CHINA CLASSIFICATION SOCIETY

# RULES FOR CONSTRUCTION AND CLASSIFICATION OF YACHTS
# 2012

Effective from June 1 2012

**Beijing**

# CONTENTS

# PART ONE    YACHTS OF LESS THAN 24 M IN LENGTH

# CHAPTER 1 GENERAL

## Section 1 GENERAL PROVISIONS

### 1.1.1 Application

1.1.1.1 This PART applies to self-propelled yachts of new construction of less than 24 m in length ($L_H$).

1.1.1.2 The design categories of yachts are as follows:

(1) Category I means yachts designed for navigating exceeding 200 n miles off the shore and with the minimum design significant wave height① ($H_S$) of 6 m.

(2) Category II means yachts designed for navigating within 200 n miles off the shore and with the minimum design significant wave height ($H_S$) of 4 m.

(3) Category III means yachts designed for navigating within 20 n miles off the shore and with the minimum design significant wave height ($H_S$) of 2 m.

(4) Category IV means yachts designed for navigating within 10 n miles off the shore and with the minimum design significant wave height ($H_S$) of 1 m.

(5) Category V means yachts designed for navigating within 5 n miles off the shore and with the minimum design significant wave height ($H_S$) of 0.5 m.

1.1.1.3 The materials and construction technique of yachts are to be in compliance with the applicable requirements of CCS Rules for Materials and Welding or other standards accepted by CCS.

1.1.1.4 The stability, fire safety, life-saving appliances, communications, navigation and pollution prevention, etc., of yachts are to comply with the relevant provisions of the flag State Administration and navigating waters.

### 1.1.2 Equivalent and exemption

1.1.2.1 Any yacht which embodies structure and features of a novel kind may be exempted from any provision of this PART if the application of which might seriously impede the incorporation of its features or its navigation, subject to agreement of CCS.

1.1.2.2 Any fitting, material, appliance or apparatus, other than that required in this PART, may be allowed to be fitted in a yacht, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance or apparatus is at least as effective as that required in this PART.

1.1.2.3 Equivalence or substitution to those methods of calculation, criteria of evaluation, manufacturing procedures, materials, survey and test requirements specified by this PART may be accepted subject to agreement of CCS, when relevant tests, theoretical basis, experience in application are provided. CCS also accepts other recognized standards, e.g. ISO etc., as equivalent requirements.

### 1.1.3 Definitions

1.1.3.1 Unless expressly provided otherwise, for the purpose of this PART:

(1) Yacht means a boat engaged in uncommercial entertainment activities such as touring, leisure and sightseeing, including a whole chartered boat engaged in the aforementioned activities.

(2) High speed yacht means a yacht capable of a maximum speed $V$ meeting both the following formulae at its full-load displacement:

$$V \geq 7.19 \nabla^{0.1667} \quad \text{kn}$$
$$V \geq 25 \quad \text{kn}$$

where: $\nabla$ — displacement corresponding to its full-load displacement, in $m^3$.

(3) Maximum speed is the speed achieved at the maximum continuous propulsion power for which the yacht is certified at its full-load displacement and in smooth water.

① The significant wave height of the yacht's navigating waters is not to exceed the design significant wave height.

(4) Length $L_H$ (m) means the length measured in one plane passing through the foremost part of the yacht and the other through the aftermost part of the yacht. This length includes all structural and integral parts of the yacht, such as stems or sterns, bulwarks and hull/deck joints. This length excludes removable parts that can be detached without affecting the structural integrity of the yacht, e.g. pulpits at either end of the yacht, stemhead fittings, rudders, outboard motors and their mounting brackets and plates, diving platforms, boarding platforms, rubbing strakes and fenders etc.
(5) Waterline length $L_{WL}$ (m) means the length of watertight envelope of the rigid hull at the waterline at full-load displacement in rest floatation, excluding appendages at or below the waterline.
(6) Full-load displacement $\triangle$ (t) means the weight of water displaced by a yacht under a full-load service condition with the required equipment, cargo stores, accessories, rigging, etc., 100% of fuel oil, lubricating oil, fresh water, food, supplies and rated passengers onboard the yacht.
(7) Full load draft $d$ (m) means the vertical distance measured at the midpoint of waterline length ($L_{WL}$) from the top of the plate keel (or from the lower surface of plate keel for fabric reinforced plastics yacht) to the full load waterline of a yacht at full-load displacement in rest floatation.
(8) Breadth $B$ (m) means the horizontal distance measured from the outside of the yacht frame of one to that of other side; or the maximum breadth between two sides of external surfaces for fabric reinforced plastics yacht, at the widest part of a yacht, excluding protrusions, fenders, etc.
(9) Moulded depth $D$ (m) means the vertical distance measured at the midpoint of the waterline length ($L_{WL}$) from the top of the plate keel to the top of the deck beam at side on the deck (for decked yacht) or to the top end of the shell side plating (for open yacht). For fabric reinforced plastics yacht, the vertical distance measured at the midpoint of waterline length ($L_{WL}$) from the lower surface of the plate keel to the top of the freeboard deck (for decked yacht) or to the top end of the shell side plating (for open yacht).
(10) Decked yacht means a yacht having a continuous weathertight deck from bow to stern.
(11) Open yacht means a yacht not having a continuous weathertight deck from bow to stern.
(12) Yacht type survey certificate means a document showing compliance of a representative yacht type with specified requirements, by means of overall survey and test of prototype yacht and/or lead yacht.

## Section 2 COMPLIANCE SURVEY

### 1.2.1 General requirements

1.2.1.1 When the yacht applying for compliance survey by CCS is confirmed in compliance with the requirements of this PART or applicable standards as designated by the applicant, a Compliance Certificate for yacht will be issued by CCS.
1.2.1.2 A “yacht type survey certificate” is issued to a prototype yacht① and/or a lead yacht② and at the same time a “Compliance Certificate for yacht” is issued to a lead yacht, subject to satisfactory completion of examination of plans and technical documents, prototype survey and test in accordance with Table 1.2.1.2. A “Compliance Certificate for yacht” is issued to a product yacht③, subject to satisfactory completion of manufacturing survey.

**Table 1.2.1.2**

| Survey of yacht / Survey process | Prototype yacht /Lead yacht | Product yacht |
|---|---|---|
| Examination of plans and technical documents (plan approval) | X | |
| Prototype survey and test | X | |
| Manufacturing survey | | X |

Note: “X” means applicable survey items.

① A prototype yacht means a model yacht manufactured to the design which is to be evaluated for compliance with applicable requirements.
② A lead yacht means the first yacht manufactured in accordance with the approved design document.
③ A product yacht means a yacht other than a prototype yacht and a lead yacht.

1.2.1.3 The applicant may apply for partial survey in accordance with some requirements of this PART and the survey scope will be clearly indicated on the relevant yacht certificate.

1.2.1.4 If the applicant does not apply for the type survey certificate of yacht, a Compliance Certificate is to be issued after completion of items in 1.2.3 and 1.2.4.

1.2.1.5 When CCS is authorized by the Administration to carry out statutory survey and it is found in compliance with the requirements of this PART, a statutory certificate may only be issued.

**1.2.2 Assessment of manufacturer**

1.2.2.1 The yacht manufacturer is to ensure the appropriateness of the following resources, subject to the assessment of CCS:

(1) facility and equipment;

(2) quality control;

(3) production procedure;

(4) yacht manufacturing skills of worker.

1.2.2.2 The yacht manufacturer is to submit the relevant information including production scale, organization, equipment, production procedure and qualification of personnel etc., together with the application for assessment.

1.2.2.3 After a satisfactory assessment, the yacht manufacturer is to ensure compliance with applicable laws and regulations, processing procedures of the material manufacturer and accident prevention and operation practice of industry.

1.2.2.4 In case of any change affecting the assessment conditions, e.g. production equipment and procedures etc., the yacht manufacturer is to inform CCS immediately and submit the new procedure and relevant documents to CCS prior to implementation.

**1.2.3 Examination of plans and technical documents**

1.2.3.1 The following design drawings and technical documents in triplicate, as appropriate, are to be submitted together with the application to CCS for approval:

(1) Hull:

① general arrangement;

② construction profile (including main transverse sections, other typical sections and bulkheads, etc.);

③ shell plate (including laminate design);

④ decks, superstructures and compartments;

⑤ oil/water tanks integrated with the hull;

⑥ main engine seating;

⑦ rudder blades, rudder stocks and rudder bearings;

⑧ arrangement of anchoring and mooring equipment;

⑨ intact stability calculations;

⑩ material specifications;

⑪ hull construction technique;

⑫ closing devices of openings.

(2) Machinery and electrical installations:

① arrangement of engine room;

② propellers and shafting;

③ hydraulic steering gears;

④ arrangement of piping (including main/auxiliary exhaust piping, fuel oil piping, fire piping and bilge piping);

⑤ arrangements and calculations of ventilation systems of compartments containing petrol engine and / or petrol tanks;

⑥ naked fire cooking equipment, materials and arrangement plan;

⑦ fire-extinguishing apparatus arrangement plan;

⑧ electric loading calculations (including calculations of accumulator battery capacity);

⑨ electric power system, marking:

a. primary rated parameters of motors, transformers, accumulator batteries and power electric equipment;

b. all the feeder lines on switchboard;

c. types, section areas and primary rated parameters of cables;

d. types and primary rated parameters of circuit breakers and fuses;

⑩ arrangement of electric power equipment (including installation position of motors, accumulator batteries, switchboards, etc.);

⑪ schematic diagrams and arrangement of lighting.

1.2.3.2 The following plans and documents are to be submitted to CCS for information:

(1) general specifications;

(2) lines;

(3) particulars of products aboard.

1.2.3.3 Depending on the yacht type, additional plans and documents may be required as CCS deems necessary.

**1.2.4 Prototype survey and test**

1.2.4.1 After the assessment of manufacturer by CCS, lead yachts and/or prototype yachts are to be manufactured subject to the survey by CCS and comply with approved plans and technical documents.

1.2.4.2 Prototype survey of lead yachts and/or prototype yachts is at least to cover the following:

(1) to confirm the product certificate of important equipment;

(2) primary structural members of hull, including shells, decks, superstructures and main transverse bulkheads, and watertight integrity;

(3) to check the performance test report of hull laminate, as appropriate;

(4) fuel tank and water tank integrated with hull structure;

(5) strengthening area of hull structure;

(6) main engine seating;

(7) securing device for ballast;

(8) rudders, rudder stocks and rudder bearings;

(9) watertight closing arrangement (hatches, doors, windows);

(10) installations of main/auxiliary engines and steering gears, as appropriate;

(11) installation of piping;

(12) motors, accumulator batteries and switchboards, as appropriate;

(13) specification and installation of cables, including watertight or fireproof penetration of cables;

(14) explosion-proof or ignition-protection device, as appropriate;

(15) lighting system;

(16) insulation resistance for cables and electrical equipment, protective devices and earthing of electrical equipment;

(17) lightning arrester.

1.2.4.3 Prototype yachts and/or lead yachts are to be tested completely in the presence of CCS Surveyor. Test items are to include all those relating to the safety of hull, machinery and electrical equipment covered in this PART and/or applicable standards, including but not limited to:
(1) tightness test of hull and doors, windows, covers;
(2) water filling test, as appropriate;
(3) stability test, as appropriate;
(4) drop test of real yacht, as appropriate;
(5) inclination test;
(6) tightness test of piping system;
(7) test of monitoring and alarm devices;
(8) effectiveness test of remote control maneuvering devices;
(9) sea trials, including loading, steering, anchoring, main/auxiliary engine operation, emergency stopping and test of emergency devices and alarm systems.

**1.2.5 Maintenance and renewal of the type survey certificate**

1.2.5.1 Within the period of validity of the yacht type survey certificate, where any of the following changes has been made to yachts, prototype survey and test of the same scope as 1.2.4 are to be carried out:
(1) production procedures and manufacturing technique;
(2) significant modification of design.
1.2.5.2 Where the renewal of the type survey certificate is necessary, the yacht manufacture is to send a written application to CCS and inform CCS of any change to the yacht type design within 3 months before the expiry date of the certificate. After receiving the application, CCS is to:
(1) re-examine the drawings to check any change to the rules or standards applicable to the design of the yacht;
(2) assess the manufacturer.
Where there is no change to the design and manufacturing technique, the prototype survey and test may be dispensed with.

**1.2.6 Manufacturing survey**

1.2.6.1 The manufacturing process of yachts as products is to be examined by CCS, as to ensure the yachts in compliance with prototype yacht and/or lead yacht test results and the requirements of approved plans and technical documents. The survey items are at least to include:
(1) confirmation of the materials and technique used in the hull structure in compliance with approved plans and technical documents;
(2) general confirmation of the yacht and the installation and arrangement of its machinery and electrical installations in compliance with approved plans, and examination of the relevant installation and test records of the manufacturer.
1.2.6.2 The frequency of manufacturing survey depends on the nature and extent of the manufacturer's internal quality control, the scantling and type of yachts and annual production quantities, and strength and functional tests may be required if deemed necessary. The manufacturer is to ensure that the internal quality control documents are available for use by the Surveyor appointed by CCS.

**1.2.7 Certificate**

1.2.7.1 The yacht type survey certificate is valid for five years, and is to mark the following:
(1) model of yacht;
(2) name of the manufacturer;
(3) type (specification) of yacht;

(4) test scope.

1.2.7.2 The yacht type survey certificate will be invalidated automatically in one of the following cases:

(1) where the yacht type has been redesigned;

(2) where the production mode has been changed;

(3) where any major change has been made to the management organization.

1.2.7.3 The “Compliance Certificate for yacht” is to state the yacht model, name of the manufacturer, category of yacht, month and year of manufacturing, manufacturing number and the number of yacht type survey certificate (as appropriate).

# CHAPTER 2 HULL STRUCTURE

## Section 1 FABRIC REINFORCED PLASTICS YACHTS

### 2.1.1 General requirements

2.1.1.1 This Section applies to yachts whose hull structures are of FRP material. For yachts of less than 6 m in length $L_H$, the scantlings may be verified by means of drop test of real yacht①.

2.1.1.2 The manufacturers of FRP yacht are to be subject to assessment by CCS and construction quality is to be controlled strictly by the manufacturers.

2.1.1.3 The provisions of this Section are applicable to yachts with single plate and sandwich plate structures.

2.1.1.4 Principle of structural design

(1) The hull structure is to be so designed that the yacht can withstand the maximum external force that may be encountered throughout its whole period of normal navigation.

(2) The hull structure may be designed by direct calculation, however the structural calculations are to be approved by CCS.

(3) The structure of the shell in general is to be stiffened by longitudinal and transverse stiffeners, except for small size yacht of sandwich plate structure or less than 8 m in length $L_H$ where the thickness of the shell is beyond strength requirements, and the shape of the hull provides a stiffening effect.

(4) Where the shell is not fitted with stiffeners, natural stiffeners are normally the ones where the angle between two adjacent panels at hull transverse section is < 130° with a hard angle (e.g. angled bottom centerline, deck/hull angles, knuckles at sides and continuous small platforms fitted at sides, etc.). When calculating the plate thickness in way, the stiffeners spacing *s* of curved plate is to be taken as the chord length of curvature.

(5) Double bottom structures, fixed tanks, coamings and interior components which are integrated with the hull may be considered as stiffeners provided that they are sufficiently strong and rigid.

(6) The hull longitudinal components are to be kept continuous within the whole length of yacht as far as possible.

(7) The plate thickness is to be such that is not taken the gel coat and repaired composite or other non-reinforced material into account.

(8) The external windows are to be adopted of toughened glass or polycarbonate glass or laminated glass in compliance with the relevant standards, and the thickness of glass is to comply with CCS Rules for Construction of Coastal Boats or other standards accepted by CCS.

2.1.1.5 Hull girder strength

(1) Hull girder strength is to be checked for fabric reinforced plastics yacht of 15 m and over in $L_{WL}$ and $L_{WL}/D$ equal to or more than 12.

(2) The specified amidship section modulus $W$ is based on the mechanical properties of the standard laminating single skin plate moulded by lay-out with glass fiber biaxial woven rovings. For other laminating design, where the single skin plate strength is not in conformity with the strength of standard laminating single skin plate, the amidship section modulus $W$ specified may be corrected by multiplying the following coefficient $K$:

$$K = 180/\sigma_t$$

where: $\sigma_t$ — the ultimate tensile stress for the laminate of other laminating design, in N/mm².

(3) The midsection at half of $L_{WL}$ is in general to be taken as the checking section during calculation of hull girder strength. The amidship section modulus $W$ at freeboard deck side line (for decked yacht) or upper strake line (for open deck yacht) is not to be less than:

$$W = f L_{WL}^2 B_W (C_b + 0.7) \quad \text{cm}^3$$

① Refer to ISO 12215-5 Small craft —— Hull construction and scantlings.

where: $f$ — factor, $f = 0.25L_{WL} + 24$;

$L_{WL}$ — waterline length, in m;

$B_W$ — breadth in way of full load waterline, in m;

$C_b$ — block coefficient under full load waterline.

