimensions
The span to be used to determine the design bending moment and shear force shall be taken as 150 % of the distance between intersection points.
The design pressure shall be obtained using a design area, A_D, based on the stiffener spacing and 150 % of the distance between intersection points.

605. Detail of structures

The items which is not mentioned in this chapter are to be in accordance with **ISO 12215-6**. ⚓

CHAPTER 5 Stability and buoyancy

Section 1 General

101. Scope

This chapter specifies methods for evaluating the stability and buoyancy of intact (I.e. undamaged) crafts. The flotation characteristics of crafts vulnerable to swamping are also encompassed.
The evaluation of stability and buoyancy properties using this part will enable the craft to be assigned to a design category (A, B, C or D) appropriate to its design and maximum total load.

102. Definitions

The definitions of terms used in this chapter are as follows.

1. Windage area (A_{LV})

projected profile area of hull, superstructures, deckhouses and spars above the waterline at the appropriate loading condition, the craft being upright (m^2)

2. Flotation element

element which provides buoyancy to the craft and thus influences its flotation characteristics

(1) air tank
tank made of hull construction material, integral with hull or deck structure
(2) air container
container made of stiff material, not integral with the hull or deck structure
(3) low density material
material with a specific gravity of less than 1,0 primarily incorporated into the craft to enhance the buoyancy when swamped
(4) rib collar
heavy duty tubular collar fitted around the periphery of the craft and always intended to be inflated whenever the craft is being used
(5) 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 craft is being used

3. Inclining experiment

method by which the vertical position of the centre of gravity (VCG) of a craft can be determined

4. Loaded waterline

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

5. Capsize

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

6. Knockdown

event when a craft reaches a heel angle sufficient to immerse the masthead, and from which it mayor may not recover without intervention

7. Inversion

event when a craft becomes upside down

Section 2 Non-sailing Crafts of Hull Length Greater than or Equal to 6 m

201. Tests to be applied

Non-sailing crafts of hull length greater than or equal to 6 m shall comply with all the requirements of anyone of six options according to amount of flotation and decking, and whether the craft is fitted with suitable recesses. These options and the tests to be applied (as described in **202.**) are given in **Table 5.1**.

Table 5.1 Tests to be applied

Option	1	2	3	4	5	6
Categories possible	A and B	C and D	B	C and D	C and D	C and D
Decking or covering	Fully decked	Fully decked	Any amount	Any amount	Partially decked	Any amount
Downflooding openings	**202. 1 (1)**	**202. 1 (1)**	**202. 1 (1)**	**202. 1 (1)**	**202. 1 (1)**	**202. 1 (1)**
Downflooding-height test	**202. 1 (2)**	**202. 1 (2)**	**202. 1 (2)**	**202. 1 (2)**(1)	**202. 1 (2)**	**202. 1 (2)**
Offset-load test	**202. 2**	**202. 2**	**202. 2**	**202. 2**	**202. 2**	**202. 2**
Resistance to waves + wind	**202. 3**		**202. 3**			
Heel due to wind action		**202. 4**(2)		**202. 4**(2)	**202. 4**(2)	**202. 4**(2)
Flotation requirements			**202. 5**	**202. 5**		
Flotation material			Annex F(3)	Annex F(3)		

(NOTES)
(1) This test is not required for crafts assessed using option 4 if, during the swamped load test in normative **ISO 12217-1** Annex E, the craft has been shown to support an equivalent dry mass of 133 % of the maximum total load.
(2) The application of **202. 4** is only required for crafts where $A_{LV} \geq L_H B_H$.
(3) See **ISO 12217-1** Annex F.

202. Requirements of non-sailing crafts of hull length greater than or equal to 6 m

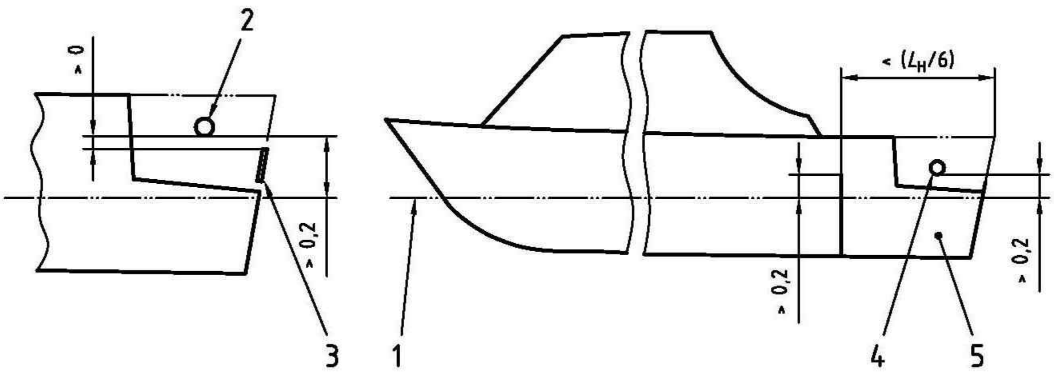
1. Downflooding

(1) Downflooding openings
  (A) The requirements given as follows shall 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) piped drains from quick-draining recesses or from watertight recesses which, if filled, would not lead to downflooding or capsize when the craft is upright;
    (c) non-opening appliances;
    (d) opening appliances located in the topsides which comply with **ISO 12216** to tightness degree 2 and which are referenced in the Owner's Manual (see normative **ISO 12217-1** Annex G) and are clearly marked "WATERTIGHT CLOSURE - KEEP SHUT WHEN UNDER WAY"; and which are
      (i) emergency escape hatches or appliances fitted with screwed closures, or
      (ii) in a compartment of such restricted volume that, even if flooded, the craft satisfies all the requirements, or
      (iii)in a craft of design category C or D and which, when at loaded displacement mass, would not sink if the affected compartment was flooded as a result of the appliance being left open;
    (e) opening appliances located inboard of the topsides which comply with **ISO 12216** to tightness degree 2 and which are referenced in the Owner's Manual and are clearly marked "WATERTIGHT CLOSURE - KEEP SHUT WHEN UNDER WAY";

(f) engine exhausts or other openings that are only connected to watertight systems;
(g) openings in the sides of outboard engine wells which are of
  (i) watertightness degree 2 and having the lowest point of downflooding more than 0.1 m above the loaded waterline, or
  (ii) 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 **Fig 5.1**, or
  (iii) 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 water line cannot drain into other parts of the interior or non-quick-draining spaces of the craft, see **Fig 5.1**.

(B) All closing appliances fitted to downflooding openings shall comply with **KS V ISO 12216**, according to design category and appliance location area.
(C) No opening type appliances shall be fitted in the hull less than 0.2 m above the loaded waterline unless they comply with **ISO 9093** or they are emergency escape hatches complying with **ISO 9094**.
(D) Openings within the craft, such as outboard engine trunks or free-flooding fish bait tanks, shall be considered as possible downflooding openings.
(E) For crafts to be given design category A or S, downflooding openings not fitted with any form of closing appliance shall only be permitted if they are essential for ventilation or engine combustion requirements.

Dimensions in metres



Key

1 Waterline
2 Watertightness degree 3 or 4
3 Drain
4 Watertightness degree 4
5 Non-quick-draining space

Fig 5.1 Openings in outboard engine wells

(2) Downflooding height
 (A) Test
  This test is to demonstrate sufficient margins of freeboard for the craft in the loaded displacement condition before water is shipped aboard.
  This test shall be performed using people as described below, using 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 craft with all items of maximum total 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 described in **202. 1** (1) (A). 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 water ingress of that coaming (see **ISO 12217-1** Annex C).

(B) Requirements

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

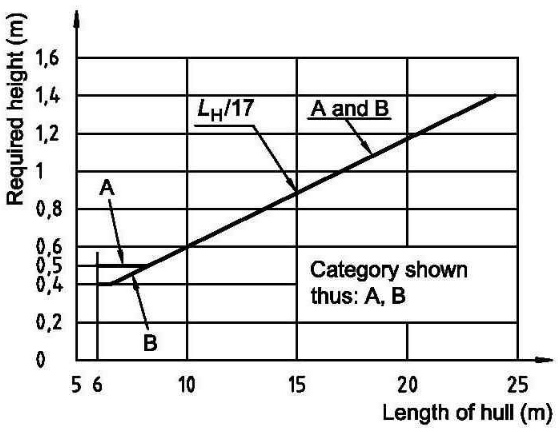
(i) the method of normative ISO 12217-1 Annex A, which generally gives the lowest requirement, or

(ii) **Figs 5.2** and **5.3** which are based only on craft length.

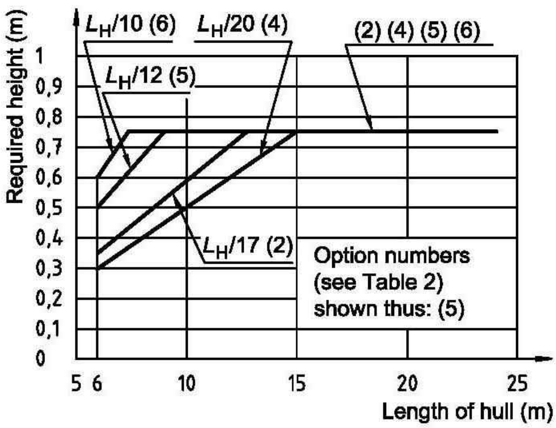
(b) For crafts assessed using option 3, 4 or 6 (see **Table 5.1**), the required downflooding height within $L_H/3$ of the bow shall be increased as shown in **Fig 5.4**.

(c) crafts assessed using option 3 or 4 are permitted a 20 % reduction in required down-flooding height in way of an outboard engine mounting position, provided that the width of the area where this reduction applies is minimized.

(d) crafts assessed using **Fig 5.2** or **5.3** shall be permitted downflooding openings having a combined clear area, in square millimetres (mm^2), of not more than 50 $L_H^{\ 2}$ within the aft quarter of L_H, provided that the downflooding height to these openings is not less than 75 % of that required by these figures.



a) Design categories A and B



b) Design category C

Fig 5.2 Required downflooding height - Design categories A, Band C

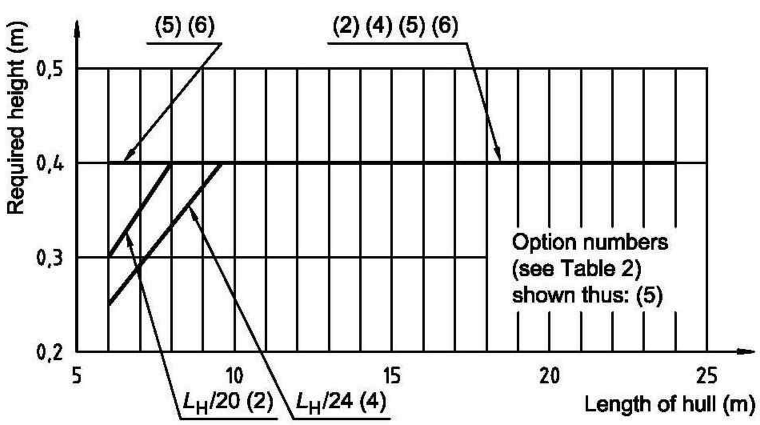
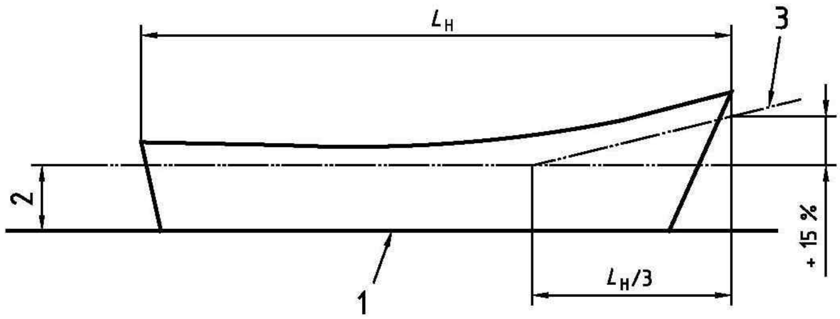


Fig 5.3 Required downflooding height - Design category D



Key

1 Waterline

2 Basic downflooding requirement

3 Increased requirement forward

Fig 5.4 Increase in required downflooding height – Options 3, 4 and 6

2. Offset-load test

This test is to demonstrate sufficient stability for the craft against offset loading by the crew.
The offset-load test shall be conducted in accordance with **ISO 12217-1** Annex B.
During the test, the heel angle ϕ_O shall be not greater than

$$\phi_{O(R)} = 11.5 + \frac{(24 - L_H)^3}{520}$$ (see **Table 5.2**)

Table 5.2 Maximum permitted heel angle for offset-load test

L_H (m)	6.0	7.0	8.0	9.0	10.0	12.0	15.0	18.0	21.0	24.0
$\phi_{O(R)}$ (°)	22.7	20.9	19.4	18.0	16.8	14.8	12.9	11.9	11.6	11.5

During the test, the freeboard margin to downflooding shall not be less than that given in **Table 5.3**

Table 5.3 Required minimum heeled freeboard margin during offset-load test

(Dimensions in metres)

Design category	A	B	C	D
Option 1 or 3 in Table 5.1	0.26 B_H	0.145 B_H	not applicable	not applicable
Option 2 in **Table 5.1**	not applicable	not applicable	0.046 B_H	0.010
Option 4 in **Table 5.1**	not applicable	not applicable	0.046 B_H	0.010
Option 5 or 6 in **Table 5.1**	not applicable	not applicable	0.110 $\sqrt{L_H}$	0.070 $\sqrt{L_H}$

3. Resistance to waves and wind (design categories A and B only)

(1) General

Crafts shall be assessed using (2) and (3).
Crafts shall be assessed in the minimum operating condition unless the ratio $m_{LDC}/m_{MOC} > 1.15$, in which case the loaded displacement condition shall also be assessed.
Recesses of crafts to be assigned design category A or B using option 1 of **Table 5.1** shall comply with the plan area limitations given below, unless specific account is taken of the mass and free-surface effect of water that recesses may contain when calculating the stability

characteristics.
If this special calculation option is used, righting moments shall be calculated assuming that each recess is treated as though it had no drainage and is assumed to initially hold water to the following percentage of its maximum (upright) capacity:

Percentage full = $60-240F/L_H$

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

Such water shall be assumed to spill out as the craft heels, the righting moments being assumed to be symmetrical about the upright.

For design category A: plan area of all recesses (m^2) 〈 $0.2\,L_H B_H$

plan area of all recesses forward of $L_H/2$ (m^2) 〈 $0.1\,L_H B_H$

For design category B: plan area of all recesses (m^2) 〈 $0.3\,L_H B_H$

plan area of all recesses forward of $L_H/2$ (m^2) 〈 $0.15\,L_H B_H$

(2) Rolling in beam waves and wind

The curve of righting moments of the craft shall be established up to the downflooding angle or the angle of vanishing stability or 50°, whichever is the least, using **ISO 12217-1** Annex D.
The heeling moment due to wind, M_W expressed in newton metres, is assumed to be constant at all angles of heel and shall be calculated as follows:

$$M_W = 0.3\,A_{LV}\left(\frac{A_{LV}}{L_{WL}} + T_M\right)v_W^2$$

where

T_M is the draught at the mid-point of the waterline length, expressed in metres;

v_W = 28 m/s for design category A, and 21 m/s for design category B;

A_{LV} is the windage area as defined in **102. 1**, but shall not be taken as less than $0.55\,L_H B_H$.

Alternatively, the heeling characteristics due to wind can be assessed from wind tunnel tests.
The assumed roll angle ϕ_R shall be calculated as follows:

$\phi_R = 25 + 20/V_D$ for design category A, and $20 + 20/V_D$ for design category B.

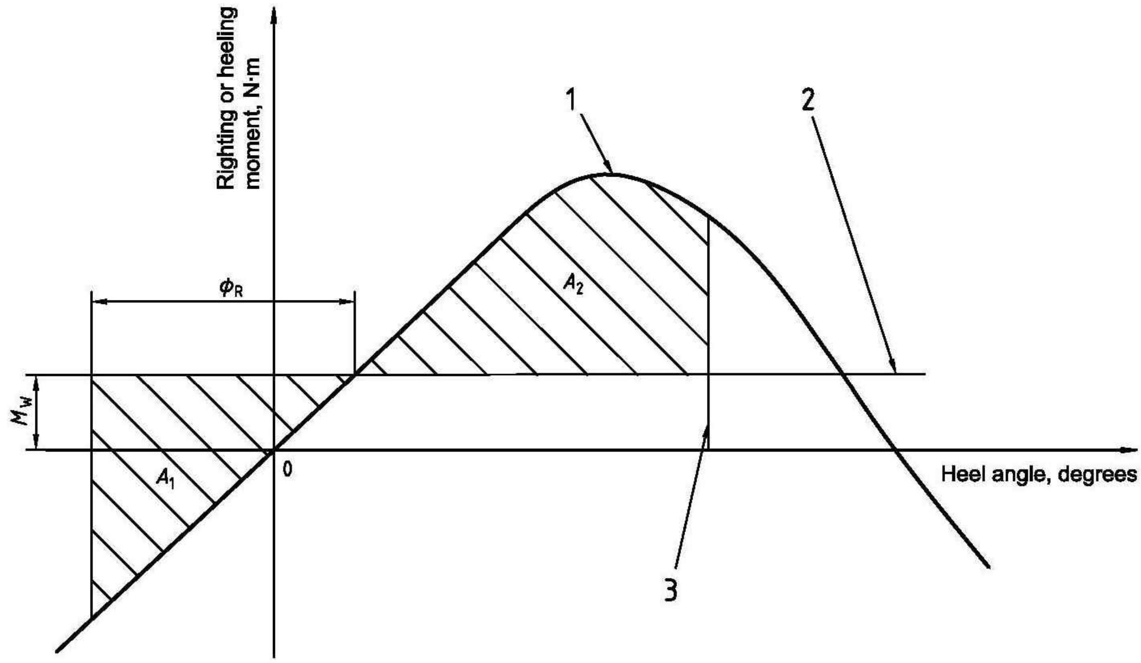
The righting moment curve and the wind heeling moment shall be plotted on the same graph as shown in **Fig 5.5**.
Area A_2 shall be greater than area A_1, where A_1 and A_2 are the areas indicated in **Fig 5.5**.

(3) Resistance to waves

In addition to the requirements of (2), the curve of righting levers at angles of heel up to ϕ_D, ϕ_V or 50° whichever is the least, shall comply with the following.

(A) Where the maximum righting moment occurs at a heel angle of 30° or more, the righting moment at 30° heel shall be not less than 25 kN·m for design category A, and 7 kN·m for design category B. In addition, the righting lever at 30° shall be not less than 0.2 m.

(B) Where the maximum righting moment occurs at a heel angle of less than 30°, the maximum righting moment shall be not less than $(750/\phi_{GZ_{\max}})$ kN·m for design category A, and $(210/\phi_{GZ_{\max}})$ kN·m for design category B.
In addition, the maximum righting lever shall not be less than $(6/\phi_{GZ_{\max}})$ m, where $\phi_{GZ_{\max}}$ is the heel angle, in degrees, at which the maximum righting lever occurs, considering only that part of the curve for heel angles less than the downflooding angle.



Key

1 Righting moment
2 Heeling moment due to wind
3 ϕ_D or ϕ_V if less, or 50° if less

Fig 5.5 Roll resistance to waves and wind

4. Heel due to wind action (design categories C and D only)

Crafts shall be assessed in the minimum operating condition unless the ratio $m_{LDC}/m_{MOC} > 1.15$, in which case the loaded displacement condition shall also be assessed.

Crafts of design categories C and D, where $A_{LV} < L_H B_H$, do not have to be assessed. Other crafts shall be assessed as follows.

The wind heeling moment (M_W) shall be calculated as in **202. 3.** (2), but using

v_W = 17 m/s for design category C, and 13 m/s for design category D.

The heel angle due to the wind heeling moment, ϕ_W, shall be determined either by comparing the heeling moment with the curve of righting moments or from the formula:

$$\phi_W = (M_W/M_C) \times \phi_O$$

where

M_C is the maximum offset-load moment, expressed in newton metres, due to the crew, see normative **ISO 12217-1 Annex B**;

ϕ_O is the offset-load heel angle observed due to M_C.

The angle ϕ_W shall be less than 0.5 $\phi_{O(R)}$, derived from **2**.

5. Flotation requirements

The flotation test to demonstrate adequate swamped buoyancy and stability shall be performed using the method given in normative **ISO 12217-1** Annex E. Where flotation materials or elements are used, they shall comply with normative **ISO 12217-1** Annex F.

Section 3 Sailing Crafts of Hull Length Greater than or Equal to 6 m

301. Requirements for monohull crafts

1. Requirements

(1) Monohull sailing crafts shall comply with all the requirements of anyone of seven options according to amount of flotation and decking, and whether the craft is fitted with suitable recesses. These options and the tests to be applied are given in **Table 5.4**

(2) The design category finally given is that for which the craft satisfies all the relevant requirements of any one of these options.

(3) For crafts using option 1 or 2, the requirements shall be satisfied in the minimum operating condition unless otherwise specifically noted. If the ratio of m_{LDC}/m_{MOC} exceeds 1.15 then all the requirements shall be satisfied in the loaded displacement condition as well as in the minimum operating condition. In calculating the position of the overall centre of gravity in the loaded displacement condition, the following shall be observed:
- fuel and water 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_{MOC}) shall be added at sheerline height at the mid-length of L_H.

(4) Crafts using option 1 or 2 and fitted with provision for asymmetric ballasting whilst under way (whether liquid or solid) shall
  (A) comply with all the requirements of the selected option as indicated in **Table 5.4**, and
  (B) comply with the requirements of **2** (3), **3** (if appropriate) and **4** for the next less demanding design category considering that the movable ballast is of whichever amount or position that gives the most adverse result when considering each individual stability requirement.

(5) Recesses of crafts to be assigned design category A or B using option 1 of **Table 5.4** shall comply with the plan-area limitations given below, unless specific account is taken of the mass and free-surface effect of water that recesses may contain when calculating the stability characteristics.
If this special calculation option is used, righting levers shall be calculated assuming that each recess is treated as though it had no drainage and is assumed to initially hold water to the following percentage of its maximum (upright) capacity:

Percentage full = (60 − 240 F/L_H)

where F is the minimum freeboard to the coaming of the recess in question.
Such water shall be assumed to spill out as the craft heels, the righting moments being assumed to be symmetrical about the upright.

For design category A : plan area of all recesses $(\mathrm{m}^2) < 0.2 L_H B_H$
plan area of all recesses forward of $L_H/2$ $(\mathrm{m}^2) < 0.1 L_H B_H$
For design category B : plan area of all recesses $(\mathrm{m}^2) < 0.3 L_H B_H$
plan area of all recesses forward of $L_H/2$ $(\mathrm{m}^2) < 0.15 L_H B_H$

Table 5.4 Requirements to be applied to monohull sailing crafts

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 decked [1]	Any amount	Any amount	Any amount	Any amount	Any amount	Any amount
Downflooding openings	301. 2 (1)	301. 2 (1)	301. 2 (1)	301. 2 (1)	301. 2 (1)	301. 2 (1)	
Downflooding-height test	301. 2 (2)	301. 2 (2)	301. 2 (2)		301. 2 (2)		
Downflooding angle	301. 2 (3)	301. 2 (3)					
Angle of vanishing stability	301. 3	301. 3					
Stability index	301. 4	301. 4					
Knockdown-recovery test			301. 5	301. 5			
Wind stiffness test					301. 6	301. 6	
Flotation requirements				301. 7		301. 7	
Capsize recovery test							301. 8
Note : [1] This term is defined in **ISO 12217-1** 3.1.6.							

2. Downflooding

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

(1) Downflooding openings

To be in accordance with **202. 1** (1) (downflooding openings of Non-sailing crafts of hull length greater than or equal to 6 m)

(2) Downflooding height

(A) Test

To be in accordance with **202. 1** (2) (test of downflooding height of Non-sailing crafts of hull length greater than or equal to 6 m)

(B) 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

(i) the method of normative **ISO 12217-2** Annex A, which generally gives the lowest requirement, or

(ii) **Fig 5.6** which is based only on craft length.

(b) Crafts assessed using **Fig 5.6** shall be permitted openings having a combined clear area, expressed in square millimetres (mm^2), of not more than 50 $L_H{}^2$ within the aft quarter of L_H. provided that the downflooding height to these openings is not less than 3/4 of that required by **Fig 5.6**

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

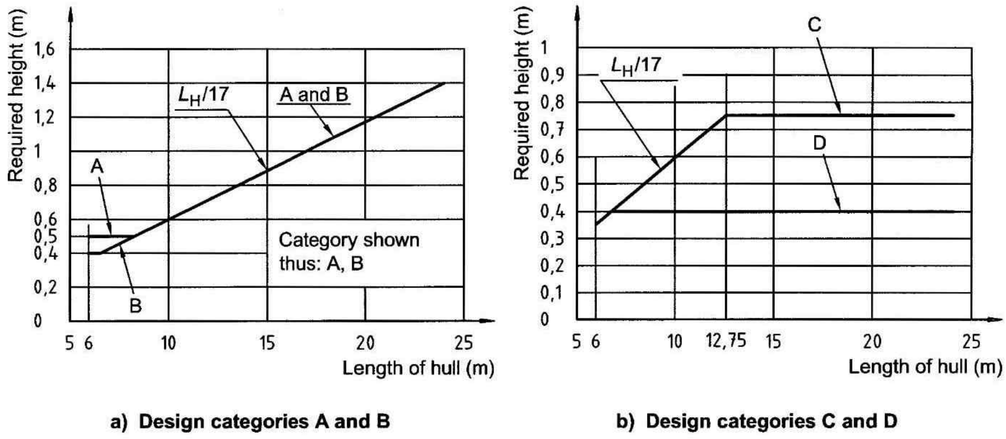


Fig 5.6 Required downflooding height

(3) Downflooding angle

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

The downflooding angle to any downflooding opening (ϕ_{DA}) apart from those excluded by (2) (A), which can be determined using either of the methods in normative **ISO 12217-2** Annex B, shall exceed the required downflooding angle ($\phi_{D(R)}$) as shown in **Table 5.5**.

Where a downflooding opening is protected by a higher coaming around the recess from which it leads, the downflooding angle shall be determined to the lowest point of that coaming, see Fig B.1 in normative **ISO 12217-2** Annex B.

Table 5.5 Required downflooding angle

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

3. Angle of vanishing stability and minimum mass

These requirements are intended to ensure an absolute minimum survival capability in severe conditions. The angle of vanishing stability for the appropriate loading conditions shall be obtained using normative **ISO 12217-2** Annex C. Crafts shall normally comply with (1), but those of design category A or B may alternatively comply with (2).

(1) Normal requirement

Crafts to be assigned to design category A or B shall comply with the requirements given in **Table 5.6**.

Table 5.6 Required angle of vanishing stability

Design category	Required angle of vanishing stability ($\phi_{V(R)}$)
A	m 〉3.000 kg, $\phi_{V(R)}$ = (130-0.002 m). but always ≥ 100 °
B	m 〉1.500 kg, $\phi_{V(R)}$ = (130-0.005 m). but always ≥ 95 °
C	$\phi_{V(R)}$ = 90 °
D	$\phi_{V(R)}$ = 75 °

(2) Alternative requirement for design categories A and B

As an alternative to **301. 3** (1), crafts may be assigned to design category A or B provided that

(A) ϕ_V ≥ 90° for design category A, or ϕ_V ≥ 75° for design category B;
(B) it has been shown by calculation using normative **ISO 12217-2** Annex D that when the swamped or inverted craft is totally immersed. the volume of buoyancy, expressed in cubic metres (m^3) available from the hull structure, fittings and flotation elements is greater than the number represented by ($m_{LDC}/850$), thus ensuring that it is sufficient to support the mass of the loaded craft by a margin. Allowance for trapped air (apart from dedicated air tanks and watertight compartments) shall not be included;
(C) where compartments accessible via hatches or doors are used to demonstrate positive flotation after capsize, the compartment shall be constructed to watertightness degree 1, with hatches and doors satisfying the watertightness requirements for degree 2.
Closures to access openings into watertight compartments shall be clearly marked on both sides:
"WATERTIGHT CLOSURE - KEEP SHUT WHEN UNDER WAY"
(D) where flotation elements are used, the requirements of **ISO 12217-2** Annex E are satisfied;
(E) stability information similar to that required by 302. 4. is provided, except that instead of being derived from normative **ISO 12217-2** Annex G, the recommended maximum wind strength for a given sail area shall be determined on the basis that the upright wind heeling moment in a gust of twice the mean wind pressure shall not be greater than the maximum righting moment at any heel angle;
(F) the warning symbols shown in **Fig 5.7** are displayed at the main control position.

Fig 5.7 Warning symbols

4. Stability index (STIX)

The stability index is a method of obtaining an overall assessment of the stability properties of mono hull sailing crafts. Details are to be in accordance with **ISO 12217-2**.

5. Knockdown-recovery test

This test is to demonstrate that a craft can return to the upright unaided after being knocked down. Details are to be in accordance with **ISO 12217-2**.

6. Wind stiffness test

This test is to demonstrate that, when a sailing craft is heeled to a steady wind speed appropriate to the design category, the craft does not start flooding. Details are to be in accordance with **ISO 12217-2**.

7. Flotation requirements

(1) Because some sailing crafts may be capsized if incorrectly handled, it shall be shown that, when the craft is inverted and/or fully flooded, either
(A) the volume of buoyancy, expressed in cubic metres, in the hull, fittings and equipment is greater than the number represented by (m_{LDC}/1,000), using the method of normative **ISO 12217-2** Annex D, thus ensuring that it is sufficient to support the mass of the loaded craft. Allowance for trapped bubbles of air (apart from dedicated air tanks and watertight compartments) shall not be included, alternatively;
(B) the craft when loaded to m_{LDC} does not sink, as demonstrated by a physical test.
(2) Where compartments accessible via hatches or doors are used to demonstrate positive flotation after capsize or swamping, the compartment shall be constructed to watertightness degree 1 (see **ISO 11812**), with access closures satisfying the watertightness requirements for degree 2 of

ISO 12216.
Closures to access openings into watertight compartments shall be clearly marked on both sides: "WATERTIGHT CLOSURE - KEEP SHUT WHEN UNDER WAY"
Where flotation elements are used, the requirements of **ISO 12217-2** Annex E shall apply.

8. Capsize-recovery test

This test is to demonstrate that a capsized craft can be returned to the upright by the actions of the crew using their body action and/or righting devices purposely designed and permanently fitted to the craft, that it will subsequently float, and to verify that the recommended minimum crew mass is sufficient for the recovery method used. Details are to be in accordance with **ISO 12217-2**.

302. Requirements for catamarans and trimarans

1. Requirements to be applied

Where catamarans and trimarans have $L_H > 5B_{CB}$, they shall comply with the requirements of clause **301.** All other catamarans and trimarans shall comply with either

(1) **2** to **7**, or
(2) capsize-recovery test as described in **301. 8**, when the craft shall be assigned either design category C or D at the discretion of the builder.

2. Downflooding openings

The requirements of **301. 2** (1) shall apply.

3. Downflooding height

The requirements of **301. 2** (2) shall apply.

4. Stability information

Since sailing multihull crafts may capsize, information on all of the following subjects shall be provided in the owner's manual (see normative **ISO 12217-2** Annex F).

(1) The stability hazards to which these crafts are vulnerable, including the risk of capsize in roll and/or pitch, particularly in breaking seas.
(2) The Beaufort wind strength at which the working sail area should be reduced when sailing in calm water in the minimum operating condition, taking account of the hazardous effects of gusts. Additional information relevant to the loaded displacement mass can also be provided if desired.
This information can be calculated using informative **ISO 12217-2** Annex G (which includes a margin for gusts). or alternatively be derived from sailing trials. The method of determination shall be stated.
If derived from sailing trials, the wind strength quoted in the owner's manual shall correspond to a wind speed of not greater than 70 % of that required to
(A) lift the windward hull of catamarans out of the water. or
(B) lift the main hull of trimarans out of the water, or submerge the leeward sidehull, whichever occurs sooner.
(3) The choice of sails to be set with respect to the prevailing wind strength, relative wind direction, and sea state.
(4) Precautions to be taken when altering course from a following to a beam wind.

5. Warning symbols

Warning symbols shall be permanently displayed at the main control position, as shown in **Figs 5.8** and **5.9**:

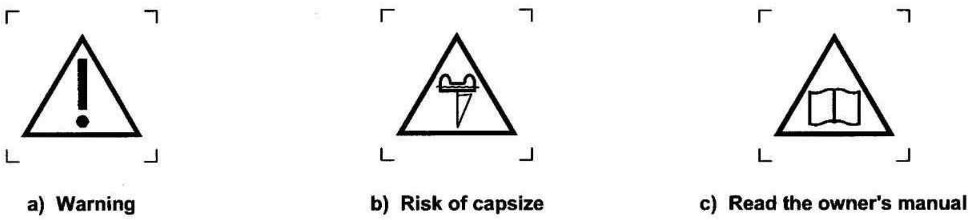


Fig 5.8 Warning symbols for catamaran

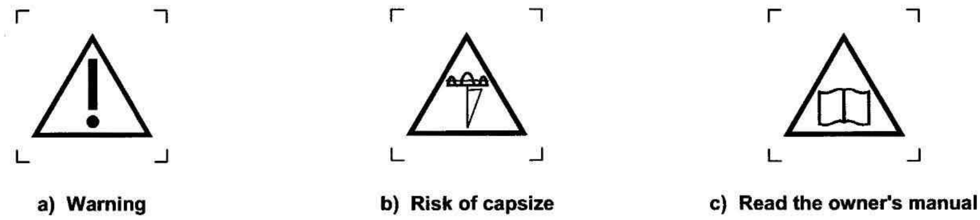


Fig 5.9 Warning symbols for trimaran

6. Buoyancy when inverted

(1) Because multihull sailing crafts may capsize, it shall be shown by calculation using normative **ISO 12217-2** Annex D that, when inverted and/or fully flooded, the volume of buoyancy, expressed in cubic metres (m^3), in the hull, fittings and equipment is greater than the number represented by ($m_{LDC}/850$), thus ensuring that it is sufficient to support the mass of the loaded craft by a margin. Allowance for trapped bubbles of air (apart from dedicated air tanks and watertight compartments) shall not be included.

(2) Where there is a means of escape provided for use in the event of inversion, it shall not compromise the stability or buoyancy whether the craft is upright or inverted.

(3) Where compartments accessible via hatches or doors are used to demonstrate positive flotation after capsize, the compartment shall be constructed to watertightness degree 1 (see **ISO 11812**), with hatches and doors satisfying the watertightness requirements for degree 2 of **ISO 12216**.

(4) Closures to access openings into watertight compartments shall be clearly marked on both sides: "WATERTIGHT CLOSURE - KEEP SHUT WHEN UNDER WAY"

(5) Where flotation elements are used, the requirements of **ISO 12217-2** Annex E shall apply.

7. Breaking waves

To provide a degree of protection against being inverted by breaking waves, the multihull size factor shall exceed the required values given in **Table 5.7**.

Table 5.7 Required multihull size factor

Design category	Required multihull size factor		
	if $L/B < 2.2$	if $2.2 \leq L/B \leq 3.2$	if $L/B \geq 3.2$
A	193,600/$(L/B)^2$	40,000	313,600/$(6-L/B)^2$
B	72,600/$(L/B)^2$	15,000	117,600/$(6-L/B)^2$
C and D	not applicable	not applicable	not applicable
NOTE For catamarans: $L/B = L_H/B_{CB}$ For trimarans: $L/B = 2L_H/B_{CB}$			

$1.75 m_{MOC}\sqrt{L_H B_{CB}}$

The minimum operating mass (m_{MOC}) shall be derived from a hull mass obtained from either a weighing or calculation from an observed waterline and the lines plan.

Section 4 Crafts of Hull Length Less than 6 m

401. General

Non-sailing crafts shall be assessed using **402.** Sailing crafts other than habitable multihulls shall be assessed using **403.** Habitable multihull sailing crafts shall be assessed using **Sec. 3**.

402. Tests to be applied to non-sailing crafts

1. General

Non-sailing crafts may be assessed by anyone of six options according to length of hull, amount of flotation and decking, and whether the craft is fitted with suitable recesses complying with **ISO 11812**. These options and the corresponding tests to be applied are given in **Table 5.8**. The design category finally given in respect of stability and buoyancy is that for which the craft satisfies all the relevant requirements.

Table 5.8 Tests to be applied to non-sailing crafts

Option	1(1)	2	3(1)	4	5	6(1)
Applicable to length of hull	Up to 6.0 m			From 4.8 m up to 6.0 m		
Design categories possible	C and D	C and D	D	C and D	D only	C and D
Applicable to engine powers of	Any amount	Any amount	≤ 3 kW	Any amount	Any amount	Any amount
Applicable to the following types of engine installation	Any	Any	Any	Any	Any	Inboard engines only
Decking or covering	Any amount	Fully decked	Any amount	Partially decked	Any amount	Any amount
Downflooding-height test	**402. 2** (2)	**402. 2**	**402. 2**	**402. 2**	**402. 2**	**402. 2**
Offset-load test	**402. 3**	**402. 3**	-	**402. 3**	**402. 3**	**402. 3**
Flotation standard	Level	-	See **402. 6**	-	-	Basic
Flotation test	**402. 4**	-	See 402. 6	-	-	402. 5
Flotation elements	Annex C (3)	-	Annex C (3)	-	-	Annex C (3)
Capsize-recovery test	-	-	402. 6	-	-	-

(NOTES)
(1) Crafts using options 1, 3 and 6 are considered to be susceptible to swamping when used in their design category.
(2) This test is not required to be applied if, when swamped during the test described in **402. 4**, the craft supports an equivalent dry mass of 133 % of the maximum total load, or if the craft does not take on water when heeled to 90° from the upright in light craft condition.
(3) See **ISO 12217-3** Annex C.

2. Downflooding-height tests

(1) Downflooding openings

To be in accordance with **202. 1** (1) (downflooding openings of Non-sailing crafts of hull length greater than or equal to 6 m)

(2) Test and requirements with maximum load

(A) Test

To be in accordance with **202. 1** (2) (test of downflooding height of Non-sailing crafts of hull length greater than or equal to 6 m)

(B) Requirements

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

(i) the method of normative **ISO 12217-3** Annex A, which generally gives the lowest requirement, or

(ii) **Fig 5.10** which is based only on craft length.

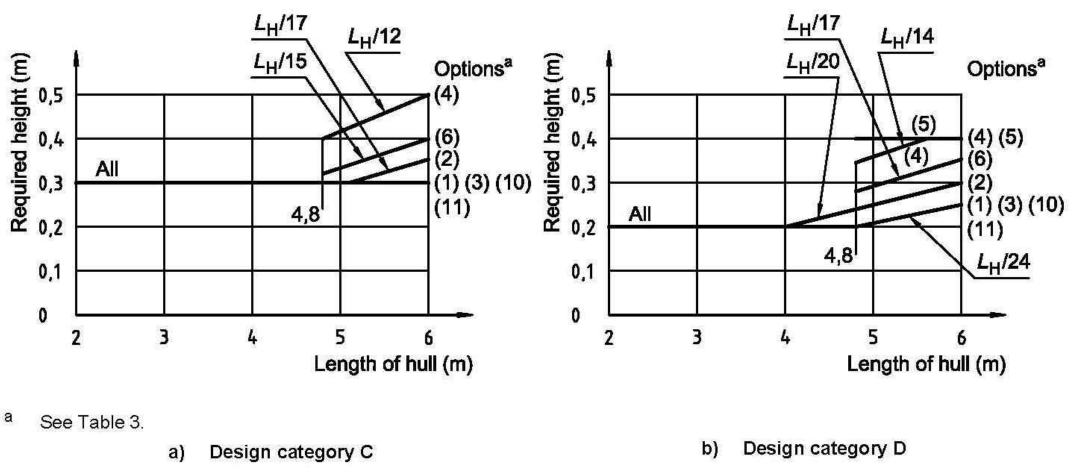
(b) For crafts assessed using options 1, 3, 5 or 6, the required downflooding height within $L_H/3$ of the bow shall be increased as shown in **Fig 5.11**.

(c) Crafts assessed using options 1 or 3 are permitted a 20 % reduction in required down-flooding height in the way of an outboard engine mounting position, provided that the width of this reduction is minimized.

(d) The required downflooding height at the transom shall be reduced by 0.05 m for crafts of design category C using option 1, provided that such crafts have a watertight recess aft (i.e.: cockpit).

(e) Crafts assessed using **Fig 5.10** shall be permitted downflooding openings having a com-bined clear area, expressed in square millimetres (mm^2), of not more than ($50\,L_H^2$) within the aft quarter of L_H provided that the downflooding height to these openings is not less than 3/4 of that required by **Fig 5.10**.

(f) For sailing crafts also equipped for use as non-sailing crafts, the required downflooding height for centreboard, drop keel or dagger-board casings shall be half that determined by (a) above.



[a] See Table 3.

Fig 5.10 Required downflooding height - Design categories C and D

(3) Outboard crafts when starting

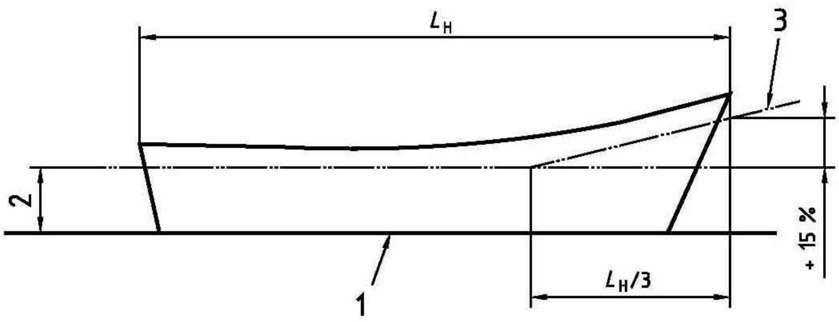
In addition and only applicable to crafts with provision for externally mounted outboard engine(s), the following requirements shall be satisfied,

(A) When the craft is in the light craft condition, with engine(s) fitted and one person of not less than 75 kg positioned 0,5 m forward of the engine attachment point, the least height from the waterline to the point at which the craft could first begin to enter any down-flooding opening shall be greater than 0,1 m.

(B) The mass of petrol engines shall be taken from columns 1 and 3 of **ISO 12217-3** of Tables B.1 and B.2 as appropriate to the maximum power recommended for the craft by the builder. For other engines, the mass of the actual engine shall be used.

3. Offset-load tests

This test is to demonstrate sufficient stability against offset loading by the crew, for unswamped crafts. Details are to be in accordance with **ISO 12217-3**.



Key

1 Waterline
2 Basic downflooding-height requirement
3 Increased requirement forward

Fig 5.11 Increase in required downflooding height – Options 1, 3, 5 and 6 (see Table 5.8)

4. Level flotation test

This test is to demonstrate adequate swamped buoyancy and stability. Details are to be in accordance with **ISO 12217-3**.

5. Basic flotation test

This test is to demonstrate that the craft has sufficient flotation to satisfy the swamped buoyancy load test. Details are to be in accordance with **ISO 12217-3**.

6. Capsize-recovery test

This test is to demonstrate that a capsized craft can be returned to the upright by the actions of the crew using their body action and/or righting devices purposely designed and permanently fitted to the craft, that it will subsequently float, and to verify that the recommended minimum crew mass is sufficient for the recovery method used. Details are to be in accordance with **ISO 12217-3**.

403. Tests to be applied to sailing crafts

1. General

Sailing crafts other than habitable multihulls may be assessed by anyone of five options according to amount of flotation and decking. These options and the tests to be applied are given in **Table 5.9.** Habitable multihull sailing crafts shall be assessed using **ISO 12217-2**. If a sailing craft is also equipped for use as a non-sailing craft, e.g. for rowing or for engine propulsion, it shall also meet the requirements for non-sailing crafts.

The design category finally given in respect of stability and buoyancy is that for which the craft satisfies all the relevant requirements.

2. Downflooding-height tests

The downflooding-height tests shall be conducted in accordance with **402. 2**, either by practical testing or by calculation.

3. Flotation tests

(1) Level flotation test
The purpose of the level flotation test is to demonstrate adequate swamped buoyancy and stability. Details are to be in accordance with **ISO 12217-3**.

(2) Basic flotation test
The purpose of the basic flotation test is to demonstrate that the craft has sufficient swamped buoyancy. Details are to be in accordance with **ISO 12217-3**.

Table 5.9 Tests to be applied to sailing crafts

Option	7[(1)]	8[(1)]	9[(1)]	10	11
Categories possible	C and D	C and D	C and D	C and D	C and D
Applicable to hull types	All	Monohull only	Monohull only	All	All
Decking or covering	Any amount	Any amount	Any amount	Fully decked	Fully decked
Downflooding-height test	-	-	-	403. 2	403. 2
Flotation standard	-	Level (Cat C) Basic (Cat D)	Level (Cat C)[(2)] Basic (Cat D)[(2)]	-	-
Flotation test	-	403. 3	403. 3[(2)]	-	-
Flotation elements	Annex C[(3)]	Annex C[(3)]	Annex C[(3)]	-	-
Capsize-recovery test	403. 4	-	-	-	-
Knockdown-recovery test	-	403. 5	-	403. 5	-
Wind stiffness test	-	-	403. 6	-	403. 6

Note :
(1) Crafts using options 7, 8 and 9 are considered to be susceptible to swamping when used in their design category, excepting those crafts using option9 and covered by the exemptions given in foot-note b.
(2) Flotation testing is not required for crafts satisfying the exemptions given in **403. 3** (1) or (2).
(3) See **ISO 12217-3** Annex C.

4. Capsize-recovery test

(1) The capsize-recovery test shall be conducted in accordance with **402. 6** (1) to (9), with the following additional preparations:
(A) fore-and-aft sails shall be hoisted and set;
(B) centreboard(s) or keel(s) shall be lowered.
(2) Crafts passing the above test shall be given either design category C or D at the discretion of the builder, and shall be permanently marked in a prominent position with the symbols shown in **Fig 5.12.**

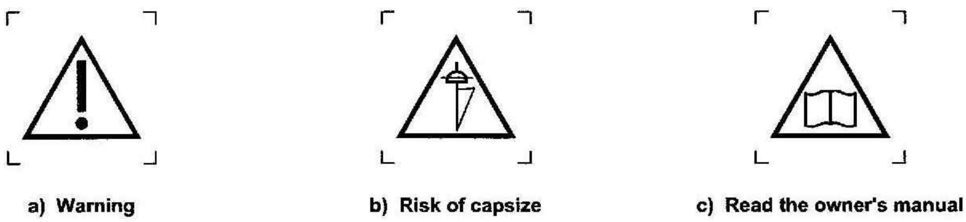


Fig 5.12 Warning symbols

5. Knockdown-recovery test

This test is to demonstrate that a craft can return to the upright unaided after being knocked down. Details are to be in accordance with **ISO 12217-3**.

6. Wind stiffness test

This test is to demonstrate that, when a sailing craft is heeled to a steady wind speed appropriate to the design category, the craft does not start flooding. Details are to be in accordance with **ISO 12217-3**.

Section 5 Maximum Load Capacity

501. Scope

This section lists items to be included in the maximum load of small craft without exceeding the limits set by other **ISO** standards for stability, freeboard, flotation and crew. It further sets requirements for seating of crew members.

502. Definitions

For the purpose of this section, the following terms and definitions apply.

1. Seat

Any surface, horizontal or nearly horizontal, where a person may sit, with minimum dimensions of 400 mm width by 750 mm length (i.e. depth of the seat plus clear foot space in front of the seat)

2. Seating area

Clear sole space in an open craft or in a cockpit provided that an area measuring 750 mm x 750 mm be available for each person so accommodated.

503. Maximum number of persons

The manufacturer's recommended maximum number of persons to be carried when the craft is underway shall not exceed

1. The number of persons for which the craft has successfully passed the requirements for freeboard, stability and flotation in accordance with **Sec2, 3** and **4**;
2. The number of persons for which seating space is assigned by the manufacturer with dimensions as defined in **502. 2.** and **3.**

504. Maximum load

The term "maximum load" is to be understood as the "manufacturer's recommended maximum load". This shall not exceed the total load that may be added to the light craft mass in accordance with **ISO 8666** without exceeding the requirements for stability, freeboard, flotation in accordance with **Sec2, 3** and **4**, and seating requirements and shall take into account the craft design category. As a minimum it shall take account of the mass of the following:

1. The number of persons at 75 kg each according to **503**. Where children are carried as part of the crew the maximum number of persons may be exceeded provided that each child's mass does not surpass a limit of 37.5 kg and the total persons mass is not exceeded ;
2. Basic equipment of $(L_{H-2.5})^2$, but not less than 10 kg;
3. Stores and cargo (if any), dry provisions, consumable liquids [not covered by **4** or **5**], and miscellaneous equipment not included in the light craft mass or in **2**;
4. Consumable liquids (fresh water, fuel) in portable tanks filled to the maximum capacity;
5. Consumable liquids (fresh water, fuel) in permanently installed tanks filled to the maximum capacity;
6. A liferaft or dinghy when intended to be carried. ⚓

CHAPTER 6 HULL EQUIPMENT

Section 1 Proteciton against Falling Overboard and Reboarding

101. General

Crafts are to be designed to minimize the risk of falling overboard and to facilitate reboarding.

102. Working deck

1. Functions of the working deck

Safe access to the following areas shall be provided either via the working deck, the interior of the craft or combination thereof:

(1) craft steering including emergency steering;
(2) strong points;
(3) sail handling and trimming;
(4) interior;
(5) engine room compartment.

2. Means of protection

Protection against falling overboard from the working deck shall be achieved by applying one of the relevant options as listed in **Table 6.1** or **Table 6.2**, taking into account the type or design of the craft and the intended use, within the limits of the design category chosen.

3. Minimum width of decks

(1) be free, continuous and not angled transversally more than 15° from the horizontal, when the craft is upright
(2) have a width of at least 100 mm for design category D, 120 mm for category C, and 150 mm for category A or B measured perpendicular
(3) to the foot stop inner limit or
(4) the lateral outer deck edge of the deck if there is no foot stop.

4. Continuity of the working deck

Working deck areas shall be connected, this may include passage through the interior. Special provision shall be made where changes in elevation or obstacles have to be surpassed. Steps higher than 500 mm and obstacles higher or longer than 500 mm shall be avoided.

103. Tables of requirements

1. General

The requirements are presented in **Tables 6.1** and **6.2**. For each design category, an “×” signifies that the corresponding safety device is required.

104. Specific requirement for slip-resistant areas

1. General

Working deck areas shall be slip-resistant. The spacing between slip-resistant patches shall not be greater than

(1) 75 mm for non-glazed areas
(2) 500 mm for glazed areas, unless the lateral sides of the area are fitted with foot stops

2. Requirements for trampolines and nets

Trampolines and nets which are part of the working deck shall have slip-resistant characteristics.

Any opening within the working deck area having a depth greater than 1 m and not provided with a hatch or lid shall be surrounded by guard-rails as required or fitted with trampolines or nets.

Table 6.1 Requirements for non-sailing crafts

Safety device	Design category					
	A	B	B	B	C	D
		L_H 〉 8.5m	$L_H \le$ 8.5m			
Slip resistant surface	×	×	×	×	×	×
Foot-stop	×	×	×	×		
Handholds	×	×	×	×	×	×
Low guard-rail or low guard-line			×			
High guard-rail or high guard-line	×	×				
Hooking points	×			×		
Body support on high-speed craft(if relevant)	×	×	×	×	×	×
Means of reboarding	×	×	×	×	×	×
NOTE A handhold meeting the requirements of **111.** may also be a hooking point.						

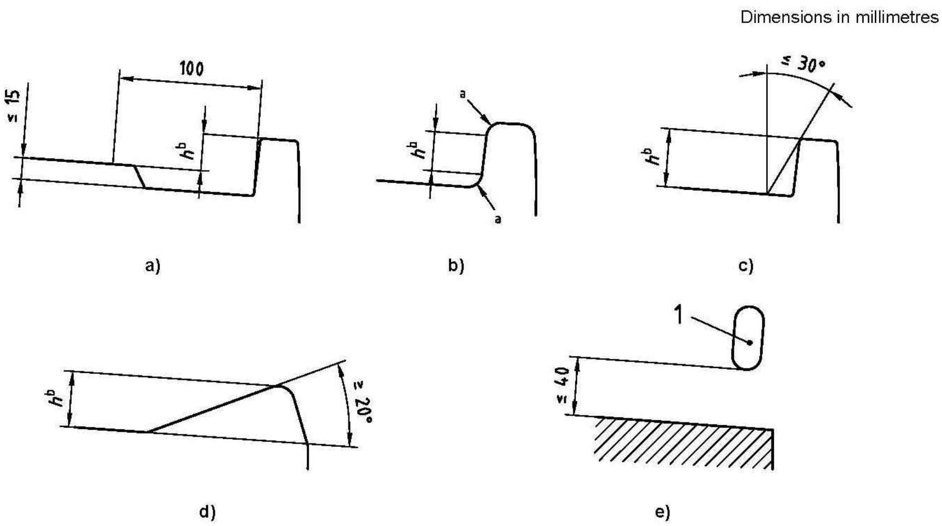
Table 6.2 Requirements for sailing crafts

Safety device	Design category					
	A	B and C	B and C	C	C[2]	D
		L_H 〉 8.5m	$L_H \le$ 8.5m	daytime		
Slip resistant surface	×	×	×	×	×	×
Foot-stop	×	×	×	×		
Handholds	×	×	×	×	×	×
Low guard-rail or low guard-line			×			
High guard-rail or low guard-line	×	×				
Hooking points[1]	×	×	×	×		
Jack-line attachment points	×	×	×			
Means of reboarding	×	×	×	×	×	×
NOTE 1. A handhold meeting the requirements of **111.** may also be a hooking point. 2. Limited to sailing crafts, either capsize or knockdown recoverable or fitted with flotation according to **Ch 5.**						

105. Requirements for foot-stops

1. General

Fig 6.1 shows a few examples of foot-stops.



Key

1 Foot-stop above deck level

a Fillet radius > 5 mm

b h according to 8.3

Fig 6.1 Diagram illustrating the requirements of 3, 4, 5 and 6

2. Provision of foot-stops

Foot-stops shall be provided as close as practicable to the outboard edges of the working deck.

Foot-stops are not required on the following:

(1) parts of the working deck where people are not intended to walk but only sit when the craft is underway, such as sailing craft deck edge where the crew hikes;
(2) the aft limit (perpendicular to the longitudinal axis) of monohull working deck, e.g. top of transoms;
(3) the aft limit (perpendicular to the longitudinal axis) of the rigid part of multihull working deck;
(4) front and aft beams (perpendicular to the longitudinal axis) of multihulls.

3. Minimum height and angle of foot-stop

The height of the upper edge of the foot-stop above the adjacent working deck level shall not be less than:

(1) for crafts of design category C
   - 25 mm for sailing crafts,
   - 20 mm for non-sailing crafts;
(2) for crafts of design category A and B
   - 30 mm for sailing crafts,
   - 25 mm for non-sailing crafts.

These heights are the smallest distances, measured perpendicularly to the deck, from the highest inner point of the foot-stop to the highest point of the deck within 100 mm of the foot-stop [see **Fig 6.1** a)].

If the edges of the foot-stop have a fillet radius greater than 5 mm, the height of the foot stop shall be measured between the closest points of these fillets [see **Fig 6.1** b)].

To stop the foot from slipping outboard, the angle in the internal face (or of a tangent to it) shall not be more than 30° from the vertical [see **Fig 6.1** c)], except on non-sailing crafts using the device described in **4** (for non-sailing crafts only).

4. Foot-stops made of angled surfaces

Angled surfaces foot-stops are allowed on non-sailing crafts of design categories C and D. These surfaces shall have an inclination of not less than 20° from the horizontal and a height according to **3** [see **Fig 6.1** d)].

These angled surfaces shall be slip-resistant.

5. Maximum foot-stop clearance between deck and foot stop

If there is a vertical clearance between deck and foot-stop level the open spaces between the deck level and the bottom of the lowest foot-stopping point shall not be greater than 40 mm [see **Fig 6.1** e)].

Ex) Soft or rigid line parallel to the working deck.

6. Continuity on the working deck level in way of the foot-stop

In order to guarantee foot-stopping action there shall be no step in the working deck level greater than 15 mm within 100 mm from the foot-stop [see **Fig 6.1** a)].

7. Gaps in the foot-stop rail

Gaps in the foot-stop rail are allowed for stanchions, pulpit feet, cleats, etc. or for water drainage, but each gap shall not be greater than 100 mm to the edge of the adjacent fitting or foot stop rail. This distance shall be measured parallel to the foot stop general line.

Fittings providing foot-stopping action are considered to be local foot-stops.

106. Requirements for handholds

1. Location in way of side decks

(1) Handholds fitted less than 300 mm inboard from the outer working deck edge shall be placed at least 350 mm above deck level, but not higher than the adjacent superstructure.
(2) On the route along the outer edges of the working deck, the maximum distance between two adjacent handholds shall not exceed 1.5 m.

107. Common requirements for low and high guard-rails and guard-lines

1. General

Guard-rails may be required, either low guard-rail/low guard-line (h ≥ 450 mm) or high guard-rail/high guard-line (h ≥ 600 mm) as specified in **2.**

Guard-rails shall completely surround the outer edges of the working deck except in the transversal direction as permitted by **3**, **6** and **8**.

2. Height of guard-rails or guard-lines

Low guard-rails/ low guard-lines shall have a height of at least 450 mm.

High guard-rails/ high guard-lines shall have a height of at least 600 mm.

If there are discontinuities in the working deck level, the vertical gap between the lowest guard-rail/guard-line and the deck or foot-stop, coaming, bulwark, etc., whichever is higher, shall not be greater than

- 560 mm for low guard-rail or low guard-line [see **Fig 6.2** a)];
- 380 mm for the intermediate line of a high guard-rail or guard-line [see **Fig 6.2** b)].

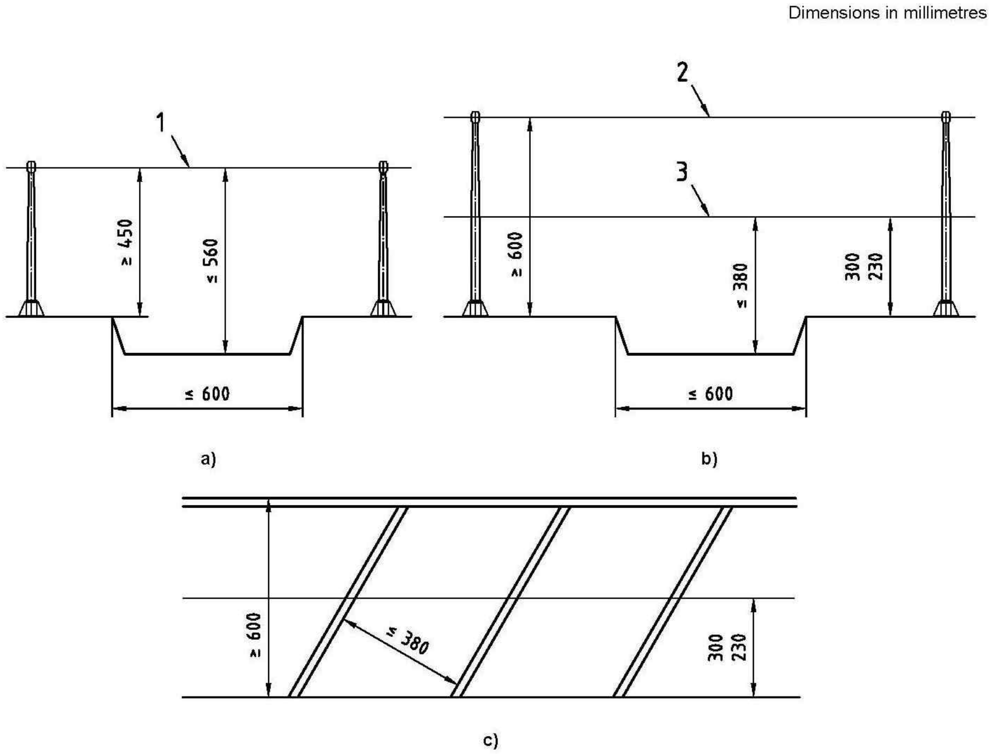
The length of these discontinuities in the main deck area shall not be greater than 600 mm, when measured parallel to the guard-rail/guard-line mean direction [see **Figs 6.2** a) and b)].

3. Intermediate lines, vertical spacing and maximum gap

On non-sailing crafts, rigid high guard-rails and pulpits need not be fitted with intermediate lines.

If high guard-rail/guard-lines are installed, an intermediate guard-rail shall be fitted, the gap between this intermediate line and the deck, foot, stop, bulwark, etc, whichever is higher, shall not be greater than 300 mm.

As an alternative, the intermediate line may be replaced by any device limiting the gap between two adjacent protections below 380 mm, in any direction [see **Fig 6.2** c)].



Key

1 Low guard-line (450 mm)

2 High guard-line (600 mm)

3 Intermediate line

Fig 6.2 Diagram illustrating the requirements of 2 and 3

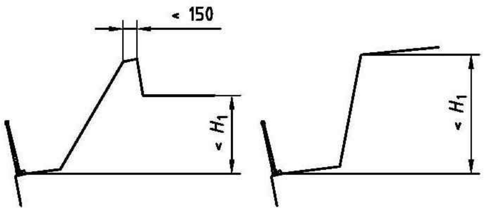
4. Risk of falling overboard from elevated parts

Even when protected from falling overboard by guard-rail/guard-line there is a risk of falling overboard from higher parts of the working deck (See **Fig 6.3.**).

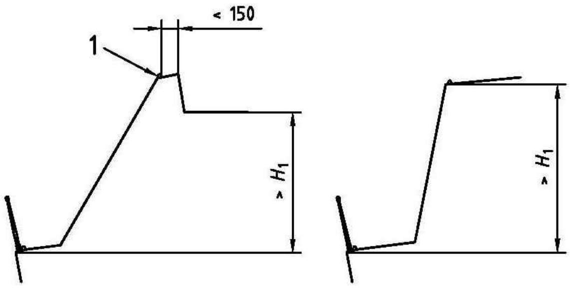
Therefore

- any part of the working deck located higher than H_1 from the adjacent part of the working deck shall at least be equipped with foot-stop according to **107.**;
- any part of the working deck located higher than H_2 from the adjacent part of the working deck shall at least be equipped with foot-stop according to **107.** and guard-rails/guard-lines having the same height as at the outer periphery of the deck.