(4) The moment of inertia $I$ for the midsection to its neutral axis is not to be less than:

$$I = 4.0WL_{WL} \quad \text{cm}^4$$

where: $L_{WL}$ — waterline length, in m;

$W$ — amidship section modulus calculated in accordance with the requirements of 2.1.1.5(2), in $\text{cm}^3$.

(5) Calculation of amidship section modulus

① All continuous longitudinal members within $0.4L_{WL}$ at amidship may be taken into account in the calculation of midsection modulus, however the sectional areas of openings on them are to be deducted from the midsection area.

② In general, a superstructure having a length greater than $0.2L_{WL}$ but within $0.4L_{WL}$ amidship may be taken into account in the hull girder strength. Where there are large amount openings on the side walls of above-mentioned superstructure and the sum of length of all openings on each side wall exceeds half of the superstructure length, the superstructure is not to be considered to make contribution to the hull girder strength.

③ Where a yacht adopted sandwich construction as parts of hull's members, the concept of equivalent section modulus ($W_e$) is to be introduced.

For the longitudinal bending of hull girder, the equivalent section modulus ($W_e$) of the middle transverse section composed by some of members made of sandwich construction is to be calculated as follows:

$$W_e = \frac{\Sigma E_i I_i}{EY} \quad \text{cm}^3$$

where: $E$ — modulus of elasticity of material at the point calculated, in $\text{N/mm}^2$;

$Y$ — vertical distance from the point calculated to the neutral axis of the amidship section in cm;

$E_i$, $I_i$ — modulus of elasticity for each member's material composing of the amidship section, in $\text{N/mm}^2$ and moment of inertia to the neutral axis of the amidship section for each member, in $\text{cm}^4$, respectively.

(6) For catamarans, the transverse strength and the torsional strength of cross-deck structure of their twin hull are to be checked in accordance with the relevant provisions of CCS Rules for Construction and Classification of Sea-Going High Speed Craft.

2.1.1.6 Main engine's foundations and engine room's framings

(1) The structures of main engine's foundations are to have enough strength and rigidity. Where allowed by arrangement, transverse separating plates and transverse bracket plates are to be provided in each frame space for girders of foundations to ensure the effective supporting.

(2) The frames in engine rooms are to be kept continuous to avoid stress concentration.

2.1.1.7 Stern transom plating

(1) The thickness of stern transom plating is not to be less than that of shell side plating, the requirements for frames and stiffeners for stern transom plating are the same as those for shell side plating.

(2) The stern transom plating is to be so designed as to ensure that an excessive stress is not produced when bending moment and thrust caused by outboard motor or stern propelling unit are transmitted to hull structure.

(3) In general, the stern transom plating of a yacht with the outboard motor or stern propelling unit is to be sandwich plate with core material such as plywood or similar rigid suitable material. The total thickness of the stern transom plating is not to be less than that as required in Table 2.1.1.7(3).

**Total thickness of stern transom plating** **Table 2.1.1.7(3)**

| **Power of engine (kW)** | **Total thickness of stern transom plating (mm) (outboard motor)** | **Total thickness of stern transom plating (mm) (stern propelling unit)** |
|---|---|---|
| ≥ 18 and < 30 | 30 | 35 |
| ≥ 30 and < 60 | 35 | 40 |
| ≥ 60 and <150 | 40 | 45 |
| >150 | Specially considered as per specific case | Specially considered as per specific case |

2.1.1.8 Local strengthening

(1) For high speed yacht, strengthening measures are to be taken for the severe areas subject to wave panting (generally within the range of $0.15L_{WL}$ from $1/3L_{WL}$ of bow).

(2) The shell plating for penetration of propeller shaft bracket, rudder post and their attachments or the plates at the strong points for anchoring, mooring and towing are to be provided with embedded parts and suitably strengthened.

(3) Openings on the shell plating are to be avoided as far as possible. If it is needed, the opening corners are to be rounded, and compensation is to be made for large openings under certain cases.

(4) Where doors, windows and openings are provided in side walls of superstructures or deckhouses, the corners are to be rounded and strengthening is to be made along the edges.

2.1.1.9 Effective breadth of attached plates

(1) The required values of section modulus of secondary members stipulated in this Section are the minimum ones for them with their attached plates. The effective breadth of attached plates of members $b_e$ is to be taken as follows:

① Where the attached plates are of a single plate, the lesser of following is to be taken:

$$b_e = s,\ b_e = 23t + b_s \quad \text{mm}$$

② Where the attached plates are of a sandwich plate:

For ineffective core such as cellular plastics, balsa wood, etc., the lesser of following is to be taken:

$$b_e = s,\ b_e = 11d \quad \text{mm}$$

For effective core such as plywood, etc., the lesser of following is to be taken:

$$b_e = s,\ b_e = 35d \quad \text{mm}$$

where: $s$ — stiffener spacing, in mm;

$t$ — thickness of attached plates, in mm;

$d$ — distance between centerlines of opposite skin laminates of attached plate, in mm;

$b_s$ — net breadth of secondary members, in mm.

(2) Where the effective material such as pine or plywood is employed as core of the member, the core affection is to be taken into account in calculating the section modulus. The sectional area of the core is to be reduced by the ratio of its bending modulus of elasticity to the bending modulus of elasticity of the member's laminate.

2.1.1.10 Design of laminated plate

(1) For shell plating and members suitable raw materials and reasonable lay up design are to be chosen in accordance with different purposes.

(2) The thickness change of laminated plate is to be gradual and the breadth of transition region is at least 30 times the thickness difference.

2.1.1.11 Mechanical properties of laminated plate specimen

(1) The mechanical properties of test specimen of FRP are to comply with the relevant requirements of CCS Rules for Materials and Welding.

(2) The thickness $t$ of each laminated plate of glass fiber is to be taken as follows or in accordance with other recognized standards (e.g. ISO):

$$t = \frac{W_G}{10\gamma_R G} + \frac{W_G}{1000\gamma_G} - \frac{W_G}{1000\gamma_R} \quad \text{mm}$$

where: $W_G$ — design weight of glass-fiber mat or glass-fiber cloth in a unit area, in g/m$^2$;

$G$ — content of glass fiber (weight ratio) of laminated plate, in %;

$\gamma_R$ — specific gravity of resin after solidification, in g/cm$^3$;

$\gamma_G$ — specific gravity of glass-fiber mat or glass-fiber cloth, in g/cm$^3$.

2.1.1.12 Tightness test of hull

(1) After the completion of hull, main compartments are to be subject to hose test for verifying the strength and/or tightness of the structural members. The test pressure is to be as practicable the pressure due to the maximum head of water which the structural elements might have to sustain in the event of damage to the yacht.

(2) During hose test, the water pressure of nozzle is not to be less than 200 kPa, the nozzle is to be placed at a distance of not greater than 1.5 m from the tested object, the inner diameter is not to be less than 12 mm. The moving speed of water-jet is not to be greater than 0.1 m/s.

### 2.1.2 Local strength

2.1.2.1 Vertical acceleration at gravity center of a yacht

(1) The vertical acceleration at gravity center of a yacht $\alpha_{cg}$ is to be provided with by the owner or the designer, normally an average value of the 1/100 maximum acceleration at gravity center of a yacht may be taken. The designer may also make an adjustment to select a reasonable value $\alpha_{cg}$.

(2) The relation among the designed vertical acceleration at gravity center of a yacht $\alpha_{cg}$ and significant wave height $H_{1/3}$ specified in its service restriction and its speed $V_H$ corresponding to the wave height is as follows:

$$a_{cg} = \frac{1}{426}\left(\frac{V_H}{\sqrt{L}}\right)^{1.4}\left(\frac{H_{1/3}}{B_{WL}} + 0.07\right)(50-\beta)\left(\frac{L}{B_{WL}} - 2\right)\frac{B_{WL}^{\;3}}{\Delta} g \quad \text{m/s}^2$$

where: $g$ — acceleration of gravity, $g = 9.81$ m/s$^2$;

$V_H$ — speed at sea with significant wave height $H_{1/3}$, in kn;

$H_{1/3}$ — significant wave height, in m;

$L_{WL}$ — waterline length, in m;

$B_{WL}$ — width of waterline, in m, means the maximum moulded width measured along the full load waterline of a yacht in rest floatation. For multi-hull yacht, it means the sum of maximum moulded widths of each hull at full load waterline;

$\beta$ — deadrise angle at LCG, in °, $\beta_{max} = 30°$, $\beta_{min} = 10°$, see Figure 2.1.2.1(2);

$\Delta$ — full-loaded displacement, in t.

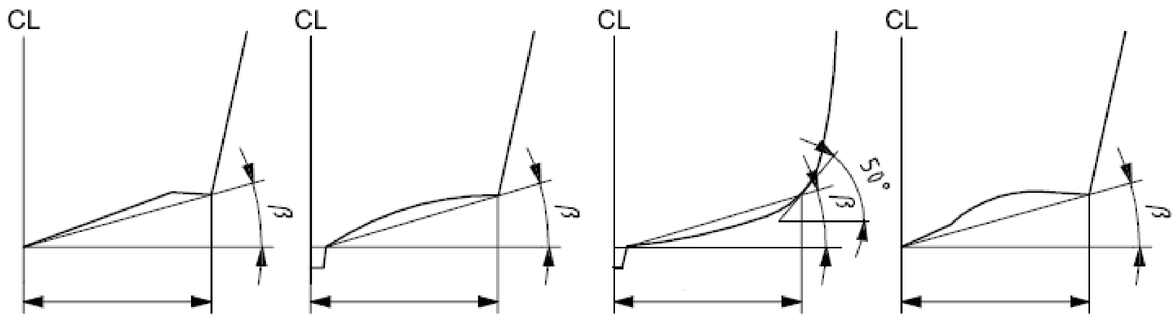



**Figure 2.1.2.1(2)**

(3) The final $\alpha_{cg}$ value is to be put in (2) above to calculate a group of corresponding values of $H_{1/3}$ to $V_H$. The values are to be recorded in the owner's manual. $H_{1/3max}$ of different categories of yachts in navigation need not be greater than those specified below:

For Category I yacht, $H_{1/3max}=8$ m;

For Category II yacht, $H_{1/3max}=6$ m;

For Category III yacht, $H_{1/3max}=4$ m;

For Category IV yacht, $H_{1/3max}=2$ m;

For Category V yacht, $H_{1/3max}=1$ m.

2.1.2.2 Local calculated pressure

(1) The wave impact pressure on bottom $P_{sl}$ is to be calculated by the following formula, and is not to be less than the impact pressure $P_s$ on side in way of corresponding position as determined by 2.1.2.2(3) of this Section:

$$P_{sl}=1.16K_{l1}\left(\frac{\Delta}{A}\right)^{0.3}a_{cg}d \qquad \text{kN/m}^2$$

where: $K_{l1}$ — longitudinal pressure distribution factor. $K_{l1}=1$ for forward of amidship, $K_{l1}=0.5$ for stern, the factor between amidship and stern is to be obtained by linear interpolation;

$A$ — area considered for impact pressure, in m²;

for plate field, $A$ is generally not to be taken greater than $2.5s^2$;

for stiffener or girder, $A$ is to be taken as the product: spacing × span;

but for plate field and frames, $A$ is in no case to be taken less than $0.002\Delta/d$;

$s$ — spacing of the frames;

$d$ — draft, in m;

$\Delta$ — full load displacement, in t;

$\alpha_{cg}$ — design vertical acceleration, in m/s², to be taken in accordance with that in 2.1.2.1 of this Section.

(2) For catamarans, the pressure at wet deck of the cross-deck structure $P_{wd}$ is to be determined by the following formula, and is not to be less than the pressure on side above the waterline in way of corresponding position as determined by 2.1.2.2(3) of this Section:

$$P_{wd}=0.75K_{l2}\left(\frac{\Delta}{A}\right)^{0.3}a_{cg} \qquad \text{kN/m}^2$$

where: $K_{l2}$ — longitudinal pressure distribution factor. $K_{l2}=1.5$ for forward of amidship, $K_{l2}=0.8$ for stern, the factor between amidship and stern is to be obtained by linear interpolation;

$\Delta$, $A$, $a_{cg}$ — the same as those in (1) above.

(3) Impact pressure $P_s$ on side is to be taken as:

$$P_s = 9.81h + 0.15P_{sl} \quad \text{kN/m}^2$$

where: $h$ — vertical distance between the lowest point of side plate and the upper edge of freeboard deck at sides (for deck yacht) or upper edge of upper strake (for open yacht), in m;

$P_{sl}$ — impact pressure on bottom in way, in kN/m$^2$.

(4) Pressure $P_d$ on deck is to be taken as:

$P_d = 0.25L_{WL} + 2.0$ kN/m$^2$, for exposed deck;

$P_d = 0.1L_{WL} + 2.0$ kN/m$^2$, for unexposed deck;

$P_d = 3.6$ kN/m$^2$, for passenger accommodation deck.

For Category II, III, IV and V yachts, the calculated pressure for exposed deck may be taken as 0.95 times, 0.9 times, 0.85 times and 0.8 times the above value respectively.

The final values calculated as above are not to be less than 3.6 kN/m$^2$.

(5) Pressure $P_h$ on bulkhead is to be taken as:

$P_h = 8h$ kN/m$^2$, for watertight bulkheads and their stiffeners;

$P_h = 12h_d$ kN/m$^2$, for collision bulkheads, bulkheads of liquid tanks and their stiffeners.

where: $h$ — vertical distance from the bottom edge of plate or midpoint of span of stiffener to the upper deck, in m;

$h_d$ — vertical distance from the bottom edge of plate or midpoint of span of stiffener to the top of the liquid tank, in m.

(6) Pressure $P$ on superstructure and deckhouse is to be taken as:

$P = 2 + 0.25L_{WL}$ kN/m$^2$, for fore end bulkhead and its stiffeners;

$P = 2 + 0.1L_{WL}$ kN/m$^2$, for side bulkheads, aft end bulkheads and their stiffeners;

$P = 3$ kN/m$^2$, for top plates and their stiffeners.

where: $L_{WL}$ — waterline length, in m.

For Category II, III, IV and V yachts, the calculated pressure for fore bulkheads and stiffeners of superstructure and deckhouse may be taken as 0.95 times, 0.9 times, 0.85 times and 0.8 times the above value respectively.

The final values calculated as above are not to be less than 3 kN/m$^2$.

2.1.2.3 Scantling of laminated plates

(1) The minimum thickness $t_{\min}$ of single plate is to be taken as follows:

$$t_{\min} = K_o\sqrt{L_{WL}} \quad \text{mm}$$

where: $K_0$ — coefficient, obtained from Table 2.1.2.3(1);

$L_{WL}$ — waterline length, in m.

**Coefficient $K_0$** **Table 2.1.2.3(1)**

| | Bottom, cross-deck structure | Side | Deck | Superstructure & deckhouse | | | Bulkhead | |
|---|---|---|---|---|---|---|---|---|
| | | | | Front | Side, behind | Top | Watertight | Collision, liquid tank |
| $K_0$ | 1.30 | 1.15 | 1.00 | 1.00 | 0.85 | 0.85 | 1.10 | 1.20 |

(2) The thickness $t$ of single plate is not to be less than the following:

$$t = 44.8 C_1 C_2 s \sqrt{\frac{P}{\sigma_{fnu}}} \quad \text{mm}$$

where: $C_1$ — reduction factor for curved plates; $C_1$ = 1 - 0.5$s/r$, where: $r$ is radius of curvature, in m;
$C_2$ — correction factor for panel aspect ratio of long side $\ell$ to short side $s$, to be taken as follows:

$$C_2 = \frac{\ell}{s}\left(1 - 0.25\frac{\ell}{s}\right) \qquad \text{for } \ell/s < 2;$$

$$C_2 = 1.0 \qquad \text{for } \ell/s \geq 2;$$

$\sigma_{fnu}$ — ultimate bending stress of laminate, in N/mm²;
$s$ — frame spacing, in m, in general means the longitudinal spacing, it is the breadth subjected to its area for girders or floors;
$P$— designed value subjected to positive pressure in member's unit area in the calculation of hull local strength, calculated in accordance with the requirements of 2.1.2.2 of this Section.

(3) The minimum thickness $t_{min}$ of each skin laminate on structural sandwich plates is to be calculated as follows:

$$t_{min} = K_0\sqrt{L_{WL}}$$ mm, and not less than 2.0 mm for exposed skin laminate①

$$t_{min} = K_0\sqrt{L_{WL}} - 0.5$$ mm, and not less than 1.5 mm for protected skin laminate②

where: $K_0$ — coefficient, obtained from Table 2.1.2.3(3).