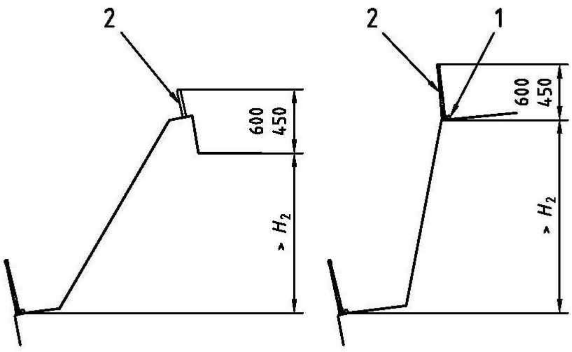
Dimensions in millimetres



a) Actual height < H_1: no specific requirement



b) Actual height > H_1: foot-stop required



c) Actual height > H_2: foot-stop and guard-rail/line required

Key

1 Foot-stop

2 Guard-rail/line

Fig 6.3 Diagram illustrating the requirements of 4

H_1 and H_2 are function of the height of the guard-rail/guard-line and defined in **Table 6.3**.

Table 6.3 Values of H_1 and H_2 according to guard-rail/guard-line height

Dimensions in millimetres

Guard-rail/line height	H_1	H_2
450	700	1200
600	900	1500

5. Openings in guard-rails/guard-lines

To facilitate boarding or reboarding of people or equipment, openings in the guard-rail/guard-lines are allowed, provided that permanently fixed and quickly operable mobile sections are fitted in way of these openings. These sections shall be designed not to open inadvertently.

Openings in guard-rails/guard-lines are also allowed for the passage of sails, provided that there is no gap transversally and that the space between the rails does not exceed 150 mm.

6. Bow pulpits for sailing crafts

Bow pulpits may be open but the opening between the pulpit and any part of the craft shall never be greater than 360 mm.

7. Transom guard-rails/guard-lines for sailing crafts

(1) On crafts where a high guard-rail/guard-line is required:
- the aft pulpits in way of the transom or guard-line support shall have at least the required 600 mm height;
- the transversal line need not meet the requirements of **1**, **2** and **3** provided that
  - the height of the line is at least 450 mm above any part of the seat;
  - the height of the line is at least 800 mm above any part of the cockpit bottom local level;
  - there is a handhold according to **106.** allowing an athwartship grip line higher than 600 mm not farther than 1,250 mm from the line end;
  - the horizontal distance between two adjacent supports is not greater than 2,500 mm.

See Fig 6.4.

(2) On crafts where a low guard-rail/guard-line is required:
- the aft pulpits in way of the transom or guard-line support shall have at least the required 450 mm height;
- the transversal line need not meet the requirements of **1**, **2**, **3** provided that
  - the height of the line is at least 300 mm above any part of the seat level;
  - the height of the line is at least 650 mm above any part of the cockpit bottom local level;
  - there is a handhold according to **106.** allowing an athwartship grip line higher than 600 mm not farther than 1,000 mm from the line end;
  - the horizontal distance between two adjacent supports is not greater than 2,000 mm.

See **Fig 6.4**.

8. Forward cross beams of sailing catamarans

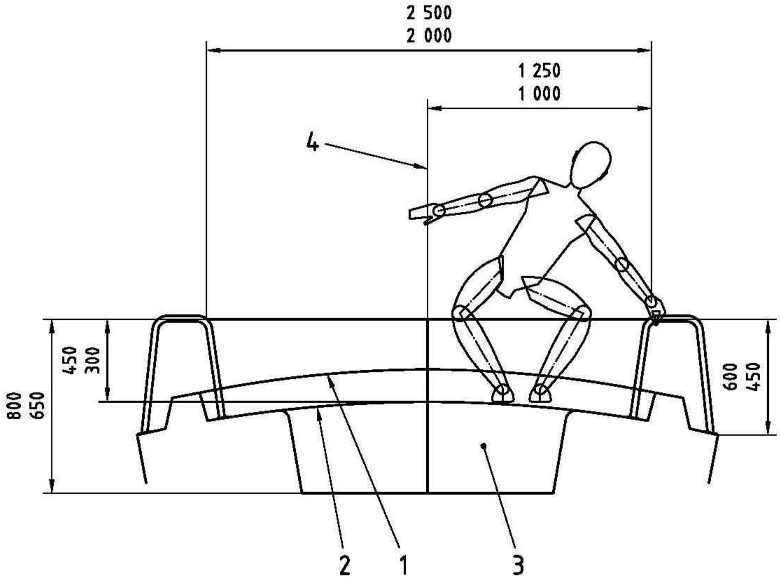
On sailing catamarans, the wire/rod and stanchion bracing on forward cross beam may be regarded as a guardrail/guard-line, even if its height varies from the minimum required height to zero at the beam end. The minimum height of this wire/rod at centreline shall be according to the option of **Table 6.2** for guard-rail/guard-line height.

Similarly, the height of the longitudinal guard-rail/guard-line system on the outer edges of the hulls may diminish to zero in way of the forward beam. As long as the greatest distance between possible handhold points on the transverse and longitudinal guard-rails shall not be greater than 0,75 m.

9. Central hull of sailing trimarans

On sailing trimarans, guard-rails/guard-lines may be omitted on the central hull in the areas where a person falling from the working deck would land on a trampoline, which shall have a width of at least 700 mm in these areas.

Dimensions in millimetres



Key

1 Aft coaming

2 Seat level

3 Cockpit level

4 Handhold (backstay, radar pole, etc.)

Fig 6.4 Transom diagram facing aft, illustrating the requirement of 7

108. Requirements for stanchions or guard-line supports

1. Spacing

The spacing between stanchions or guard-line supports shall not be greater than 2,2 m.

2. Fixture and disposition of stanchion and line supports

Stanchions/line supports shall not be angled outboard more than 10° from the vertical, at any point above 50 mm from the deck.

109. Requirements for hooking points

1. General

Hooking points are eye, fitting, or any device to which people can clip directly a safety harness and be able to move around an area of the working deck.

2. Location

Hooking points shall be located as follows :

(1) within 1 m of the edge of the main access hatch/door;
(2) within 2 m of all outside steering positions;
(3) within 2 m of the mast of sailing crafts;
(4) within 2 m of the winch positions of sailing crafts;
(5) within 2 m of the windlass or towing strong point(s).

Hooking points shall be located no more than 3 m apart.

Habitable sailing multihulls of design category A and B shall be fitted with at least one hooking point in the vicinity of each escape hatch, to be used if the craft is in the inverted position.

3. Size

In order to allow a correct closing of the harness hook, any hooking point shall be inscribed within a circle of 15 mm diameter.

110. Attachment points for jack-lines

1. General

Jack-line means flexible line or rigid bar intended for attachment of the safety harness allowing safe movement of the crew along its length when attached.

2. Fitting

Attachment points for jack-lines shall be fitted on deck, port and starboard to provide secure fixing for jack-lines. These lines shall be long enough to allow the movements on the working deck needed for craft operation.

Jack-lines may be fitted in sections, but each section of jack-line shall be as long as practicable. Attachment points shall be fitted at the ends of each section.

111. Body support on high-speed crafts

1. General

High-speed crafts shall be fitted with means of support for each of its occupants, when the craft is underway, limiting the risk of being thrown overboard in case of sharp turns, strong acceleration, or movements in the sea.

To provide support, one of the following option shall be chosen, for each person:

- one handhold plus body support as required in **2**;
- two handholds allowing simultaneous gripping of both hands.

2. Body support

If the occupants are seated, the body support shall have a height of no less than 120 mm above the rigid bottom of the seat or where a cushion is if fitted, with the cushion fully compressed.

If the occupants are standing or leaning, the body support may only provide support for the back or the torso.

If the occupants are sitting riding astride a seat, i.e. riding, the body support may be provided by the action of the knees.

112. Means of reboarding

It shall be equipped with a specific means of reboarding from the water, e.g. ladders, steps, handholds, brackets.

The ladders have the lowest point serving as foot step located at least 300 mm below the waterline.

Reboarding means is rigid or flexible fitting or part of the hull which allows a person to reboard without assistance

113. Requirements for strength

Requirements for strength of each safety device shall comply with **ISO 15085**.

114. Owner’s manual

The owner’s manual provided with the craft shall indicate the items specified in **Table 6.4**.

Table 6.4 Requirements for owner's manual

Subclause in ISO 15085	Required indication in owner's manual
102. 1	If appropriate, a text or a sketch in the owner's manual shall indicate the working deck area(s) defined by the craft builder.
Table 6.2, Design Category C(Daytime)	A sentence in the owner's manual shall indicate that the craft is only intended for daytime sailing and not for use at night.
107	If relevant, information on maintenance requirements for guard-lines pointing out the need for periodic inspection of synthetic wires for UV degradation and chafe that might necessitate replacement.
112	Description of the means of reboarding.

Section 2 Windows, Portlights, Hatches, Deadlights and Doors

201. Terms

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

1. Appliance location area

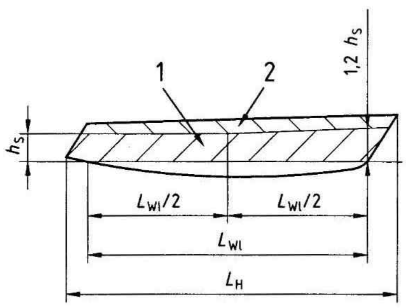
Area of the craft where the appliance is fitted

See **ISO 12216** Annex A for sketches showing examples of appliance location areas.

(1) Area I

Part of the hull sides situated above waterline, i.e. up to its intersection with the weather deck (for decked craft), or the upper edge of the hull (for open craft or partially decked craft), but only to the following upper boundary:

- a horizontal line located at the height h_S above waterline in the rear half of the waterline (see **Fig 6.5**);
- a sloped line having a height h_S at mid waterline, and a height 1.2 h_S at the front end of the waterline, with
  - $h_S = L_H/12$ for sailing monohulls.
  - $h_S = L_H/17$ for non-sailing crafts, sailing catamarans and central hull of sailing trimarans.



Key

1 Area I

2 Area II b

Fig 6.5 Limits of Areas I and II b

(2) Area II a

Area, other than Area I, where persons are liable to walk or step, such as decks, super-structures, cockpit soles, at an inclination of less than 25° to the horizontal in a longitudinal di-rection, and at an inclination of less than 50° to the horizontal in the transversal direction re-spectively for sailing monohulls, or 25° for multihulls

(3) Area II b
Areas from the hull sides not belonging to Area I
(4) Area III
Area, other than Area I or II
(5) Area IV
Parts of Area III protected from the direct impact of sea or slamming waves

2. Type of plate end connection

See **ISO 12216** Annex B for sketches showing examples of types of plate end-connection.

(1) Semi-fixed (SF plate)
Plate fixed in a way to restrict deflection and prevent lateral movement at its boundaries
(2) Simply supported (SS plate)
Plate that can deflect at its boundaries and/or perform lateral movement
(3) Flexibly connected plate
Simply supported plate where the connection is achieved by an elastic support around the perimeter of the plate

202. General requirements

To avoid flooding, all appliances shall be designed and fixed to prevent substantial ingress of water when closed.

1. Minimum degree of watertightness

The required minimum degree of watertightness of an appliance is a function of the craft's design category. These requirements are given in **Table 6.5.**

Table 6.5 Minimum degree of watertightness

Type of craft	Appliance location area	Type of appliance	Design category			
			A	B	C	D
Any	Area I	Any	2	2	2	2
Any	Area II	Any	2	2	3	4
Any	Area II	Sliding companionway hatch	3	3	3	4
Any	Area III	Any	3	3	3	4
Sailing monohull	Area IV	Any	3	3	3	4
Non-sailing + Multihull	Area IV	Any	3	3	4	4

2. Additional requirements related to watertightness

(1) Sliding appliances
Sliding appliances shall not be used in Area I.
(2) Deck hatches of trimaran outrigger hulls
Hatches fitted on the decks of trimaran outrigger hulls shall not be sliding appliances.

203. Plate materials

1. General

Appliance plates shall be made of

(1) A transparent glazing material, such as poly(methyl)methacrylate (PMMA), polycarbonate (PC), tempered glass, chemically reinforced glass or laminated glass, or
(2) A non-transparent plate material, such as plywood (PW), glass-fibre reinforced thermosetting plastic (GRP), aluminium alloy, steel, etc.; or
(3) Any other material of strength and stiffness equivalent to those cited above.

2. Acrylic sheet materials

Poly(methyl)methacrylate (PMMA) made with a technique other than the casting procedure shall have mechanical properties and resistance to ageing at least equal to those of cast PMMA

3. Glass

The use of glass is restricted to (1) and (2) plus **204. 1** (1) (A) for use of simply supported plates, **204. 3** (1) (D) for use in Area I and **204. 3** (2) for use in Area II.

(1) Monolithic glass
Monolithic glass shall only be made of tempered glass, or chemically reinforced glass.

(2) Laminated glass
The glass plies used in laminated glass can be made of any type of glass.

204. Specific requirements

1. End connection and location of plate

(1) Simply supported plates

(A) Plates in Area I
Simply supported plates shall not be used in Area I:
- on sailing monohulls in design categories A and B and sailing multihulls in design category A;
- on non-sailing crafts in design category A.

On other types of craft and design categories, simply supported plates may be used provided that all the following conditions are met:
- the glazing material is PMMA or PC (see clause **203.**) ;
- the plate thickness is equal to 1.3 times the one required by clause 205. ;
- the fixing devices of the plate (hinge bolts, fixing knob, etc.) are not spaced more than 250 mm.

The above restrictions of use need not be considered if the appliance is equipped with a deadlight meeting the requirements of **3** (6).

(B) Flexibly connected plates
Flexibly connected plates may only be used on non-sailing crafts of design categories C and D in Areas III and IV.

(2) Semi-fixed plates

(A) Plates made of material other than glass
Semi-fixed plates may be used in crafts of all design categories and in all location areas with the restrictions of the special requirements given in **3**.
This type of end connection can be achieved by one of the following means.

(a) Connected with a counter frame: The edge fixity is achieved by pinching the plate at its periphery between the craft shell or a frame and a counter frame. The counter frame shall be mechanically fastened and/or glued to the structure of the craft.

(b) Connected by gluing: The edge fixity is achieved by gluing the plate at its periphery to the craft shell, to the structure of the craft or to a frame. This gluing can either be in a rabbet or a face, edge gluing or any combination of these gluing methods.

(c) Connected by direct fastening: The edge fixity is achieved by fastening the plate inside its periphery to the shell, the structure of the craft or to a frame by correctly spaced and sized mechanical fasteners. These fasteners may be bolts, rivets, self-tapping screws or any adequate mechanical fasteners.

(B) Plates made of glass
Metal to glass contact shall be avoided.

2. Fastening requirements

(1) Fastening of plates and frames
Plates and frames can be fastened by mechanical means, glue or elastomer joints. All types of fastening shall ensure watertightness of the plate or frame, and resistance to loads due to normal operating pressure.
Every part of the mechanical elements connecting appliances to the rest of the craft shall be capable of withstanding, without breaking, twice the force induced by the pressure loads defined in **205.** This requirement shall be verified for inwards opening appliances, where hinges, locks or any other part of the link chain between the plate and the support shall be checked by calcu-

lation or testing in accordance with **ISO 12216** Annex D D.2.

(2) Fastening of semi-fixed plates

Mechanical fasteners shall not induce parasitic stresses due to deflection or temperature changes, nor stress concentration or stress raising.

Additional stresses brought by cold forming shall be considered when determining the plate scantlings in **205.**

(3) Fastening of glued plates

Glued joints shall be resistant to (or protected against) sunlight (UV, heat, etc.) and all environmental effects or cleaning chemicals normally encountered in the manufacture and use of the craft.

Glued joints shall fulfil the requirements of one of the following items:

(A) the inside pressure test (**ISO 12216** Annex D D.3.2);

(B) the separation test (**ISO 12216** Annex D D.3.3);

(C) the manufacturer's gluing procedure and conditions are followed and the bond strength checked by calculation to meet test pressure in **ISO 12216** Annex D D.3.2.2.

The above requirements shall be verified after any change in material or gluing procedure.

Plates, with or without framing, are considered glued if they are fastened with mechanical devices, such as bolts, rivets or screws, spaced more than 20 times t, where t is the nominal plate thickness defined in **205.**

3. Special requirements

(1) Appliances fitted in Area I

(A) Height above waterline and maximum short side dimension

The lower edge of any opening appliance shall be placed at least 200 mm above the waterline, the craft being in the fully loaded ready-far-use condition and upright. These opening appliances shall in any case be located according to the relevant requirements of **Ch 5**.

The small unsupported dimension b (or the equivalent of b) of any appliance (see **ISO 12216** Annex C) placed in Area I shall not exceed 300 mm.

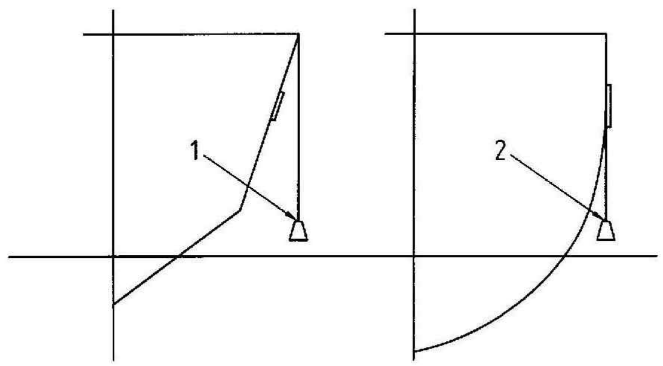
The above requirements do not apply to escape hatches of sailing multihulls, or designated escape hatches, when required by **ISO 9094**.

(B) Opening side

All opening appliances shall open inwards, with the exception of multihull escape hatches or designated escape hatches, when required by **ISO 9094**.

(C) Protection

On crafts of design categories A and B, no part of the plate or its framing shall extend outside the local vertical tangent to the hull, deck, rubbing strake, fixed fender, or of a built-in fairing which is an integral part of the hull. **Fig 6.6** explains this requirement.



Key

1 The local vertical tangent is outside the porthole: no problem

2 The local vertical tangent is inside the porthole: the porthole shall either be placed in a recess or protected by a built-in fairing

Fig 6.6 Sketch explaining the requirement of (C)

(D) Use of glass

Glass shall not be used on sailing crafts of all design categories and on non-sailing crafts of design categories A and B, unless the plate is made of high-impact-resistance glass, or if the appliance is equipped with a deadlight meeting the requirements of (6). High-impact-resistant glass types are listed in normative **ISO 12216** Annex E.

(2) Appliances fitted in Area II a

(A) Use of glass

On non-sailing crafts, the usage of monolithic and laminated glass is accepted without restriction.

On sailing crafts, neither monolithic nor laminated glass shall be used forward of the mast or foremast, unless the plate is made of high-impact-resistance glass, or if the appliance is equipped with a deadlight meeting the requirements of (6). High-impact-resistance glass types are listed in **ISO 12216** Annex E.

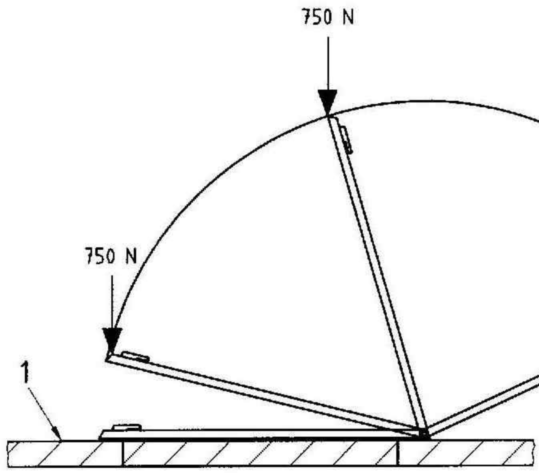
This restriction need not be considered if the plate is protected against shocks by an adequate device.

(B) Tests on hinged deck hatches

(a) Unintentional stepping test

The test is performed on a hinged deck hatch fixed to a rigid flat support of dimensions twice those of the hatch, as shown in **Fig 6.7**.

The hatch is open in any position, up to its maximum operating position, and shall be able to withstand a concentrated force of 750 N applied anywhere on the outside edge of the hatch, without permanent deformation or damage to the hatch, its framing or hinge. The hatch will normally close under the applied force, and the system that is used to maintain the hatch open may be damaged. The hatch is considered to fulfil the requirements of this test if the integrity of the hatch, and its closing and watertightness capabilities, are maintained.



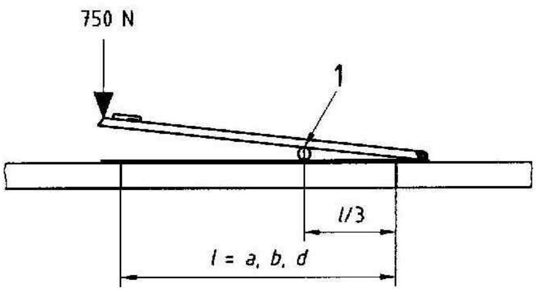
Key

1 Flat plate (see 6.3.2.2.1)

Fig 6.7 Unintentional stepping test

(b) Rope jamming test

The test is performed on the same test device and loading as in (a), but with a 14 mm, three-strand polypropylene rope simultaneously jamming both sides, as shown in **Fig 6.8.** The test is considered as passed if there is no permanent deformation or damage to the plate, its framing or hinges.



Key

1 Three-strands polypropylene rope of diameter 14 mm

Fig 6.8 Rope jamming test

(c) Hatch and hinge strength test

The test is performed on the same test device as in (a), with the hatch open at 90°, as shown in **Fig 6.9**.

Apply a twisting torque made by two parallel and opposite forces of 200 N, acting on the two outside corners (or horizontal diameter) of the opening part of the hatch.

The test is considered as passed if there is no permanent deformation or damage to the plate, its framing or hinges.

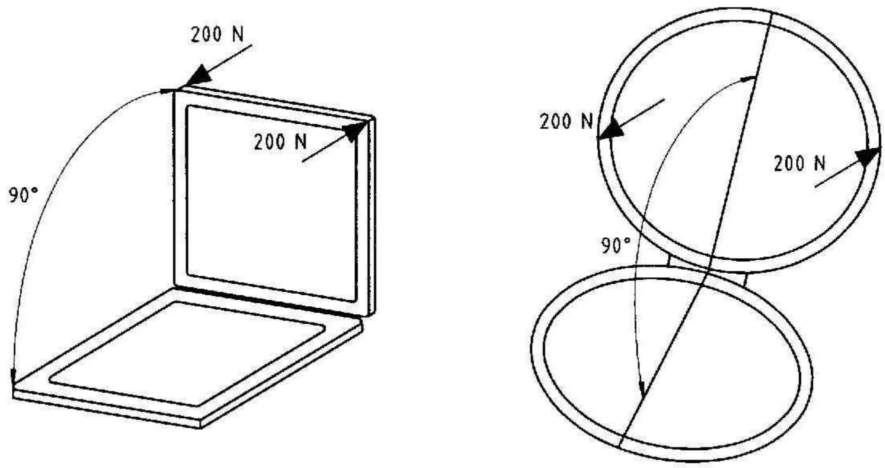


Fig 6.9 Hatch and hinge strength test

(3) Sliding appliances

(A) Rabbet depth

The depth of the rabbet shall be sufficient to prevent any disengagement of the plate under the pressure loads defined in **205.**, taking into account the size of the appliance, the material of which it is made, and the rigidity of the structure it is fixed on. For unframed plates made of PMMA, PC, or materials with similar modulus of elasticity, this depth shall be at least 12 mm.

(B) Stops

The appliance shall be fitted with stops at each end of its stroke to prevent any disengagement of the sliding part of the frame.

(4) Doors made with removable sections: washboards

Doors made with removable sections, usually called "washboards", shall be

(A) fitted with a device to keep them in position, when in use, and to be at least operable from inside, and

(B) stored inside the craft in the vicinity of the door opening, and easily reached without the use of tools.

Craft of design category A shall be equipped with a device connecting the boards together when not in use.

(5) Locking system

Any appliance shall have a locking device which maintains it in a closed position, operable at least from inside.

On doors, this system shall be operable from both sides.

In crafts of design categories A and B, if the companionway door is used together with a companionway hatch, the locking device need only be efficient when both the door and the hatch are closed together. In this case, if the companionway door is made with washboards, the locking device may only act between the upper panel of the washboard and the hatch.

(6) Deadlights

Any part of a deadlight shall meet the requirements of **405.** and **407. 2**. Deadlights of windows fitted in Area I. if required, shall be permanently attached to the appliance, its framing, or the craft structure, and be operative even in the case of rupture of the opening part of the window.

(7) Multihull escape hatches

(A) Minimum dimensions

On crafts with L_H 〉 12 m, the multihull escape hatches shall have the following minimum clearing characteristics:

- circular shape: diameter of at least 450 mm;
- any other shape: a minimum dimension of 380 mm and 0,18 m^2 minimum area. The hatch shall be big enough for a 380 mm diameter circle to be inscribed.

(B) Material

Glass shall not be used, unless it is high-impact-resistance glass. High-impact-resistance glass types are listed in **ISO 12216** Annex E.

(C) Opening and hinge disposition

Multihull escape hatches shall be free to open from the inside and the outside when secured but unlocked.

The hinge or hinges of an escape hatch that opens outwards shall be such that the hatch cannot be torn out by the action of the sea if it is partially, or totally, opened.

(8) Commercially available appliances

Commercially available appliances shall, at the time of purchase, have an information notice which indicates, for the benefit of the fitter and consumer, the upper design category, craft type and location area allowed. This notice may be a sticker glued on the appliance, a label on the appliance box, a leaflet or any other type of information device.

205. Scantling determination of non-stiffened plates

See clause **7. of ISO 12216.**

Section 3 Watertight Cockpits and Quick-draining Cockpits

301. Scope

This section specifies requirements for cockpits and recesses to be designated either as "watertight" or as "quick-draining".

302. Definitions

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

1. Cockpit and recess

Any area that may retain water, however briefly, due to rain, waves, craft heeling, etc.

2. Cockpit sole

Essentially horizontal surface(s) of the cockpit on which people normally stand

3. Cockpit bottom

Lowest surface of the cockpit sole where water collects before being drained

4. Bridge deck

Area just outside the companionway opening and above the cockpit bottom, onto which people normally step before entering the accommodation

5. Closing appliance

Device used to cover an opening in the cockpit, hull or superstructures

6. Cockpit water-retention height(h_C)

Height of the water contained in the cockpit measured between the cockpit bottom and the point of overflow outboard, the craft being upright, at rest and fully loaded

7. Cockpit bottom height(H_B)

Height of the cockpit bottom above the waterline. the craft being upright, at rest and fully loaded

8. Cockpit volume(V_C)

Volume, in cubic metres, of water that can be instantaneously contained in the cockpit before discharge, which is the volume below h_C

9. Cockpit volume coefficient(k_C)

Ratio between the cockpit volume and the reserved buoyancy

$$k_C = \frac{V_C}{L_H B_{\max} F_M}$$

303. General requirements

1. Loading and measurement conditions

The loading conditions for the subclauses **2** to **4** are "fully loaded ready-for-use" as defined in **ISO 8666**. In some cases, the mass of water contained in specific volumes shall be added to this loading (see **304. 2** (1) and (2)).

The measurement or calculations shall be made with the craft upright and at rest in smooth water.

2. Requirements for "watertight" cockpits and recesses

A "watertight" cockpit or recess shall

- have its sills in accordance with **306.**
- show a degree of watertightness in accordance with **307.**

3. Requirements for "quick draining" cockpits and recesses

A "quick-draining" cockpit or recess shall

- have its bottom height H_B above the waterline in accordance with **304.**
- have its draining devices in accordance with **305.**
- have its sills in accordance with **306.**
- show a degree of watertightness in accordance with **307.**

4. Closing appliances

Closing appliances fitted in watertight cockpits and quick-draining cockpits, and giving access to the interior of the craft, shall fulfil the requirements of **Ch 2** and of **307.**

304. Requirements for quick-draining cockpit bottom

1. Minimum cockpit bottom height, $H_{B,\min}$

The minimum cockpit bottom height, $H_{B,\min}$, above the waterline shall be according to **Table 6.6.**

Table 6.6 Minimum height, $H_{B,\min}$, of the cockpit bottom

Dimensions in metres

Design category	Height, $H_{B,\min}$
A	0.15
B	0.1
C	0.075
D	0.05
NOTE Greater heights than these minimum values may be required to fulfil the maximum acceptable draining time according to **305. 2**	

2. Exception to 6.1 for recesses or lockers

(1) Exception up to 10 % of cockpit bottom area
Surfaces up to a total 10 % of the horizontal projection of the cockpit bottom are not required to comply with **1.** Among these surfaces, those containing water after the cockpit has drained will be considered full of water when assessing the fully loaded condition.

(2) Lockers in the cockpit bottom
Lockers placed in the cockpit bottom
- which are intended for the storage of liferafts, ice, fish, baits, etc., and
- which are watertight towards the interior of the craft, and
- whose closing appliances do not fulfil all the requirements of **303. 3**,

305. Requirements for drainage of quick-draining cockpits

1. Cockpit drainage

(1) General
Draining shall only be by gravity.

(2) When the craft is upright
When the craft is upright, at least 98 % of the cockpit volume shall drain, excluding any recess in accordance with the exceptions of **304. 2.**

(3) When the craft is heeled
The requirements in (A) and (B) shall be fulfilled when the craft is heeled to both port and starboard.

(A) Sailing monohulls
On sailing monohulls, drainage shall be provided for at least 90 % of V_C at the lesser heel angle of
- 30° heel, or
- when the deck at side begins to touch the water.

(B) Non-sailing crafts and multihulls
On non-sailing crafts and multihulls, drainage shall be provided for at least 90 % of V_C at 10° heel.

2. Draining time

The draining time is the time needed to drain the cockpit from the full height of water, h_C, down to a remainder of 0,1 m above cockpit bottom.

The draining time shall be measured or calculated with every appliance closed.

If the draining section. expressed in square metres, is greater than or equal to 0,05 V_C, it is considered large enough to fulfil the requirements and does not require a draining time assessment.

For other drain configurations, the draining time shall be assessed, and shall not be greater than $t_{\max}$ given by the formulae in **Table 6.7** or by the curves in **Fig 6.10.**

Table 6.7 Maximum acceptable draining time, $t_{\max}$

Time in minutes

Design category	$t_{\max}$
A	$0.3/k_C$ but not greater than 5
B	$0.45/k_C$ but not greater than 5
C	$0.6/k_C$ but not greater than 5
D	$0.9/k_C$ but not greater than 5

The cockpit volume, V_C, shall be measured from the cockpit bottom up to the top of h_C, with the eventual exception of **304. 2**, assuming that all closing appliances and drains are closed.

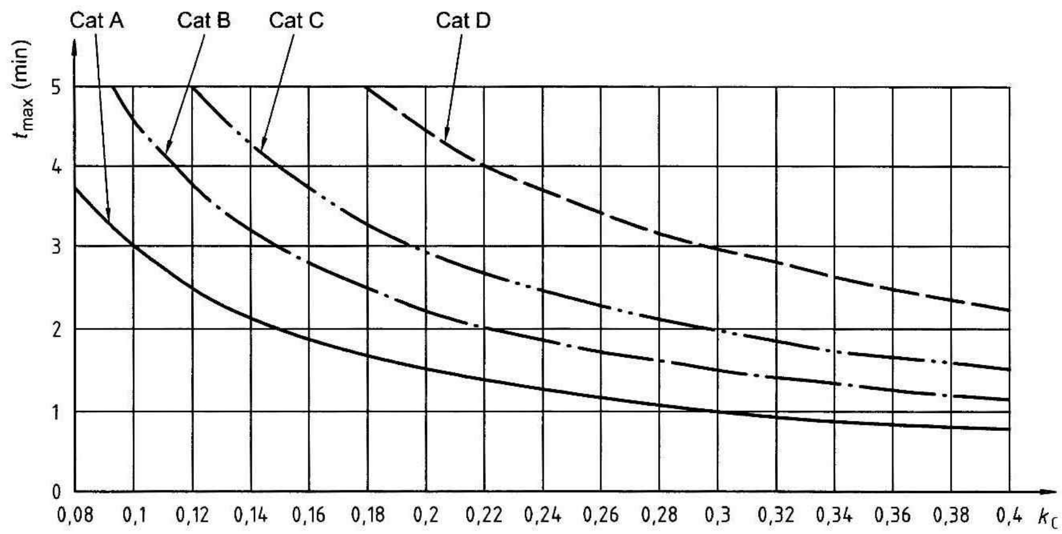


Fig 6.10 Maximum acceptable draining time $t_{\max}$ according to k_C and design category

3. Number of drains

A quick-draining cockpit shall have at least two drains, one port and one starboard, unless one opening enables drainage when the craft is heeled to both port and starboard, as required in **1.**

4. Minimum drain dimensions

(1) Internal dimensions of the drain
Drains with a circular cross section shall have a diameter of at least 25 mm. Drains with other cross-sectional shapes shall have a cross-sectional area of at least 500 mm^2 and a minimum dimension of 20 mm.

(2) Eventual protective grids
If the drains are equipped with systems preventing loose objects from falling into the draining system, one shall be aware that a grid of small holes is more prone to be clogged than the drain itself.
If the minimum passage dimension inside any part of these devices has at least a section of 125 mm^2 (or a diameter of 12 mm), and the total entry cross-section is at least 1.5 times the cross-section of the drain, **Table 6.8** may be used for calculation of the draining time.

If the above conditions are not met, the head losses from the protection grid shall be considered. See **ISO 11812 Annex D**.

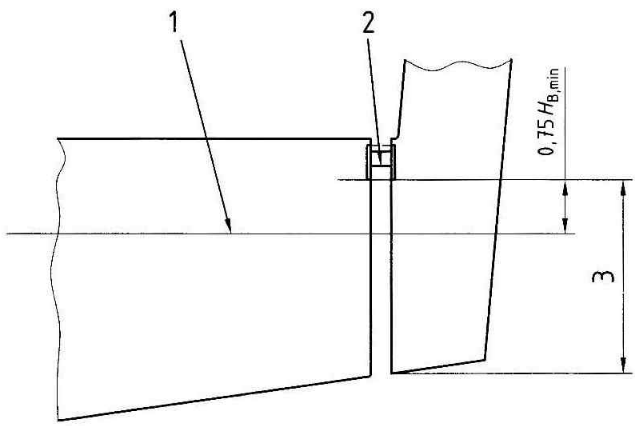
5. Centreboard housings and other types of drain

Centreboard housings and other types of aperture may be used as drains if they are designed for this purpose.

6. Drain fitting

The drain outlet running through the hull shall either be located above the waterline or, if below the waterline, be fitted with seacocks (see **7**), unless the drain outlet is an integral part of the hull extending from the outlet up to at least 0.75 $H_{B,\min}$ above the waterline.

Fig 6.11 shows a drain outlet integral with the hull.



Key

1 Waterline

2 Top of integral penetration above 0,75 $H_{B,min}$: no seacock required

3 In this area, the drain is integral with the hull shell

Fig 6.11 Drain outlet as an integral part of the hull

7. Drain piping design and construction

The scantling and design of drains shall take into account all the loads to which they may be subjected.

Drain piping shall be protected against damage from loose objects stowed in the craft and against being kicked or stepped on.

Drain piping shall not trap water and shall only be used for cockpit drainage. This requirement does not apply to drains fitted in centreboard housing or outboard wells and trunks.

Seacocks, through-hull fittings, and associated components shall comply with the requirements of **Ch 2** or **Ch 3**.

8. Draining time assessment

(1) General
The draining time shall be determined either by measurement of the actual draining time, or by calculation.

(2) Measurement of the draining time
The craft shall be placed near the fully loaded displacement and corresponding design trim.
The cockpit is filled with water up to h_C. and the draining time to empty the cockpit between h_C and 0.1 m of water remaining in the cockpit is measured. This latter height shall be measured above the centre of the bottom surface of the cokpit.

(3) Calculation of the draining time

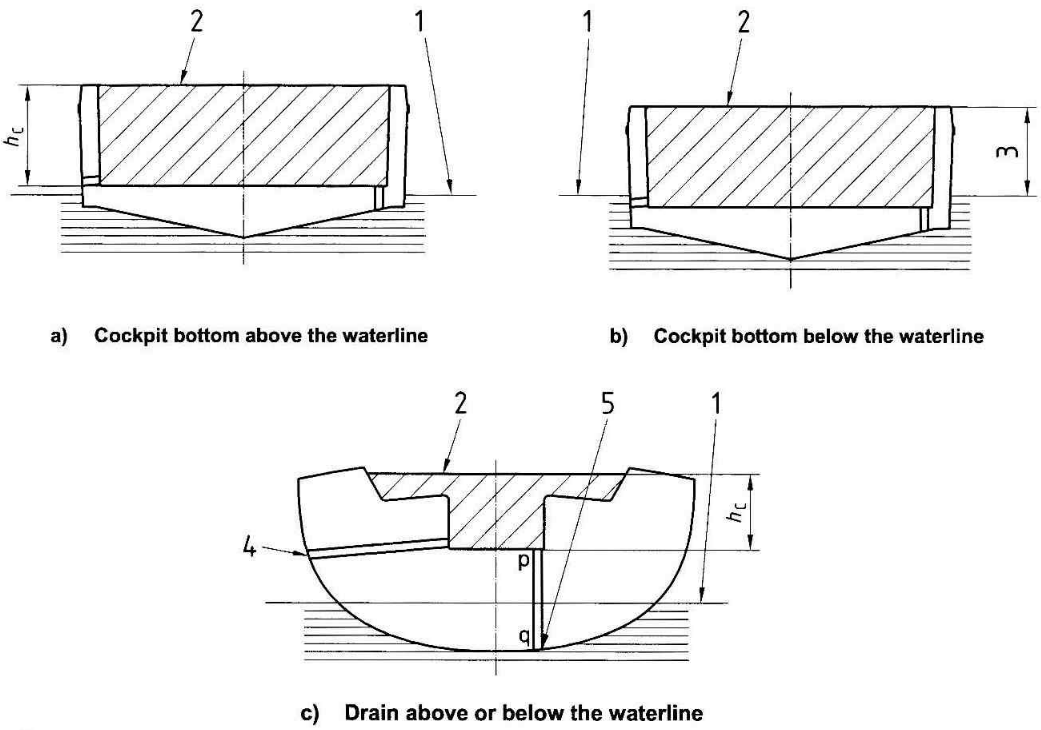
A quick and approximate method of calculating the draining time calculation is given in (4). Simplifications in this method may lead to small differences between measured and calculated draining time, but both methods are considered valid.
More thorough methods of calculation are specified in **ISO 11812** Annex C.
If the arrangement of cockpit and drains does not correspond to the cases of (4) or the methods of **ISO 11812** Annex C. the calculation method used shall be based on a practical test on a similar arrangement.

(4) Quick method of calculation for cockpit fitted with two drains

(A) Step 1: Determination of the required maximum draining time $t_{\max}$
Determine $t_{\max}$ using $k_C = V_C / (L_H B_{\max} F_{mean})$, i.e. the cockpit volume coefficient in accordance with **2.**

(B) Step 2: Determination of the reference draining time, t_{ref}
Calculate $t_{ref} = t_{\max} / V_C$ which is the reference draining time (without head loss) for a set of two drains.

(C) Step 3: Determine whether the drain outlet is above or below the waterline
Determine whether the drain outlet is above or below the waterline when the cockpit is full. If the drain outlet is above the waterline when the cockpit is empty and below it when the cockpit is full, one shall either conservatively consider that the drain is always below the waterline, or make the calculation in both cases and calculate the final time by interpolation.
Fig 6.12 shows some drain arrangements, but other arrangements may be used.



Key

1	Waterline	4	Discharge above the waterline
2	Level of water overflow	5	Discharge below the waterline
3	Height above the waterline		

Fig 6.12 Examples of some drain arrangements

(D) Step 4: Determination of the required drain diameter
Table 6.8 gives the approximate draining time for six cases: drain above or below the waterline, no elbow or two elbows, and freeing port with and without a flap.
Enter the line corresponding approximately to the cockpit configuration and choose the drain diameter giving a draining time t_{ref} corresponding to the requirements. Interpolations may be used.

Table 6.8 Drain diameter as a function of t_{ref} and typical drain arrangement

Typical drain arrangement	Values of t_{ref} (min)																	
Drain outlet above W_L, no elbow	8.8	5.8	4.1	3.0	2.3	1.8	1.5	1.2	1.0	0.9	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
Drain outlet above W_L, two elbows	10.0	6.7	4.7	3.5	2.7	2.2	1.8	1.5	1.3	1.1	0.9	0.8	0.6	0.5	0.4	0.4	0.3	0.3	0.2
Drain outlet above W_L, no elbow	10.8	7.2	5.1	3.9	3.0	2.4	2.0	1.6	1.4	1.2	1.0	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2
Drain outlet above W_L, two elbows	11.8	7.9	5.7	4.3	3.3	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.6	0.5	0.4	0.4	0.3	0.3
Freeing port above W_L, no flap	10.1	7.0	5.2	3.9	3.1	2.5	2.1	1.8	1.5	1.3	1.1	1.0	0.8	0.6	0.5	0.4	0.4	0.3	0.3
Freeing port above W_L, withflap	15.2	10.5	7.7	5.9	4.7	3.8	3.1	2.6	2.2	1.9	1.7	1.5	1.2	0.9	0.8	0.7	0.6	0.5	0.4
Drain diameter d(mm) two drains	25	30	35	40	45	50	55	60	65	70	75	80	90	100	110	120	130	140	150

However, for a non-circular drain section, the section area shall be the same as that of a circular drain.

306. Requirements for sills

1. Sill height for watertight cockpits

Watertight cockpits shall have no opening below the height h_C.

2. Sill height and other requirements for quick-draining cockpits

(1) Sill-height measurement

When measuring the sill height, all closing appliances shall be considered to be closed, with the exception of companionway door(s). The sill height is the lowest height of the openings considered to be sills.

Any vertical bulkhead or partial bulkhead cut by a companionway aperture leading to the interior, and located close to a cockpit or on the deck shall fulfil all the requirements for sill height and watertightness of **306.** and **307.**

The sill height shall be measured vertically from the cockpit bottom to the lowest point on the sill edge that allows ingress of water.

If the cockpit bottom is not horizontal, the sill height shall be measured to the closest point of the cockpit bottom.

Cockpits having more than one bottom level shall be assessed using informative **ISO 11812** Annex A.

(2) Requirements for sill height of quick draining cockpits

The required minimum sill height $h_{S,\min}$ according to craft type and design category is given in **Table 6.9**.

The value of $h_{S,\min}$ may be used in **307.** or informative **ISO 11812** Annex A when considering multi-level cockpits.

Table 6.9 Minimum values $h_{S,\min}$ for fixed sills and semi-fixed sills

Dimensions in metres

Design category	Sailing monohulls			Non-sailing crafts and sailing multihulls		
	Fixed sill	Semi-fixed sill		Fixed sill	Semi-fixed sill	
	Top of sill	Top of fixed part	Top of mobile part	Top of sill	Top of fixed part	Top of mobile part
	$h_{S,\min}$	$h_{S,\min}/2$	$h_{S,\min}$	$h_{S,\min}$	$h_{S,\min}/2$	$h_{S,\min}$
A	0.3	0.15	0.3	0.2	0.1	0.2
B	0.25	0.125	0.25	0.15	0.075	0.15
C	0.15	0.075	0.15	0.1	0.05	0.1
D	0.05	0.025	0.05	0.05	0.025	0.05

(3) Requirements for companionway doors and appliances above sill height
Above sill level, whether fixed or semi-fixed, appliances complying with **Sec 2** shall be used to close the openings, at least up to h_C.

(4) Other requirements
Semi-fixed sills and washboards shall have a device maintaining them in place, when in use, which shall at least be operable from inside.
Semi-fixed sills and washboards shall meet the strength requirements of **Sec 2**.
Semi-fixed sills shall only be detachable with the use of tools.
Provision shall be made for washboards to be stowed in a readily accessible specific location in the vicinity of the companionway.

307. Watertightness requirements

1. Watertightness requirements of watertight cockpits

All surfaces of watertight cockpits up to h_C shall have a watertightness degree 1.

2. Watertightness requirements of quick-draining cockpits

(1) Watertightness of the cockpit
All surfaces of quick-draining cockpits up to h_C shall have a watertightness degree 1.
The watertightness degrees of the closing appliances shall be as required by **Table 6.10**.

Table 6.10 Required degree of watertightness of quick-draining-cockpit closing appliances

Location of the closing appliance in the cockpit	Degree of watertightness
Closing appliances on bottom and horizontal areas	2
Closing appliances on cockpit sides up to $h_{S,\min}$	2
Closing appliances on cockpit sides between $h_{S,\min}$ and $2h_{S,\min}$ [a]	3
Closing appliances on cockpit sides above $2h_{S,\min}$ [a]	4
[a] $h_{S,\min}$ being measured from the nearest part of the cockpit bottom. Informative **ISO 11812 Annex A** explains how to consider the main examples of cockpit layout.	

Hatches and appliances located in the bottom or sides of the cockpit up to $h_{S,\min}$ shall be fitted with seals and sills at least 12 mm high, or tested as installed to watertightness degree 2 according to **ISO 11812** Annex E.
The above watertightness degrees, if appropriate, shall be tested according to **ISO 11812** Annex E.

(2) Permanently open ventilation openings
The lowest point of non-closable ventilation openings leading to water ingress in the interior shall be at least at a height 2 $h_{S,\min}$ or 0.3 m, whichever is the greater, above the cockpit bottom, and shall be watertight to degree 4.

Section 4 Rudders

401. Scope

This section gives requirements on the scantlings of rudders and those not specified in this section to be complying with **ISO 12215-8**.

402. Design stresses

1. Rudder material

Values of design stresses shall be taken from **Table 6.11**

Table 6.11 Values of design stresses (Stresses in newtons per square millimetre)

Material	Direct stresses			Combined stresses
	Tensile/compressive σ_d	Shear τ_d	Bearing σ_{db}	
Metals[a]	$\min(\sigma_y;0.5\sigma_u)$	$0.58\tau_d$	$1.8\sigma_d$	$\sqrt{\sigma^2+3\tau^2} \le \sigma_d$
Wood and fibre-reinforced plastics (FRP)	$0.5\times\sigma_u$	$0.5\tau_u$	$1.8\sigma_d$	$\left(\frac{\sigma}{\sigma_u}\right)^2+\left(\frac{\tau}{\tau_u}\right)^2 < 0.25$
[a] Steel, stainless steel, aluminium alloys, titanium alloys, copper alloys (see **Annex A**). In welded condition for welded metals.				

- σ_d is the design tensile, compressive, or flexural strength (as relevant);
- σ_u is the ultimate tensile, compressive, or flexural strength (as relevant);
- σ_y is the yield tensile, compressive, or flexural strength (as relevant);
- σ_{db} is the design bearing strength;
- τ_d is the design shear strength;
- τ_u is the ultimate shear strength.

403. Rudder types

1. Type I (spade) rudders (see Fig 6.13 and 6.14)

- A is the rudder (spade) area;
- $\Lambda = \frac{h_r^2}{A}$ is the rudder geometric aspect ratio
  where h_r is the average height of the rudder;
- h_b is the height between rudder top and centre of hull bearing;
- c_1 and c_2 are, respectively, the top and bottom chords or their natural extension;
- co_1 and co_2 are the top and bottom compensation, respectively, i.e. the distance, measured from fore to aft, between the leading edge and the rotation axis;
- c is the chord length at the height of the centroid of rudder area;
- h_c is the height between rudder top and centroid of rudder area (this is the position

where the rudder force is considered to act);

- k_b is the rudder bending coefficient with $k_b = h_c/h_r$
- r is the horizontal distance between the position of the resultant of the rudder force (taken at rudder centroid) and the rudder's rotational axis and shall not be taken less than $r_{\min}$;
- u is, for Type I (spade) rudders, the horizontal distance from fore to aft, from the leading edge to the rudder rotational axis at the height of centroid of rudder area (i.e. the geometric centre of the profile area);
  u is positive if the leading edge is forward of the axis (see **Fig 6.14** Types I a, I b, or I c) or negative in the opposite case (see Type I d).

2. Rudder spade with trapezoidal shape

For spade rudders with a trapezoidal (or close to) shape some values are easily calculated as follows:

$A = h_r \dfrac{c_1 + c_2}{2}$ is the area of a trapezoidal spade;

$k_b = \dfrac{h_c}{h_r} = \dfrac{1+2\alpha}{3(1+\alpha)}$ for a trapezoidal spade;

where $\alpha = \dfrac{c_2}{c_1}$ is the taper coefficient, See **Table 6.12**

Table 6.12 Calculated values of k_b for a trapezoidal spade as a function of c_2/c_1

$c_2/c_1 = \alpha$	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20
k_b	0.50	0.49	0.48	0.47	0.46	0.44	0.43	0.41	0.39

$h_c = k_b \times h_r$

$c = c_1 - k_b(c_1 - c_2)$ for a trapezoidal spade

$u = co_1 - k_b(co_1 - co_2)$ for a trapezoidal spade

The value of h_c can also be determined graphically, as shown in **Fig 6.13**

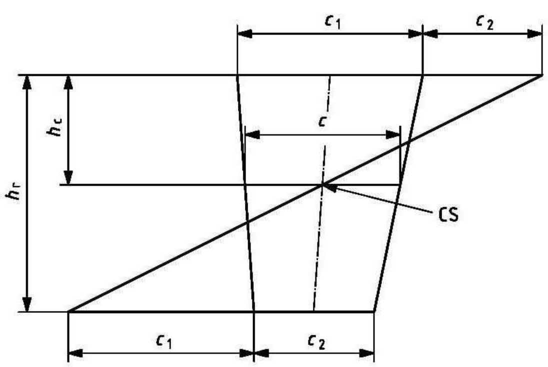
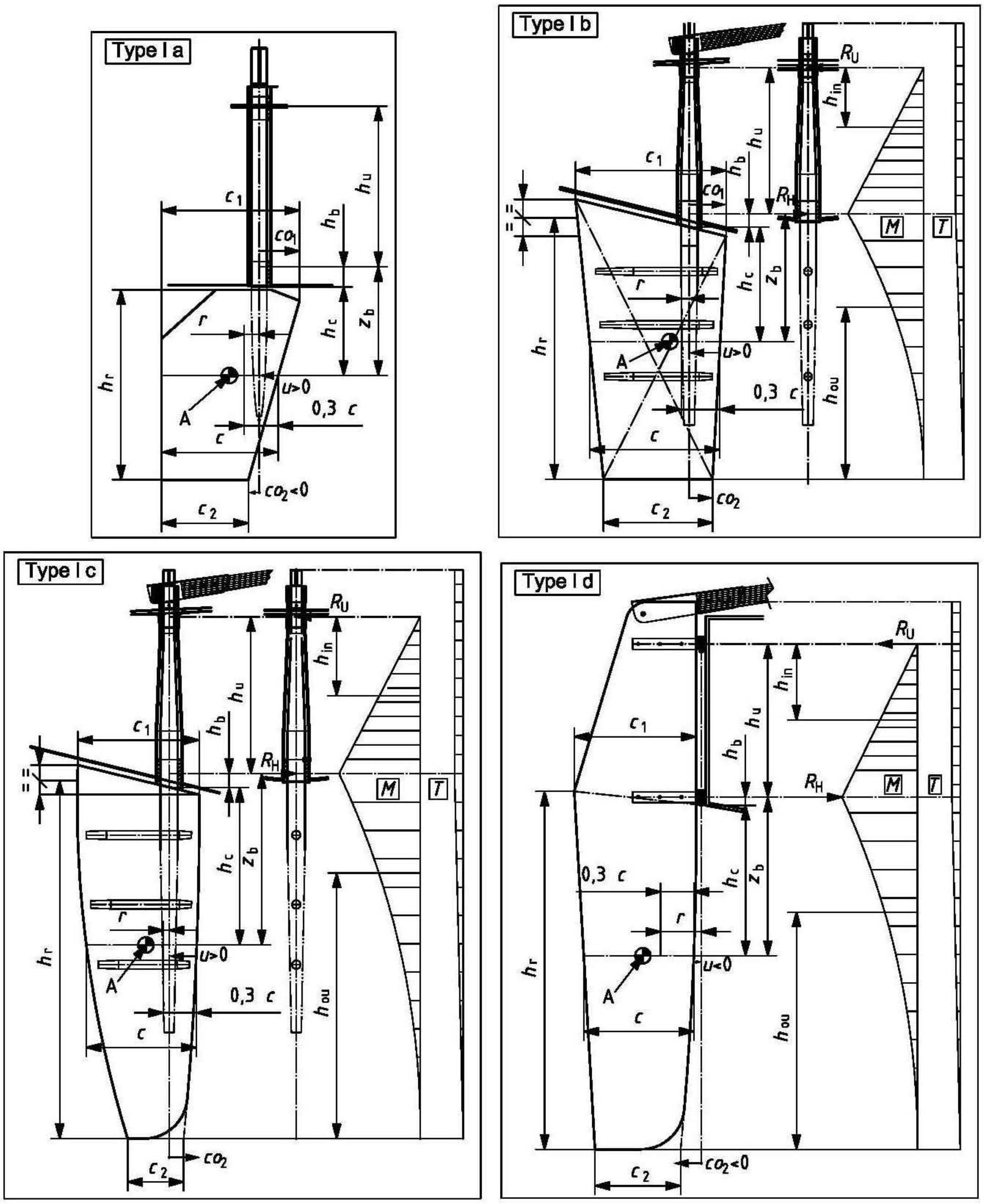


Fig 6.13 Graphical determination of centroid, CS, of a trapeze



Type I a: Typical fast motor craft spade rudder with low aspect ratio and cut out top aft to avoid ventilation
Type I b: Near-rectangular shape
Type I c: Semi-elliptical shape typical on performance sailing craft
Type I d: Transom-hung spade rudder

NOTE The marking with a shaded circle shows the geometric centre of surface. The rudder force is located at the same height, but at a distance 0,3 c aft of the chord's leading edge.

Fig 6.14 Spade rudders: Type I

3. Rudder types II to V (see Fig 6.15)

The dimensions are the same as for spade rudders, except that:

- A is the total area of the moving part of the rudder, divided into A_1 and A_2 in Type V;
- A_3 is the skeg area (only used to determine the type in **Fig 6.15**);

- h_r is the average height of the rudder;
- $\Lambda = \dfrac{h_r^2}{A_0}$ is the effective rudder geometric aspect ratio

  where A_0 is the rudder effective area (moving part plus effective part of the skeg, see **Table 6.13**);
- $c = A_0 / h_r$ is the mean chord;
- h_s is the height of the skeg/horn between hull and mid-skeg bearing for Type V and the lower bearing for Types III and IV.

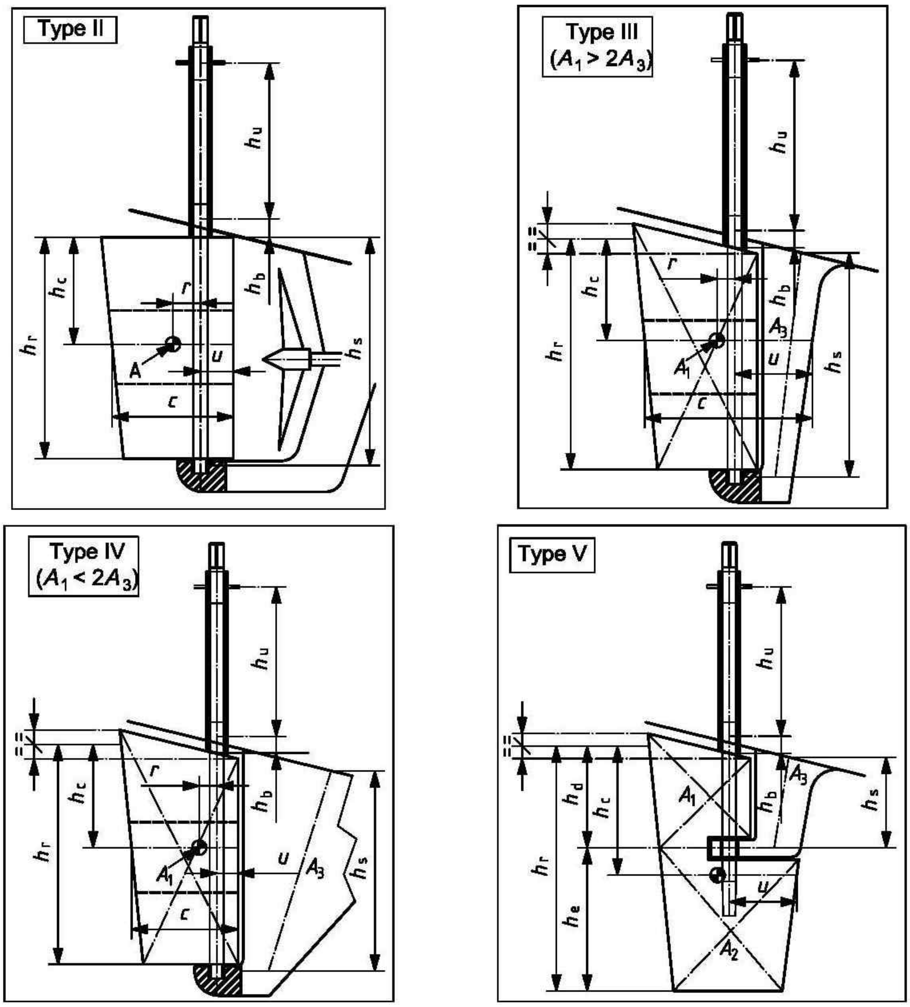
Table 6.13 gives values of A and A_0 according to rudder type.

Table 6.13 Rudder types and effective areas

Type	Value	
	A	A_0
II	A	
III	A_1	$A_1 + A_3$
IV	A_1	A_1
V	$A_1 + A_2$	$A_1 + A_2 + A_3$

For Type V, h_d and he are the portions of h_r above and below the skeg bearing, respectively.
For Types II to V:
- u is, for rudder Types II and IV, the horizontal distance, fore to aft, from the leading edge of the rudder to the stock vertical axis at the height of centroid of rudder area. For rudder Types III and V, u is measured aft of the leading edge of the partial or full narrow skeg (see **Fig 6.15**);
- r is the horizontal distance between the position of the centroid of rudder area and the rudder's rotational axis and shall not be taken less than $r_{\min}$.

  The rudders of Types II to V are considered to be held by three bearings (two bearings inside the hull and one skeg bearing, see **405. 3** (1))



Type II	Supported by skeg (solepiece) and skeg bearing	Type III	Narrow full skeg
Type IV	Wide full skeg	Type V	Partial skeg

Fig 6.15 Other rudder types: Types II to V

404. Design rudder force calculation

1. General

The design rudder force, F, shall be taken as follows:

(1) For non-sailing craft, the greater of F_1 and F_2, defined in **2** and **3**, respectively;
(2) For sailing craft, the force F_1, defined in **2.**

2. Force F_1 and corresponding load case

This case corresponds to loads associated with craft handling in the design category sea state.

$$F_1 = 23 \times L_{WL} \times k_{SEA} \times k_{LD}^2 \times k_{GAP} \times k_{USE} \times A$$

where

k_{SEA} =

- 1.4 for sailing craft of design categories A and B and non-sailing craft of design category A,

- 1.2 for non-sailing craft of design category B,
- 1.0 for craft of design categories C and D;

k_{LD} = 6.15 for non-sailing craft of all design categories and sailing craft of design categories C and D;

for sailing craft of design categories A and B, but shall not be taken less than 6.15;

$$k_{LD} = \frac{L_{WL}}{\left(\frac{m_{LDC}}{1025}\right)^{1/3}}$$

k_{GAP} =

- 1.0 for rudders where the root gap (average clearance between the hull and the rudder root plane) is less than 5 % of the mean rudder chord. This gap shall not be exceeded at any rudder angle,
- 0.85 for rudders which are surface piercing (e.g. transom held) or exceed the gap limitation or can otherwise exhibit significant 3-D flow over the root;

k_{USE} = 1 for all craft but may be taken as 0.9 for category C and D sailing craft which are essentially used for close inshore racing with suitable safety procedures in place and for which the rudder can be easily inspected on a regular basis. If k_{USE} is taken as 0.9, a warning requiring regular inspection of rudder(s) should be included in the owner's manual.

3. Force F_2 and corresponding load case

This case corresponds to loads connected with non-sailing craft handling during a turn at speed in slight seas. It is therefore only applicable to non-sailing craft.

$$F_2 = 370 \times \Lambda^{0.43} \times {V_{MAX}}^{1.3} \times k_{GAP} \times k_{SERV} \times k_{FLAT} \times k_{SIG} \times A$$

where

Λ is the geometric aspect ratio defined in Equation (1) or (7);

V_{MAX} is the craft maximum speed in calm water and mLDC conditions;

k_{GAP} is as given in **807. 2**;

k_{SERV} =

- 1.0 for design category A and B craft,
- 0.8 for design category C and D craft (may also be taken as 1);

If k_{SERV} = 0.8 is used, a note to this effect should be placed in the owner's manual.

$k_{FLAT} = 1.08 - 0.008 \times V_{MAX}$ with $0.75 \le k_{FLAT} < 1$

$k_{SIG} = 1.25$

405. Rudder bending moment and reactions at bearings

1. Spade rudder (Type I)

(1) Values of k_b, bending moment M and reactions at bearings for spade rudders (Type I)

$$M_H = F \times z_b$$

is the design rudder bending moment (at hull bearing) for spade rudders, where

- F is determined according to **404.**;

- z_b is the bending moment lever for spade rudders (see **403. 1** (1)):

$$z_b = (k_b \times h_r) + h_b = h_c + h_b$$

where k_b is the rudder bending coefficient, determined according to rudder type, as follows.

To calculate z_b, one shall first determine the value of h_c:

- for a trapezoidal or near trapezoidal shape, either
  - a) use the value of k_b given by Equation in **403. 2.** or **Table 6.12**, or
  - b) apply the graphical method shown in **Fig 6.13** ;
- for other shapes, find $h_c = k_b \times h_r$ by any geometrical method and then calculate $z_b = h_c + h_b$.

The reactions at bearings for spade rudders are as follows:

$$R_U = F\frac{z_b}{h_u}$$

is the reaction at the upper bearing (at deck or intermediate level), where h_u is the vertical distance between the centres of the upper and lower bearings (see **Fig 6.14**);

$$R_H = R_U + F$$

is the reaction at the hull bearing.

2. Skeg rudders (Types II to V)

(1) General

Rudders supported by a skeg or horn are considered to be held, from bottom to top, by three bearings (see **Fig 6.15**):

- a skeg bearing, with reaction R_S
- a hull bearing located close to the hull bottom at the rudder level, with reaction R_H
- an upper bearing located at deck level at the rudder level or an intermediate level between hull and deck, with reaction R_U.

(2) Methods of calculation

Rudders of Types II to V may be analysed by one of the following methods:

- continuous beam theory (also known as the three-moment equation) or the method in **ISO 12215-8** Annex C;
- the simplified method of **405. 3** (4).

(3) Continuous beam theory

See ISO 12215-8.

(4) Simplified method

See ISO 12215-8.

406. Rudder design torque, T

$T = F \times r$ is the rudder design torque

where

F is as defined in **404.** ;

r is the rudder torque arm but shall not be taken less than $r_{\min}$, as defined in **Table 6.14.**

Table 6.14 Values of r and $r_{\min}$ according to rudder type

Type	r	$r_{\min}$
I	$0.3c-u$	$0.1c$
II	$0.3c-u$	$0.1c$
III	$0.5c-u$	$0.05c$
IV	$0.25c-u$	$0.05c$
V	$\left(0.2\frac{h_d}{h_r}+0.3\right)c-u$	$\left(0.1-0.05\frac{h_d}{h_r}\right)c$
NOTE c and u are defined in **403.**		

407. Rudder and rudder stock design

See ISO 12215-8.