**Coefficient $K_0$** **Table 2.1.2.3(3)**

| | Bottom, cross-deck | Side | Deck | Superstructure & deckhouse | | | Bulkhead | |
|---|---|---|---|---|---|---|---|---|
| | | | | Front | Side, behind | Top | Watertight | Collision bulkhead, liquid tank |
| $K_0$ | 0.6 | 0.5 | 0.45 | 0.45 | 0.35 | 0.35 | 0.40 | 0.45 |

(4) The total thickness $t$ of a structural sandwich plate is not to be less than:

$$t = \frac{1.428}{K}\left(1 + \frac{1}{\gamma}\right)\frac{Ps}{\tau_c} \qquad \text{mm}$$

where: $\gamma$ — ratio of the distance between centerlines of opposite skin laminates to the mean thickness of opposite skin laminates, $6 \leq \gamma \leq 14$;
$\tau_c$ — ultimate shear stress of sandwich core material, in N/mm²;
$K$ — coefficient,
$K$ = 1.86 - 0.06 $\gamma$ and $K \not< 1$, for core of PU cellular plastic;
$K$ = 1.95 - 0.079 $\gamma$ and $K \not< 1$, for core of PVC cellular plastic;
$K$ = 1 for core of plywood;
$s$, $P$ — refer to 2.1.2.3(2) of this Section.

① Exposed skin means the skin laminate subjected to liquid continuously or milling of machine or impacting load.
② Protected skin means the laminate not subjected to the above load.

2.1.2.4 Stiffeners and frames

(1) The section modulus $W$ of stiffeners and frames is not to be less than that obtained from the following:

$$W = K \frac{l^2 sP}{\sigma_{fnu}} \quad \text{cm}^3$$

where: $\sigma_{fnu}$ — ultimate bending stress of laminate, in N/mm²;

$K$ — coefficient, obtained from Table 2.1.2.4(1);

$l$ — span of stiffeners and frames, in m, where bracket is provided at the ends of stiffeners and frames, span point may be at half of the bracket length; where no bracket is provided at the ends of stiffeners and frames, span point may be at their ends. For hull stiffeners and frames (e.g. keels, plate floors and girders), the bulkhead connected may be taken as the end point of that stiffeners and frames. For stiffeners and frames of decks and superstructures, (e.g. web beams and girders), in addition to bulkhead, the pillar connected may be taken as the end point of that stiffeners and frames;

$s$, $P$ — refer to 2.1.2.3(2) of this Section.

(2) Where calculation of section modulus for keels as per (1) above is not practicable, such section modulus may be specially considered, but at least the following condition is to be satisfied:

① the section modulus for center keelson is not to be less than 1.5 times the section modulus for plate floor in way; the section modulus for side keelson is not to be less than that for plate floor in way.

**Coefficient *K*** **Table 2.1.2.4(1)**

| | *K* | |
|---|---|---|
| | Keel, girder, web frame, plate floor, web beam | Longitudinals, floor, frame, beam, stiffener |
| Bottom, cross-deck | 480 | 400 |
| Side | 480 | 400 |
| Deck | 480 | 400 |
| Superstructure | — | 400 |
| Watertight bulkhead | — | 400 |
| Liquid tank & collision bulkhead | — | 480 |

2.1.2.5 Effective web plate area of girders

(1) The effective web plate area of girders $A_e$ is to be calculated as follows:

$A_e = 0.01\, h_w t_w$ cm², for no bracket at ends of girder

$A_e = 0.01\, h_w t_w + \Delta A_e$ cm², for bracket at ends of girder

where: $h_w$ — effective girder height after deduction of cutouts in the cross section considered, in mm;

$t_w$ — total thickness of FRP web plate, in mm;

$\Delta A_e$ — additional shear area for girder with bracket at end, in cm², obtained in accordance with the horizontal angle $\theta$ of the bracket's face plate, refer to Figure 2.1.2.5(1).

$\Delta A_e = 0.9 f_1$, where $\theta = 45°$,

$\Delta A_e = 0$, where $\theta = 0°$,

The value $\Delta A_e$ may be obtained by linear interpolation where $\theta = 0 \sim 45°$, $f_1$ is area of the bracket's face plate in the cross section considered, in cm².

(2) The effective web plate area $A_e$ calculated in accordance with the requirements of 2.1.2.5(1) above is not to be less than $A_e$ min as follows:

$$A_{e\,\min} = \frac{25.5slP}{\tau_u} \quad \text{cm}^2$$

where: $\tau_u$ — limited shear stress of sandwich plate, in N/mm²;

$s$, $P$, $l$ — refer to 2.1.2.4(1) of this Section.

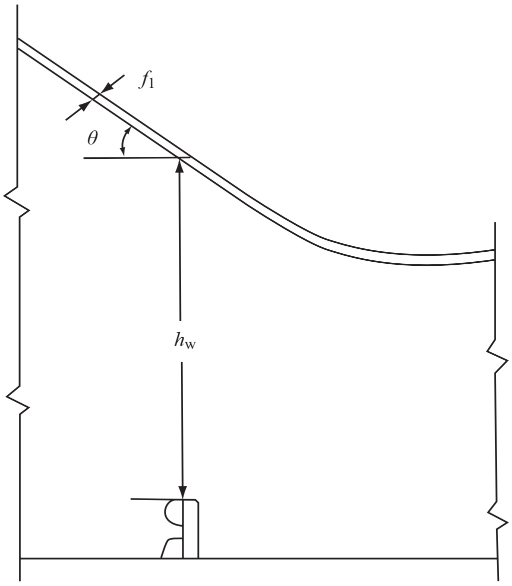



**Figure 2.1.2.5(1)**

## Section 2 STEEL YACHTS

### 2.2.1 General requirements

2.2.1.1 This Section applies to yachts whose hull structures are of steel material.

2.2.1.2 Principle of structural design

(1) The hull structure is to be so designed that the yacht can withstand the maximum external force that may be encountered throughout its whole period of service life.

(2) The hull structure may be designed by direct calculation, however the structural calculations are to be approved by CCS.

(3) Longitudinal members of longitudinal framings are to be continuous or equivalently continuous.

(4) The plate floors, web frames and deck web beams are to be arranged in a same section.

(5) The plate floors in general are to be fitted in the engine room, additional strengthening is to be provided in way of the thrust bearing.

(6) The plate floors are to be fitted on both ends of a main engine foundation in the engine room.

(7) For yachts of less than 6 m in length $L_H$, the hull scantlings may be verified by means of drop test of real yacht.[①]

(8) The external windows are to be adopted of toughened glass or polycarbonate glass or laminated glass in compliance with the relevant standards, and the thickness of glass is to comply with CCS Rules for Construction of Coastal Boats or other standards accepted by CCS.

(9) Where the decimal part of the calculated plate thickness in this Section is 0.25 mm or less, it may be neglected; where it is greater than 0.25 mm but less than 0.75 mm, it is to be taken as 0.5 mm; where it is 0.75 mm or more, a round number of 1.0 mm is to be taken.

① Refer to ISO 12215-5 Small craft — Hull construction and scantlings.

2.2.1.3 Local strengthening

(1) The requirements for local strengthening of steel yachts are to be same as in 2.1.1.8 of this Chapter.

2.2.1.4 Tightness test of hull

(1) After the completion of hull, tightness test is to be carried out as required by 2.1.1.12 of this Chapter.

(2) Where a hose test is not practicable because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by a careful visual examination of welded connections.

### 2.2.2 Local strength

2.2.2.1 The requirements for vertical acceleration at gravity center of a yacht are to be same as in 2.1.2.1 of this Chapter.

2.2.2.2 The requirements for local calculated pressure in way of the bottom, side, deck and superstructure are to be same as in 2.1.2.2 of this Chapter.

2.2.2.3 Thickness of plating

(1) The minimum thickness $t_{min}$ of plating is to be taken not less than that from the following:

$$t_{min} = K_0 \sqrt[3]{L_{WL}} \quad \text{mm}$$

where: $K_0$ — coefficient, to be obtained from Table 2.2.2.3(1);

$L_{WL}$ — waterline length, in m.

**Coefficient $K_0$** **Table 2.2.2.3(1)**

| Item | | $K_0$ |
|---|---|---|
| Bottom plating | | 1.4 |
| Wet deck of cross-deck structure | | 1.3 |
| Side plating | | 1.3 |
| Deck: exposed/unexposed | | 1.1/0.9 |
| Superstructure | Front | 1.2 |
| | Side, behind | 0.86 |
| | Top | 0.65 |
| Bulkhead | | 1.0 |
| Main engine seating | | 1.90 |

(2) The thickness $t$ of plating is to be taken not less than that from the following:

$$t = K_1 C_1 C_2 s \sqrt{\frac{P}{\sigma_S}} \quad \text{mm}$$

where: $K_1$ — coefficient, to be obtained from Table 2.2.2.3(2);

$s$ — spacing of frames, in m, normally for longitudinal frame spacing, and width subjected to the area for girders or floors;

$C_1$ — reduction factor for curved plates; $C_1 = 1-0.5s/r$, where: $r$ is radius of curvature, in m;

$C_2$ — correction factor for panel aspect ratio of long side $\ell$ to short side $s$, to be taken as follows:

$$C_2 = \frac{\ell}{s}(1 - 0.25\frac{\ell}{s}) \qquad \text{for } \ell/s < 2$$

$$C_2 = 1.0 \qquad \text{for } \ell/s \geq 2$$

$P$ — design pressure, to be taken as required by 2.1.2.2 of this Chapter;
$\sigma_s$ — yield stress of material, in N/mm².

**Coefficient $K_1$** **Table 2.2.2.3(2)**

| Item | | $K_1$ | | |
|---|---|---|---|---|
| | | Within $0.1L_{WL}$ from F.P. | Within $0.4L_{WL}$ at amidship | Within $0.1L_{WL}$ from A.P. |
| Bottom, wet deck of cross-deck structure | | 21.8 | 25.0 | 21.8 |
| Side | Near bottom | 21.8 | 25.0 | 21.8 |
| | Near neutral axis | 20.5 | 20.5 for longitudinally framing<br>21.8 for transversely framing | 20.5 |
| | Near deck | 20.5 | 25.0 | 20.5 |
| Deck, including superstructure/ deckhouse top | | 20.5 for longitudinally framing<br>21.8 for transversely framing | 25.0 | 20.5 for longitudinally framing<br>21.8 for transversely framing |
| Superstructure/deckhouse wall | | 21.8 | | |
| Bulkhead | Collision | 21.8 | | |
| | Watertight | 19.0 | | |
| | Liquid tank | 21.8 | | |

2.2.2.4 Stiffeners and frames

(1) The section modulus $W$ including attached plating of stiffeners and frames is not to be less than:

$$W = K_2 \frac{l^2 sP}{\sigma_S} \qquad \text{cm}^3$$

where: $K_2$ — coefficient, to be obtained from Table 2.2.2.4(1);
$P$, $s$, $\sigma_S$ — same as in 2.2.2.3(2) of this Section;
$l$ — same as in 2.1.2.4(1) of Section 1.

**Coefficient $K_2$** **Table 2.2.2.4(1)**

| Item | | Secondary members | | | Primary members |
|---|---|---|---|---|---|
| | | Longitudinal member | Beam, frames, floors | Stiffeners | Girders, web frames, plate floors, web beams |
| Bottom, wet deck of cross-deck structure | | 136 | 150 | | 150 |
| Side | | 128 | 150 | | 150 |
| Deck, including superstructure/deckhouse top | | Deck: 136<br>Top: 150 | 150 | | 150 |
| Superstructure/deckhouse front and side walls | | | | 150 | 150 |
| Superstructure/deckhouse rear walls | | | | 150 | 150 |
| Bulkhead | Collision and liquid tank | | | 150 | 150 |
| | Watertight | | | 109 | 109 |

2.2.2.5 Shearing strength for longitudinals and girders

(1) The effective shear area $A_e$ at end of longitudinals is not to be less than $A_{e\,min}$ obtained from the following formula:

$$A_{emin} = 22.67\frac{(l-s)sP}{\sigma_S} \quad \text{cm}^2$$

The shear area $A_e$ is to be calculated as follows:

$$A_e = 0.01ht \quad \text{cm}^2$$

where: $h$ — web depth of longitudinals, in mm;

$t$ — web thickness of longitudinals, in mm;

$l$, $P$, $s$, $\sigma_S$ — same as in 2.2.2.3(2) of this Section.

(2) The effective shear area $A_e$ at end of girders is not to be less than $A_{e\,min}$ obtained from the following formula:

$$A_{emin} = 13.5\frac{slP}{\sigma_S} \quad \text{cm}^2$$

The shear area $A_e$ is to be calculated as follows:

$A_e = 0.01h_w t_w$ cm$^2$, for no brackets at ends of girder;

$A_e = 0.01h_w t_w + \Delta A_e$ cm$^2$, for brackets at ends of girder

where: $h_w$ — net girder height after deduction of cutouts in the cross section considered, in mm;

$t_w$ — web thickness, in mm;

$l$, $P$, $s$, $\sigma_S$ — same as in 2.2.2.4(1) of this Section;

$\Delta A_e$ — additional shear area at end of girder with bracket, obtained according to the horizontal angle $\theta$ of the bracket's face plate, see Figure 2.1.2.5(1) of this Chapter;

$\Delta A_e = 0.9f_1$ where $\theta = 45°$; $\Delta A_e = 0$ where $\theta = 0°$; $\Delta A_e$ may be obtained by linear interpolation where $\theta = 0\sim45°$; $f_1$ is area of the bracket's face plate in the cross section considered, in cm$^2$.

## Section 3 ALUMINUM ALLOY YACHTS

### 2.3.1 General requirements

2.3.1.1 This Section applies to yachts whose hull structures are of aluminum alloy material.

2.3.1.2 Principle of structural design

The principle of structural design is same as in 2.2.1.2 of this Chapter.

2.3.1.3 Others

The local strengthening and hull tightness testing requirements for aluminum alloy yachts are same as to that for steel yachts.

### 2.3.2 Vertical acceleration

2.3.2.1 The requirements for vertical acceleration at gravity center of a yacht are same as in 2.1.2.1 of this Chapter.

### 2.3.3 Local calculated pressure

2.3.3.1 The requirements for local calculated pressure of bottom, side, deck and superstructure are same as in 2.1.2.2 of this Chapter.

### 2.3.4 Plate thickness

2.3.4.1 The minimum thickness $t_{min}$ of plating is to be taken not less than that from the following:

$$t_{min} = K_0 \sqrt[3]{L_{WL}} \quad \text{mm}$$

where: $K_0$ — coefficient, to be obtained from Table 2.3.4.1;
$L_{WL}$ — waterline length, in m.

**Coefficient $K_0$** **Table 2.3.4.1**

| Item | | $K_0$ |
|---|---|---|
| Bottom plating | | 1. 55 |
| Wet deck of cross-deck structure | | 1. 40 |
| Side plating | | 1. 40 |
| Deck: exposed/unexposed | | 1. 40/1. 16 |
| Superstructure | Front | 1.30 |
| | Side, behind | 0.92 |
| | Top | 0.80 |
| Bulkhead | | 1.16 |
| Main engine seating | | 1.90 |

2.3.4.2 The thickness $t$ of plating is to be taken not less than that from the following:

$$t = KC_1C_2s\sqrt{\frac{P}{\sigma_{SW}}} \quad \text{mm}$$

where: $K$ — coefficient, to be obtained from Table 2.3.4.2;
$s$ — spacing of frames, in m, normally for longitudinal frame spacing, and width subjected to the area for girders or floors;
$C_1$ — reduction factor for curved plates; $C_1$ = 1-0.5$s/r$, where: $r$ is radius of curvature, in m;
$C_2$ — correction factor for panel aspect ratio of long side $\ell$ to short side $s$, to be taken as follows:

$$C_2 = \frac{\ell}{s}(1 - 0.25\frac{\ell}{s}) \quad \text{for } \ell/s < 2$$

$$C_2 = 1.0 \quad \text{for } \ell/s \geq 2$$

$P$ — design pressure, to be taken as required by 2.1.2.2 of this Chapter;
$\sigma_{sw}$— yield stress after welding of material, in N/mm². Where the stiffened plates formed by extruding area used and the welded joint of the plates are far away from the edge of the plates, $\sigma_{sw}$ in the formula may be taken as the yield stress of material $\sigma_s$. Where riveting structure is used, $\sigma_{sw}$ is to be taken as 0.9$\sigma_s$.