408. Clearance between stock and bearings

Where the bushing manufacturer specifies the necessary clearance between stock and bushing, this shall be adopted. In the absence of such information, the following equations may be used. **Table 6.15** gives pre-calculated values for these equations.

$D-d=\frac{1.5\times d}{1000}+0.1+$ water soaking expansion, in millimetres, is the minimum recommended value.

$D-d=\frac{3\times d}{1000}+0.2+$ water soaking expansion, in millimetres, is the maximum recommended value.

Table 6.15 Computed recommended values of diametric clearance $D-d$ between stock and bushing

Dimensions in millimetres

Stock outer diameter d	Diametric clearance $D-d$	
	min.	max.
40	0.16	0.32
60	0.19	0.38
80	0.22	0.44
100	0.25	0.50
120	0.28	0.56
140	0.31	0.62
160	0.34	0.68
180	0.37	0.74
200	0.40	0.80

Section 5 Anchoring, Mooring and Towing – Strong Points

501. Scope

This section specifies requirements for strong points for attaching chains, cables and lines for anchoring, mooring and towing.

502. General requirements

1. A strong point may be used for different purposes. An anchoring or towing strong point may be used for mooring.

2. The minimum number of strong points shall be as follows:

(1) all craft: one anchoring/towing point forward;
(2) craft over 6 m L_H: at least one mooring point aft;
(3) craft over 12 m L_H: at least one additional mooring point both forward and aft;
(4) craft over 18 m L_H: at least one additional mooring point both port and starboard.

503. Strength requirements

1. Introduction

The assessment of the breaking strength shall be made according to **2**, **3** or **4**.

2. Horizontal load

Each strong point shall be designed and installed, so that it will take a horizontal load, P_n, in kilonewtons without failure of the strong point or the surrounding structure to which it is attached:

– forward, for anchoring and being towed:

$$P_1 = f(4.3L_C - 5.4)$$

– forward, for mooring:

$$P_2 = f(3.5L_C - 4.3)$$

– aft

$$P_3 = f(3.0L_C - 3.8)$$

where

f = 1.0 (design categories A and B)
= 0.9 (design category C)
= 0.75 (design category D)

L_C is the calculation length:

$$L_C = \frac{L_H + L_{WL}}{2}$$

The breaking strength of a strong point for any application need not be higher than that required to withstand a load representing the mass of the craft in the fully loaded ready-for-use condition, m_{LDC}.

3. Direct calculation

The assessment of the breaking strength of the strong points may be made by direct calculation, taking into account the design category, the configuration of the craft with special regard to the windage area, the hull form, and the wave spectrum in the intended area of operation.

4. Matching strength

=Where a craft manufacturer specifies or supplies lines, chains or cables which exceed the requirements of **2** (e.g. where the craft is intended to be used in extreme conditions or lines are required to be easier to handle), the breaking strength of the related strong point shall be not less than 125 % of the rope or chain that is specified or supplied.

504. Detailed requirements

1. Structural support

Craft structures in the vicinity of strong points shall be reinforced to take the loads calculated according to **503. 2** to **4**. Doubling plates or washers of adequate size shall be used where the strong points are secured with nuts and bolts.

2. Corrosion resistance

Strong points shall be made of materials that are resistant to or protected against corrosion.

Where non-metallic (plastics) strong points are provided, the material shall be UV stabilized. In addition, a warning notice shall be listed in the owner's manual to replace strong points showing visible signs of deterioration.

3. Labelling

Where the intended use of a strong point for anchoring and/or being towed is not self evident, the strong point shall be labelled.

505. Owner's manual

The information specified in **ISO 15084** Annex A shall be included in the owner's manual

506. Strength of synthetic fibre ropes

See **ISO 15084** Annex B. ⚓

CHAPTER 7 STEERING SYSTEM

Section 1 General

101. General

1. Steering systems are to be designed, constructed and installed in order to allow the transmission of steering loads under foreseeable operating conditions.
2. Sailing craft and single-engine inboard powered non-sailing crafts with remote-controlled rudder steering systems are to be provided with emergency means of steering the craft at reduced speed.
3. Remote-controlled steering systems are also to comply with ISO 8848 or ISO 9775, in addition to the requirements in this chapter.
4. Cable and pulley system are to be in accordance with the requirements of ISO 8847 and gear driven steering systems are to be in accordance with the requirements of ISO 13929.

Section 2 Hydraulic Steering System

201. General requirements for hydraulic steering systems

1. The components of hydraulic steering systems are to be compatible with each other in order to be used as a complete system.
2. All component parts are to be supported independently of the connecting tubes.
3. Connections, fittings, oil fill openings and air bleeders are to be readily accessible.
4. Components in the system are to be externally protected against corrosion. The complete hydraulic steering system is to be designed to withstand conditions of pressure, vibration, shock and movement without failure or leakage.
5. Hydraulic systems with a non-functional autopilot are to be capable of operation throughout an ambient temperature range of −10 ℃ to +60 ℃ and be capable of withstanding storage at −30 ℃ to +60 ℃.
6. Fittings, hoses, piping and components are to be capable of withstanding the system test pressure without permanent deformation, external leakage or other malfunction.
7. Materials used in hydraulic steering systems are to be resistant to deterioration by liquids or compounds with which the material may come in contact under normal marine service, e.g. grease, lubricating oil, hydraulic fluid, common bilge solvents, salt and fresh water.
8. In vessels over 12.5 m in length, the hydraulic steering system is to be capable of putting the rudder over from 30° on one side to 30° on the other in not more than 30 s when the vessel is at maximum forward service speed with the rudder totally submerged, and, if normally operated, is to be designed to prevent violent recoil of the steering-wheel.

202. Hydraulic fluid

1. The type of hydraulic fluid to be used in a hydraulic steering system is to be specified by the manufacturer of the steering system and is to be stated in the owner's manual.
2. The hydraulic fluid is to be non-flammable or have a flash point of 157 °C or over.

203. Materials

In addition to the general requirements of 201., the following requirements are to be met.

1. Components of different materials are to be galvanically compatible or separated by a galvanic barrier.

2. Plastics and elastomers which may be exposed to sunlight are to be chosen to resist degradation by ultraviolet radiation.

3. Plastics and elastomers which may be installed in engine compartments are to be chosen to resist degradation by saline atmospheres, fuel. oil, heat and fire.

204. Outboard non-sailing and inboard-outdrive requirements

1. Steering stops on an outboard non-sailing is to permit at least 30° of angular movement to either side. The design torque at the rudder stock is to be sufficient to put the helm from hard over to hard over (30° port to 30° starboard or vice versa) in not more than 30 s.

2. Outboard non-sailings are to meet the applicable dimensional requirements indicated in **Fig 7.1** and **Fig 7.2**.

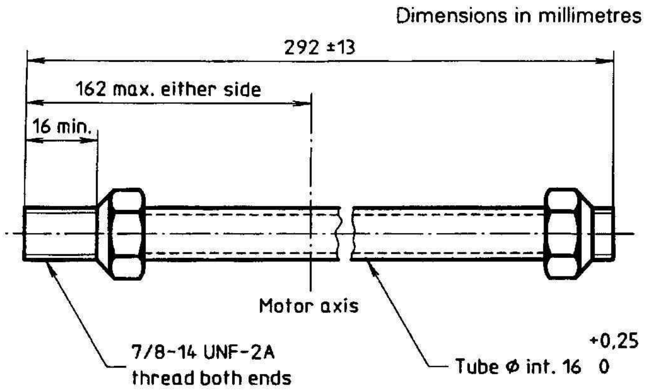
3. Necessary fittings to attach an outboard non-sailing to the cylinder output rod are to be supplied with the outboard non-sailing.

4. Outboard non-sailings are to be designed so that with any combination of non-sailing turn and tilt, there are to be no damaging interference between the non-sailing, its accessories, and both the craft-mounted and the non-sailing-mounted system, if the non-sailing is designed for both systems. Appropriate written information and installation instructions are to be provided, clearly indicating the type of steering system(s) that should be used.

5. Outboard non-sailings are to be designed so that the geometry ensures that a static force of 3,300 N, applied at the steering arm connection point normal to the steering arm in its normal plane of operation throughout the maximum steering arc, will not result in steering output ram loadings greater than those specified in **206.**

6. The steering arm of an outboard non-sailing is to be provided with a 3/8 in-24 UNF thread, or a plain hole of 9.65 mm to 9.9 mm diameter at the connection point.

7. Inboard-outdrives are to be designed with proper geometry to ensure that a torque of 680 Nm applied on the outdrive steering axis will not result in a steering component loading greater that specified in **206.**



NOTE — The tube may be threaded equal length on both ends or reversible for port steering installation.

Fig 7.1 Non-sailing-mounted steering tube

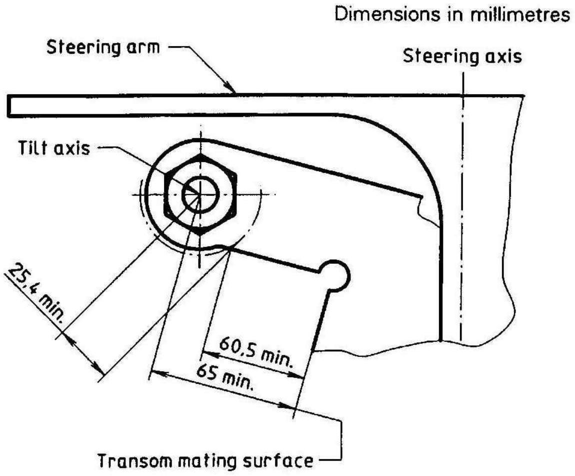


Fig 7.2 non-sailing-mounted steering tilt axis

205. Installation

1. The installation is to be carried out following the directions of the manufacturers of the system. Hydraulic lines are to be supported by clips, straps or other means to prevent chafing or vibration damage. The clips, straps or other devices are to be corrosion-resistant and are to be designed to prevent cutting, abrading or damage to the lines and are to be compatible with hydraulic line materials. A flexible section is to be installed between rigid piping and cylinder(s).

2. Hoses and piping are to be protected from contact with hot objects and from abrasion. There are to be no joints or connections directly above hot objects.

3. Hydraulic components are to be secured to the craft's structure considering the potential forces to be transmitted. Specifically, the mounting location for hydraulic cylinders is to provide a rigid attachment.

4. All threaded fasteners whose integrity affects safe operation of the hydraulic steering system are to be provided with a locking means.

5. Steering wheels and helm shafts are to be selected to fit each other. Current configurations are shown in **Fig 7.3.**

6. Threaded fasteners whose integrity affects safe operation of the steering system, and which are intended to be mounted or adjusted at the installation of the steering system in the craft and which may be expected to be disturbed by installation or adjustment procedures, are to be locked by locking devices referenced by instructions for correct assembly and complying with the following requirements.

   (1) Loose lock-washers. fasteners with metallic distorting threads and adhesive are prohibited.

   (2) A locking device is to be so designed that its presence can be determined by visual inspection or felt by a layman after installation.

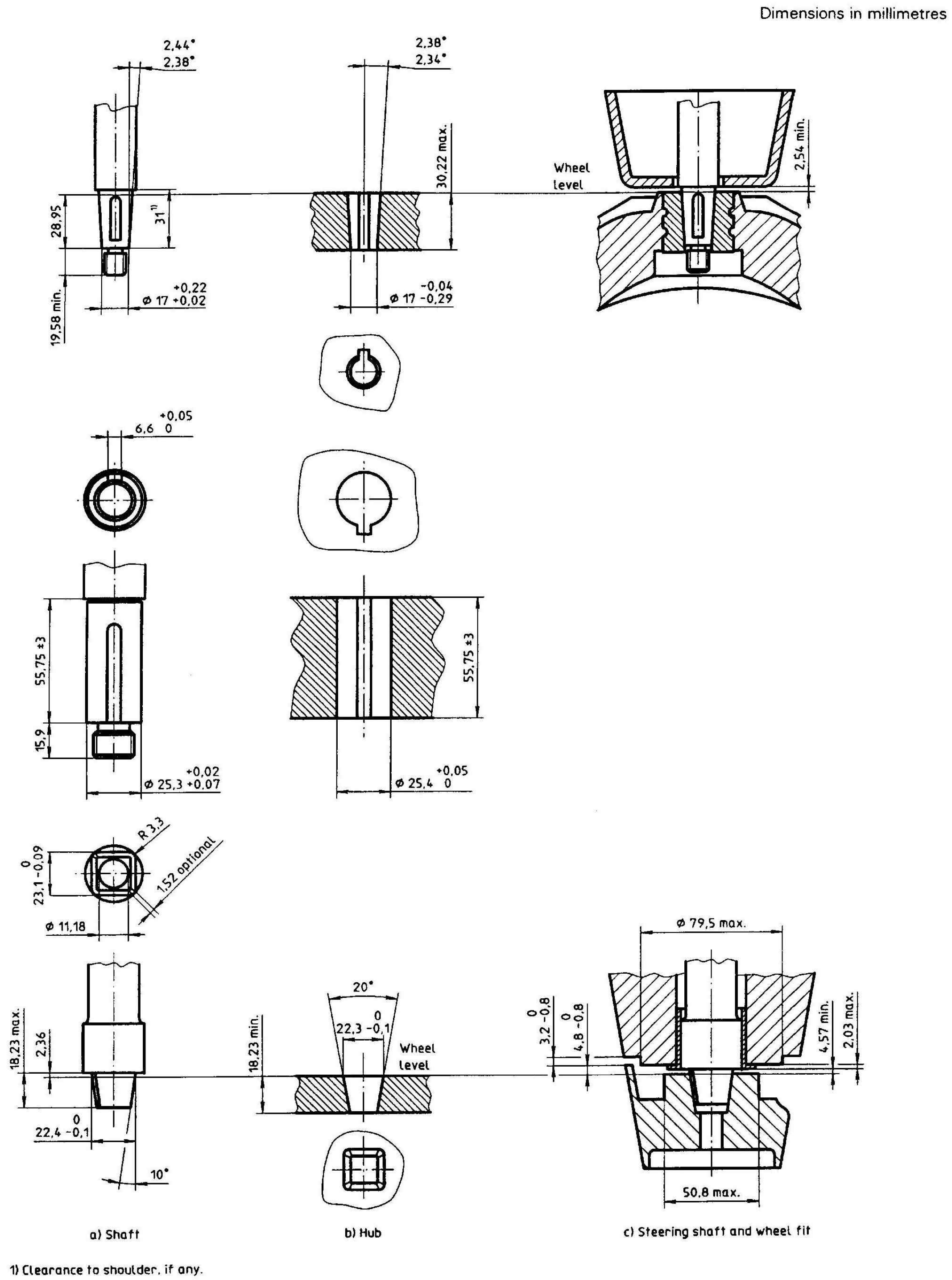


Fig 7.3 Steering shafts and steering-wheel hubs

206. Tests

Hydraulic steering systems are to subject to tests in accordance with **9.** in **ISO 10592** to verify the design strength and to verify that components are meet with minimum acceptable design criteria.

207. Manual and marking

1. An owner's manual and an installer's manual are to include the information in accordance with 10 and 11 in ISO 10592.

2. Hydraulic steering systems are to provided with marking in accordance with 12 in **ISO 10592** and components are to proded with marking in accordance with 13 in **ISO 10592**.

Section 3 Field of Vision from Steering Position

301. General

1. All glazing through which vision from the steering position shall have at least 70 % light transmission.

2. For ships having more than one steering station and position designed to be used from either standing or sitting, are to be complied with the requirements of **ISO 15085** from at least one of the steering stations and position.

3. Throttle and shift controls, as intended for use by the steersman, shall be positioned within 0.7 m of the high eye position and shall enable the maintenance of at least the low eye position by the steersman at all throttle settings. For ships designed to be operated from both the seated and standing positions, the controls shall be located to meet these requirements from at least the seated position.

4. The requirements for the low eye position may be met by a steersman's seat with vertical height adjustment.

5. Permanent and removable tops and/or other structural parts and mounted instruments in the vicinity of the steersman shall not obstruct forward vision.

6. Field vision of fore and aft is to comply with the requirements of **ISO 15085**.

302. Definition

1. High eye position (standing position)

Position of 1730 mm above the surface on which the steersman stands, 400 mm from the centre of the steering-wheel rim. (See **Fig 7.4**)

2. High eye position (seated position)

Position of 840 mm above the intersection of the compressed seat and the seat back, 400 mm from the centre of the steering-wheel rim. (See **Fig 7.5**)

3. Low eye position (standing position)

Position of 1480 mm above the surface on which the steersman stands, 400 mm from the centre of the steering-wheel rim. (See **Fig 7.4**)

4. Low eye position (seated position)

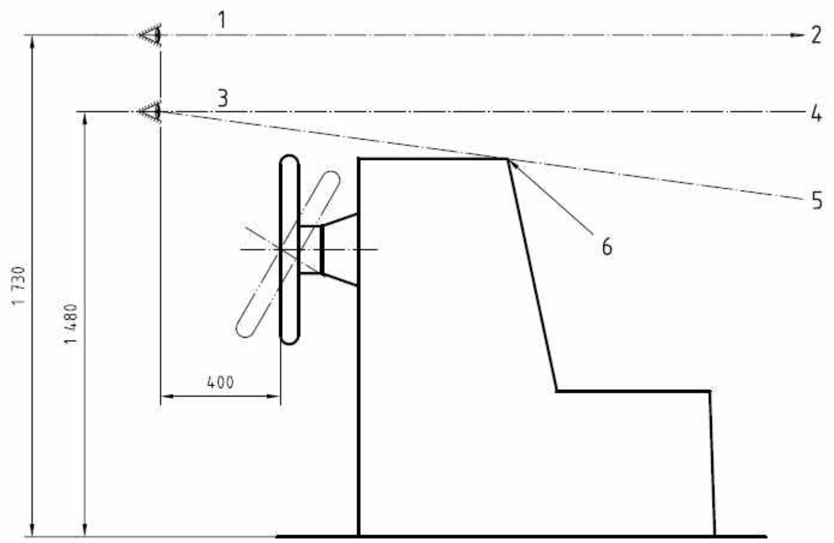
Position of 840 mm above the intersection of the compressed seat and the seat back, 400 mm from the centre of the steering-wheel rim. (See **Fig 7.5**)

5. Compressed seat bottom

Surface of the centre of the steering seat at the intersection of the seat-back and seat-bottom when compressed by a 25 mm diameter spherical object under a vertical load of 100N. (See **Fig 7.5**)

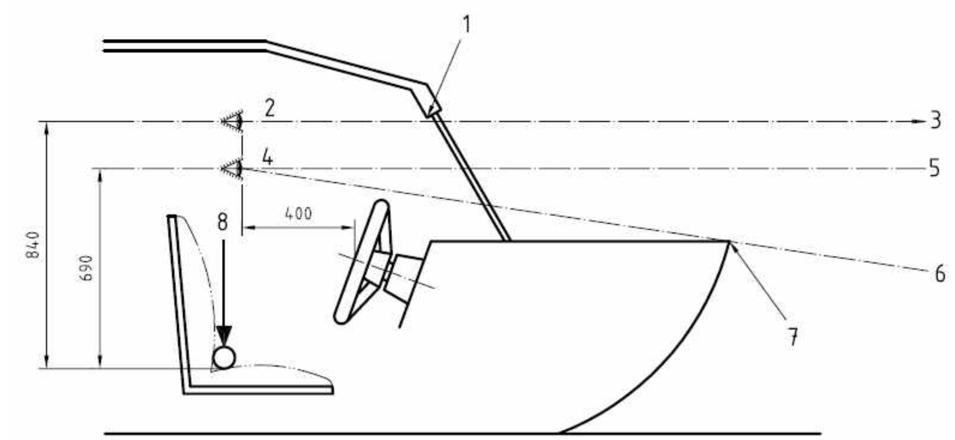
6. Vertical range of vision

Range between the lowest unobstructed line of vision from the low eye position and the highest unobstructed line of vision from the high eye position. ⚓



1. High eye position
2. To horizon
3. Low eye position
4. Required vertical range of vision
5. Lowest unobstructed line of vision
6. Point of visual obstruction

Fig 7.4 Eye positions and vertical range of vision – steersman in standing position



1. Vision obstruction
2. High eye position
3. To horizon
4. Low eye position
5. Required vertical range of vision
6. Lowest unobstructed line of vision
7. Point of visual obstruction
8. Seat compression

Fig 7.5 Eye positions and vertical range of vision – steersman in seated position

CHAPTER 8 MACHINERY INSTALLATIONS

Section 1 Engine and Engine Spaces

101. Inboard engine

1. All inboard mounted engines are to be placed within an enclosure separated from living quarters and installed so as to minimize the risk of fires or spread of fires as well as hazards from toxic fumes, heat, noise or vibrations in the living quarters.

2. Engine parts and accessories that require frequent inspection and/or servicing are to be readily accessible.

3. Fuel and electrical components mounted on the inboard petrol engines are to comply with the requirements of **ISO 15584**.

4. Fuel and electrical components mounted on the inboard diesel engines are to comply with the requirements of **ISO 16147**.

5. The propulsion engine which have a clutch or drives controllable pitch propeller is to be provided with governor to prevent overspeed.

6. The main engine seat is to be of rigid structures integrated with hull structure and supported by transverse reinforcements. And the structures are to be easily accessible for operation of lubricating oil, drainage, bilge suction or sea water suction valves etc.

7. Main engine setting bolts are to be of suitable size and contacted completely with engine seats, and the bolts are to be provided with anti-loosening devices.

8. In case of using chock liner which has a elasticity for main engine installation, the main engine is to be connected with shafting system using flexible coupling.

9. Unless the engine is protected by a cover or its own enclosure, exposed moving or hot parts of the engine that could cause personal injury are to be effectively shielded.

102. Outboard engine starting

1. All crafts with outboard engines are to have a device to prevent starting the engine in gear, except:

(1) when the engine produces less than 500 N of static thrust;

(2) when the engine has a throttle limiting device to limit thrust to 500 N at the time of starting the engine.

2. Non-sailings equipped with remote starting systems may have either an integral start-in-gear protection device or a similar device incorporated in the remote control system. In the latter case, a label shall be affixed to the non-sailing close to the control connection with the WARNING and the READ OWNER'S MANUAL symbols in accordance with ISO 11192.

3. Non-sailings which are normally started by remote control but also have provision for manual local starting that is not readily accessible need not be fitted with a start-in-gear protection device for this system, provided the information label in **Fig 8.1** is displayed on the product. The information label is to be displayed in a prominent position visible to the person operating this manual starting system

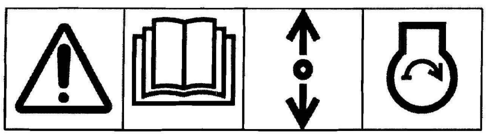


Fig 8.1

4. Owner's Manual is to contain the information that controls installed with this non-sailing must have a start-in-gear protection device and contain an explanation correct use of the manual starting system.

Section 2 Propulsion System

201. Propulsion system

1. The material of shafts is to be of mild steel, stainless steel, bronze or monel and the tensile strength of the material is not to be less than $45 \mathrm{kg/mm^2}$. The shafts are to be made of forged or rolled steel and pressed steel is not to used for shaft.
2. Propeller shaft or stern tube of mild steel is to be of construction which is not to be contacted with sea water, such as continuos bronze sleeve. However, the above requirements are not apply to the oil lubricating system with approved oil sealing device. The part between stern tube and bracket is to be protected from contact with sea water using approved paint.
3. In case propeller shafts or stern tube shafts are made of corrosion resistance steel such as stainless steel, bronze or monel, the measurement to prevent from contact with sea water is not needed.
4. The diameter of intermediate shaft(d_0) is not to be less than that obtained from following formula.

$$d_0 = 102\sqrt[3]{\frac{H}{n}} \quad \text{(mm)}$$

H : Continuous maximum output of engine (PS)
n : Continuous maximum revolution of shaft (rpm)

5. The diameter of propeller shaft or stern tube shaft (d_p) is not to be less than that obtained from following formula.

$$d_p = 1.2 d_0 \quad \text{(mm)}$$

d_0 : Required diameter of intermediate shaft (mm)

6. Where the propeller shafts or stern tube shafts used the materials of which the tensile strength exceeds 45 $\mathrm{kg/mm^2}$, the diameter of propeller shafts or stern tube shafts may be reduced to the value multiplied by K of following formula.
However, the propeller shafts or stern tube shafts made of mild steel are not allowed to reduce the diameter even if the materials of high tensile steel are used.

$$K = \sqrt[3]{\frac{45}{45 + \frac{2}{3}(S - 45)}}$$

S : minimum tensile strength($\mathrm{kg/mm^2}$)

7. The thickness of bronze sleeves used in propeller shaft or stern tube shaft is not to be less than that obtained from following formula.

$$t_1 = 0.03 d_p + 7.0 \quad \text{(mm)}$$
$$t_2 = 0.75 t_1 \quad \text{(mm)}$$

t_1 : thickness of sleeve where stern tube or strut bearings are contacting

t_2 : thickness other than above

d_p : Required diameter of propeller or stern tube in calculating (mm)

8. In case of propeller shaft set sleeve, the construction between propeller and propeller shaft is to be prevented sea water from ingress.

9. The diameters of coupling bolts at contacting surface of shaft coupling are not to be less than that obtained from following formula. However, in case of material of which tensile strength exceeds 45 $\mathrm{kg/mm^2}$, the diameters may be reduced to the values which are deemed appropriate by the Society.

$$d_b = 0.75\sqrt{\frac{d_0^3}{nD}} \quad \text{(mm)}$$

d_0 : Required diameter of intermediate shaft in calculating (mm)

n : Number of coupling bolts

D : Diameter of pitch circle (mm)

10. The thickness of coupling on pitch circle is not to be less than the required diameter of coupling bolt in calculating. However, the coupling thickness of propeller shaft is to be greater than 0.25 times of required diameter of intermediate shaft. Also, the radius of roots in coupling is to be greater than 0.125 times of shaft diameter. In case, the coupling is fabricating type, it is to be of the structure to withstand in full astern condition.

11. The bearing length of stern tube or strut bracket supporting propeller shaft is not to be less than 4 times of required propeller shaft diameter in calculating.

12. Where the propeller bearing is a lignumbite or approved synthetic material, it is to be designed to lubricate by sufficient sea water. In relatively large stern tube bearing system, it is needed to supply sea water by circulating pump or other water pressure for lubricating.

13. The stern tube and propeller brackets are to be rigidly fitted with hull structures to maintain shaft centerline in normal voyage condition. And, where the length of shaft is long, the bearings are to be supported so that the space between bearings is not be too long. The bearings installed below engine room upper plate are to be readily accessible.

14. The machinery installation and shaft centerline is to be confirmed by the surveyor in crafts afloat condition.

Section 3 Starting System

301. Starting system

1. The generators are to be installed to charge the starting batteries for the main engine starting by batteries.

2. In case the main engine started by compressed air, at least tow air compressors are to be installed and these may be driven by main engine. Each air compressor is to be provided with safety valves.

3. The construction of air tanks are to be of approved ones and each tank is to be provided with safety valves or plug and drain system.

4. The compressed air pipes are to be made of seamless steel pipe, and the thickness t are not to be less than that obtained from following formula.

$$t = \frac{pd}{C} + 1.0 \quad \text{(mm)}$$

p : maximum working pressure ($\mathrm{kg/cm^2}$)
d : outer diameter of pipe (mm)
C : coefficient, in case of steel pipe 844, in case of cupper pipe 422.

Section 4 Sea Water and Drainage Piping System

401. General

Sufficient number of freeing ports and scuppers are to be installed on bulwarks and decks.

402. Drain pipe

1. When drain pipes are installed to discharge water from upper deck or accommodations to the below waterline or adjacent area, check valves or cock are to be installed and discharge lines are to have sufficient thickness.

2. For the crafts of 20 m or less in length, in case the drain pipes of upper deck is installed to discharged water to the above waterline, the drain pipes may be reclaimed in the side plating. The weight of drain pipe wall is not to be less than 75 % of side shell plating.

3. Drain pipes installed between decks are to be led to bilge well in crafts.

4. Sanitary supply lines and pipe lines for washbasin are to be connected to side shell plating.

5. Cast steel with check valve or other elbow, etc. are to be of strong structure and of approved material except normal cast iron. Pipes attached to valve or elbow are to be of galvanized and thick steel pipes.

403. Sea suction and overboard discharging system

1. The sea suction and overboard discharging system are to be fitted at the location which are easily accessible and valve and cocks are to be connected with shell plate or short and rigid distance piece directly. The shell openings are to be reinforced with doublers properly.

2. Where the fitting of a seacock/valve or through-hull fitting impairs the local strength of the hull, a reinforcement or a backing block is to be installed to compensate for the loss of strength.

3. In reinforced plastics hulls built in sandwich construction, the core material is to be replaced by a material that cannot be compressed when tightening the through-hull fitting, or the area around the fitting is to be built in single skin construction with local reinforcement.

4. The attachment of through-hull fittings and seacock/valve to the hull is to be watertight and so installed as to prevent loosening under normal operating conditions.

5. Sea cocks/valves are to be readily accessible and securely fastened to the hull to permit easy operation without damage to the hull structure or to the sea cock/valve itself and without destroying the watertight integrity or the sea cock/valve installation.

6. Cocks/valves, outfitting penetrating hull are to be complied with the requirements of ISO 9093-1 and ISO 9093-2.

404. Bilge piping sysytem

1. Type, number and location

(1) General
Bilge-pumping systems are to be capable of removing water from all main compartments of the craft where water can accumulate. Fore and aft peaks with a combined volume of less than or including 10 % of the displacement of the craft in the fully loaded ready-for-use condition, according to **ISO 8666**, need not be linked to the bilge-pumping system if trapped water in those compartments can be emptied into the main bilges by a valve, or drained by other means. Types, numbers and locations of bilge-pumping systems are to be in accordance with require-

ments in (2) and (3).

(2) Open and partially decked crafts(For crafts in design categories A, B C and D)
For open and partially decked crafts, the means of bailing are to be specified in the owner's manual.

(3) Fully decked crafts
(A) Fully decked crafts are to be fitted with one or more bi1ge pumps according to the requirements in (B) and (C).
(B) Primary bilge pump (For craft in design categories A, B and C)
(a) Where the main steering position is exposed and the water head in the discharge line is less than 1.5 m, one manual bilge pump is to be installed, permanently attached to the craft structure and operable from within the cockpit, with all doors, hatches and other accesses to the interior of the craft closed;
(b) Where the main steering position is exposed and the water head in the discharge line is 1.5 m or more, one manual or powered bilge pump or bilge pumping system (e.g. electric) is to be installed, permanently attached to the craft structure and operable from the main steering position, with all doors, hatches and other accesses to the interior of the craft closed;
(c) Where the main steering position is enclosed within the craft, one powered bilge pump or bilge-pumping system is to be installed and the bilge pump is to be operable from the main steering position.
(C) Primary bilge pump(For craft in design category D)
(a) If L_H is greater than 6 m, one manual or powered bilge pump or bilge-pumping system is to be installed;
(b) If L_H is less than or equal to 6 m, one manual bilge pump or other means of bailing is to be available, which is to be specified in the owner's manual.
(D) Secondary bilge pump
For craft in design categories A, B and C, one additional manual, mechanical or electric bilge pump or bilge-pumping system is to be installed, which is to be capable of removing water from all bilge compartments and which is to be operable from a readily accessible position. For craft in design category D, no secondary bilge pump is required.