**Coefficient *K*** **Table 2.3.4.2**

| Item | | Plating | Secondary members | | | Primary members |
|---|---|---|---|---|---|---|
| | | | Longitudinal member | Beam, frames, floors | Stiffeners | Girders, web frames, plate floors, web beams |
| Bottom, wet deck of cross-deck structure | | 25.0 | 115 | 135 | | 135 |
| Side | | 25.8 | 130 | 150 | | 150 |
| Deck, including superstructure/deckhouse top | | 27.8 | 130 | 150 | | 150 |
| Superstructure/deckhouse front walls | | 25.8 | | | 170 | 150 |
| Superstructure/deckhouse side and rear walls | | 25.8 | | | 150 | 150 |
| Bulkhead | Collision and liquid tank | 25.8 | | | 130 | 150 |
| | Watertight | 23.4 | | | 120 | 150 |

### 2.3.5 Stiffeners and frames

2.3.5.1 The section modulus *W* including attached plating of stiffeners and frames is not to be less than:

$$W = K\frac{l^2 sP}{\sigma_{SW}} \quad \text{cm}^3$$

where: $K$ — coefficient, to be obtained from Table 2.3.4.2;

$l$, $P$, $s$ — same as in 2.2.2.4(1) of Section 2;

$\sigma_{sw}$ — yield stress after welding of material, in N/mm². The following requirements are to be complied with:

(1) the yield stress $\sigma_{sw}$ after welding is to be taken for all longitudinals except for bulkhead stiffeners;

(2) the yield stress $\sigma_S$ of the material may be taken as in the above formula for all girders, web frames and web beams, except for bottom and flat bottom above water;

(3) $\sigma_{sw} = 0.9\sigma_S$ for riveting structure.

2.3.5.2 Shearing strength for longitudinals and girders

(1) The requirements for the shearing strength for longitudinals and girders are same as in 2.2.2.5 of this Chapter.

# CHAPTER 3    MACHINERY INSTALLATIONS

## Section 1    GENERAL PROVISIONS

### 3.1.1    General requirements

3.1.1.1    Design and construction of machinery, fuel oil tanks and associated piping and fittings are to comply with their intended purposes, and are to be so installed and protected as to minimize the hazards to persons when the yacht is in normal navigation. Therefore, particular attention is to be paid to moving parts, hot surfaces and other hazards.

3.1.1.2    All of the vital machines and equipment onboard, such as engines, gear boxes, elastic couplings, bilge pumps, fire pumps, propellers, Z-type propelling units, water-jet unit, etc., are to have appropriate marine product certificates.

### 3.1.2    Ambient conditions

3.1.2.1    Main propelling machinery and auxiliary machinery essential to yacht's propulsion and safety are to be so designed as to ensure normal operation under the inclination conditions in Table 3.1.2.1.

**Angle of inclination of yacht    Table 3.1.2.1**

| Installation and equipment | Angle of inclination (°)① | | | |
|---|---|---|---|---|
| | athwartships | | Fore-and-aft | |
| | Static | Dynamic | Static | Dynamic |
| Main and auxiliary machinery | 15 | 22.5 | 5 | 7.5 |

Note: ①  Athwartship and fore-and-aft inclination may occur simultaneously.

3.1.2.2    In general, the rated power of engine means the maximum continuous power for the engine under the ambient conditions of 0.1 MPa absolute atmosphere, 45℃ ambient temperature, 60% relative humidity and 32℃ sea water temperature.

### 3.1.3    Means of going astern

3.1.3.1    Suitable power for going astern is to be provided to secure proper control of the yacht in all normal circumstances.

### 3.1.4    Doorways

3.1.4.1    At least one doorway is to be provided in engine room. Stairways are to be provided in doorways of the engine room requiring to be manned and to be easily accessible for operators.

### 3.1.5    Ventilation

3.1.5.1    Diesel oil engine room is to be adequately ventilated so as to ensure that an adequate supply of air is maintained to the engine room when the engines are operated at full power under any weather conditions for the safety of personnel and normal operation of engines.

3.1.5.2    The ventilation in compartments containing petrol engine and/or petrol tank is to comply with the requirements of Section 3 in this Chapter.

3.1.5.3    The ventilation opening is not to be located within or vertically above a 400 mm horizontal radius of any fuel filling point or outlet of vent pipe of fuel oil system, except where the yacht's coaming, superstructure or hull creates a barrier to prevent fuel vapour entering the yacht.

### 3.1.6 Monitoring

3.1.6.1 The following maneuvering and monitoring instruments are to be provided near the steering position of yachts:

(1) rudder indicator;

(2) main engine speed indicator;

(3) remote stoppage of main/auxiliary engines;

(4) stopping of fuel pump;

(5) bilge-water level alarm;

(6) failure alarm for engine room fan (only applicable to engine room containing petrol engine or LPG engine).

### 3.1.7 Testing

3.1.7.1 Sea trials are to be carried out after completion of installation of machinery.

## Section 2 ENGINES

### 3.2.1 General requirements

3.2.1.1 Each engine driving propelling machinery is to be provided with reliable governors and overspeed protective devices, which are to comply with the following requirements:

(1) Governors are to prevent the engine from exceeding 115% of its rated speed.

(2) Overspeed protective devices are to be independent of governors, and to prevent the engine from exceeding 120% of its rated speed.

3.2.1.2 Each engine driving generator is to be provided with reliable governors and safety devices, which are to comply with the following requirements:

(1) When sudden rated load drops or sudden rated load accelerates, the rate of instantaneous and steady regulating speed is not to be more than 10% and 5% of the rated speed respectively. When sudden rated load accelerates, the steady time (i.e. the time of returning to the range with pulsating rate being ±1%) is not to be more than 5 s.

(2) When rated power of engine is more than 220 kW, overspeed protective devices independent of governors are to be provided to prevent the engine from exceeding 115% of its rated speed.

3.2.1.3 Main engines are to be provided with emergency stopping devices. For main engine remotely controlled in bridge room, the emergency stopping device is to be provided in the bridge room.

3.2.1.4 The total capacity of the starting arrangements is to be sufficient to provide, without replenishment, not less than six consecutive starts of the main engine in cold condition and not less than three consecutive starts of the auxiliary engine in cold condition.

3.2.1.5 The engines are to be so installed inside the yacht as to be easily accessible and be maintained and inspected conveniently by operators.

3.2.1.6 The rigid installation of engines inboard is to comply with the following requirements:

(1) The nuts for securing bolts are to be provided with locking devices.

(2) The securing bolts of main engine and gear box are to be provided with at least two fitting bolts respectively.

(3) The main engine and gear box are to use a common foundation as far as practicable.

3.2.1.7 Not less than two sea inlets are in general to be connected with the cooling water pump of sea-water cooling piping system or circulating system and to be fitted on both sides of yacht as far as practicable. One sea inlet may be fitted only if the cooling water supply to the systems above can be ensured in any condition.

### 3.2.2 Alarm device

3.2.2.1 Main engines are to be provided with the following alarm devices:

(1) low-pressure alarm device for lubricating oil;

(2) high-temperature alarm device for cooling water.

For main engine remotely controlled in bridge room, the above alarms are to be extended in the bridge room.
3.2.2.2 For prime mover of generator with power more than 35 kW, low-pressure alarm device for lubricating oil is to be provided.

**3.2.3 Special requirements for outboard engine**
3.2.3.1 The outboard engines are to be reliably fixed on the stern transom plating by through bolts or equivalent means.
3.2.3.2 The installation trunk of outboard engine is to have sufficient dimension so that the outboard engine can be moved around according to the operating conditions.
3.2.3.3 The openings for operational cable and fuel hose of outboard engine are to be effectively sealed if penetrating hull structure.
3.2.3.4 For outboard engine with total power less than 40 kW, the speed and direction can be operated by single handle. For outboard engine with total power of 40 kW and above, handwheel console is to be provided in stem.
3.2.3.5 Where the steering position is open onboard a yacht with the speed exceeding 20 kn, a safety rope is to be provided near the steering position, which can cut off and stop the outboard engine in case that the navigating officer falls outside.

## Section 3 PETROL ENGINE AND/OR PETROL TANK COMPARTMENTS

**3.3.1 Definitions**
3.3.1.1 Open compartment means a 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.

**3.3.2 General requirements**
3.3.2.1 Except open compartments, ventilation system is to be provided in petrol engine and /or petrol tank compartments in accordance with the provisions of 3.3.3 and/or 3.3.4 of this Section.
3.3.2.2 Compartments containing petrol engines and/or petrol tanks are to be separated from the enclosed passenger and crew spaces to prevent the petrol gas from entering the passenger’s cabins.
3.3.2.3 For compartments containing petrol engines and/or petrol tanks, neither supply nor exhaust ducts are to open into a passenger and crew’s cabin.
3.3.2.4 Except open compartments, all electrical components installed in compartments containing petrol engines and/or petrol tanks and in other compartments connecting to such compartments are to be of ignition-protected type.①
3.3.2.5 The electrical components installed on the petrol engines are to comply with the relevant requirements of Chapter 4 of this PART.
3.3.2.6 Portable petrol tank or equipment with petrol fuel is not to be arranged in enclosed spaces, they are to be arranged in a place provided with quick-securing devices and to be ready for jettison in an emergency.

**3.3.3 Natural ventilation systems**
3.3.3.1 Natural ventilation is to be provided in non-open compartments containing any of the following appliances:
(1) where a petrol engine is provided;
(2) where a permanently installed petrol tank and electrical component other than petrol level gauge sending unit are provided;
(3) where it is designed to contain a portable petrol tank.
3.3.3.2 A supply opening or duct from the atmosphere and an exhaust opening or duct to the atmosphere are to be provided in natural ventilated compartments. The arrangement of air intake and exhaust system is to comply with all of the following requirements:
(1) Each exhaust opening or duct is to originate in the lower 1/3 of the compartment.

① Refer to ISO 8846.

(2) Each supply opening or duct and each exhaust opening or duct in a compartment are to be above the normal level of accumulated bilge water.
(3) Compartment air intake and exhaust duct openings are to be separated by at least 600 mm with compartment dimension permitting.
3.3.3.3 The combined internal cross-sectional area of supply openings or ducts, and the combined internal cross-sectional area of exhaust openings or ducts are to have a minimum internal cross-sectional area calculated as follows, and the internal cross-sectional area of each supply, exhaust opening or exhaust duct is not to be less than 3,000 mm$^2$:

$$A = 3300\ln(V/0.14)$$

where: $A$ — the minimum combined internal cross-sectional area of the openings or ducts, in mm$^2$;
$V$ — the net compartment volume equal to the total compartment volume minus the volume of permanently installed components in it, in m$^3$;
ln — natural logarithm.

### 3.3.4 Powered ventilation systems
3.3.4.1 Unless open to the atmosphere, each compartment containing a petrol engine is to be ventilated by removing air from the compartment to the atmosphere outside the yacht by an exhaust blower system. The blower is to be of non-spark type.
The exhaust ducts used for natural ventilation in 3.3.3 above may be used as the suction draft ducts in powered ventilation system.
3.3.4.2 Each intake duct for an exhaust blower is to be in the lower 1/3 of the compartment and above the normal level of accumulated bilge water.
3.3.4.3 The exhaust outlet of blower is to be as far apart as possible from the outlet of exhaust pipe for engine.
3.3.4.4 The total airflow capacity $Q$ of each exhaust blower or combination of blowers in compartment is not to be less than that in Table 3.3.4.4.

**Total airflow capacity *Q*** **Table 3.3.4.4**

| Net volume of compartment $V$ (m$^3$) | Total airflow capacity $Q$ (m$^3$/min) |
|---|---|
| $V$<1 | 1.5 |
| 1≤ $V$ ≤3 | 1.5 × $V$ |
| $V$ >3 | 0.5 × $V$ +3 |

3.3.4.5 The exhaust blower fitted in the petrol engine compartment is to be operated 4 min before starting of engine. During the navigation period of yacht (including embarkation, disembarkation or laid-up), continuous powered ventilation is to be kept in petrol engine compartment. When it stops due to any reasons, visual and audible alarms are to be given in the machinery space and bridge.

## Section 4 SHAFTING AND PROPULSOR

### 3.4.1 Diameter of shaft
3.4.1.1 Materials for shafting are to comply with the relevant provisions of CCS Rules for Materials and Welding. If forged steel is used for shafting, the tensile strength is to be selected within the following general limits:
(1) for carbon and carbon-manganese steel, 400 to 760 N/mm$^2$;
(2) for alloy steel, not exceeding 800 N/mm$^2$.
Where the tensile strength of the material exceeds the limits in 3.4.1.1(1) and (2) of this Chapter, the calculation of shaft diameter is to comply with the provisions of 3.4.1.2 of this Chapter.
3.4.1.2 The diameter of shaft $d$ is not to be less than:

$$d = 100C\sqrt[3]{\frac{N_e}{n_e}\left(\frac{560}{R_m+160}\right)} \quad \text{mm}$$

where: $C$ — factor for design features of different shafts (for details, see Table 3.4.1.2);

$N_e$ — rated power transmitted by the shaft, in kW;

$n_e$ — rated speed of the shaft at $N_e$, in r/min;

$R_m$ — tensile strength of the shaft materials. If carbon and carbon-manganese steel are used, for intermediate shaft, if $R_m$ > 760 N/mm², it is to be taken as 760 N/mm²; for propeller shaft and tube shaft, if $R_m$ > 600 N/mm², it is to be taken as 600 N/mm². If alloy steel or stainless steel is used, for intermediate shaft, propeller shaft and tube shaft, if $R_m$ > 800 N/mm², it is to be taken as 800 N/mm².

3.4.1.3 If the shaft material is of alloy or stainless steel, shaft diameter $d$ may be taken as 0.9 times of the above-mentioned calculation value.

**Factor *C* for design features of different shafts** **Table 3.4.1.2**

| Intermediate shaft with following type | | | | | Thrust shaft outside engine | | Screwshaft with following type | |
|---|---|---|---|---|---|---|---|---|
| Integral flange | Hydraulic keyless coupling | Keyway | Longitudinal hole, transverse hole | Longitudinal groove | The part from thrust ring to outside with the same distance as diameter of thrust shaft, other parts may be reduced to the diameter of intermediate shaft according to cone | In way of axial bearing when the roller bearing is used as thrust bearing | Keyless or flanged screwshaft, air screwshaft, jet thrust pump shaft | Screwshaft with key |
| 1.0① | 1.0⑦ | 1.10②⑤⑧ | 1.10③⑤ | 1.20④⑤ | 1.10 | 1.10 | 1.22 | 1.26 |

Notes: ① The fillet radius at the base of the flange is not to be less than 0.08$d$.

② For over a length of at least 0.2$d$ of the shaft from the ends of keyway and, the diameter of the shaft is to be increased by taking $C$ = 1.10. The diameter of the shaft is to be decreased by taking $C$ = 1.0 for the range beyond. The fillet radius in the transverse section at the bottom of the keyway is not to be less than 0.0125$d$.

③ For over a length of at least 0.2$d$ of the shaft from the ends of hole and, the diameter of the shaft is to be increased by taking $C$ = 1.10. The diameter of the shaft is to be decreased by taking $C$ = 1.0 for the range beyond. The diameter of the hole is not to be greater than 0.3$d$.

④ For over a length of at least 0.3$d$ of the shaft from the longitudinal slot and its ends, the diameter of the shaft is to be increased by taking $C$ = 1.20. The diameter of the shaft is to be decreased by taking $C$ = 1.0 for the range beyond. In general, the groove is to have length less than 0.8$d$, width more than 0.1$d$ and inside diameter less than 0.8$d$. The end fillet of groove is not less than half of the groove width and the amount of groove is not to be more than 3.

⑤ For shaft having several design features, the factor is to be the product of several factors.

⑥ Where, $d$ is calculated with $C$ = 1.0.

⑦ If torsional vibration stress of shaft exceeds 90% of sustained allowable torsional vibration stress, shrinking diameter is to be increased, e.g. by 1~2%.

⑧ Keyway is not used for shafting with forbidden zone of rotating speed.

### 3.4.2 Shaft liners (if fitted)

3.4.2.1 The thickness $t$ of bronze shaft liners shrunk on screwshafts, in way of bushes, is not to be less than:

$$t = 0.03d + 7.5 \quad \text{mm}$$

where: $d$ — diameter of screwshaft in way of bushes, in mm.

The thickness of stainless steel liners, where used, is to be one half of that required for bronze liners but not less than 6 mm.

The thickness of a continuous liner between the bushes may be somewhat reduced, but is not to be less than 0.75$t$.

3.4.2.2 Continuous liners are to be generally cast in one piece. Where necessary, they may consist of two or more pieces, but these are to be welded by reliable methods to prevent water ingress.

3.4.2.3 Where the portion of the shaft between any two lengths of the liner is protected with fiber reinforced plastic or other equivalent materials, the protection at the junction of the liner ends is to be of such a construction as to prevent the shaft from water ingress. The connection portions are not to be located within the bearing range.
3.4.2.4 Shaft liners which are cast in one piece or consist of two or more lengths, are to be subject to hydraulic test to a pressure of 0.2 MPa after rough machining, and there is to be no crack or leakage.

### 3.4.3 Stern tube and bearings

3.4.3.1 The length of sea water lubricated after bearing of stern tube is not to be less than 4 times the stipulated diameter of screwshaft.
3.4.3.2 The length of oil lubricated after bearing of stern tube is not to be less than 2 times the stipulated diameter of screwshaft.
3.4.3.3 For oil or water lubricated bearings which are lined with plastics composition materials, the length of the bearing is not to be less than twice the diameter of propeller shaft required by the Rules.
3.4.3.4 Bearings which are oil lubricated are to be fitted with a reliable oil sealing gland and provision is to be made for cooling the oil.
3.4.3.5 Stern tubes are to be subjected to hydraulic testing with a pressure of 0.2 MPa before being fitted onboard.

### 3.4.4 Coupling

3.4.4.1 For couplings which are transmitted torque by keys, the tensile strength of the key material is not to be less than that of the shaft material, the effective sectional area of the key in shear is to be determined by the following formula:

$$BL \geqslant \frac{d^3}{2.6d_m} \quad \text{mm}$$

where: $B$ — breadth of key, in mm;
$L$ — effective length of key, in mm;
$d$ — diameter of intermediate shaft determined by 3.4.1.2, in mm;
$d_m$ — diameter of shaft at mid-length of the key, in mm.

3.4.4.2 The diameter $d_f$ of fitting bolts at the jointing faces of couplings is not to be less than:

$$d_f = 0.65\sqrt{\frac{d^3(R_m + 160)}{DZR_{mb}}} \quad \text{mm}$$

where: $d$ — Rule diameter of the solid intermediate shaft, in mm;
$Z$ — number of bolts;
$D$ — pitch circle diameter, in mm;
$R_m$ — tensile strength of the intermediate shaft material for calculation, in N/mm²;
$R_{mb}$ — tensile strength of the fitted coupling bolts material taken for calculation, in N/mm²,
where: $R_m \leq R_{mb} \leq 1.7R_m$, but not higher than 1,000 N/mm².

3.4.4.3 Where general bolts are used, the diameter $d_n$ at the root of thread of bolts is not to be less than:

$$d_n = 25\sqrt{\frac{N_e \times 10^6}{n_e DZR_m}} \quad \text{mm}$$

where: $N_e$ — rated power transmitted by shaft, in kW;
$n_e$ — speed of the shaft at $N_e$, in r/min;
Other symbols are same as defined in 3.4.4.2 of this Section.

### 3.4.5 Propeller

3.4.5.1 The blade thickness of propeller and the installation of propeller to screwshaft are to comply with the relevant requirements of CCS Rules for Construction and Classification of Sea-Going High Speed Craft or the standards as accepted.

### 3.4.6 Z-type propelling unit

3.4.6.1 Where the power unit of rotatable system is electro-dynamic or electro-hydraulic, stand-by power unit or other emergency operating means are to be provided. Power unit can be exempted if the yacht is provided with two or more Z-type propelling units.
3.4.6.2 Rudder indicators for steering and propulsion system are to be provided in bridge room and steering gear room.
3.4.6.3 The diameters of input shaft, vertical spindle and screwshaft for steering and propulsion system are not to be less than those obtained from 3.4.1.2 in this Section.
3.4.6.4 The strength and installation requirements for propeller of such system are to be in compliance with the relevant requirements of 3.4.5 of this Section.
3.4.6.5 Such system is to be well lubricated with a temperature of lubricating oil not more than 70℃.
3.4.6.6 After completion of manufacture, the parts and components of the system, such as upper gear box, lower gear box and rotatable gear box are to be subject to a hydraulic test at 0.2 MPa and after assembly, they are to be subject to a tightness test at 0.1 MPa.
3.4.6.7 Hydraulic testing is to be carried out for hydraulic piping with 1.5 times the design pressure, after installation onboard, the hydraulic piping together with its accessories are to be subject to a tightness test at 1.25 times the design pressure.

### 3.4.7 Water-jet unit

3.4.7.1 The water-jet units are to be capable of sustaining loads under all possible working conditions.
3.4.7.2 The diameter of pump shafts of the water-jet units is to comply with the relevant requirements of 3.4.1.2 of this Section.
3.4.7.3 The installation of a water-jet unit, including shafting alignment, is to give safety performance of propulsion system under all working conditions.
3.4.7.4 The pump case of water-jet unit is to be subject to a hydraulic test at 1.5 times the design pressure.
3.4.7.5 Where lubricating oil bearing is used for water-jet unit, a reliable shaft sealing device is to be provided in order to prevent water from ingress to oil lubricated parts of the pump.
3.4.7.6 Directional control device for water-jet unit is to be capable of operating in the bridge room.
3.4.7.7 Indicators are to be provided in the bridge room to show speed of water-jet pumps and the water-jet asterning position.

## Section 5 FUEL OIL SYSTEM

### 3.5.1 General requirements

3.5.1.1 Each part of fuel oil system is to have a sufficient strength and to be so installed as to be capable of bearing impact and vibration which will possibly take place and not to cause any leakage.
3.5.1.2 The material of parts of fuel oil system is to be capable of resisting environment corrosion and temperature effect.

### 3.5.2 Fuel oil tanks

3.5.2.1 The structure and arrangement of fuel oil tanks are to comply with the following:
(1) The fuel oil tanks are to be tightly fixed on the foundation. The fuel oil tank is not to be used to support decks, bulkheads or other members.
(2) The fuel oil tanks are not to be positioned above engines, exhaust pipes and electrical installations, and apart from accumulator batteries, etc., as far as possible.
(3) Vent pipes with sufficient flow area are to be provided for fuel oil tanks and they are led to open spaces where neither flooding nor danger caused by leakage of oil or oil gases. Flame-proof gauze diaphragm is to be provided for opening of vent pipe.

(4) Sounding pipes are to be provided for fuel oil tanks, and the approved liquid level indicator is allowed to substitute for sounding pipe. Glasses oil level gauges cannot be used for petrol tanks. Where glasses oil level gauges are provided for diesel oil tanks, self-closing stopping valves are to be provided on upper and lower ends where spillage may occur.

(5) The space where fuel oil tank is located is to be effectively ventilated.

(6) Fuel oil tanks are not to be arranged forward of collision bulkheads.

(7) Hydraulic pressure testing is to be carried out before fuel oil tank is installed, the test head is to reach 2.4 m above the top of the tank, and leakage is not to be allowed.

3.5.2.2 The arrangement of petrol tanks is to comply with the following additional requirements:

(1) Petrol tanks are not to be integral with the hull.

(2) No oil draining pipes are allowed to be provided for petrol tanks.

(3) Petrol tanks are to be so arranged as to avoid direct sunlight, and means for prevention of shifting of petrol tank is to be provided.

3.5.2.3 The fuel oil tank is to have enough strength and the minimum wall thickness is not to be less than the values specified in Table 3.5.2.3.

**Minimum wall thickness of fuel oil tanks (in mm)** **Table 3.5.2.3**

| Material | Minimum wall thickness | Note |
|---|---|---|
| Copper, with internal tin plating | 1.5 | Not used for diesel oil |
| Aluminum alloy with the content of copper not more than 0.1% | 2 | |
| Passive austenite, low carbon chrome nickel steel | 1 | Removing all welding scale |
| Low carbon steel | 2 | Not used for petrol |
| Low carbon steel subjected to external hot dipping zinc after manufacture | 1.5 | Not used for petrol |
| Low carbon steel subjected to external and internal hot dipping zinc after manufacture | 1.5 | |
| Polyethylene | 5 | Not used for petrol |

### 3.5.3 Fuel oil pipeline

3.5.3.1 The pipeline is to be suitably fastened and protected to prevent from damage and abnormal wearing. Pipeline is not to be combined with the attachment made of different metal material in order to avoid electric erosion.

3.5.3.2 The pipeline is to be made of seamless annealed copper, copper-nickel alloy or other equivalent alloy. For diesel oil, aluminum pipeline may be used.

3.5.3.3 Where hose is used for pipeline, the fire-proof type hose[①] is to be adopted and it is to be fixed with skid-proof metallic hose clamps. Non-fireproof hoses[②] may be used for outboard engine.

3.5.3.4 Stop valve is to be provided on the fuel oil pipeline as near as possible to the oil tank. The valve can be closed at an appropriate position outside the engine room, or other equivalent measures are to be taken[③].

3.5.3.5 Fuel oil pipeline is not to be positioned above engines, exhaust pipes and electrical installations. If unavoidable, effective protection is to be provided.

## Section 6 EXHAUST SYSTEM

### 3.6.1 General requirements

3.6.1.1 Exhaust pipe is to be bound with suitable insulation material, the surface temperature of insulation is not to exceed 60℃. Means is to be taken to prevent the high temperature surface from injuring persons.

① Refer to ISO 7840.
② Refer to ISO 8469.
③ Refer to ISO 10088.

3.6.1.2 The exhaust pipes are to be so arranged that the outboard water can not flood into the engine. Anti-back-water device is to be provided for the discharge positioned at less than 300 mm above waterline, and draining cock is to be provided in the lowest place of exhaust pipes where water may easily accumulate.

## Section 7 BILGE PUMPING SYSTEM

### 3.7.1 General requirements

3.7.1.1 Effective bilge pumping system is to be provided in each yacht. The system is to be so arranged as to drain water effectively from any watertight compartment other than that intended for permanently storing liquid and prevent water flowing from one compartment to another.

3.7.1.2 For individual compartment, the drainage may be exempted provided that the safety of the yacht is not affected by drainage of this compartment through calculation or necessary demonstration.

3.7.1.3 Where deemed necessary, the bilge suction pipes are to be fitted with effective strum boxes for the purpose of protecting bilge water piping. The strum boxes are to be easily removed and replaced for cleaning and the combined area of a box is not to be less than twice the sectional area of the bilge suction pipe.

3.7.1.4 When all hatches are closed, bilge pumps, other than portable pumps, are to be capable of being operated.

3.7.1.5 Discharge of bilge water is to satisfy the pollution prevention requirements of the Administration.

### 3.7.2 Bilge pump

3.7.2.1 In general, the bilge pump is to be of self-priming type.

3.7.2.2 A hand bilge pump is to be provided for a yacht of less than or equal to 12 m in $L_{WL}$. At least one power bilge pump is to be provided for a yacht of more than 12 m in $L_{WL}$. Open deck yacht is to be additionally provided with a bailer or a bucket.

3.7.2.3 The bilge pump is not to be used as an oil pump. For a yacht of more than 12 m in $L_{WL}$, a hand bilge pump is to be additionally provided where the bilge pump is used as a fire pump.

3.7.2.4 The total displacement of bilge pump is not to be less than the requirements of Table 3.7.2.4.

**Total displacement of bilge pump** **Table 3.7.2.4**

| $L_{WL}$ (m) | Total displacement of bilge pump ($m^3/h$) |
|---|---|
| $L_{WL} \leq 6$ | 0.6 |
| $6 < L_{WL} \leq 12$ | 1.0 |
| $L_{WL} > 12$ | 2.0 |

### 3.7.3 Bilge water level alarms

3.7.3.1 A watertight compartment fitted with propelling machinery, or any other compartment (except void space) where bilge water may easily accumulate but not be found easily, is to be provided with bilge water high-level alarms.

3.7.3.2 Any one dry compartment fitted with fixed or portable bilge water suction, where bilge water level is not found easily, are also to be provided with bilge water high-level alarms.

3.7.3.3 Bilge water high-level visual and audible alarms are to be provided at the maneuvering position of the yacht.

## Section 8 STEERING GEAR

### 3.8.1 General requirements

3.8.1.1 The steering gear is to ensure the reliable maneuvering for the yacht in navigation.

3.8.1.2 Power steering gears are to be provided with two power sources (except for steering oar integral installation). For power steering gears with single power source, manually operated gears independent of power source are to be provided.

3.8.1.3 The Z-type propelling unit is to comply with the requirements of 3.4.6 of this Chapter.

3.8.1.4 The water-jet unit with directional control function is to comply with the requirements of 3.4.7 of this Chapter.

3.8.1.5 The steering position is to have a good visibility of navigation for the steering persons.

# CHAPTER 4 ELECTRICAL INSTALLATIONS

## Section 1 GENERAL PROVISIONS

### 4.1.1 General requirements

4.1.1.1 The design, manufacture, test and installation of main electrical installations onboard are to comply with the relevant requirements of this Chapter, or to meet other standards accepted by CCS. Electrical equipment and cables are to have appropriate certificates of marine products as required by CCS.

4.1.1.2 Electrical installations onboard are to ensure:

(1) that they are capable of giving power supply to all electrical auxiliary services necessary for maintaining the yacht in normal operation;

(2) the safety of passengers, crew and the yacht from electrical hazards.

### 4.1.2 Design, manufacture and installation of electrical equipment

4.1.2.1 Electrical equipment are to be so designed, manufactured and installed as to ensure safe operation and to be easy for inspection and repair.

4.1.2.2 Electrical equipment is to be operated satisfactorily under the voltage and frequency fluctuations as given in Table 4.1.2.2.

**Voltage and frequency fluctuation** **Table 4.1.2.2**

| Equipment | Parameter | Variation | | |
|---|---|---|---|---|
| | | Permanent(%) | Transient | |
| | | | % | Maximum recovery time (s) |
| General equipment | Voltage | +6～-10 | ±20 | 1.5 |
| | Frequency | ±5 | ±10 | 5 |
| Equipment supplied by accumulator batteries:<br>Connected to batteries during charging<br>Not connected to batteries during charging | Voltage | +30～-25<br>+20～-25 | - | - |

4.1.2.3 All electrical equipment is to be operated satisfactorily under the following environmental conditions:

(1) The ambient air temperatures are as given in Table 4.1.2.3(1).

**Ambient air temperatures** **Table 4.1.2.3(1)**

| Location | Temperature |
|---|---|
| In enclosed spaces | 0℃ to 40℃ |
| In spaces subject to temperatures 40℃ more and below 0℃ | According to specific local conditions |
| On exposed deck | - 25℃ to 40℃ |

Note: The upper limit of temperature for tropical zone is 45℃. The upper limit of ambient air temperature for the electronic installations is 55℃.

(2) Moisture air, salt mist, oil vapour and mould.

(3) Vibration and shock likely to arise under normal navigation of yacht.

(4) The inclination of yacht from the normal position is as given in Table 4.1.2.3(4).

**Inclination** **Table 4.1.2.3(4)**

| Equipment components | Angle of inclination (°)[1] | | | |
|---|---|---|---|---|
| | Athwartships | | Fore-and-aft | |
| | Static | Dynamic | Static | Dynamic |
| Electrical equipment, switchgear, electrical and electronic equipment | 22.5 | 22.5 | 10 | 10 |
| Electrical equipment excluding items stated above | 15 | 22.5 | 5 | 7.5 |

Note: ① Athwartship and fore-and-aft inclination may occur simultaneously.

4.1.2.4 The electrical equipment are to be arranged in the places apart from inflammable material and with effective ventilation and where no inflammable gas may concentrate and where they are not easily subjected to mechanical damage or oil and water corrosion. Where they are fitted in the above mentioned various hazardous places, suitable structural protection or enclosure is to be provided for such equipment.
4.1.2.5 The type of protective enclosures selected for electrical equipment is to meet the requirements in Table 4.1.2.5.

**Type of protective enclosures** **Table 4.1.2.5**

| Location onboard | Grade of protection |
|---|---|
| Compartments with well protection below deck | IP20 |
| On the top sheltered deck | IP22 |
| On the splashed deck | IP44 |
| On the immersed deck | IP56 |

### 4.1.3 Earthing

4.1.3.1 All accessible metal parts of electrical equipment and cables, other than current-carrying accessible parts, are to be earthed reliably.
4.1.3.2 Yacht with non-metallic hulls is to be provided with a ground plate, which is to be made of copper with cross sectional area not less than 0.1 $m^2$ and thickness not less than 1 mm or other conducting material compatible with sea water, such as stainless steel. Where engines or propellers of the yacht with non-metallic hulls have an equivalent function of the ground plate, such ground plate is not required.
4.1.3.3 The metal ground plate is to be fixed below the waterline, and is to be immersed in water in any navigation conditions of the yacht. For a twin-hull yacht, ground plate is to be provided on each hull.
4.1.3.4 The neutral conductor is only to be earthed at the source of power, i.e. at the onboard generator, the secondary winding of power transformer onboard. The neutral point of shore power supply is to be earthed through the shore-power cable and not be onboard the yacht.
4.1.3.5 A direct current equipotential bonding conductor (if fitted) is to be connected to the yacht's ground to minimize stray current corrosion.

### 4.1.4 Lightning-protection systems

4.1.4.1 Lightning rod is to be provided for a yacht with non-metallic structure and non-metallic mast, and such rod is to be at least 150 mm higher than the mast. The mast is to have a suitable height in order that lightning rod can function for the yacht.
4.1.4.2 The entire circuit from the top of the lightning-protective mast to the lightning ground plate is to have a mechanical strength and a conductivity not less than that of a 21 $mm^2$ copper conductor. For a yacht with metallic mast, the mast is to be regarded as lightning rod. Special lightning rod is to be provided for the electrical equipment fitted on the top of metallic mast.