Table 8.1 Bilge pump requirements

Craft type	Craft characteristics	Type of pump	Bilge-pump requirements or means of bailing
Open and partially decked crafts (Design categories A, B, C, D)			See Owner's manual
Fully decked crafts (Design category A, B, C)	Exposed steering position	Primary pump	1 manual pump (water head less than 1.5 m) 1 manual, mechanical or electric pump (water head 1.5 m or more) (operable from the cockpit)
		Secondary pump	1 manual or mechanical or electric pump
	Enclosed steering position	Primary pump	1 powered pump (operable from the main steering position)
		Secondary pump	1 manual or mechanical or electric pump
Fully decked crafts (Design category D)	L_H greater than 6 m	Primary pump	1 manual or mechanical or electric pump
	L_H less than or equal to 6 m	Primary pump	1 manual pump, for alternative see Owner's manual

2. Capacity

(1) The capacity of each bilge pump, according to **1** (3) is to be not less than
   (A) 10 L/min for crafts with L_H, less than or equal to 6 m,
   (B) 15 L/min for crafts with L_H, greater than 6 m and less than 12 m, or
   (C) 30 L/min for crafts with L_H, greater than or equal to 12 m.
(2) These volumes per minute are to be achieved when the pump is subjected to a back pressure of 10 kPa. For manual bilge pumps, the capacity is to be rated for 45 strokes per minute.

3. Design and construction

(1) The design and construction of bilge-pumping systems are to withstand the pressures, temperatures and stresses likely to be encountered under normal operating conditions. Bilge pumps are to be operable within temperature limits ranging from 0 °C to +60 °C and are to withstand storage temperatures, without operation, of −40 °C to +60 °C when in the dry condition.
(2) Spigots/spuds of bilge pumps and other components are to be long enough to provide support for the hose, and permit the use of clamps.
(3) Unless permanently fitted, bilge-pump handles are to be secured to minimize the risk of accidental loss.
(4) No bilge pump may discharge into a cockpit unless the cockpit opens aft to the sea. Bilge pumps are not to be connected to cockpit drains.
(5) Electrically operated pumps
   (A) Electric bilge pumps are to comply with **ISO 8849**.
   (B) Electrical connections are to be water resistant to a degree of IP 67 according to **IEC 60529**, and are to be placed above the maximum acceptable water level, unless submersible.
   (C) Where the switch is subject to spray water, it is to be water resistant to a degree of IP 56 according to **IEC 60529**.
(6) The inner diameter of bilge suction pipes are not to be less than that obtained from following formula. However, the inner diameter is not to be less than 25 mm in any case and the inner diameter of bilge branch line need not be exceed 50mm.

$$d = \frac{L}{1.2} + 25$$

d : inner diameter of bilge pipe (mm)
L : craft length (m)

4. Installation

(1) Bilge pumps are to be mounted in an accessible location for servicing and clearing the intake.
(2) Bilge-pump water inlets (e.g. strainers) are to be designed and installed to minimize ingestion of debris likely to cause pump failure and are to be accessible for cleaning.
(3) Intake hoses are not to collapse under maximum pump suction.
(4) Bilge-pump pipes and hoses are to be installed to minimize flow restriction.
(5) Outlets on the hull are to be above the maximum heeled waterline, unless a seacock is installed in accordance with **ISO 9093**, and there is a means to prevent backflow into the craft.
(6) Where several pumps discharge through one through-hull fitting, the system is to be designed so that the operation of one pump will not feed back through another pump, and the simultaneous operation of the pumps will not diminish the pumping capacity of the system.
(7) Hose connections are to be secured with non-corrosive types of clamps, or with permanently attached end-fittings.
(8) Non-submersible bilge pump non-sailings are to be located above the critical bilge-water level.
(9) Bilge pumps with automatic controls are to be provided with a readily accessible manual power-supply switch to activate the pump.
(10) Automatic controls are to be provided with a visual indication showing that power is supplied to the pump and that the pump is set and ready to operate in automatic mode.
(11) Hand pumps are to be installed in such a way that they can be operated at their rated capacity according to **2**.

5. Owner's manual

The manufacturers of craft and/or pump are to provided with the following information for bilge pumping system in the owner's manual.

(1) Type, capacity and position of installation of each bilge pump

(2) Methods of operation
(3) Requirements for maintenance

Section 5 Discharge Prevention and Installations Facilitating the Delivery Ashore of Waste

501. General

1. Crafts are to be constructed so as to prevent the accidental discharge of pollutants (oil, fuel, etc.) overboard.

2. Craft fitted with toilets is to have holding tanks or provision to fit holding tanks.

3. Crafts with permanently installed holding tanks are be fitted with a standard discharge connection to enable pipes of reception facilities to be connected with the craft discharge pipeline.

4. Toilet waste retention system and a standard discharge connection are to comply with the requirements in **ISO 8099**.

5. In addition, any through-the-hull pipes for human waste is to be fitted with valves which are capable of being secured in the closed position.

Section 6 Fuel System

601. General

Design, materials, installation and tests of permanently installed gasoline and diesel fuel system and permanently installed fuel tanks for inboard engines for propulsion and auxiliary and outboard engines are to be comply with the requirements in this Section.

602. Fuel system

1. Materials and design

(1) The filling, storage, venting and fuel-supply arrangements and installations are to be designed and installed so as to minimize the risk of fire and explosion.
(2) Individual components of the fuel system, and the fuel system as a whole, are to be designed to withstand the combined conditions of pressure, vibration, shocks, corrosion and movement encountered under normal operating conditions and storage.
(3) Each component of the fuel system, and the fuel system as a whole, are to be capable of operation within an ambient temperature range of −10 °C to +80 °C, without failure or leakage, and be capable of being stored without operation within an ambient temperature range of −30 °C to +80 °C, without failure or leakage.
(4) All materials used in the fuel system are to be resistant to deterioration by its designated fuel and to other liquids or compounds with which it may come into contact under normal operating conditions, e.g. grease, lubricating oil, bilge solvents and sea water.
(5) The only outlets for drawing fuel from the fuel system are to be :
 (A) Plugs in petrol filter bowls intended solely for the purpose of servicing the filter,
 (B) Plugs or valves in diesel filter bowls intended solely for the purpose of servicing the filter.
(6) Each metal or metallic plated component of a petrol fuel fill system and fuel tank which is in contact with the fuel are to be grounded so that its resistance to the craft's ground is less than one ohm. Grounding wires are not to be clamped between a hose and its pipe or spud.
(7) Fuel filling systems are to be designed to avoid blowback of fuel through the fill fitting. Fuel systems are to be tested in accordance with **4** (3).
(8) Provision is to be made to prevent fuel overflow from the vent opening from entering the craft or the environment.
(9) All fuel system components in the engine compartment, excluding permanently installed fuel tanks, which are tested in accordance with **ISO 21487**(e.g. filters, water separators, and hoses) are to individually, or as installed in the craft, be capable of withstanding a 2.5 min fire test as specified in **ISO 7840 Annex A**. Fasteners supporting metal fuel lines constitute an exception to this requirement.

(10) Copper-base alloy fittings may be used for aluminium tanks if protected by a galvanic barrier to reduce galvanic corrosion.
(11) A means to determine fuel tank level or quantity is to be provided.

2. Fuel pipes, hoses, connections and accessories

(1) Fuel filling lines
(A) The minimum inside diameter of the filling pipe system is to be 31.5 mm and the minimum inside diameter of fuel filling hoses is to be 38 mm.
(B) Fuel filling hoses located in the engine compartment are to be fire resistant, of type A1 or A2 in accordance with **ISO 7840**. Fuel filling hoses outside the engine compartment are to be of either type A1 or A2 in accordance with **ISO 7840**, or of type B1 or B2 in accordance with **ISO 8469**.
(C) Fuel filling lines are to be self-draining to the tank when the craft is in its static floating position.
(D) Fuel filling lines are to run as directly as practicable, preferably in a straight line from the deck plate or equivalent filling point to the tank.
(E) The fuel filling system is to be designed so that accidental fuel spillage does not enter the craft when it is in its static floating position.
(F) The distance between compartment ventilation openings and fuel filling openings is to be at least 400 mm, except where the craft's coaming, superstructure or hull creates a barrier to prevent fuel vapour entering the craft through the ventilation opening.
(G) The fuel filling point are to be marked “petrol” or “diesel” and/or with a symbol specified in **ISO 11192** to identify the type of fuel to be used.

(2) Vent lines
(A) Each fuel tank is to have a separate vent line.
(B) Vent hoses located in the engine compartment are to be fire resistant, of type A1 or A2 in accordance with **ISO 7840**. Vent hoses outside the engine compartment are to be of either type A1 or A2 in accordance with **ISO 7840**, or type B1 or B2 in accordance with **ISO 8469**.
(C) The cross-sectional area of any vent component is not to be less than 95 mm^2(inside diameter 11 mm).
(D) Vent lines are not to have valves other than those that permit free flow of air and prevent flow of liquid both in and out of the tank.
(E) Vent lines are to be self-draining when the craft is in its static floating position.
(F) The distance between compartment ventilation openings and fuel vent openings is to be at least 400 mm, except where the craft's coaming, superstructure or hull creates a barrier to prevent fuel vapour entering the craft through the ventilation opening.
(G) The vent line is to be arranged to minimize intake of water without restricting the release of vapour or intake of air and is not to allow fuel or vapour overflow to enter the craft.
(H) The vent-line termination or a gooseneck in the vent-line routing is to be arranged at sufficient height to prevent spillage of fuel through the vent line during filling and entry of water under normal operating conditions of the craft. On mono-hull sailing craft, the vent line is to be arranged to minimize the risk of fuel spillage or entry of water through the vent when sailing at a heel angle of up to 30°.
(I) The vent lines on all fuel installations are to incorporate a flame arrester device.
(J) For components installed in the vent line, the requirements in (2) apply.
(K) For vent-line components in the engine compartment, with the ability to capture fuel, the fire test requirements in **1** (9) apply.

(3) Fuel distribution lines and fuel return lines
(A) Metal fuel distribution and return lines are to be made of seamless annealed copper or copper-nickel or equivalent metal with a nominal wall thickness of at least 0.8 mm. Aluminium lines may be used for diesel fuel.
(B) Rigid fuel distribution and return lines are to be connected to the engine by a flexible hose section. Support is to be provided within 100 mm of the connection to the metal supply line on the rigid side of the connection.
(C) Connections in rigid fuel distribution or return lines are to be made with efficient screwed, compression, cone, brazed or flanged joints.
(D) Flexible fuel distribution and return hoses are to be used where relative movement of the craft structures supporting the fuel lines would be anticipated during normal operating conditions.

(E) Flexible fuel distribution and return hoses are to be accessible for inspection and maintenance.
(F) Petrol distribution and return hoses are to be fire-resistant, type A1 hoses in accordance with **ISO 7840**, except hoses entirely within the splash well at the stern of the craft connected directly to an outboard engine, which are to be type B1 or B2 hoses in accordance with **ISO 8469** or A1 or A2 hoses in accordance with **ISO 7840**.
(G) Diesel-fuel distribution and return hoses are to be fire-resistant, type A1 or A2 hoses in accordance with **ISO 7840**.
(H) Fuel distribution and return lines are to be properly supported and secured to the craft structure above bilge water level, unless specifically designed for immersion or protected from the effects of immersion.
(I) There are to be no joints in fuel distribution and return pipes or hoses other than those required to connect required fuel-line components, e.g. filters and bulkhead connections.
(J) Fuel distribution lines to petrol engines are to be designed or installed to prevent fuel siphoning out of the tank following a failure in the system. The following examples illustrate how this can be achieved:
(a) routing all parts of fuel lines, from which an assumed leakage can enter the craft, above the level of the tank top when the craft is in its static floating position, including fuel-containing parts on the engine; or
(b) fitting an anti-siphon valve at the tank fittings with a rated siphon-protection head greater than that required to avoid the siphon effect; or
(c) fitting a manual shut-off valve, which are to be capable of being closed from an indicated accessible location outside the engine compartment, in a position that is self-draining from the valve to the tank; or
(d) fitting an electrically operated valve at the tank withdrawal fitting which is activated to open only when the engine is running or the starting device is operated. A momentary override type is acceptable for starting.
(K) Fuel distribution lines to diesel engines to either meet the requirements of (J), or be fitted with a manual shut-off valve. This valve is to be capable of being closed from an indicated accessible location outside the engine compartment. If electrically operated valves are used, they are to be equipped with a manual emergency operating or by-passing device.
(L) Diverting valves in diesel return lines are to ensure that the return line flow is not restricted.
(4) Hose fittings and hose clamping
(A) Fuel hoses are to be secured to the pipe, spud or fitting by metal hose clamps or be equipped with permanently attached end fittings such as a swaged sleeve or a sleeve and threaded insert.
(B) Pipes, spuds or other fittings for hose connection with hose clamps are to have a bead, flare, series of annular grooves or serrations. The fuel-tank spud constitutes an exception to this requirement. Continuous helical threading knurls or grooves, which can provide a path for fuel leakage, are not to be used.
(C) Spuds or other fittings for hose connection with hose clamps are to have a nominal outer diameter which is the same as the nominal inner diameter of the hose, and should be chosen from a series of preferred numbers, e.g. 3.2, 4, 5, 6.3, 8, 10, 12.5 16, 20, 25, 31.5, 40, 50, 63.
(D) Hose connections designed for a clamp connection are to have a spud at least 25 mm long.
(E) Hose connections having a nominal diameter of more than 25 mm are to have two hose clamps. The spud is to be at least 35 mm long, to provide space for the clamps.
(F) Spuds intended for hose connection are to be free from sharp edges that could cut or abrade the hose.
(G) Hose clamps are to be made of CrNi 18-8 stainless steel, or equivalent, and be reusable. Clamps depending solely on spring tension are not to be used. The nominal clamp band width is to be at least 8 mm for nominal outside hose diameters up to and including 25 mm and at least 10 mm for bigger hoses. Clamps are to be of the correct size and are to be fitted according to the clamp manufacturer's requirements.
(H) Clamps are to be installed to fit directly on the hose and are not to overlap each other. Clamps are to be installed behind the bead, if any, or fully on the serrations on spuds at least one clamp width from the end of the hose.
(5) Valves
(A) Manually operated valves are to be designed with positive stops in the open and closed positions or are to clearly indicate their open and closed positions.

(B) The integrity and tightness of a valve are not to depend solely on spring tension.
(C) Threaded valve housing covers that can be exposed to an opening torque when the valve is operated are to be secured against unintentional opening by a device that can be reused.

(6) Fuel filters
(A) Petrol fuel systems are to be equipped with a fuel filter, which may be fitted on the engine.
(B) Diesel fuel systems are to be equipped with at least one fuel filter and one water separator. The two functions may be combined in one unit.
(C) Each filter is to be independently supported on the engine or craft structure.

(7) Labelling
All components (e.g. filters, pumps and water separators) that have passed the test for fire resistance specified in **ISO 7840** Annex A, are to be labelled or marked with the following:
(A) Manufacturer's name or trademark;
(B) **ISO 10088**, fire resistant;
(C) Type of fuel or fuels for which the component is suitable.

3. Installation

(1) The fuel system is to be permanently installed. All component parts, except small connectors and fittings and short sections of flexible hoses, are to be independently supported.
(2) All valves and other components intended to be operated or observed during normal operation of the craft, or for emergency purposes, are to be readily accessible. All other components of the system are to be accessible. Tanks need not be accessible for removal.
(3) The clearance between a petrol fuel tank and a combustion engine is not to be less than 100 mm.
(4) The clearance between a petrol tank and dry exhaust components is not to be less than 250 mm, unless an equivalent thermal barrier is provided.
(5) Fuel system electrical components are to be installed in accordance with **ISO 10133** or **ISO 13297**.
(6) Fuel tanks and components of petrol fuel systems are not to be installed directly above batteries unless the batteries are protected against the effects of fuel leakage.

4. Tests

(1) After installation, the fuel system is to be subject to pressure test as follows;
(A) A complete fuel system as installed in the craft is to be subject to the test pressure with the pressure of 20 kPa. and the pressure-drop method is to be used. The time during which the system is exposed to the pressure is to be equal to the greater of the following two values: 1.5 s per litre of tank capacity or 5 min, up to a maximum of 30 min. Tanks with a capacity of less than 200 L are to be tested for at least 5 min. During this test, fuel-fill deck plates and vent-line through-hull fittings may be replaced by plugs. The fuel connection at the fuel feed pump of the engine is to be disconnected and sealed. Anti-siphon valves and other fuel valves are to be open.
(B) A component or fuel system is not to show any leakage during pressure testing for 5 min.
(2) Fuel system components that are small enough, such as fuel valves, and required to be fire tested according to **1** (9) are to be tested as specified in **ISO 7840** Annex A. **The component to be tested is to be a complete assembly and include all accessories intended to be attached directly to the component.**
(3) There are to be no blow back of fuel through the fill fitting when filling at a rate of 30 L/min from 25 % to 75 % of the capacity on the tank label. For fuel tanks of 100 L capacity or less, the fill rate may be reduced to 20 L/min. The test to determine compliance with this is to be performed on at least one craft or a representative installation.

603. Fuel tanks

1. Design general

(1) Fuel tanks, lines and hoses are to be secured and separated or protected from any source of significant heat. The material of the tanks and their method of construction are to be according to their capacity and the type of fuel. All tank spaces are to be ventilated.
(2) Petrol fuel is to be kept in tanks which do not form part of the hull and are insulated from the engine compartment and from all other source of ignition and are separated from living quarters.
(3) Diesel fuel may be kept in tanks that are integral with the hull.
(4) Metal tanks are to be designed or installed so that no exterior surface will trap water.

(5) Rigid fuel suction tubes and filling pipes which extend near the tank bottom are to have sufficient clearance to prevent contact with the bottom during normal operation of the craft.
(6) Non-integral tanks shall be installed so that the loads due to the mass of the full tank are safely introduced into the structure, with due consideration given to upward and downward acceleration due to the craft's movements at maximum speed in the sea. All non-integral tank supports, chocks or hangers are to either be separated from the surface of metal tanks by a non-metallic, non-hygroscopic, non-abrasive material or welded to the tank.
(7) If baffles are provided, the total open area provided in the baffles is to be not greater than 30 % of the tank cross section in the plane of the baffle.
(8) Baffle openings are to be designed so that they do not prevent the fuel flow across the bottom or trap vapour across the top of the tank.

2. Materials

(1) All seals such as gaskets, o-rings and joint-rings are to be of non-wicking, i.e. non-fuel absorbent, material.
(2) All materials used are to be resistant to deterioration by the fuel for which the system is designed and to other liquids or compounds with which the material can come in contact as installed under normal operating conditions, e.g. grease, lubricating oil, bilge solvents and sea water.
(3) The melting point of materials used for manufacturing of plastic fuel tanks is to be higher than 150 °C.
(4) Copper-based alloys for fittings are acceptable for direct coupling with all tank materials specified in **Table 8.2** except aluminium. Copper-based alloy fittings are allowed for aluminium tanks only if a galvanic barrier is arranged between fitting and tank.
(5) Suitable metallic tank materials and minimum recommended material thicknesses required for corrosion resistance are given in **Table 8.2**. Other materials may be used if they demonstrate equivalent fuel and corrosion resistance.

Table 8.2 Metallic tank materials

Material	Minimum nominal sheet thickness for corrosion resistance mm	Fuel
Copper, internally tin-coated	1.5	Petrol only
Aluminium alloys containing no more than 0.1 % copper	2.0	Diesel and petrol
Stainless steel, with all welding deposits removed	1.0	Diesel and petrol
Mild steel	2.0	Diesel only
Mild steel externally hot-dip zinc-coated after fabrication	1.5	Diesel only
Mild steel externally and internally hot-dip zinc-coated after fabrication	1.5	Petrol only
Aluminized steel	1.2	Diesel and petrol

3. Petrol fuel tanks

(1) Petrol fuel tanks are not to be integral with the hull.
(2) Petrol fuel tanks are to have all fittings and openings on top, except metallic filling and ventilation pipes, which may be connected to the sides or ends of metal petrol fuel tanks, provided that they are welded to the tank and reach above the top of the tank.
(3) Tank drains are not permitted on petrol fuel tanks.
(4) Petrol fuel tanks are to be subjected to leakage test in accordance with 7.1.2 of **ISO 21487** and to be subjected to pressure-impulse test in accordance with 7.2 of **ISO 21487**.
(5) Non-metallic petrol fuel tanks are to meet the fire test in accordance with 7.3 and 7.4 of **ISO 21487**.

4. Diesel fuel tanks

(1) Diesel fuel tanks may be constructed independent of or integral with the hull. Care should be taken to avoid penetration of fuel in the hull.
(2) Diesel fuel integral tanks are to be built in accordance with **ISO 12215-5**.
(3) Diesel fuel tanks may have side inspection openings. Fittings in the bottom, sides or ends are allowed provided that each connection has a shut-off valve directly coupled to the tank. The valve is to be protected or located to prevent physical damage or be of at least 25 mm nominal diameter.
(4) Diesel fuel tank drains, where fitted, are to have a shut-off valve with a plug on the outlet that can only be removed by the use of tools, or the handle of the drain shut-off valve is to be removable with the valve in its closed position.
(5) Diesel tanks are to be subjected to leakage test in accordance with 7.1.2 **and** are to be subjected to pressure/strength test in accordance with 7.1.3 of **ISO 21487**.

5. Marking to the Tanks

All fuel tanks are to display the following information in contrasting or embossed letters and numerals at least 3 mm high:

- manufacturer's name or trademark, city or equivalent, and country;
- year of manufacture (last two digits);
- design capacity, expressed in liters;
- fuel or fuels for which the tank is suitable, in symbols (as specified in **ISO 11192**) or in words;
- maximum fill-up height above tank top, expressed in meters, and allowable test pressure, expressed in kP; "ISO 21487" marking or label if the tank is a non-metallic petrol fuel tank fire tested in accordance with this International Standard;
- CE marking and identification number of notify authority (if applicable)

Section 7 Ventilation

701. General of ventilation

1. The engine compartment is to be sufficiently ventilated with adequate natural ventilation, etc.

2. The dangerous ingress of water into the engine compartment through all inlets must be prevented.

3. The machinery spaces are to be provided with intake and discharge ducts of ventilating system and at least one intake duct are to be extended to the low location of proper space. The discharge duct may be connected to top of machinery space or to the natural or mechanical ventilator.

4. Where ventilation system is installed other than this regulation, the detail documents are to be submitted to the Society before installation and it may be approved when it is considered equivalents.

702. Ventilation of petrol engine and/or petrol tank compartments

1. Natural ventilation systems

(1) Unless open to the atmosphere, each compartment contains a permanently installed petrol engine, a permanently installed petrol tank or a portable petrol tank in a craft is to have a natural ventilation system.
(2) Natural ventilation may be supply opening or supply duct or exhaust opening or exhaust duct and each exhaust opening or exhaust duct is to originate in the lower one-third of the compartment.
(3) Each supply opening or supply duct and each exhaust opening or exhaust duct in a compartment is to be above the normal accumulation of bilge water.
(4) Compartment air intake and exhaust duct openings are to be separated by at least 600 mm, compartment dimensions permitting.
(5) Except as provided in (6), the combined area of supply openings or supply ducts, and the com-

bined area of exhaust openings or exhaust ducts is to have a minimum internal cross-sectional area calculated as follows:

$$A = 3300\ell n(V/0.14)$$

where,

A : is the minimum combined internal cross-sectional area of the openings or ducts, (mm^2) ;

V : is the net compartment volume equal to the total compartment volume minus the volume of permanently installed components in it, (m^3).

(6) The minimum internal cross-sectional area of each supply opening or duct, and exhaust opening or duct is to exceed 3000 mm^2.

(7) The minimum internal cross-sectional area of terminal fittings for flexible ventilation ducts installed to meet the requirements of clause (5) is not to be less than 80 % of the required internal cross-sectional area of the flexible ventilation duct.

(8) The exhaust of the natural ventilation system may be part of the powered ventilation system.

2. Power ventilation systems

(1) Unless open to the atmosphere, each compartment containing a permanently installed petrol engine is to be provided with power ventilation system removing air from the compartment to the atmosphere outside the craft by an exhaust blower system.

(2) Each exhaust blower or combination of blowers are to be rated at an airflow capacity Qr not less than that given in **Table 8.3**. Blower rating is to be determined according to ISO 9097.

Table 8.3

compartment volume(V) m^3	airflow capacity (Qr) m^3/min
〈 1	1.5
1 ≤ V ≤ 3	1.5 × V
〉 3	0.5 × V+3

(3) Each intake duct for an exhaust blower is to be in the lower one-third of the compartment and above the normal level of accumulated bilge water.

(4) More than one exhaust blower may be used in combination to meet the requirements of clause (2).

(5) Each craft that has an exhaust blower is to have a label in accordance with 6.5 of **ISO 11105** and to include an information in accordance with 7 of **ISO 11105** in the owner's manual.

3. The ventilation duct sizes and airflow requirements are to be calculated based on compartment volumes.

4. Compartments containing petrol engines and/or petrol tanks are to be sealed from enclosed accommodation spaces. Separating structures are regarded as being sealed if they fulfil the following requirements:

(1) the boundaries are welded, brazed, glued, laminated or the like;
(2) penetrations for cables, piping etc. are closed by fittings and/or sealants; and
(3) access openings, for example doors and hatches, are equipped with fittings and are secured.

5. No ventilation is required in petrol engine or petrol tank compartments which are open to the atmosphere, that is; compartment or space having at least 0.34 m^2 of permanent open area directly exposed to the atmosphere for each cubic meter of net compartment volume.

6. Neither supply nor exhaust ducts are to open into an accommodation space.

7. Electrical components installed in petrol engine and petrol tank compartments and any connecting compartments, not open to the atmosphere, are to be ignition-protected in accordance with **ISO 8846**. ⚓

Chapter 9 ELECTRICAL EQUIPMENT

Section 1 Direct Current System

101. Scope

1. This section is to be applied to the extra-low-voltage direct current (d.c) electrical systems which operate at nominal potentials of 50 V d.c. or less on the recreational crafts. It specifies the requirements for the design, construction and installation of the d.c electrical systems but engine wiring as supplied by the engine manufacturer is not covered by this section. However, the craft operated by alternating current systems shall comply with the **Sec 2**.

2. In addition to requirements in this section, the systems shall also comply with **ISO 10133** (Extra-low-voltage d.c. installations). However, for the direct current (d.c) electrical systems exceeding d.c. 50 V, other standards in the **IEC 60092** series are to be applied.

3. Requirements for electrically operated direct-current bilge pumps applies to the pumps rated for less than 50 V direct current, the pumps intended for use in removing bilge water from the recreational crafts and also shall comply with **ISO 8849** (Electrically operated direct-current bilge pumps). This pumps do not cover pumps intended for damage control.

102. General

1. Electrical systems shall be designed and installed so as to ensure proper operation of the craft under normal conditions of use and shall be such as to minimise risk of fire and electric shock.

2. Attention shall be paid to the provision of overload and short-circuit protection of all circuits, except engine starting circuits, supplied from batteries.

3. Ventilation shall be provided to prevent the accumulation of gases, which might be emitted from batteries. Batteries shall be firmly secured and protected from ingress of water.

4. The system type shall be either a fully insulated two-wire d.c. system or a two-wire d.c. system with a negative ground. The hull shall not be used as a current-carrying conductor. Engine-mounted wiring systems may use the engine block as the grounded conductor.

5. An equipotential bonding conductor, if fitted, shall be connected to the craft's ground(earth) to minimize stray current corrosion.

6. Switches and controls shall be marked to indicate their use, unless the purpose of the switch is obvious and its mistaken operation will not cause a hazardous condition.

7. Protective devices such as circuit-breakers or fuses shall be provided at the source of power, e.g the panel-board(switchboard), to interrupt any overload current in the circuit conductors before heat can damage the conductor insulation, connections or wiring-system terminals. The selection, arrangement and performance characteristics should be such that the following is achieved.

(1) maximum continuity of service to healthy circuits under fault conditions through selective operation of the various protective devices.
(2) protection of electrical equipment and circuits from damage due to overcurrents, by coordination of the electrical characteristics of the circuit or apparatus and the tripping characteristics of the protective devices.

8. All d.c. equipment shall operate under the voltage range of accumulator terminals like below (1). Except where the circuit includes equipment requiring a higher minimum voltage, the specified minimum voltage shall be used in the calculation of the conductor size (refer to (2))

(1) for a 12 volt system : 10.5 ~ 15.5 V, for a 24 volt system : 21 ~ 31 V
(2) the voltage drop E(V) may be calculated by the following formula

$$E = \frac{0.0164 \times I \times L}{S}$$

where

S : the cross-sectional area of the conductor(mm^2)

I : load current (A)

L : the length (m) of the condition from the positive power source to the electrical device and back to the negative source connection.

9. The length and cross-sectional area of conductors in each circuit shall be such that the calculated voltage drop shall not exceed 10 % of the nominal battery voltage for any appliance, when every appliance in the circuit is switched on at full load.

10. Electrical systems shall comply with the **ISO 8846** in order to protect against ignition of surrounding flammable gases.

103. Batteries

1. Batteries shall be permanently installed in a dry, ventilated location above the anticipated bilge-water level.

2. Batteries shall be installed in a manner to restrict their movement horizontally and vertically considering the intended use of the craft. A battery, as installed, shall not move more than 10 mm in any direction when exposed to a force corresponding to twice the battery weight.

3. The batteries installed in the craft shall be capable of inclinations of up to 30° without leakage of electrolyte. In monohull sailing craft, means shall be provided for containment of any spilled electrolyte up to inclinations of 45°.

4. Batteries shall be installed, designed or protected so that metallic objects cannot come into unintentional contact with any battery terminal.

5. Batteries, as installed, shall be protected against mechanical damage at their location or within their enclosure.

6. Batteries shall not be installed directly above or below a fuel tank or fuel filter.

7. Any metallic component of the fuel system within 300 mm above the battery top, as installed, shall be electrically insulated.

8. Battery cable terminals shall not depend on spring tension for mechanical connection to them

104. Battery-disconnect switch

1. A battery-disconnect switch shall be installed in the positive conductor from the battery, or group of batteries, connected to the supply system voltage in a readily accessible location, as close as practical to the battery or group of batteries. The following constitute exceptions.

(1) outboard-powered craft with circuits for engine starting and navigation lighting only

(2) electronic devices with protected memory and protective devices such as bilge-pumps and alarms, if individually protected by a circuit-breaker or fuse as close as practical to the battery terminal

(3) ventilation exhaust blower of engine/fuel-tank compartment if separately protected by a fuse or circuit-breaker as close as practical to the battery terminal

(4) charging devices which are intended to be used when the craft is unattended (e.g. solar panels, wind generators) if individually protected by a fuse or circuit-breaker as close as practical to the battery terminal.

2. The minimum continuous rating of the battery switch shall be at least equal to the maximum current for which the main circuit-breaker is rated and also the intermittent load of the starter motor circuit, or the current rating of the feeder conductor, whichever is less.

3. Remote-controlled battery-disconnect switches, if used, shall also permit safe manual operation.

105. Conductors

1. Electrical distribution shall use insulated stranded-copper conductors.(refer to **Table 9.1**) Conductor insulation shall be of fire-retardant material, (e.g. not supporting combustion in the absence of flame.)

2. Conductors that are not sheathed shall be supported throughout their length in conduits, cable trunk, or trays, or by individual supports at maximum intervals of 300 mm.