## Section 2 SOURCE OF ELECTRICAL POWER AND DISTRIBUTION

### 4.2.1 Type and provision of electrical power source

4.2.1.1 Unless otherwise stated in 4.2.1.5, at least two sources of electrical power are to be provided onboard, in the event of any one electrical power source in failure, the capacity of remainder will still supply those services necessary to provide in normal navigation conditions.
4.2.1.2 The sources of electrical power may be either:
(1) generators driven by main independent prime movers;
(2) generators driven by main propulsion engine;
(3) accumulator batteries.
4.2.1.3 Where the steering gears, various auxiliary machines serving for main propulsion engine and the necessary equipment to ensure the safety navigation of yachts are powered by electricity, at least one generating set independent from the main engine is to be provided.
4.2.1.4 For all the power equipment onboard without electrical power during the normal navigation of yachts, main engine shaft-driven generator and accumulator batteries may be provided as the source of electrical power. The capacity of shaft-driven generator is to supply all the necessary electrical equipment onboard and the capacity of accumulator batteries is to be capable of supplying the electrical equipment, e.g. lighting, communication and information equipment etc., to maintain the safety navigation of yachts, within a period corresponding to the whole voyage (not less than 3 h as a minimum).
4.2.1.5 For Category V yachts, two sets of accumulator batteries can be provided as the source of electrical power and the total capacity of them is to be capable of supplying the equipment to maintain the normal navigation of yachts.

**4.2.2 Accumulator batteries**
4.2.2.1 For a yacht using accumulator batteries as electrical source, if the accumulator batteries have enough capacity and charging during navigation is not necessary, shore charging device instead of charging device onboard is to be provided.
4.2.2.2 Accumulator batteries are to be permanently installed in a dry, ventilated location above the bilge-water level. Batteries are to be installed in a manner to restrict their movement horizontally and vertically considering the intended use of the yacht.
4.2.2.3 Accumulator batteries installed onboard are to be capable of inclination of up to 45° without leakage of electrolyte.
4.2.2.4 Accumulator batteries, as installed, are to be protected against mechanical damage at their location.
4.2.2.5 Accumulator batteries are not to be installed directly above or below a fuel tank or fuel filter.
4.2.2.6 The acid accumulator batteries are to be placed in different enclosed space apart from that for the alkaline accumulator batteries. The switch, fuse and other electrical appliances which are easily to cause electrical arc are not to be fitted in the space where accumulator batteries are placed.
4.2.2.7 The installation position of accumulator batteries is to be separated from the yacht's shell with a certain distance.
4.2.2.8 Accumulator batteries with a charging power① of up to 2 kW are to be installed in a room assigned to the batteries only, or may be located in a box or a locker if the batteries are installed on exposed decks.
4.2.2.9 The exhaust gas emitted $Q$ from the gas-permeability battery rooms, boxes or lockers is not to be less than:

$$Q = 0.11In \qquad \text{m}^3/\text{h}$$

where: $I$ — the maximum charging current during the production of gas, but not less than 25% of the maximum charging current output by the charger, in A;
$n$ — number of battery cells.
4.2.2.10 The exhaust gas emitted from the valve-regulated sealed battery rooms, boxes or lockers may be reduced to 25% of that required in 4.2.2.9.

**4.2.3 Distribution system**
4.2.3.1 Where the maximum voltage of distribution system does not exceed 500 V, the following distribution systems may be used:

① The charging power means the nominal voltage of accumulator batteries multiples the value of maximum charging current.

(1) D.C.
two-wire insulated system;
two-wire system with negative pole earthed.

(2) A.C.
sing le-phase two-wire insulated system;
single-phase two-wire system with one pole earthed;
three-phase three-wire insulated system;
three-phase four-wire system with neutral point earthed;
three-phase four-wire insulated system.

**4.2.4 Switchboards (boxes)**

4.2.4.1 The switchboards (boxes) are to be installed in a dry, readily accessible and well-ventilated position.

4.2.4.2 Yachts equipped with both D.C. and A.C. electrical systems are to have their distribution from either separate panel boards or from a common one with a partition or other positive means provided clearly to separate the A.C. and D.C. sections from each other. Wiring diagrams to identify circuits, components and conductors are to be included with the yacht.

4.2.4.3 Skid-proof and oil-resisting insulated carpet or insulated wood granting are to be provided in the front of and behind the main switchboard, with the exception for the voltage less than 50 V.

**4.2.5 Sockets**

4.2.5.1 For the sockets of distribution systems with different voltages and/or frequencies, non-interchangeable plug and socket connections are to be used.

4.2.5.2 Sockets installed in locations subject to rain, spray or splash are to be able to be enclosed in IP55 enclosures as a minimum, when not in use. Sockets mated with the appropriate plug are to be also remained sealed.

4.2.5.3 Sockets installed in areas subject to flooding or momentary submersion are to be in IP56 enclosures as a minimum, also meeting these requirements when in use with electrical plugs.

4.2.5.4 Sockets provided for the galley area are to be located so that appliance cords may be plugged in without crossing above a galley stove or sink or across a traffic area.

## Section 3 PROTECTION

**4.3.1 Protection**

4.3.1.1 Electrical installations are to be protected against accidental over-current, including short-circuit by appropriate devices.

4.3.1.2 Each independent circuit is to be provided with a reliable short-circuit current and overload protective device.

4.3.1.3 Generators are to be protected by means of circuit breakers. For a generator with the power of less than 24 kW, a multi-pole switch with a fuse may be used for protection.

4.3.1.4 Over-current protection devices for motor loads are to have a predetermined value of current flow consistent with demand load characteristics of the protected circuit.

4.3.1.5 The rating of the over-current protection device is not to exceed the maximum current-carrying capacity of the conductor being protected.

4.3.1.6 Over-current protection is to be provided for power transformer including two or three single-phase transformers operating as a unit. Each transformer is to be protected by an individual over-current device on the primary side, of which rating is not more than 125% of the rated primary current of the transformer.

4.3.1.7 The rated or corresponding setting value of the overload protection appliance for each circuit is to be permanently indicated at the location of the protection appliance.
4.3.1.8 Accumulator batteries, other than engine starting batteries, are to be protected against short-circuit with electrical appliances positioned as near as possible to the accumulator batteries.
4.3.1.9 A battery-disconnect switch is to be installed in the positive conductor from the accumulator battery, or group of batteries, connected to the supply system voltage in a readily accessible location, as close as practical to group of batteries. The following constitute exception:
(1) outboard-powered yachts 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 at the source of power.

### 4.3.2 Power equipment

4.3.2.1 Motors rated at 1 kW or above and motors required for essential services are to be supplied by separate final sub-circuits from distribution boards.
4.3.2.2 Every electrical motor is to be provided with efficient means of starting and stopping which are, in general, placed near the motor concerned. Where it is impracticable or unreasonable, the means of starting may be placed at the switchboards (boxes).

### 4.3.3 Aluminum hull yachts

4.3.3.1 Distribution systems are to be insulated with hull or provided with cathodic protection system.
4.3.3.2 For D.C. system, accumulator batteries are not to be earthed through propelling machinery or associated machinery components. The starting accumulator batteries of engine may be earthed through the engine.

## Section 4 LIGHTING

### 4.4.1 General requirements

4.4.1.1 Lighting is to be provided for decks and for those parts normally accessible to and used by passengers and crew onboard.
4.4.1.2 Where the main power source is not accumulator batteries, lighting supplied by accumulator batteries is to be provided. If the main lighting fails, lighting supplied by accumulator batteries is to be automatically operable and remain at least 2 h.

## Section 5 CABLES

### 4.5.1 General requirements

4.5.1.1 Shipboard bunched flame-retarding cables or wires are to be used onboard. Cables or wires selected are to be selected according to the environmental conditions of the location, methods of installation, rated current, duty, diversity factor, permissible voltage drop, etc.
4.5.1.2 Conductor insulation temperature rating of cables or wires in engine room is to be oil-resistant at 70℃ minimum, or protected by insulating conduit or sleeving.
4.5.1.3 The insulation temperature rating of cables or wires outside the engine room is to be at least 60℃.

### 4.5.2 Cable runs

4.5.2.1 Cables or wire runs are to be straight and accessible for inspection and repair as far as possible.
4.5.2.2 Single conductors not sheathed are to be supported at maximum intervals of 250 mm unless run in conduits or trunking, or supported by trays.
4.5.2.3 Sheathed conductors and battery conductors are to be supported at maximum intervals of 450 mm with the first support nearest to the terminal not more than 1 m from the terminal. Starter motor conductors constitute an exception to this requirement.
4.5.2.4 Each conductor longer than 200 mm installed separately is to have at least 1 $mm^2$ area. Each conductor in a multi-conductor sheath is to have at least 0.75 $mm^2$ area and may extend out of the sheath a distance not to exceed 800 mm.
4.5.2.5 Each electrical conductor that is part of the electrical system is to have a means to identify its function in the system, except for conductors integral with engines as supplied by their manufacturers.
4.5.2.6 Conductor connections are to be in locations protected from the weather or in IP55 enclosures as a minimum.
4.5.2.7 Current-carrying conductors are not to be routed above foreseeable levels of bilge water and other areas where water may accumulate. If conductors must be routed in the bilge area, suitable water-proof means are to be taken.
4.5.2.8 Metals used for terminal posts, nuts and washers are to be corrosion-resistant and galvanically compatible with the conductor and terminal. Aluminum and unplated steel are not to be used for studs, nuts or washers in electrical circuits.
4.5.2.9 All conductors are to have suitable terminals installed, i.e. no bare wires attached to stud or screw connections unless end strands are made rigid by soldering over the length of their contact with the terminal post connection. Soldered connections are not to be used for connecting or terminating any conductor of nominal cross-sectional area greater than 2.5 $mm^2$.
4.5.2.10 Twist-on connectors (wire nuts) are not to be used.
4.5.2.11 Exposed shanks of terminals are to be protected against accidental shorting by insulating barriers or sleeves, except those in the protective conductor system.
4.5.2.12 Conductors are to be routed away from exhaust pipes and other heat sources which can damage the insulation. The minimum clearance is 50 mm from water-cooled exhaust components and 250 mm from dry exhaust components, unless an equivalent thermal barrier is provided.
4.5.2.13 Conductors which may be exposed to physical damage are to be protected by sheaths, conduits or other equivalent means. Conductors passing through bulkheads or structural members are to be protected against insulation damage by chafing.
4.5.2.14 No more than four conductors is to be secured to one terminal stud. Cable or wire runs are not to be in the laminating plate in FRP.

## Section 6 ADDITIONAL REQUIREMENTS FOR INBOARD-MOUNTED PETROL ENGINE

### 4.6.1 General requirements

4.6.1.1 Engine-mounted electrical system components which can create an electrical spark, externally or internally, capable of igniting a petrol and air mixture, such as circuit breakers, switches, solenoids, alternators, generators, voltage regulators and electric motors, as designed and installed, are to be ignition protection in accordance with the standards① accepted by CCS.

### 4.6.2 Engine electrical systems and components

4.6.2.1 All electrical system components are to be mounted as high as practical on the engine excluding the engine-cranking motor and ignition distributor position which is to be according to the basic engine manufacturer's design.

① Refer to ISO 8846.

4.6.2.2 Ignition coils and magnetos are to be mounted or protected so that water will not accumulate around the high voltage cap.

4.6.2.3 If an electrical component is required to be ignition-protected and bands or other covers form part of the ignition-protection enclosure, a permanent warning tag is to be affixed to the component, or the band or cover is to be permanently and visibly marked, with appropriate language or symbols, indicating that the band or cover must be in place when the engine is operating.

4.6.2.4 Ignition distributors are to comply with the following requirements:

(1) The distributor, when operating during engine cranking and operation, is to meet the ignition-protection requirements. Means used to secure distributor caps are to be of strength to prevent the cap lifting off the sealing surface during an internal explosion of a fuel and air vapour mixture. During test, high-tension (secondary) ignition wiring is to be in place on all distributor cap towers with terminal covering boots as installed during engine operation.

(2) All vent or drain openings are to be protected by effective flame-arrester screens or are to be of a size and length providing equivalent ignition protection.

(3) Terminal covering boots are to be close fitting to effect a watertight seal on the outside of high-tension wire insulation and on the outside of the distributor cap tower when in place and meeting the dielectric leakage test requirements of 4.6.2.5(1).

4.6.2.5 The high-tension (secondary) ignition cable assemblies are to comply with the following requirements:

(1) The high-tension ignition cable assemblies are to have boots and nipples installed which form a watertight seal with the outside of the high-tension wire insulation, the outside of the distributor cap terminal towers and the outside of the spark-plug ceramic insulator, such that leakage of electrical current will not occur when the connection is submerged for 2 h at 3 cm to 5 cm below the surface of a grounded salt and water solution of mass fraction 3%, with a voltage of 20 kV peak (14 kV r.m.s) at 50 to 60 Hz applied to the conductor. The voltage is to be applied at a rate of 500 V peak (355 V r.m.s) per second between the free end of the high-tension lead and the grounded salt water solution.

(2) Boots and nipples installed on high-tension ignition cables are to meet the dielectric leakage test requirements of (1) after conditioning at 125℃ ±2℃ for 40 h and subsequent flexing by installation and removal, at room temperature, 10 times on the spark plug and distributor cap tower.

(3) Boots and nipples installed on high-tension ignition cables are to meet the dielectric leakage test requirements of (1) after conditioning for 30 h in a sealed glass container at room temperature when suspended 25 mm ±5 mm above test liquid C in accordance with ISO 1817, and subsequent flexing by installation and removal 10 times from the spark plug and distributor cap tower.

(4) Boots and nipples installed on high-tension ignition cables are to meet the dielectric leakage test requirements of (1) after conditioning for 40 h in test oil No.3 in accordance with ISO 1817 maintained at 125℃ ±2℃. Remove from oil; cool to room temperature; remove excess oil. Flex boots and nipples by installing and removing 10 times from the spark plug and distributor cap tower.

(5) Tests as described in (2), (3) and (4) above are to be conducted on separate groups of high-tension ignition cable assemblies.

# CHAPTER 5 OUTFITTING

## Section 1 RUDDERS

**5.1.1 General requirements**

5.1.1.1 For yachts with rudders and rudder stocks, the structural materials, design and connection structures of rudders and rudder stocks are in general to comply with CCS relevant rules or standards accepted by CCS.

5.1.1.2 The steering gears are to comply with the relevant requirements of Chapter 3 of this PART.

## Section 2 ANCHORING AND MOORING EQUIPMENT

**5.2.1 General requirements**

5.2.1.1 The arrangement of anchoring and mooring equipment is to be fit for the intended navigation conditions and structural configuration of yachts. The requirements for the arrangement of anchoring equipment in this Section are not mandatory.

5.2.1.2 Anchors manufactured with stainless steel and aluminum alloy materials will be specially considered, depending on the designed test load.

5.2.1.3 For FRP yachts, the anchoring equipment onboard is to be such storage to prevent damage to hull.

**5.2.2 Anchoring equipment**

5.2.2.1 An anchor with high holding power is in general to be arranged at the bow. The weight of it is taken from Table 5.2.2.1 based on the mean value of Length $L_H$ and waterline length $L_{WL}$ of yachts, multiplied by the following coefficient k:

Category I yachts: $k$ =1.5;
Category II yachts: $k$ =1.2;
Category III yachts: $k$ =1;
Category IV yachts: $k$ =0.9;
Category V yachts: $k$ =0.85.

**Anchoring, cables and ropes** **Table 5.2.2.1**

| $(L_H + L_{WL})/2$ | Anchor | Diameter of cable | | Fiber ropes for mooring | |
|---|---|---|---|---|---|
| m | Weight (kg) | Cable (mm) | Rope (mm) | Length (m) | Breaking strength (Kn) |
| 6 | 5 | 6 | 10 | 22.5 | 25 |
| 7 | 6 | 6 | 10 | 22.5 | 25 |
| 8 | 7 | 6 | 10 | 22.5 | 25 |
| 9 | 9 | 8 | 12 | 22.5 | 25 |
| 10 | 10 | 8 | 12 | 22.5 | 25 |
| 11 | 12 | 8 | 12 | 25 | 30 |
| 12 | 15 | 8 | 12 | 25 | 30 |
| 13 | 17 | 8 | 14 | 25 | 30 |
| 14 | 19 | 8 | 14 | 25 | 30 |
| 15 | 21 | 10 | 14 | 25 | 30 |
| 16 | 23 | 10 | 14 | 30 | 30 |

| $(L_H + L_{WL})/2$ | Anchor | Diameter of cable | | Fiber ropes for mooring | |
|---|---|---|---|---|---|
| 17 | 26 | 10 | 14 | 35 | 32 |
| 18 | 28 | 10 | 16 | 35 | 32 |
| 19 | 31 | 12 | 16 | 40 | 32 |
| 20 | 34 | 12 | 16 | 40 | 32 |
| 21 | 38 | 12 | 16 | 40 | 32 |
| 22 | 42 | 12 | 16 | 45 | 34 |
| 23 | 46 | 14 | 18 | 45 | 34 |
| 24 | 50 | 14 | 18 | 45 | 34 |

5.2.2.2 Where it is not a high holding power anchor, the weight is not to be less than 1.3 times the weight specified above, but the diameter of cable does not need to be increased.

### 5.2.3 Cable

5.2.3.1 The length of rope attached to an anchor is to be fit for the navigation area of yacht; however, for anchor at the bow, the rope length in general is not to be less than 4 times the Length $L_H$ of yacht or 30 m, whichever is the greater.

5.2.3.2 The whole cable or cable plus rope may be used. The whole rope may be used, too.

5.2.3.3 Where fibre rope or steel wire rope is used as rope, it is to be ensured that the breaking strength of the rope is to be equal to that of the cable to be equipped.

5.2.3.4 Anchoring system integral with the windlass is to be provided with a fixed end of rope secured to hull structure and capable of being released in emergency.

5.2.3.5 Where steel wire rope is used as rope, eye splice is to be provided on both ends of the wire rope.

### 5.2.4 Mooring equipment

5.2.4.1 Mooring ropes are to be provided on yachts based on yacht categories and navigation conditions. 2 mooring ropes are in general to be provided on yachts of more than 12 m in $L_{WL}$. The length and breaking strength of every rope for mooring is to be obtained in accordance with the mean value of Length $L_H$ and waterline length $L_{WL}$ of yachts from Table 5.2.2.1.

5.2.4.2 The diameter of mooring rope is not to be less than 15 mm.

5.2.4.3 Suitable number of bitt or cleat is to be fitted on each yacht, depending on yacht categories, navigation conditions and structural configuration; however, the minimum number is to be as follows:

(1) For yachts having a Length $L_H$ not more than 6 m, one bitt or cleat in general is to be fitted on fore deck or equivalent structure.

(2) For yachts having a Length $L_H$ more than 6 m, apart from a mooring hole or a fairlead being fitted on top of stem, at least one bitt or cleat in general is to be fitted on afterdeck or equivalent structure.

5.2.4.4 Protective measures, i.e. rubber fender and collision mat are to be provided on each yacht.

5.2.4.5 Towed equipment is to be provided. The length of tow ropes in general is to be same as that of cable of bower anchor, with diameter not to be less than 0.85 times that of equipped anchoring rope.

5.2.4.6 Structural strengthening

(1) The hull structure in way of the installation places where the equipment (bitt bollard, cleat and towing post) for securing chains, cables, ropes, towing ropes, is to be strengthened and capable of bearing the loads.

(2) Where the fittings for securing chains, cables, ropes, towing ropes are fastened by nuts and bolts, appropriate washers or doubling plates are to be used in installation places.

# CHAPTER 6 ADDITIONAL REQUIREMENTS FOR LPG POWER-DRIVEN YACHTS

## Section 1 GENERAL PROVISIONS

### 6.1.1 General requirements

6.1.1.1 This Chapter specifies additional requirements for yachts with LPG engine as their main power.

6.1.1.2 For yachts applicable to this Chapter, the use of dual fuel is prohibited.

6.1.1.3 Special requirements for outboard LPG engines may be referred to in Chapter 3 of this PART.

### 6.1.2 Definitions

6.1.2.1 For the purpose of this Chapter:

(1) LPG means mixture of light hydrocarbon which is in a gaseous state under normal temperature and atmospheric pressure and may be kept in a liquid state by pressurization and cool-down, the basic composed are propane, propylene, butane and butylenes. It may also be composed of commercial butane or commercial propane or the mixture of both.

(2) Gas tank means a special steel cylinder for storage of LPG.

(3) Gas tank space means a space for storage of gas tanks.

(4) Enclosed space means a space enclosed by bulkheads and decks but may have windows and doors.

(5) Semi-enclosed space means a space having structures such as top plating, deck so that its natural ventilation condition is different from that on open deck and it is so arranged that gases can not diffuse.

(6) Open space means an open deck space.

### 6.1.3 Surveys

6.1.3.1 The following plans and documents are to be submitted to CCS for approval:

(1) Arrangement of LPG machinery space and gas tank space;

(2) LPG supply system;

(3) Ventilation of LPG machinery space and gas tank space;

(4) LPG detection and alarm system;

(5) Operation Manual of LPG Power System.

6.1.3.2 The following items for survey of yachts are required in addition:

(1) installation survey and test of LPG engine;

(2) installation survey and test of LPG supply system;

(3) installation survey and test of ventilation system in LPG machinery space and gas tank space;

(4) installation survey and test of LPG remote-control closing devices;

(5) examination of installation position and number of LPG probes and test of LPG detection and alarm system;

(6) confirmation and safety inspection of explosion-proof equipment or ignition-protection equipment.

## Section 2 LPG ENGINE

### 6.2.1 General requirements

6.2.1.1 The design and manufacture of LPG engine (hereinafter called the engine) are to comply with the relevant requirements of national standards.

6.2.1.2 Where the engine is used as a main engine, reliable governors are to be provided to prevent the engine from exceeding 115% of its rated speed. Governors are to be provided for prime movers for driving generators and their performances are to be in compliance with the relevant requirements of CCS Rules for Construction and Classification of Sea-Going High Speed Craft.

6.2.1.3 Engines are to be provided with emergency shut-down devices which may cut-off the fuel manifold on LPG supply main and it may be remotely controlled in the bridge room.

6.2.1.4 Heating installation is to be provided in cooling water system of engine in order to ensure that the engine can be normally started in winter.

6.2.1.5 Spark arrester or equivalent means is to be provided in the outlet of exhaust pipe of engine and the outlet of exhaust pipe is to be as far as possible apart from those for ventilation of engine room and gas tank space.

## Section 3 LPG SUPPLY SYSTEM

### 6.3.1 Gas tanks and accessories

6.3.1.1 The gas tanks are to be installed in an independent gas tank space with permanent fixing means to ensure they can not fall during the sea voyages and can be easily dismantled and exchanged. The collision rubber or wood packing is to be provided between gas tank and fixed seating.

6.3.1.2 Effective and reliable working of gaseous and liquid phase joint elements and liquidometer are to be taken into consideration for the installation direction and location of gas tanks.

6.3.1.3 Gas tanks are as far as possible apart from heat sources to avoid direct sunlight. In general, the temperature of gas tank special holds or gas tank compartments is not to be more than 45℃, and suitable cooling means is to be provided in summer.

6.3.1.4 The metering valve of gas tank is to automatically stop charging when the LPG charging capacity achieves 80% volume of gas tank.

6.3.1.5 The safety valve of gas tank is to ensure the pressure not exceeding its design pressure.

6.3.1.6 The sealed protective box is to seal the opening of gas tank and its accessories reliably and vent pipe is to be provided to lead the leakage gases to safe spaces outboard.

6.3.1.7 The gas tanks and accessories are to comply with the relevant requirements of national standards[①], the products are to have the approved certificates of the authorities concerned.

### 6.3.2 LPG control equipment

6.3.2.1 Each LPG supply system is to be provided with an evaporation pressure regulator, which is to be capable of supplying suitable and rated working pressure for each gas-driven engine. The pressure within the pipelines after LPG passes through the evaporation pressure regulator is not to be more than 0.005 MPa.

6.3.2.2 Each outlet of gas tank is to be provided with flow-limiting valve which is automatically closed when the pressure deficiency between two ends of the valve is 0.35 MPa.

6.3.2.3 Automatic stop valve is to be provided in way of inlet of evaporation pressure regulator for LPG supply pipe main, and it can automatically cut off LPG supply in the following cases:

(1) ignition switch is not on;

(2) engine is not operated;

(3) exhaust blower is not operated.

① Refer to GB 17259.

6.3.2.4 For the LPG supply system with more than one gas tank, stop valve is to be provided in supply pipe branch of each gas tank for use when gas tanks are exchanged.
6.3.2.5 For supply system simultaneously supplying for more than one engine, stop valve is to be provided in way of inlet pipe of each engine.
6.3.2.6 The gas tank is to be provided with capacity measuring means, pressure sensor and capacity indicator so as to show its present capacity in the bridge room.

### 6.3.3 LPG supply piping

6.3.3.1 The rigid drawn copper tube or drawn stainless tube is to be used for rigid supply pipe. For the pipelines with outer diameter of 12 mm and below, the thickness is not to be less than 0.8 mm, for those more than 12 mm, the thickness is not to be less than 1.5 mm. The approved rubber hose may be used for low pressure pipelines after the evaporation pressure regulator, however, plastic hose is not to be used.
6.3.3.2 The high pressure supply pipelines from gas tank to evaporation pressure regulator are to be installed within enclosed or semi-closed gas tank spaces. Where it is installed in an open space, protective members are to be used for fixing and sheltering so as to prevent from stepping on or collision.
6.3.3.3 LPG supply pipelines are not to penetrate passenger and crew spaces and control stations.
6.3.3.4 The approved rubber hoses are to be used for connection between LPG engine and any permanently installed metal pipelines so as to avoid failure caused by vibration.
6.3.3.5 Where hose is used partially in supply pipeline, double clamps are used for the joint at both ends of hose and the clamps are to have a certain contacting length, no pinch-cock clamps are permitted to use and the clamps are to be so fitted as to be accessible.
6.3.3.6 The partial pipelines which gas may possibly leak in LPG supply pipelines are to be apart from electrical equipment as far as possible.
6.3.3.7 The LPG supply pipe is not to contact directly with bulkhead or deck and avoid contacting in way of the intersection of other pipelines.

### 6.3.4 Test

6.3.4.1 Hydraulic and tightness tests are to be carried out for LPG piping, the test pressure is in accordance with the requirements of Table 6.3.4.1.

**Test pressure** **Table 6.3.4.1**

| LPG Piping | Test pressure | |
|---|---|---|
| | Hydraulic test (in workshop) (MPa) | Tightness test (onboard) (MPa) |
| Pipeline from gas tank to pressure regulator | 3.3 | 2.2 |
| Pipeline from pressure regulator to engine | 0.2 | 0.1 |

6.3.4.2 Effectiveness test is to be carried out after the installation of LPG supply system and no gas leakage exists. The tightness test mentioned in 6.3.4.1 may also be carried out together with effectiveness test.

## Section 4 ARRANGEMENT AND VENTILATION

### 6.4.1 Arrangement

6.4.1.1 Engine room and gas tank space are to be independent from each other and it is prohibited to arrange them with passenger and crew spaces. The gas tank space is to be as far as possible arranged in a place with good ventilation above deck by a semi-enclosed way. The gas tank space is to be capable of being locked to prevent persons other than the staff from touching and removing. No holes and stairway openings leading to the holds below are permitted to provide in the gas tank spaces. The distance from the gas tank and high pressure pipeline on deck to the outline edge of the yacht (excluding fenders) is not to be less than 100 mm.

6.4.1.2 The engine rooms and gas tank spaces are to be provided with independent drainage systems and the drainage systems are to be separated from those in other compartments.
6.4.1.3 The bottom structures of engine rooms and gas tank spaces are to keep gastight and platforms are to be provided as far as possible. For bottoms with strengthening stiffeners, the arrangement is not to impair the drainage of combustible gases.
6.4.1.4 The bulkheads between engine room, gas tank space and passengers, crew spaces and the bulkheads between gas tank space and engine room are to keep gastight, and in general, openings are not to be provided. Where it is necessary for the pipelines or cables to penetrate the bulkheads, airtight is to be kept in way of the penetration and structural fire integrity is to be ensured.
6.4.1.5 For open yacht with windows and doors of non-weathertight type in passengers, crew spaces, drainage groove and bilge well are to be provided in the bottom plating of passengers, crew spaces.

### 6.4.2 Ventilation

6.4.2.1 Powered ventilation system having sufficient capacity is to be provided in enclosed or semi-enclosed engine rooms or gas tank spaces with the air charge ratio not less than 30 times/h and 20 times/h respectively. The powered ventilation in engine room is to be realized by interlocking start/operation with the main engine, i.e. after the blower is operated at least 4 min, the engine is started, where the blower is stopped caused by some reasons, the engine can be automatically stopped and the following requirements are to be complied with:
(1) In general, powered ventilation system is to be used in enclosed engine room and gas tank space. Each intake duct for an exhaust blower is to be under 1/3 height of the compartment and above the normal level of accumulated bilge water. The exhaust outlet is to be so arranged as to discharge the air in compartments to outboard and as far apart from the outlet of exhaust pipe for engine as possible. Where the exhaust outlet is near waterline, means to prevent water flooding is to be provided.
(2) Where mechanical blast is used for ventilation system, in general, the exhaust outlet is to be under 1/3 height of compartment and above the normal level of accumulated bilge water. The exhaust outlet is to be so arranged as to discharge the air in compartments to outboard and as far apart from the outlet of exhaust pipe for engine as possible. Where the exhaust outlet is near waterline, means to prevent water flooding is to be provided.
(3) The blower is to be of the non-spark type.
6.4.2.2 In general, natural ventilation is also to be provided in the engine room and gas tank space mentioned in 6.4.2.1 above. The inlet is to be as far apart from the outlet as possible. The exhaust outlet is to be under 1/3 height of compartment and above the normal level of accumulated bilge water. The exhaust outlet is generally of shutter type.

## Section 5 DETECTION AND ALARM SYSTEM

### 6.5.1 LPG combustible gas detector

6.5.1.1 The LPG combustible gas detection system is to be subject to approval.
6.5.1.2 Fixed LPG combustible gas detector are to be provided in enclosed and semi-enclosed gas tank spaces and enclosed engine room.
6.5.1.3 LPG combustible gas detectors are to be so arranged to meet the following requirements:
(1) Probes are to be provided in a position where LPG combustible gas leaks and accumulates easily.
(2) Where the concentration of LPG combustible achieves 30% lower limit of explosion, visual and audible alarm is to be given in the bridge, where it achieves 60% lower limit of explosion, manifold on LPG supply main may be automatically cut-off or remotely cut-off in the bridge.

## Section 6 STRUCTURAL FIRE PROTECTION AND FIRE EXTINGUISHING APPARATUS

### 6.6.1 Structural fire protection

6.6.1.1 The side of separating bulkheads facing fire hazard zone between engine room, gas tank space and passengers, crew spaces and between gas tank space and engine room is to be made of materials having noncombustible or flame-retardant performance or equivalent materials.

6.6.1.2 Coating and insulation which may set easily fire and emit large amount of smoke or noxious gases during burning can not be used in engine room and gas tank space.
6.6.1.3 Prominent “No Smoking” signs are to be posted in engine room and gas tank spaces.

### 6.6.2 Fire extinguishers

6.6.2.1 Engine room is to be provided with fire extinguishers as required in Table 6.6.2.1.

**Provision of fire extinguishers in engine room Table 6.6.2.1**

| Total power in engine room *P*(kW) | Provision of fire extinguishers |
|---|---|
| $P \leq 37.5$ | One dry powder fire extinguisher with a capacity not less than 2 kg |
| $37.5 < P \leq 150$ | Two dry powder fire extinguisher with a capacity not less than 2 kg each |
| $150 < P \leq 300$ | Two dry powder fire extinguisher with a capacity not less than 3 kg each |
| $300 < P \leq 450$ | Two dry powder fire extinguisher with a capacity not less than 4 kg each |

6.6.2.2 At least two dry powder fire extinguishers with a capacity not less than 2 kg each are to be provided in a gas tank space.

## Section 7 MISCELLANEOUS

### 6.7.1 Electrical equipment in gas tank space

6.7.1.1 Electrical equipment is not to be installed in gas tank space as far as possible. Where it is needed, electrical equipment preventing LPG combustible gas from igniting is to be provided. Where it is necessary, one portable explosion-proof light with batteries is to be provided in emergency use onboard the yacht.

### 6.7.2 Navigational requirements

6.7.2.1 Yacht’s safety certificate and operation manual of LPG power-driven system, etc., required in this PART are to be provided onboard the yacht.

### 6.7.3 Accessing spaces

6.7.3.1 When the crew accesses a compartment, void space or other enclosed spaces where LPG is likely to accumulate, one of the following means is to be taken:
(1) fixed or portable LPG detecting device is to be used to confirm that no dangerous concentration of LPG combustible gas exists in the air of the above-mentioned spaces;
(2) respirators and other necessary protective equipment are to be provided for personnel.
6.7.3.2 Where personnel access the above-mentioned spaces, any potential fire source can not be brought in, unless it is verified that free gas is carried out for the space and it is still kept in such a condition.