3. Sheathed conductors and battery conductors to the battery disconnect switch shall be supported at maximum intervals of 300 mm, with the first support not more than 1m from the terminal. Other sheathed conductors shall be supported at maximum intervals of 450 mm. Sheathed out-board-non-sailing starter conductors constitute an exception to this requirements.

4. Conductors which may be exposed to physical damage shall be protected by sheaths, conduits or other equivalent means. Conductors passing through bulkheads or structural members shall be protected against damage to insulation by chafing.

5. Conductors shall have minimum dimensions in accordance with **Table 9.1**, or the conductor manufacturer's rated current-carrying capacity, based on the load to be supplied and allowable voltage drop for the load to be carried. Conductors in voltage-critical circuits, such as starter non-sailing circuits, navigation-light circuits and ventilation-blower circuits, whose output may vary with system voltage, shall be sized in compliance with the component manufacturer's requirements. (refer to **102. 8** & **9**)

6. Each conductor longer than 200 mm installed separately shall have an area of at least 1 mm^2. Each conductor in a multi-conductor sheath shall have an area of at least 0.75 mm^2 and may extend out of the sheath a distance not to exceeding 800 mm. An exception may be made for conductors of minimum area 0.75 mm^2 which may be used as internal wiring in panel-boards.

7. A d.c. circuit shall not be contained in the same wiring system as an a.c. circuit, unless one of the following methods of separation is used.

(1) For a multicore cable or cord, the cores of the d.c. circuit are separated from the cores of the a.c. circuit by an earthed metal screen of equivalent current-carrying capacity to that of the largest core in either circuit.
(2) The cables are insulated for their system voltage and installed in a separate compartment of a cable ducting or trunking system.
(3) The cables are installed on a tray or ladder where physical separation is provided by a partition.
(4) A separate conduit, sheathing or trunking system is used.
(5) The d.c and a.c. conductors are fixed directly to a surface and separated by at least 100 mm.

8. Each electrical conductor that is part of the electrical system shall have a means to identify its function in the system, except for conductors integral with engines as supplied by their manufacturers.

(1) All equipotential bonding conductors shall be identified by green, or green with a yellow stripe insulation, or may be uninsulated. Conductors with green, or green with a yellow stripe insulation shall not be used for current-carrying conductors.
(2) Means of identification other than colour for d.c. positive conductors is permitted if properly identified on the wiring diagram of the electrical system(s) of the craft.
(3) All d.c. negative conductors shall be identified by black or yellow insulation. If the craft is equipped with an a.c. electrical system (refer to **ISO 13297**) which may use black insulation for live conductors, yellow insulation shall be used for d.c. negative conductors of the d.c. system. Black or yellow insulation shall not be used for d.c. positive conductors.
(4) Insulation-temperature ratings of conductors in engine spaces shall be 70 °C minimum. The conductors shall be rated oil resistant, or shall be protected by an insulating conduit or sleeving, and shall be derated in allowable current-carrying capacity in accordance with **9**.
(5) For additional conductor specifications, refer to **ISO 6722-3** and **ISO 6722-4**.
(6) Current-carrying conductors of the d.c. system shall be routed above anticipated levels of bilge water and in other areas where water may accumulate, or at least 25 mm above the level at which the automatic bilge-pump switch activates. If conductors must be routed in the bilge area, the wiring and connections shall be in an IP 67 enclosure, in accordance with **IEC 60529**, as a minimum, and there shall be no connection below the foreseeable water level.
(7) Conductors shall be routed away from exhaust pipes and other heat sources which can damage the insulation. The minimum clearance of the conductors is 50 mm from water-cooled exhaust components and 250 mm from dry exhaust components, unless an equivalent thermal barrier is provided.

9. Cross-sectional area of conductor, allowable continuous current and the number of strands for conductors are as follows.

(1) Cross-sectional area of conductor, allowable continuous current and stranding

Table 9.1 Cross-sectional area of conductor, allowable continuous current and stranding

(based on ambient temperature 30 ℃)

Cross-sectional area mm^2	Maximum current, in amperes, for single conductors at insulation temperature ratings						Minimum number of strands	
	60 ℃	70 ℃	85 ~ 90 ℃	105 ℃	125 ℃	200 ℃	Type A	Type B
0.75	6	10	12	16	20	25	16	-
1	8	14	18	20	25	35	16	-
1.5	12	18	21	25	30	40	19	26
2.5	17	25	30	35	40	45	19	41
4	22	35	40	45	50	55	19	65
6	29	45	50	60	70	75	19	105
10	40	65	70	90	100	120	19	168
16	54	90	100	130	150	170	37	266
25	71	120	140	170	185	200	49	420
35	87	160	185	210	225	240	127	665
50	105	210	230	270	300	325	127	1,064
70	135	265	285	330	360	375	127	1,323
95	165	310	330	390	410	430	259	1,666
120	190	360	400	450	480	520	418	2,107
150	220	380	430	475	520	560	418	2,107
Conductors with at least Type A stranding shall be used for general wiring of the craft. Conductors with Type B stranding shall be used for any wiring where frequent flexing is involved during use. Conductor current ratings may be interpolated for cross-sectional areas between those shown above.								

(2) Correction factors about temperature rating of conductors insulation in engine rooms
For conductors in engine rooms (60 ℃ ambient), the maximum current rating in **Table 9.1** shall be derated by the factors listed below.

Temperature rating of conductor insulation	Multiply maximum current from **Table 9.1** by
70 ℃	0.75
85 ~ 90 ℃	0.82
105 ℃	0.86
125 ℃	0.89
200 ℃	1

106. Overcurrent protection

1. A manually reset trip-free circuit-breaker, or a fuse, shall be installed within 200 mm of the source of power for each circuit or conductor of the system or, if impractical, each conductor shall be contained within a protective covering, such as a sheathing conduit or cable trunking, for its entire length from the source of power to the circuit-breaker or fuse. The following constitute exceptions.

(1) The main power-feed circuit from the battery to an engine-cranking non-sailing, if sheathed or supported to protect against abrasion and contact with conductive surfaces. (refer to **105. 2**)

(2) The main power-feed from the battery to the panel-board (switchboard), distribution panel or fuse block, if sheathed or supported to protect against abrasion and contact with conductive surfaces. (refer to **105. 2**)

If the fuse or circuit-breaker at the source of the supply conductor is sized to protect the smallest conductor in the circuit, only the fuse or circuit-breaker at the source is required.

2. The voltage rating of each fuse or circuit-breaker shall not be less than the nominal circuit voltage; the current rating shall not exceed the value for the conductor of smallest diameter in the circuit.

3. Output circuits of self-limiting generators and battery chargers do not require fuses or circuit-breakers.

107. Panel-boards (switchboards)

1. Panel-boards (switchboards) shall be installed such that the control elements, indicating instruments, circuit-breakers and fuses are readily accessible. The terminal side shall be accessible.

2. Connections and components on panel-boards shall be in locations protected from the expected conditions in conformity with **IEC 60529**

(1) IP 67 as a minimum, if exposed to short-term immersion

(2) IP 55 as a minimum, if exposed to splashing water

(3) IP 20 as a minimum, if located in protected locations inside the craft

3. Panel-boards (switchboards) shall be permanently marked with the nominal

4. Craft equipped with both direct current (d.c.) and alternating current (a.c.) electrical systems shall have their distribution from either separate panel-boards or a common one with a partition or other positive means provided to separate clearly the a.c. and d.c. sections from each other. Wiring diagrams to identify circuits, components and conductors shall be included, with the craft.

108. Wiring connection and terminals

1. Conductor connections shall be in locations protected from the weather or in IP 55 enclosures, in accordance with **IEC 60529** as a minimum. Connections above deck exposed to intermittent immersion shall be in IP 67 enclosures, in accordance with **IEC 60529** as a minimum.

2. Metals used for terminal studs, nuts and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal. Aluminium and unplated steel shall not be used for studs, nuts or washers in electrical circuits.

3. All conductors shall have suitable terminals installed, i.e. no bare wires attached to stud or screw connections.

4. Screw-clamp or screwless terminal blocks shall conform to **IEC 60947-7-1**(Low-voltage switchgear and controlgear - Part 7-1: Ancillary equipment - Terminal blocks for copper conductors). Other terminals shall be of the ring or self-locking captive-spade type, not dependent on screw or nut tightness alone for retention on the stud or screw. An exception is that friction-type connectors may be used in circuits not exceeding 20 A if the connection does not separate when subjected to a force of 20 N.

5. Twist-on connectors (wire nuts) shall not be used.

6. Exposed shanks of terminals shall be protected against accidental shorting by the use of insulating barriers or sleeves, except for those in the grounding system.

7. Solderless crimp-on terminals and connectors shall be attached with the type of crimping tool designed for the termination used and for a connection meeting the following requirements.

Each conductor-to-connector and conductor-to-terminal connection shall be capable of withstanding a tensile force equal to at least the value shown in **Table 9.2** for the smallest conductor in the connection, without separating.

Table 9.2 Tensile values for connectors

Conductor size mm^2	Tensile force N	Conductor size mm^2	Tensile force N	Conductor size mm^2	Tensile force N
0.75	40	6	200	50	400
1	60	10	220	70	440
1.5	130	16	260	95	550
2.5	150	25	310	120	660
4	170	35	350	150	770

8. No more than four conductors shall be secured to one terminal stud.

109. Receptacles/sockets

1. Receptacles/sockets and matching plugs used on d.c. systems shall not be interchangeable with those used on a.c. systems on the craft.

2. Receptacles/sockets installed in locations subject to rain, spray or splashing shall have a minimum protection of IP 55, in accordance with **IEC 60529** when not in use, e.g. protected by a cover with an effective weatherproof seal.

3. Receptacles/sockets installed in areas subject to flooding or momentary submersion shall have a minimum protection of IP 67, in accordance with **IEC 60529**, including when in use with connecting plugs.

110. Electrically operated direct-current bilge pumps

1. General

(1) Bilge pumps shall be designed to operate continuously at 87.5 % of nominal voltage, i.e. 10.5 V for a 12 V system, 21 V for a 24 V system, up to their design voltage at the point within the range of performance recommended for the pump that results in the highest power consumption.

(2) Bilge pumps and devices used to convert bilge pumps to automatic operation shall be ignition-protected in accordance with the requirements of **ISO 8846**(protection against ignition of surrounding flammable gases) and shall meet the electrical requirements of **ISO 10133**(extra-low-voltage d.c. installations).

(3) Bilge pumps shall be rated in litres of water flow per minute or per hour at nominal voltage, at static pressures of 0 kPa, 10 kPa and 20 kPa, i.e. 0 m, 1 m and 2 m output lift, with 1.5 times the lift in a smooth bore hose length of an inside diameter equal to the pump-outlet outside diameter fixed to the pump outlet.

(A) The pump rating and capacities shall be stated in the installation and operating instructions.

(B) The pump rating shall include the maximum output pressure and lift at which the pump ceases operation, i.e. the discharge of water.

(4) Bilge pumps shall be provided with means of fastening them to the craft independently and securely.

(5) Materials used in the construction of bilge pumps, which can be expected to come in contact with sea water, shall be

(A) selected or coated to be resistant to corrosion,

(B) galvanically compatible, and

(C) resistant to deterioration by bilge-cleaning agents and intermittent exposure to petrol(gasoline), oil and diesel fuel.

(6) Submersible pumps shall be provided with a strainer or other means of preventing debris entering the pump inlet. Inlet strainers and screens shall be designed such that they can cleaned.

(7) Installation and operating instructions shall be available for each bilge pump. An electrical diagram shall be provided. It shall identify each conductor and shall include the proper location of the control switch in the circuit and the bonding connection, if applicable. The recommended over-current protection for non-integrally protected bilge pumps shall be stated. Installation instructions shall require remote-mounted pumps to be fitted with a strainer or other means of preventing debris from entering the pump inlet.
(8) Centrifugal and axial flow pumps shall be capable of operating dry at their design voltage for at least 7 hours without creating a fire hazard. Alternatively, a means integral with the pumps shall be provided to shut the pump off automatically to prevent a fire hazard.
(9) Positive or semi-positive displacement pumps, i.e. those in which the impeller may be in continuous
contact with the housing when operating dry, shall be capable of operating dry for at least 5 min without damage to the impeller or housing and for at least 1 hour without creating a fire hazard. Alternatively, a means integral with the pumps shall be provided to shut the pump off automatically to prevent a fire hazard. A label shall be provided cautioning against operating the pump dry for more than 1 min.

2. Electrical requirements

(1) Bilge pumps shall be of the two-wire type or three-wire type if for manual or automatic operation, with both power (positive) and return (negative) conductors insulated from the motor housing and the pump housing.
(2) Conductors used for connection to the power supply shall be of stranded copper meeting the size, current capacity and insulation requirements of **ISO 10133**.
(3) Submersible pumps shall have watertight electrical connections, IP 56 in accordance with **IEC 60529**. The use of a length of watertight electrical cable sealed at the pump connection is recommended, so that connections to the power supply may be made above the normal bilge-water level.
(4) Metallic parts of the pump housing that could be exposed to contact with bilge water and may become a source of stray current leakage shall have provisions for bonding conductor connections. However, pumps designed with a double-Insulated electrical system, requiring a break in two distinct insulation systems before electrical leakage can reach exposed metallic parts, do not require a bonding connection.
(5) Bilge pumps shall be protected against continuously locked rotor conditions by
(A) integral overcurrent protection, or
(B) overcurrent protection in the circuit of a size to protect the bilge-pump motor, or
(C) being capable of sustaining operation with a locked rotor for 7 hours without generating surface temperatures in excess of 150 ℃, at an ambient temperature of 60 ℃, and without evidence of charring, burning or melting.
(6) Bilge pumps shall be capable of withstanding a d.c. voltage of 500 V for 1 minute without leakage in excess of 1 mA. The test voltage shall be applied between the current-carrying parts and the non-current-carrying metal parts. If the pump is internally earthed, the earth connection shall be broken in order to carry out this test.
(7) Bilge pumps designed for automatic operation shall be provided with an override switch to permit manual operation if the automatic operation fails.

111. Ignition protection

1. Electrical components installed in compartments which may contain explosive vapour and gases shall be ignition-protected in accordance with **ISO 8846**(protection against ignition of surrounding flammable gases). Compartments which may contain explosive gases are those containing, or which have open connections with compartments containing, such items as

(1) spark-ignition engines or their fuel tanks
(2) joints or fittings in fuel lines connecting spark-ignition engines with their fuel tanks

Open compartments having 0.34 m^2 of open area per cubic metre of compartment volume exposed to the open atmosphere outside the craft constitute an exception to this requirement.

2. Electrical components installed in certain compartments in the craft with liquefied petroleum gas (LPG) systems, such as lockers and housings containing LPG cylinders and pressure regulators, shall be ignition-protected (refer to **ISO 8846**) as required in **ISO 10239**(Small craft-Liquefied petroleum gas (LPG) systems)

3. Electrical fans shall be in accordance with the requirements of **ISO 9097** and shall be ignition-protected in accordance with the requirements of **ISO 8846**.

112. Test

The following system tests should be performed upon completion of the d.c. installation.
(1) Continuity test of circuit, particularly ring and protective circuits.
(2) Insulation resistance testing at 500 V d.c. for each circuit.

113. Owner's manual

Instructions supplied by manufacturers of low voltage d.c. systems are to be included in owner's manual of **Ch 1, 206.** and owner's manual are to include the instructions according to **ISO 10133** Annex B

Section 2 Alternating Current System

201. Application

1. This section is to be applied to the alternate current (a.c) electrical systems which operate at nominal potentials of one pole 250 V a.c. or less on the recreational crafts. In addition to requirements in this section, the systems shall also comply with **ISO 13297**. However, three pole a.c. electrical systems or one pole 250 V over a.c. electrical systems are to comply with the following.

(1) For alternating current systems having exceeding voltages 250 V single-phase or 500 V three-phase, other standards in the **IEC 60092** series are to be applied.
(2) For alternating current systems having not exceeding voltages 500 V three-phase, **IEC 60092-507** are to be applied.

202. General

1. The protective conductor insulation shall be green or green with a yellow stripe. Neither colour shall be used for current-carrying conductors.

2. The protective conductor shall be connected to the craft's d.c. negative ground (earth) as close as practicable to the battery (d.c.) negative terminal.

3. For craft with fully insulated d.c. systems (refer to **ISO 10133**), the a.c. protective conductor shall be connected to the hull of a metallic hull craft, the craft external ground (earth) or the craft lightning-protection ground plate, if fitted.

4. Metallic craft hulls shall not be used as conductors.

5. The protective conductor shall be connected to metallic hulls at a location above any anticipated water accumulation.

6. Individual circuits shall not be capable of being energized by more than one source of electrical power at a time. Each shore-power inlet, generator or inverter is a separate source of electrical power. The transfer from one power-source circuit to another shall be made by a means which opens all current-carrying conductors, live and neutral, before closing the other source circuit, prevents arc-over between contacts and is interlocked by mechanical or electromechanical means. Both current-carrying conductors, live and neutral, shall be broken simultaneously Vvf1en changing power sources.

7. Energized parts of electrical equipment shall be guarded against accidental contact by the use of enclosures of at least IP 2X type, in accordance with **IEC 60529**, or other protective means which shall not be used for non-electrical equipment. Access to energized parts of the electrical system shall require the use of hand tools or have a protection of at least IP 2X, unless otherwise specified. A suitable warning sign shall be displayed (refer to 5.2 of **ISO 13297**).

8. The neutral conductor shall be grounded (earthed) only at the source of power, i.e. at the onboard generator, the secondary of the isolation or polarization transformer, or the shore-power connection. The shore-power neutral shall be grounded through the shore-power cable and shall not be grounded on board the craft.

9. A galvanic isolator or other suitable device may be fitted in the protective conductor to resist imported stray galvanic current flow Vv'hile permitting the passage of a.c. current, if present. Galvanic isolators shall be designed to withstand the application of power from a short-circuit test from a source capable of delivering 5000 A r.m.s. symmetrically to its output test terminals for the time required for the circuit-breaker in the test circuit to trip. After three applications of the short-circuit test, the electrical and mechanical characteristics of the isolator shall be unchanged.

203. Ignition protection

Electrical components installed in compartments which may contain liquified petroleum gases(LPG) or petrol vapour, e.g. petrol tank, engine compartment and LPG lockers, are to be designed to be compliant with ISO 8846 or in accordance with IEC 60079-0, and are to be located in accordance with ISO 9094-1.

204. Overcurrent protection

1. General

(1) In unpolarized systems. double-pole Circuit-breakers that open both live and neutral conductors are required.
(2) Fuses shall not be Installed In unpolarized systems.
(3) Overcurrent protection devices for moto loads shall have a predetermined value of current flow that is consistent with demand-load characteristics of the protected circuit.
(4) All a.c. motor installations and each motor of a motor-operated device shall be individually protected in accordance with (3) by an integral overcurrent or thermal protection device. An exception may be made for motors that will not overheat under continuous locked-rotor conditions.
(5) The rating of the overcurrent protection device shall not exceed the maximum current-carrying capacity of the conductor being protected. (refer to **Table 9.1**)

2. Main supply circuits

(1) Double-pole circuit-breakers shall be installed in conductors to the shore-power supply circuits.
(2) A manually reset trip-free circuit-breaker shall be Installed within 0.5 m of the source of power or, if impractical, the conductor from the source of power to the panel-board circuit-breaker shall be contained within a protective covering, such as a junction box, control box, enclosed panel-board, or within a conduit or cable trunking or equivalent protective covering. If the location of the main shore-power inlet circuit-breaker exceeds 3 m from the shore-power inlet connection or the electrical attachment point of a permanently installed shore-power cord, additional fuses or circuit-breakers shall be provided within 3 m of the inlet or attachment point to the electrical system in the craft, measured along the conductor.
(3) Overcurrent protection shall be provided for isolation and polarization transformers, including a bank of transformers operating as a unit. Each transformer shall be protected by an individual overcurrent device on the primary side, rated at not more than 125 % of the rated primary current of the transformer.

3. Branch circuits

(1) The live conductor of each branch-circuit in a polarized system shall be provided with overcurrent protection, i.e. a fuse or circuit-breaker, at the point of connection to the main panel-board bus.
(2) Both conductors of each branch circuit in unpolarized systems shall be provided with overcurrent protection by double-pole circuit-breakers and double-pole switches, if used, at the point of connection to the main panel-board bus.

205. Ground-fault protection/earth-leakage protection

1. GFCIs (RCDs) shall be of the trip-free type.

2. The craft shall be provided with earth-leakage protection in the main supply circuit by

(1) a double-pole RCD having a maximum nominal trip sensitivity of 30 mA and 100 ms maximum trip time located in accordance with **203. 2** (2) or
(2) each receptacle located in the galley, toilet, machinery space or weather deck shall be protected by a GFCI(RCD) having a maximum sensitivity of 10 mA.

3. The GFCI (RCD) device shall have an internal circuit for manual testing of the trip function.

206. Appliances and equipment

Applicances and fixed a.c. electrical equipment installed on a craft shall have exposed conductive parts connected the the protective conductor, unless the appliance is of double-insulated construction. Integral overcurrent protection shall be provided.

207. System wiring

1. Conductors shall have a minimum rating of 300/500 V. Flexible cords shall have a minimum rating of 300/300 V.

2. Conductors and flexible cords shall be of multistrand copper, and of sizes no smaller than those determined by reference to **Table 9.1**.

3. The insulation-temperature rating of conductors and flexible cords outside engine spaces shall be at least 60 °C.

4. Conductors shall be at least 1 mm^2 in area. An exception may be made for conductors of minimum 0.75 mm^2 area which may be used as internal wiring in switchboards.

5. Temperature ratings of conductor insulation in engine spaces shall be 70 °C minimum. The conductors shall be rated oil-resistant, or shall be protected by an insulating conduit or sleeving, and shall be derated in allowable current-carrying capacity in accordance with **ISO 13297** annex A.

6. The protective conductor shall not have a cross-sectional area less than that of the live conductor in the supply circuit.

7. Live, neutral and protective conductors of the a.c. system shall be identified. Identification may be made by the insulation colour, by numbering or other means, if a wiring diagram for the system indicating the means of identification is supplied with the craft.

Insulation colours used, in conformance with **IEC 60446**:

(1) Live conductors : black or brown
(2) Neutral conductors : white or light blue
(3) Protective conductors : green or green with a yellow stripe(refer to **201. 1**)

208. Installation

1. Conductor connections shall be in locations protected from the weather or in IP 55 enclosures, in accordance with **IEC 60529**, as a minimum. Connections above deck exposed to intermittent immersion shall be in IP 67 enclosures, in accordance with **IEC 60529**, as a minimum.

2. Conductors shall be supported throughout their length in conduits, cable trunking or trays, or by individual supports at maximum intervals of 450 mm.

3. An a.c. circuit shall not be contained in the same wiring system as a d.c. circuit, unless one of the following methods of separation is used.

(1) For a multicore cable or cord, the cores of the a.c. circuit are separated from the cores of the d.c. circuit by an earthed metal screen of equivalent current-carrying capacity to that of the largest core of the a.c. circuit.
(2) The cables are insulated for their system voltage and installed in a separate compartment of a cable ducting or trunking system.
(3) The cables are installed on a tray or ladder where physical separation is provided by a partition.
(4) A separate conduit, sheathing or trunking system is used.
(5) The a.c and d.c. conductors are fixed directly to a surface and separated by at least 100 mm

4. Current-carrying conductors of the a.c. system shall be routed above forseeable levels of bilge water and in other areas where water may accumulate, or at least 25 mm above the water level at which the automatic bilge pump switch activates.

If conductors must be routed in the bilge area, the wiring and connections shall be in IP 67 enclosures, in accordance with **IEC 60529**, such as continuous conduit, as a minimum, and there shall be no connections below the forseeable water level.

5. Metals used for terminal studs, nuts and washers shall be corrosion-resistant and galvanically compatible with the conductor and terminal. Aluminium and unplated steel shall not be used for studs, nuts or washers in electrical circuits.

6. Solderless crimp-on terminals and connectors shall be attached with the type of crimping tool designed for the termination used and for producing a connection meeting the requirements of **13**.

7. All conductors shall have suitable terminals installed, i.e. no bare wires attached to stud or screw connections.

8. Screw-clamp or screwless terminals shall conform to **IEC 60947-7-1**. Other terminals shall be of the ring or captive-spade type, not dependent on screw or nut tightness alone for retention on the screw or stud. Captive-spade terminals shall be of the self-locking type.

An exception is that friction-type connectors may be used in circuits not exceeding 20 A if the connection does not separate when subjected to a force of 20 N.

9. Twist-on connectors(wire nuts) shall not be used.

10. Exposed shanks of terminals shall be protected against accidental shorting by the use of insulating barriers or sleeves, except those in the protective conductor system.

11. Conductors shall be routed away from exhaust pipes and other heat sources which can damage the insulation. The minimum clearances is 50 mm from water-cooled exhaust components, and 250 mm from dry exhaust components, unless an equivalent thermal barrier is provided.

12. Conductors which may be exposed to physical damage shall be protected by sheaths, conduits or other equivalent means. Conductors passing through bulkheads or structural members shall be protected against insulation damage by chafing.

13. Each conductor-to-connector and conductor-to-terminal connection shall be capable of withstanding a tensile force equal to at least the value shown in **Table 9.2** for the smallest conductor in the connection for 1min, without separating.

14. No more than four conductors shall be secured to one terminal stud.

209. Switchboards

1. An a.c. system switchboards with a lamp indicating the system on/off function shall be installed.

2. A system voltmeter shall be installed on the panel-board if the system is designed to supply motor circuits or if an on-board generator is installed.

3. Panel-boards shall be permanently marked with the system voltage.

4. The front side of panel-boards, i.e. the switch and circuit-breaker operating face, shall be readily accessible, and the rear side, i.e. the terminal and connection side, accessible.

5. Connections and components on panel-boards shall be in locations protected from the weather, in conformity with **IEC 60529**

(1) IP 67 as a minimum, if exposed to short-term immersion
(2) IP 56 as a minimum, if exposed to splashing water
(3) IP 20 as a minimum, if located in protected locations inside the craft

6. Craft equipped with both d.c. and a.c. electrical systems shall have their distribution from either separate switchboards or from a common one with a partition or other positive means provided to separate clearly the a.c. and d.c. sections from each other, and be clearly identified. Wiring diagram to identify circuits, components and conductors shall be included with the craft.

210. Receptacles/sockets

1. Receptacles/sockets and matching plugs used on a.c. systems shall not be interchangeable with those used in the d.c. system on the craft.

2. Receptacles/sockets installed in locations subject rain, spray or splashing shall be able to be enclosed in IP 55 enclosures, in accordance with **IEC 60529**, as a minimum, when not in use. Receptacles mated with the appropriate plug shall also remain sealed, in accordance with **IEC 60529**.

3. Receptacles/sockets installed in areas subject to flooding or momentary submersion shall be in IP 56 enclosures, in accordance with **IEC 60529**, as a minimum, also meeting these requirements when in use with electrical plugs.

4. Receptacles/sockets shall be of the earthing type with a terminal provided for the protective conductor.

5. Receptacles/sockets provided for the galley area shall be located so that appliance cords may be plugged in without crossing above a galley stove or sink or across a traffic area.

6. Receptacles/sockets shall have a voltage rating in accordance with the voltage supplied by the power sources.

211. Power-source options

1. Power for the a.c. system shall be supplied by one of the following means:

(1) single shore-power cable, power inlet, wiring and components with a capacity to supply the required design system load;
(2) multiple shore-power cables, power inlets, wiring and components with a capacity to supply the required design-system load;
(3) inverter supplying a.c. power from the craft's d.c. system;
(4) on-board a.c. generator(s) supplying the required system load;
(5) combination of shore-power cable(s) and on-board generator(s) used simultaneously if the craft's circuitry is arranged such that the load connected to each source is isolated from the other in accordance with **202. 6**.

2. The shore-power cable(s) capacity alone, or with on-board generator(s) capacity in addition, shall be at least as large as the required system load(s).

3. A.C. generators, where installed, shall be connected to the electrical distribution system as required in **202. 6** or protected in accordance with **202. 7**.

4. The power-feeder conductor from the a.c. generator shall be sized to transmit at least the generator's maximum rated output and shall be protected at the generator with over current protection devices with a rating such that 120 % of the generator nominal output is not exceeded. An exception may be made for self-limiting (self-adjusting) generators whose maximum over current does not exceed 120 % of its rated current output; these do not require additional external overcurrent protection.

212. Test

1. The following system tests should be performed upon completion of the a.c. installation.

(1) Residual current device (RCD) testing
(2) Continuity test of circuits, particularly ring and protective circuits
(3) Insulation resistance testing at 500 V d.c. for each circuit
(4) Polarity test at distribution and at each outlet.

213. Owner's manual

Instructions supplied by manufacturers of a.c. systems are to be included in owner's manual of **Ch 1, 206.** and owner's manual are to include the instructions according to **ISO 13297** Annex B.

Section 3 Navigation Lights

301. Application

In case of navigation lights are installed, **1972 COLREG**, **CEVNI** or relevant **ISO** standards are to be complied with. ⚓

CHAPTER 10 LPG SYSTEM FOR DOMESTIC USE

Section 1 General

101. General

1. LPG(hereinafter referred to as "gas") system for domestic use are to be of the vapour-withdrawal type, i.e. fuel released only under gas condition.
2. Gas systems are to be designed and installed so as to avoid leaks and the risk of explosion and be capable of being tested for leaks.
3. Gas system and all its components are to be capable of withstanding storage at -30 ℃ to +60 ℃, as well as vibration and exposure in a marine environment.
4. All gas appliances installed on the craft are to be designed for use at the same working pressure.
5. Each system is to be fitted with a pressure gauge. The pressure gauge is to read the cylinder pressure side of the pressure regulator.
6. A sign is to be fixed in the vicinity of the cylinder shut off valve listing the leak test procedure using the pressure gauge:
   (1) With appliance valves closed, open the cylinder valve;
   (2) Close cylinder valve, observe pressure on gauge for 3 minutes;
   (3) If pressure remains constant, no leak is present. If pressure fails, a leak exists. Do not use gas system until leak is repaired.
7. Each appliance is to be equipped with a flame failure device effective on all burners. Each gas-consuming appliance must be supplied by a separate branch of the distribution system, and each appliance must be controlled by a separate closing device.
8. Adequate ventilation must be provided to prevent hazards from leaks and products of combustion.
9. All craft with a permanently installed gas system are to be fitted with an enclosure to contain all gas cylinders. The enclosure are to be separated from the living quarters, accessible only from the outside and ventilated to the outside so that any escaping gas drains overboard.
10. Any permanent gas system is to be tested after installation.

Section 2 Pressure Reduction System

201. General

1. Each gas system is to be equipped with, or have provision for installation of, a pressure-reduction system designed to provide a fixed working pressure suitable for the consuming appliances but not more than 0.005 MPa. A label indicating the working pressure of the gas appliances installed is to be affixed in the vicinity of the gas cylinder installation.
2. The gas pressure-reduction system is to have an overpressure device to prevent uncontrolled pressure increase in the low-pressure side. Any gas discharge of the device is to be inside the cylinder locker or housing or is to be separately vented outside the craft. The device may be a pressure-relief governor, pressure-relief valve or an automatic safety shut-off valve.
3. The nominal regulated working pressure is to be indicated on the pressure regulator.
4. Pressure regulators of the external manual-adjustment type are not to be fitted.
5. The pressure regulator is to be located within the cylinder locker or housing.
6. If not rigidly connected to, and supported by, the cylinder connection, the pressure regulator is to be separately secured within the cylinder locker or cylinder housing to protect it from damage and exposure to dirt and water.

7. Pressure regulators are to be made of corrosion-resistant metallic material or have an coating, such as paint or plastic, that is effective against external corrosion. Fasteners used are to be of corrosion-resistant material or have a corrosion-resistant plating or coating.

Section 3 Gas Supply Line System

301. General

1. The gas supply-line system is to be either a solid piping system in accordance with **302.**, except for short hose connections to gimbaled stoves, or continuous hoses in accordance with **303.**

2. Hoses are to be used to connect gimbaled stoves to their gas supply, and supply piping to the pressure regulator. The hose and its connections between supply piping and the pressure regulator are to be within the cylinder locker or cylinder housing.

3. The piping and hose are to be sized so that the pressure drop due to pipe resistance does not reduce the working pressure at any appliance below the value required by the appliance manufacturer when all appliances are operating simultaneously(See Annex A of **ISO 10239**).

302. Piping

1. Only solid drawn coper piping or drawn stainless steel piping, which are galvanically compatible, are to be used for rigid supply lines. The minimum wall thickness is to be 0.8 mm.

2. Except for bulkhead fittings, there is to be no joints or fittings in piping that passes through engine compartments.

3. Metallic gas supply piping routed through engine compartments is to be protected by conduit or trunking or be supported by non-abrasive attachments which are no more than 300 mm apart.

4. Fittings for connections and joints in piping are to be metallic and of any of the following types:

(1) Hard soldered connections;
(2) Cutting-ring fittings in accordance with Table 3 of **ISO 8434-1**;
(3) Compression fittings of copper alloy with copper rings on copper piping;
(4) Stainless steel rings on stainless steel piping.

A jointing compound shall not be used on compression or flared fittings.

5. Piping is to be installed as high as practicable above the bilge water level.

6. Supply piping is to be made up with as few fittings as practicable joints and fittings are to be readily accessible.

303. Hoses and hose lines

1. Hose assemblies for gas installations are to meet the requirements of **EN 1763-1** and **EN 1763-2**, Class 2 or 3 for the low-pressure side and Class 3 or 4 for the supply pressure side.

2. Hoses are not to be routed through an engine compartment and are to be of minimum practical length.

3. Hoses are to have permanently attached end fittings, such as swaged sleeve or sleeve and threaded insert, in accordance with **EN 1763-2**, and are to be accessible for inspection over their entire length. Connections are to be readily accessible.

4. Hose connections are to be stress free, i.e. not subjected to tension or kinking under any conditions of use.

5. Hoses used for the gas supply line are to be continuous and have no joints or fittings from within the cylinder locker or cylinder housing to the appliances, or the readily accessible shut-off valve near the appliance except where metallic supply piping is connected to a flexible hose leading to a movable appliance, such as a gimbaled stove.

304. Materials

1. The melting point of materials at welded or brazed connections is not to be less than 450 °C.

2. Fittings are to be galvanically compatible with the metallic piping to which they are connected.

3. Hose c1amps, if used to secure cylinder-locker vent hoses, are to be made of corrosion-resistant material, such as stainless steel, of type 18Cr 8Ni, or equivalent corrosion resistant material, and be reusable.

4. End-connecting fittings are to be of corrosion-resistant material such as brass or stainless steel, or be of equivalent corrosion resistance in marine environment.

5. Where cutting-ring fittings are used in conjunction with copper piping, a brass insertion sleeve and brass cutting ring are to be fitted. All components are to be matched, i.e. of the same series.

305. Installation

1. Piping is not to have direct contact with metallic parts of the craft structure.

2. Gas supply lines and components are to be routed at least 30 mm away from electrical conductors, unless the gas supply line passes through a jointless conduit, or the conductors are sheathed or in conduit or trunking in accordance with **ISO 10133** and **ISO 13297**.

3. Gas supply lines are to be at least 100 mm from components of the engine exhaust system. Metallic gas lines are to be at least 100 mm from exposed terminals of electrical devices or accessories.

4. Gas supply lines are to be supported by fixing devices or other means, such as inside vented, non-metallic, supported conduit or piping, to prevent chafing or vibration damage. For copper or stainless steel piping, such fixing devices are to be pipe rings spaced at intervals not exceeding 0.5 m, and hoses by the fixing devices not more than 1 m. The fixing devices are to be corrosion resistant, non-abrasive, designed to prevent cutting or other damage to the lines and compatible with the line material.

5. All joints and connections in piping and hose in the systems are to be made such that no undue stress is created at the fitting.

6. Piping and hoses passing through bulkheads intended to maintain watertight integrity in the craft at the level of penetration are to be sealed by materials or fittings capable of maintaining the water tightness.

7. Piping and hoses are to be protected from abrasion or chafing at the point where they pass through walls or bulkheads.

8. All threaded connections required to ensure gas tightness of the system are to be of the taper-pipe-thread type conforming with **ISO 7-1** and using sealants conforming to **EN 751-2** or **EN 751-3**. Sealants are to be applied to the male thread only, before assembly.

306. Shut-off valves

1. Each gas system is to be equipped with a readily accessible manually operated main shut-off valve in the supply-pressure side. The main shut-off valve can be the cylinder valve. The main shut-off valve may be incorporated in the regulator, as long as its action isolates the cylinder contents from the regulator input and removal of the pressure regulator from the cylinder closes the cylinder valve.

2. A dual cylinder system is to be provided with an automatic or manual change-over device (selector valve), with non-return valves fitted, in addition to each cylinder shut-off valve, to prevent the escape of gas when either cylinder is disconnected.

3. A shut-off valve is to be installed in the low-pressure supply line to each appliance. The valve or its control is to be readily accessible and operable from within the vicinity of the appliance, and operable without reaching over the top of open-flame appliances such as stoves. If there is only one appliance in the system and the main shut-off valve at the cylinder is readily accessible from the vicinity of the appliance, the shut-off valve on the low-pressure supply line is not required. A solenoid valve located within the cylinder locker or cylinder housing, operable from the vicinity of the appliance, is considered as meeting this requirement. Solenoid valves are to be closed by lack of tension i.e. loss of electrical actuating energy.

4. Controls of shut-off valves in the low-pressure side of the system are to be readily accessible. Unmistakable and easily recognized means of identifying the open and closed positions are to be provided.

5. For shut-off valves which are not located immediately adjacent to the appliance that they control, means of identifying the appliance controlled are to be provided. If a valve is not visible, its location is to be clearly indicated with a visible and permanent label.

6. Taper-plug type valves are to be spring loaded and may be used only in the low-pressure side of the system.

7. Shut-off valves are to be located such that inadvertent or accidental operation is avoided.

8. Needle valves are not to be used as shut-off valves in the low-pressure side of the system. Gate valves are not to be used as shut-off valves.

Section 4 Gas Appliances

401. General

1. Only appliances suitable for use with gas in a marine environment are to be installed in the system. They are to be fitted in accordance with the manufacturer's instructions for installation in small craft.

2. Each gas-consuming appliance is to be securely fixed to the craft so as to eliminate undue stress on piping, hose and fittings.

3. Each gas-consuming appliance, including gas lamps, is to be equipped with flame-supervision devices which control all burners and pilot lights.

4. All unattended appliances are to be of the room-sealed type, with air-intake ducting and flues for outgoing products of combustion terminating outside the craft, including any areas that can be enclosed by canopies.

5. Each appliance is to be labelled to indicate the type of gas to be used as fuel, for example "PROPANE" or "BUTANE". Additionally, the label is to be referred to the owner's manual.

6. For cooking appliances, a permanent, legible warning label with a minimum character height of 4 mm, is to be affixed in a conspicuous position, on, or adjacent to, the appliance (cooking stove or oven) which is to provide at least the following information in a language acceptable in the country of intended use:

"DANGER-AVOID ASPHYXIATION. PROVIDE VENTILATION WHEN THE STOVE IS IN USE. DO NOT USE FOR SPACE HEATING."

7. The proximity and flammability of materials in relation to appliances are to be in accordance with ISO 9094-1.

8. Space heaters and water heaters installed in exposed locations in accommodation spaces of small craft are to be installed with regard to the risk of injury due to inadvertent contact with hot working surfaces.

9. Sufficient free area is to be provided around appliances, in accordance with ISO 9094-1 and the manufacturers instructions to prevent overheating of adjacent surfaces and permit inspection and servicing.

10. Means are to be provided on or adjacent to stove-top cooking surfaces to prevent both deep and shallow cooking utensils from sliding across or off the stove during craft motion, at pitch angles up to 15° or roll angles up to 30° for monohull sailing craft, 15° angles pitch or roll for engine driven and multihull sailing craft.

Section 5 Location and Installation of Gas Cylinders

501. General

1. Gas cylinders, regulators and safety devices are to be secured against any movement as expected to result from marine service.

2. Gas cylinders, pressure regulators and safety devices are to be installed in cylinder lockers or cylinder housing.

3. Cylinders, pressure regulators and safety devices located below decks or in cockpits are to be mounted in cylinder lockers which, when closed, are gas-tight to the craft interior, openable only from top of the locker, and are vented at the bottom by a drain of not less than 19 mm inside diameter or the equivalent area if not circular.

(1) The locker drain is to be run outboard, i.e., to the outside of the craft, and without sumps which can retain water, and with the outlet at a level lower than the locker bottom and as high as practicable, but not less than 75 mm above the at-rest waterline in the fully loaded ready-for-use condition.

(2) All hoses or metal piping penetrating the locker walls are to be sealed at the wall so as to maintain gas-tightness to the craft interior.

4. Cylinder-locker drain openings and cylinder-housing ventilation openings are to be located at least 500 mm from any hull opening to the interior of the craft.

5. No for storage of loose components that could damage the cylinder, pressure regulator, piping or hose installation or obstruct the locker drain is to be made in a cylinder locker or cylinder housing.

6. Cylinders, valves and pressure regulators are to be installed so that they are readily accessible, and are secured rigidly in their intended position so that gas in the vapour phase is withdrawn during use.

7. Provisions for storage of unconnected gas cylinders, whether filled or empty, are to be the same as cylinders connected to the system(See **2**).

Section 6 Ventilation

Ventilation is to be provided in accommodation spaces where open-flame unflued appliances are used, or to which compartments containing such appliances are connected by open passageways. The design of such ventilation is to take into account the air consumption of the appliances and occupants of the spaces and allow outside air to pass through fixed openings. Minimums for sizing and locations for ventilation openings are given in annex B of **ISO 10239**.

Section 7 Ducts and Flues for Air Intake and Combustion-product Discharge

701. General

1. Flue components including ductwork and terminals are to be installed in accordance with the manufacturer's instructions for small craft installations.

2. Flues are to be routed and sized to ensure complete discharge of the products of combustion outside the craft, including any areas which can be enclosed by canopies, and so as not to be obstructed by an accumulation of water.

3. The flue system and air-intake duct system are each to be continuous and sealed to be vapour-tight from the appliance to its terminal outside the craft.

4. Dampers (shut-off valves) are not to be installed in flue systems.

5. The entire flue system is to be accessible for inspection.

6. Flue terminals for exhaust-product discharge are not to be positioned within 500 mm of a ventilator, opening port, hatch, window, refueling fitting or fuel-tank vent outlet.

7. Flue terminals are to be of substantial construction or provided with guards that are sufficient to prevent damage by accidental contact. Such guards on exhaust discharge outlets also prevent injury due to contact with hot surfaces.

Section 8 Electrical Devices for Ignition Protection

There are to be no potential sources of ignition in gas cylinder lockers, housings or compartments. If electric devices are located in such places, the equipments are to be ignition protected in accordance with **ISO 8846**.

Section 9 Gas Installation System Tests

901. General

1. Before putting the gas system into operation, verify, from the connection at the pressure regulator to the closed burner valves at the appliances, that the system has been correctly installed and submit it, with shut-off valves open, to an air pressure test at three times the working pressure but not more than 150 mbar prior to charging the system with gas. The system is to be deemed sound if, after a period of 5 min (to allow for pressure equilibrium), the pressure remains constant ±5 mber during the following 5 min. An appropriate leak detection fluid may be used on connections to locate sources of leakage.

2. All connected appliances, including the function of the flame-supervision devices at the burners and pilot lights, are to be subjected to a burner-function test following the system-pressure test. A visual check for flame lift-off due to excessive pressure at individual burners is to be made; also for adequate flame height with all appliance burners in the system operating(this ensures adequate, not excessive, working pressure at each appliance).

3. Where a bubble-leak detector is permanently fitted in the system, it is to be securely mounted in the low-pressure side of the system and in the cylinder housing or cylinder locker. A pressure gauge is to be installed in the high-pressure side of the system.

Section 10 Owner's Manual

Owner's manual which is in accordance with **Ch 1, 205.** is to include with the user instructions supplied by the manufacturers of equipment and appliances. Requirements and Guidance for the contents of the owner's manual are given in Annex C of **ISO 10239**. ⚓

CHAPTER 11 FIRE PROTECTION AND FIRE EXTINCTION

Section 1 Fire Protection

101. Arrangement and design of craft

1. The type of equipment installed and the layout of the craft are to take account of the risk and spread of fire. Special attention is to be paid to the surroundings of open flame devices, hot areas or engines and auxiliary machines, oil and fuel overflows, uncovered oil and fuel pipes and avoiding electrical wiring above hot areas of machines.

2. Materials used for the insulation of engine space are to be of non-combustible and are to comply with the requirements of 4.5.2 in **ISO 9094-2**.

3. Bilges that may contain spillage of flammable liquids are to be accessible for cleaning.

4. Components containing petrol/gasoline engines and/or petrol/gasoline tanks are to be separated from enclosed accommodation spaces. The condition is met if the structure fulfills the following requirements:

(1) The boundaries are to be continuously sealed.(e.g. welded, brazed, glued, laminated or otherwise sealed)
(2) Penetrations for cables, piping, etc. are to be closed by fittings, seals and/or sealants.
(3) Access openings, such as doors, hatches, etc., are to be equipped with fittings so that they can be secured in the closed position.

5. Petrol/gasoline tanks within an engine room are to be insulated from the engine or any other source of heat by either.

(1) a physical barrier between the tank and engine, engine-mounted components including fuel-and water-supply lines, and any source of heat (e.g. bulkhead, wall, insulating material, etc.), or
(2) an air gap to prevent any contact between the tank and engine, and engine-related components, and any source of heat, the gap being wide enough to allow for servicing the engine and its related components. The air gap is to be at least;
 (A) 100 mm between a petrol engine and a fuel tank, and
 (B) 250 mm between a dry exhaust and a fuel tank.

6. Passages through accommodation spaces are not to be obstructed.

7. Where a non-metallic flexible hose is part of a water-cooled exhaust system, an alarm at the main steering position is to be activated if there is a loss of cooling water or if the temperature inside the exhaust line surpasses a preset limit(craft with a length of over 15 m).

102. Escape routes and exits

1. Escape routes

(1) Escape routes for crafts with a length of up to and including 15 m are to comply with the following.
 (A) The distance to the nearest exit to the open air is not to exceed 5 m.
 (B) Where the exit route passes beside an engine space, the distance to the nearest exit is not to exceed 4 m.
 (C) The distance is to be measured in the horizontal plane as the shortest distance between the centre of the exit and following point, and whichever is to be the greater distance.
  - the farthest point where a person can stand (minimum height 1.60 m), or
  - the midpoint of a berth
 (D) Where only one escape route is provided, this is not to pass directly over a cooker.
 (E) Where living or sleeping accommodation is separated from the nearest exit by a solid partition (e.g. a door) and leads directly past a cooker or engine space, an alternative exit is to be provided.
(2) Escape routes for crafts with a length of over 15 m are to comply with the following.
 (A) The following requirements are to be met irrespective of the accommodation arrangement.
  (a) Where there are two escape routes, only one may pass through, over and beside an

engine space.

(b) Where the distance between a cooking or open-flame heating-appliance burner and the nearest side of an escape route is less than 750 mm, a second escape route is to be provided. In an enclosed galley, this requirement does not apply where the dead end beyond the cooker is less than 2 m.

(c) No escape route is to pass directly over a cooking or open-flame heating appliance.

(B) Open-accommodation arrangement

Where living or sleeping accommodation is not separated from the nearest exit, i.e. people can move around without passing through any door, the following is to apply(Doors of toilet or shower compartments are disregarded.).

(a) The distance to the nearest exit is not to exceed (L_H/3) m.

(b) The distance is to be measured in the horizontal plane as the shortest distance between the center of the exit and following point, and whichever is to be the greater distance.

- the farthest point where a person can stand (minimum height 1.60 m), or
- the midpoint of a berth

(C) Enclosed accommodation arrangement

Where living or sleeping accommodation is separated from the nearest main exit by bulkheads and doors, escape routes and exits from accommodation areas are to be arranged to reduce the risk of people being trapped and the following conditions are to be met.

(a) Each accommodation section is to have more than one escape route leading finally to the open air, unless it is a single cabin or compartment intended to accommodate no more than four persons and the exit leads directly to the open air without passing through or over engine spaces or over cooking appliances. The cabin must not contain cooking or open-flame heating devices.

(b) For individual cabins intended to accommodate no more than four persons, and not containing cooking or open-flame heating devices, escape routes may form shared escape ways for up to 2 m, measured to a two-way escape route from the door or entrance.

(c) Shower and toilet compartments are regarded as part of the compartment or passageway that gives access to their doors and therefore do not require alternative escape routes.

(d) With multi-level arrangements, the exits are to lead to a different accommodation section or compartment, as far as practicable.

Fig 11.1 shows a typical cabin arrangement of a big non-sailing yacht. According to the conditions specified above, this section of the craft requires two exits, because the shared route from cabins C and D is longer than 2 m. In this case, the two exits are the main staircase (primary exit) and a deck hatch between cabins C and D (secondary exit).

2. Exits

(1) Any exit from an accommodation space or from any other space is to have the following minimum clear openings:

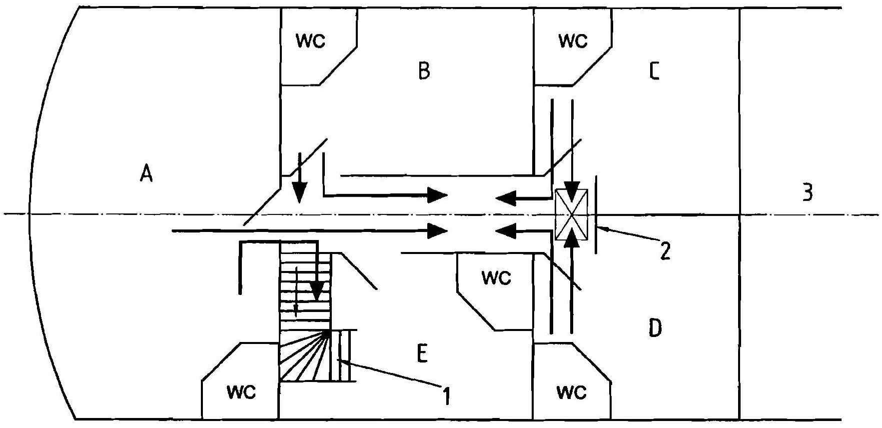
(A) Circular shape : diameter 450 mm;

(B) Any other shape : minimum dimension of 380 mm and minimum area 0.18 m^2. The exit is to be large enough to allow for a 380 mm diameter circle to be inscribed. The measurement of the minimum clear opening is illustrated in **Fig 11.2**.

(2) Exits are to be readily accessible. Exits leading to the weather deck or to the open air are to be capable of being opened from the inside and outside when secured and unlocked. The requirement does not apply to port-lights of sufficient size to be designated as exits.

(3) Where deck hatches are designated as exits, footholds, ladders, steps or other means are to be provided. The vertical distance between the upper foothold and the exit is not to exceed 1.2 m.

(4) Escape facilities or doors are to be identified by the appropriate **ISO** or national symbol.



Key
A Cabin A
B Cabin B
C Cabin C
D Cabin D
E Cabin E
1 Primary exit
2 Secondary exit
3 Engine space

Fig 11.1 Escape routes and exits

Dimension in millimetres

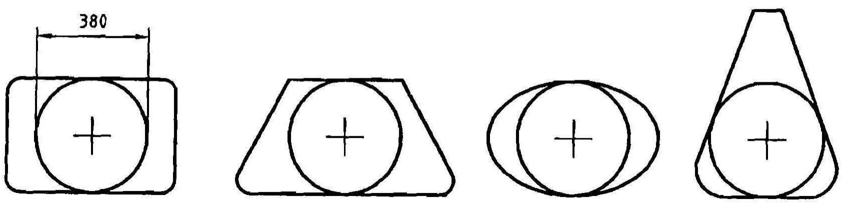


Fig 11.2 Measurement of minimum clear opening

103. Cooking and heating appliances

1. Where flues are installed, they are to be insulated or shielded to avoid overheating or damage to adjacent material or to the structure of the craft.

2. For cooking and heating units using fuel which is liquid at atmospheric pressure, the following are to apply.

(1) Stoves and heating units are to be securely fastened.
(2) Open-flame burners are to be fitted with a readily accessible drip-pan.
(3) Where open-flame-type water heaters are installed, adequate ventilation and flue protection are to be provided.
(4) Where a pilot light is installed, the combustion chamber is to be room sealed, except for cookers.
(5) Appliances using petrol for priming, or as a fuel, are not to be installed.
(6) For non-integral tanks and supply lines, the following are to be met.
  (A) Non-integral tanks are to be securely fastened and are to be installed at a sufficient distance from cooking and heating units.
  (B) A readily accessible shut-off valve is to be installed on the tank. If this is outside the galley, a second valve is to be fitted in the fuel line in the galley space. This requirement does not apply where the tank is located lower than the cooker/heater and there is no possibility of back siphoning.

3. Materials used in the vicinity of cooking and heating devices are to be in accordance with 4.3.1 of **ISO 9094-1**(crafts with a length of up to and including 15m) or 4.4.1 of **ISO 9094-2**(crafts with a length of up to and including 15m).

Section 2 Fire Fighting Equipment

201. General

1. Crafts are to be supplied with fire-fighting equipment appropriate to the fire hazard and capacity and location of fire-fighting equipment are to be indicated.
2. Petrol engine enclosures are to be protected by a fire extinguishing system that avoids the need to open the enclosure in the event of fire.
3. Where fitted, portable fire extinguishers are to be readily accessible and one is to be so positioned that it can easily be reached from the main steering position of the craft.

202. Furnishing of fire fighting equipment

1. The weather deck of the craft is to be protected by water hose system or provided with at least two(2) buckets with lanyard. The buckets are to be painted with red color and provided in the place that is readily accessible in case of fire.
2. Portable fire extinguishers and fixed fire extinguishers are to comply with the requirements of 6. and 7. in **ISO 9094-1/9094-2**.
3. A fire blanket is to comply with the requirements of 9. in **ISO 9094-1/9094-2**.
4. The accommodation area is to be equipped with either;
   (1) Portable fire extinguisher according to **2** or,
   (2) Fixed fire extinguisher according to **2** and either one or more portable fire extinguishers
5. The galley of the craft with a length of up to and including 15 m is to be protected either by a portable fire extinguisher or by a fire blanket or by water-fog systems. Sprinkler-type water systems are not to be used.
6. The galley of the craft with a length of over 15 m is to be protected by one or more portable fire extinguishers and a fire blanket. Sprinkler-type water systems are not to be used. Water-fog systems are regarded as being suitable.
7. The protection of engine and fuel spaces is to comply with the following.
   (1) The protection of engine and fuel spaces are to comply with **Table 11.1.**
   (2) The extinguishing medium is to be suitable for extinguishing an engine room fire and flooding the entire space. The extinguishing capacity of the portable extinguisher is to be sufficient for the volume of the engine space. A discharge opening is to be provided so that the extinguishing medium can be discharged into the engine space without opening the primary access. For engine spaces which a gross volume is 1 m^3 and less, any extinguishing medium suitable for extinguishing Class B fires is considered to fulfil this requirement.
   (3) The fire port is to comply with the followings.
      (A) Identified.
      (B) Sized to accept the discharge nozzle.
      (C) Open or openable to provide ready access for discharge of the medium into the engine space.
      (D) Located so that the required size of extinguisher can be operated in a position that will allow complete discharge of the extinguishing medium.
8. Other enclosed spaces are to be treated as accommodation spaces according to **4**, except where they are designated for the storage of fuel or other flammable goods when they are to be protected as specified in **Table 11.1** containing main engines and auxiliaries with a total combined capacity of less than or equal to 120 kW.

Table 11.1 Protection of the engine and fuel space

Engine position	Type and rating of engine	Protection achieved by
Open craft with engine(s) or part of engines above cockpit sole, nearly vertical casting	Petrol inboard engine of less than 120 kW Diesel engine	- fixed fire-fighting system, or - portable fire extinguisher sized and suited to flood the engine space through a fire port in the engine casing
Open craft with trans-om-mounted outboard mo-tor, and portable fuel tank stowage in the open at-mosphere	Petrol outboard engine	No requirement for single outboard engine 〈 25 kW (clause 6.4 in **ISO 9094-1** applies)
Open craft with trans-om-mounted outboard mo-tor(s), and more than one portable fuel tank per en-gine or tank(s) installed in an enclosed space	Petrol outboard engine	- fixed fire-fighting system to protect the fuel space, or - portable fire extinguisher sized and suited to flood the fuel space through a fire port tin the fuel-space boundary
Engine below cockpit level or inside craft	Petrol inboard engine	- fixed fire fighting system
	Diesel inboard engine(s) of less than or equal to 120 kW combined rating (main and auxiliaries)	- fixed fire-fighting system, or - portable fire extinguisher of a type and size suitable to flood the engine space through a fire port in the engine casing
	Diesel inboard engine(s) of more than 120 kW combined rating (main and auxiliaries)	- fixed fire-fighting system

Section 3 Others

301. General

1. Displayed information and owner's manual are to be in accordance with the requirements of 8 and 10 in **ISO 9094-1/9094-2**. ⚓

CHAPTER 12 ESSENTIAL REQUIREMENTS FOR EXHAUST EMISSIONS FROM PROPULSION ENGINES

Section 1 General

101. General

Propulsion engines is to comply with the following essential requirements for exhaust emissions.

Section 2 Essential Requirements

201. Engine identification

1. Each engine is to be clearly marked with the following information:

(1) engine manufacturer's trademark or trade-name;
(2) engine type, engine family, if applicable;
(3) a unique engine identification number; and
(4) CE marking, if applicable.

2. These marks must be durable for the normal life of the engine and must be clearly legible and indelible. If labels or plates are used, they must be attached in such a manner that the fixing is durable for the normal life of the engine, and the labels/plates cannot be removed without destroying or defacing them.

3. These marks must be secured to an engine part necessary for normal engine operation and not normally requiring replacement during the engine life.

4. These marks must be located so as to be readily visible to the average person after the engine has been assembled with all the components necessary for engine operation.

202. Exhaust Essential requirements

1. Propulsion engines are to be designed, constructed and assembled so that when correctly installed and in normal use, emissions are not exceed the limit values obtained from the following table:

Table 12.1 limit values of exhaust emission

Type	Carbon monoxide CO = A + B / P_N^n g/kWh			Hydrocarbons HC = A + B / P_N^n g/kWh			Nitrogen oxides NOx g/kWh	Particulates PT g/kWh
	A	B	n	A	B	n		
Two-stroke spark ignition	150.0	600.0	1.0	30.0	100.0	0.75	10.0	N/A
Four-stroke spark ignition	150.0	600.0	1.0	6.0	50.0	0.75	15.0	N/A
Compression ignition	5.0	0	0	1.5	2.0	0.5	9.8	1.0

2. Where A, B and n are constants in accordance with the table, P_N is the rated engine power in kW and the exhaust emissions are measured in accordance with the **ISO 8178-1**.

3. For engines above 130 kW, either E3 (IMO) or E5 (recreational marine) test cycles may be used.

4. The reference fuels to be used for the emissions test for engines fuelled with petrol and diesel are to be of those accepted by this Society.

203. Durability

1. The manufacturer of the engine is to supply engine installation and maintenance instructions, which if applied, is to mean that the engine in normal use will continue to comply with the above limits throughout the normal life of the engine and under normal conditions of use.

2. This information is to be obtained by the engine manufacturer by use of prior endurance testing, based on normal operating cycles, and by calculation of component fatigue so that the necessary maintenance instructions may be prepared by the manufacturer.

3. The normal life of the engine is considered to mean:

(1) inboard or stern drive engines with or without integral exhaust: 480 hours or 10 years, whichever occurs first;

(2) outboard engines: 350 hours or 10 years, whichever occurs first.

204. Owner's manual

1. Each engine is to be provided with an owner's manual in english or languages, which may be determined in which the engine is to be used. This manual is to :

(1) provide instructions for the installation and maintenance needed to assure the proper functioning of the engine to meet the requirements of **203.**(durability); and

(2) specify the power of the engine when measured in accordance with the **ISO 8665**. ⚓

CHAPTER 13 ESSENTIAL REQUIREMENTS FOR NOISE EMISSIONS

Section 1 General

101. General

Recreational crafts with inboard or stern drive engines without integral exhaust, outboard engines and stern drive engines with integral exhaust are to comply with the following essential requirements for noise emissions.

Section 2 Essential Requirements

201. Noise emission levels

1. Recreational crafts with inboard or stern drive engines without integral exhaust, outboard engines and stern drive engines with integral exhaust are to be designed, constructed and assembled so that noise emissions measured in accordance with tests defined in the **ISO 14509** are not exceed the limit values in the following table:

Table 13.1 The limit values of emission level

Single engine power (kW)	Maximum Sound Pressure Level = $L_PAS_{\max}$(dB)
$P_N \le 10$	67
$10 < P_N \le 40$	72
$P_N > 40$	75

where,
1. P_N = rated engine power in kW at rated speed and $L_PAS_{\max}$ = maximum sound pressure level in dB.
2. For twin-engine and multiple-engine units of all engine types an allowance of 3 dB may be applied.

2. As an alternative to sound measurement tests, recreational craft with inboard engine configuration or stern drive engine configuration, without integral exhaust, is to be deemed to comply with these noise requirements if they have a Froude number of ≤ 1.1 and a power displacement ratio of ≤ 40 and where the engine and exhaust system are installed in accordance with the engine manufacturer's specifications.

3. 'Froude number' is to be calculated by the following formula;

$$F_n = \frac{V}{\sqrt{g.Lwl}}$$

where,

V = the maximum craft speed (m/s)

g = gravitational constant (9.8 $\mathrm{m/s^2}$)

Lwl = the waterline length (m)

'Power displacement ratio' is to be calculated by the following formula;

$$\text{Power displacement ratio} = \frac{P}{D}$$

where,

P = the engine power (kW) (measured in accordance with ISO 8665)

D = he craft's displacement (t) (measured at the performance test mass condition in accordance with ISO 8666)

4. As a further alternative to sound measurement tests, recreational craft with inboard or stern drive engine configurations without integral exhaust, is to be deemed to comply with these noise requirements if their key design parameters are the same as or compatible with those of a certified reference craft to tolerances specified in the **ISO 14509-2**.

5. 'Certified reference craft' is to mean a specific combination of hull/ inboard engine or stern drive engine without integral exhaust that has been found to comply with the noise emission requirements, when measured in accordance with para. **1**, and for which all appropriate key design parameters and sound level measurements have been included subsequently in the published list of certified reference crafts.

202. Owner's manual

1. For recreational craft with inboard engine or stern drive engines with or without integral exhaust, the owner's manual required under **Ch 1, 205.**, is to include information necessary to maintain the craft and exhaust system in a condition that, insofar as is practicable, will ensure compliance with the specified noise limit values when in normal use.

2. For outboard engines, the owner's manual required under **Ch 12, 204.** is to provide instructions necessary to maintain the outboard engine in a condition, that insofar as is practicable, will ensure compliance with the specified noise limit values when in normal use. ⚓

GUIDANCE FOR RECREATIONAL CRAFTS

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