### 6.7.4 Operation Manual of LPG power-driven system

6.7.4.1 Operation Manual of LPG power-driven system approved by CCS is to be readily available onboard, and it is used as safe operation guidance in normal conditions and in emergency.
6.7.4.2 The Operation Manual is to contain at least the following.
6.7.4.3 The starting procedures of LPG engine is to comply with the following requirements:
(1) to switch on detection and alarm system to confirm no LPG leakage, where LPG leakage is detected in engine room (if any) and gas tank space by the probe, examination is to be made immediately to find the leakage reason and handle with it;

(2) to switch on blowers in engine room and gas tank space;
(3) in order to prevent mal-operation, interlocking device is to be provided between blower and engine. After the blower is operated more than 4 min, the engine can be started, where the blower is stopped caused by some reasons, the engine can be automatically stopped.

6.7.4.4 During the yacht's navigation period (including embarkation, disembarkation or temporary laid-up), powered ventilation is to be kept in the enclosed or semi-enclosed engine room and gas tank spaces and blower can not be stopped.

6.7.4.5 Fixed LPG combustible gas probe is to be provided onboard the yacht. Where the concentration of LPG combustible gas achieves 30% lower limit of explosion, visual and audible alarm is to be given in the bridge, where it achieves 60% lower limit of explosion, manifold on LPG supply main is to be automatically cut-off, if it fails, the navigating officer must cut-off the LPG supply main immediately in the bridge.

6.7.4.6 Changing of gas tanks

(1) After recharged, the gas tank and its accessories are to be examined whether it leaks or not, if found damage and leakage, the gas tank can not be onboard.
(2) After it is installed onboard, the connection between outlet valve and quick connection of gas tank is to be examined, leakage is not to be found there.

6.7.4.7 Other requirements

(1) Where it is found the LPG supply system leaks, it can not be used before the cause is determined and repair is made, means are to be taken to cut off LPG supply source, start the blower, various fire sources are prohibited and electrical equipment is not to be used.
(2) It is prohibited to discharge, store or deal with the LPG residual liquid in gas tanks onboard.
(3) All supply valves of LPG engine are to be closed during yacht's laid-up.
(4) Where fire takes place onboard, the gas tanks are to be dismantled and thrown outboard quickly to protect the safety of yacht and passengers and crews.
(5) Special-assigned persons are to be responsible for the management, maintenance and service of LPG equipment.

# PART TWO　YACHTS OF 24 M IN LENGTH AND ABOVE

# CHAPTER 1 GENERAL

## Section 1 GENERAL PROVISIONS

### 1.1.1 Application

1.1.1.1 Unless expressly provided otherwise, this PART applies to self-propelled yachts of new construction of 24 m and above but less than 90 m in length ($L_H$), excluding sailing yachts.

1.1.1.2 This PART applies to yachts of the following design categories:

(1) Category I means yachts designed for navigating exceeding 200 n miles off the shore and with the minimum design significant wave height① ($H_S$) of 6 m.

(2) Category II means yachts designed for navigating within 200 n miles off the shore and with the minimum design significant wave height ($H_S$) of 4 m.

(3) Category III means yachts designed for navigating within 20 n miles off the shore and with the minimum design significant wave height ($H_S$) of 2 m.

(4) Category IV means yachts designed for navigating within 10 n miles off the shore and with the minimum design significant wave height ($H_S$) of 1 m.

(5) Category V means yachts designed for navigating within 5 n miles off the shore and with the minimum design significant wave height ($H_S$) of 0.5 m.

1.1.1.3 The materials of yachts are to be in compliance with the applicable requirements of CCS Rules for Materials and Welding or other standards accepted by CCS.

1.1.1.4 The statutory requirements for stability, fire safety, life-saving appliances, communications and navigation, etc., of yachts are to comply with the relevant provisions of the flag State Administration.

### 1.1.2 Equivalent and exemption

1.1.2.1 Any yacht which embodies structure and features of a novel kind may be exempted from any provision of this PART if the application of which might seriously impede the incorporation of its features or its navigation, subject to agreement of CCS.

1.1.2.2 Any fitting, material, appliance or apparatus, other than that required in this PART, may be allowed to be fitted in a yacht, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance or apparatus is at least as effective as that required in this PART.

1.1.2.3 Equivalence or substitution to those methods of calculation, criteria of evaluation, manufacturing procedures, materials, survey and test requirements specified by this PART may be accepted subject to agreement of CCS, when relevant tests, theoretical basis, experience in application is provided. CCS also accepts other recognized standards as equivalent requirements.

### 1.1.3 Definitions

1.1.3.1 Unless expressly provided otherwise, for the purpose of this PART:

(1) Yacht means a boat engaged in uncommercial entertainment activities such as touring, leisure and sightseeing, including a whole chartered boat engaged in the aforementioned activities.

(2) High speed yacht means a yacht capable of a maximum speed $V$ meeting the following formula at its full-load displacement:

$$V \geq 7.19 \nabla^{0.1667} \quad \text{kn}$$

where: $\nabla$ — displacement corresponding to its full-load displacement, in $m^3$.

(3) Maximum speed $V$ (kn) is the speed achieved at the maximum continuous propulsion power for which the yacht is certified at its full-load displacement and in smooth water.

① The significant wave height of the yacht's navigating waters is not to exceed the design significant wave height.

(4) Full-load displacement △ (t) means the displacement of yachts in full-load departure condition in rest floatation.
(5) Length $L_H$ (m) means the length measured in one plane passing through the foremost part of the yacht and the other through the aftermost part of the yacht. This length includes all structural and integral parts of the yacht, such as stems or sterns, bulwarks and hull/deck joints. This length excludes removable parts that can be detached without affecting the structural integrity of the yacht, e.g. pulpits at either end of the yacht, stemhead fittings, rudders, outboard motors and their mounting brackets and plates, diving platforms, boarding platforms, rubbing strakes and fenders etc.
(6) Waterline length $L_{WL}$ (m) means the length of watertight envelope of the rigid hull at the waterline at full-load displacement in rest floatation, excluding appendages at or below the waterline.
(7) Design draft $d$ (m) means the vertical distance measured at the midpoint of waterline length ($L_{WL}$) from the top of the plate keel (or from the lower surface of plate keel for fabric reinforced plastics yacht) to the full load waterline of a yacht at full-load displacement in rest floatation.
(8) Design waterline means a waterline parallel to the baseline corresponding to the design draft $d$.
(9) Breadth $B$ (m) means the maximum moulded breadth (including the plating thickness for fabric reinforced plastics yacht) of watertight envelope of the rigid hull, excluding appendages at or below the design waterline.
(10) Design waterline breadth $B_{WL}$ (m) means the maximum moulded breadth measured along the design waterline in rest floatation.
(11) Moulded depth $D$ (m) means the vertical distance measured at the midpoint of the waterline length ($L_{WL}$) from the top of the plate keel (or from the lower surface of plate keel for fabric reinforced plastics yacht) to the edge line of freeboard deck.
(12) Block coefficient $C_B$ means the coefficient of ship type determined by the following formula:

$$C_B = \frac{\Delta}{\rho L_{WL} B_{WL} d}$$

where: $\rho$ — the water specific gravity of the yacht's navigating waters.
(13) Freeboard deck means the uppermost complete deck exposed to weather and sea, which has permanent means of closing all openings in the weather part thereof, and below which all openings in the sides of the ship are fitted with permanent means of watertight closing.

## Section 2 SCOPE AND CONDITIONS OF CLASSIFICATION

### 1.2.1 General requirements

1.2.1.1 Yachts built in accordance with the Rules or with alternative arrangements equivalent thereto, will be assigned a class according to the application and included in the Register of Ships after satisfactory surveys and will continue to be classed so long as they are found, upon examination at the prescribed surveys after construction, to be maintained in a fit and efficient condition and in accordance with the requirements of this PART[①].
1.2.1.2 Classification will be conditional upon compliance with CCS requirements in respect of both hull (including equipment) and machinery (including boilers, pressure vessels, engines, pumping arrangements, control and electrical equipment, etc.) essential to the safety and operation of the yacht.
1.2.1.3 The stability and fire safety are the conditions of classification of yachts and are to comply with the requirements of the flag State Administration.

### 1.2.2 Characters of classification

1.2.2.1 The hull (including equipment) and machinery (including electrical installations) of a yacht complying with the provisions of this PART will be assigned one of the following characters of classification as appropriate according to different conditions:

① For suspension, cancellation and reinstatement of class, see the provisions of Section 9, Chapter 2, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

★ CSA
★ CSM
or
★ CSA
★ CSM
or
★ CSA
★ CSM

The meanings of the characters of classification are:

★ CSA — indicating that the yacht's hull structure and equipment have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules;

★ CSA — indicating that the yacht's hull structure and equipment have been constructed not with plan approval by and not under the supervision of CCS, and that they have been found upon classification survey by CCS to be in compliance with CCS rules;

★ CSM — indicating that the yacht's propulsion and essential auxiliary machinery have been inspected by CCS, and that its machinery and electrical installations have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules;

★ CSM — indicating that the yacht's propulsion and essential auxiliary machinery have not been inspected by CCS, and that its machinery and electrical installations have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules;

★ CSM — indicating that the yacht's machinery and electrical installations have been constructed not with plan approval by and not under the supervision of CCS, and that they have been found upon classification survey by CCS to be in compliance with CCS rules.

### 1.2.3 Class notations

1.2.3.1 Class notations indicate different features of a yacht in sequence, and will be appended to the characters of classification.

1.2.3.2 The yacht type notation is given in Table 1.2.3.2.

**Table 1.2.3.2**

| Yacht type | Class notation |
|---|---|
| Yacht<br>High speed yacht | Yacht<br>High Speed Yacht |

1.2.3.3 The design category notation is given in Table 1.2.3.3. For yachts only navigating in inland waters, the class notation "Inland Waters" will be appended.

**Table 1.2.3.3**

| Design category | Class notation |
|---|---|
| Category I<br>Category II<br>Category III<br>Category IV<br>Category V | Design category I ($H_s$ = ×× m)①<br>Design category II ($H_s$ = ×× m)<br>Design category III ($H_s$ = ×× m)<br>Design category IV ($H_s$ = ×× m)<br>Design category V ($H_s$ = ×× m) |

① "$H_S$ = ××m" means the design significant wave height corresponding to the design category.

1.2.3.4 The yacht management notation is given in Table 1.2.3.4.

**Table 1.2.3.4**

| Yacht management | Class notation |
|---|---|
| Club[①] management<br>Other management | Club Management<br>Other Management |

1.2.3.5 Where novel design or construction of a yacht or its machinery has been approved by CCS, an appropriate special notation will be appended and entered in the Register of Ships.

**1.2.4 Issuance and endorsement of classification certificates**

1.2.4.1 For yachts complying with the applicable requirements of this PART after the initial classification survey or special survey, a classification certificate for yacht will be issued by CCS, which will be valid for a period not exceeding:

(1) 5 years for yachts of club management;
(2) 2 years for yachts of other management.

1.2.4.2 When the yacht is confirmed in compliance with the applicable requirements of this PART after intermediate surveys and surveys of the outside of the yacht's bottom and related items, the classification certificate for yacht will be endorsed by CCS.

1.2.4.3 When the yacht is confirmed in compliance with the applicable requirements of this PART after occasional surveys, a new classification certificate for yacht will be issued or the existing certificate will be endorsed by CCS.

## Section 3 PLAN APPROVAL

**1.3.1 General requirements**

1.3.1.1 For a yacht of new construction requesting to be classed with CCS, the plans and documents as specified in this Section are to be submitted by the applicant in triplicate to CCS for examination prior to commencement of construction.

1.3.1.2 When any major modifications or additions are made to the yacht construction, the related plans and documents are also to be submitted to CCS for examination.

**1.3.2 Plans and documents to be submitted prior to commencement of construction**

1.3.2.1 The following hull plans and documents are to be submitted to CCS for approval:

*(1) principal transverse structure sections;
*(2) construction profile;
(3) details for typical joints;
*(4) superstructures and deckhouses construction;
*(5) main bulkheads construction;
(6) shell expansion (where applicable);
(7) fabric reinforced plastics laminate design (where applicable);
(8) main engine foundation and thrust bearing foundation construction;
(9) propeller shaft brackets construction;

① The club is to be furnished with a qualification certificate issued by the Administration.

(10) arrangements, constructions and materials of exposed doors, windows and covers, including thickness calculations and joint calculations of window glass, diagram for joints, etc.;

*(11) configuration, construction and strength calculations of rudder, including rudder blade, rudder stock, rudder carrier and connections;

(12) calculations of equipment number;

(13) arrangement of anchoring and mooring equipment;

*(14) intact stability calculations and damage stability calculations (where applicable);

(15) fire control plans or arrangement of fire-fighting appliances (including structural fire protection);

(16) constructions of embedded parts in any places under heavier stress where anchoring and mooring equipment and seats are sited (where applicable).

1.3.2.2 The following hull plans and documents are to be submitted to CCS for information:

(1) hull specifications;

*(2) general arrangement;

*(3) lines;

*(4) hydrostatic curves;

*(5) arrangement of fresh water tank and oil tank, including capacity plans;

(6) calculations of weight and gravity center;

(7) structural strength calculations or structural rules calculations, including longitudinal and local strength;

(8) structural direct calculations (if any);

(9) calculations of vibration of propeller shaft brackets (if any);

(10) list of hull materials and their test reports of mechanical property (including glue for window glass).

1.3.2.3 The following machinery plans and documents are to be submitted to CCS for approval:

*(1) engine room arrangement;

*(2) bilge and ballast water piping;

(3) air, sounding, overflow and filling pipes;

(4) discharge and deck drain pipes;

(5) fuel oil pipes;

(6) lubricating oil pipes;

(7) cooling water pipes;

(8) compressed air piping;

*(9) steering gear hydraulic transmission system;

(10) exhaust piping;

*(11) ventilation piping in machinery space;

(12) propulsion systems, mainly including:

① arrangement of shafting;

*② thrust shaft, intermediate shaft, tube shaft (if any) and screwshaft;

③ general arrangement of stern tube, including oil sealing gland and tube shaft bearings;

④ strength calculations of shafting, including calculations for the connection of couplings and strength calculations of bolts;

⑤ strength calculations for propellers;

*⑥ propellers;

⑦ oil shrink fitting of key or keyless propeller together with calculations;

*⑧ torsional vibration calculations of propelling shafting (which may not be submitted for yachts of 2 years of age and above for initial classification).

(13) oil shrink fitting of propeller with calculations (where applicable).

1.3.2.4 The following machinery plans and documents are to be submitted to CCS for information (if relevant information is reflected in the submitted plans, submission of following plans and documents are not necessary):

(1) specifications of machinery installations;

(2) particulars of machinery equipment;

(3) calculations of machinery equipment.

1.3.2.5 The following plans and documents of electrical installations are to be submitted to CCS for approval:

(1) electrical loading calculations;

*(2) diagrams of power systems, in which the following are to be indicated:

① main ratings of motors, transformers, accumulator batteries, electrical and electronic equipment;

② all feeders connected to main and emergency switchboards (boxes);

③ all feeders connected to distribution boards (boxes);

④ type, cross-sectional area and current loadings of cables;

⑤ type and main rating of circuit breakers and fuses;

⑥ remote stops (ventilating fans and oil pumps).

*(3) Arrangement of electrical equipment, in which the positions of the following items are to be indicated:

① generators;

② switchboards;

③ accumulator batteries and charging facilities;

④ shore power supply equipment;

⑤ electrical equipment for essential services.

(4) schematic diagrams of lighting, including main lighting and emergency lighting;

(5) arrangement of lighting equipment, including main lighting and emergency lighting;

(6) schematic diagrams of internal communication system (applicable to yachts of more than 48 m in $L_{WL}$);

(7) arrangement of internal communication system (applicable to yachts of more than 48 m in $L_{WL}$);

(8) schematic diagrams of safety systems for the ship and persons on board (applicable to yachts of more than 48 m in $L_{WL}$);

(9) arrangement of safety systems for the ship and persons on board (applicable to yachts of more than 48 m in $L_{WL}$);

(10) calculations for short-circuit currents (for yachts with generators having a total capacity of more than 250 kVA and capable of being connected in parallel).

1.3.2.6 The following plans and documents of electrical installations are to be submitted to CCS for information:

(1) specifications for all electrical equipment.

1.3.2.7 Additional plans and documents may be required if considered necessary by CCS.

## Section 4 SURVEYS DURING CONSTRUCTION

1.4.1 General requirements

1.4.1.1 When applying for classification of a new yacht, the applicant is to submit a written application prior to the commencement of construction. The responsibilities of both parties, characters of classification and particulars of the yacht are to be clearly specified in the application or contract/agreement. A separate application for the plan approval may be accepted. In any case, the applicant is to provide the appropriate “date of contract for construction”.

1.4.1.2 The shipbuilder of the yacht is to be assessed and examined prior to commencement of construction in accordance with Chapter 4 of PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

### 1.4.2 Examination of plans and documents and check of other test/survey documents

1.4.2.1 When it is intended to build a yacht for classification with CCS, constructional plans and all necessary documents, are to be submitted (see for detailed list of documents in Section 3 of this Chapter) to CCS for examination. Any subsequent modifications or additions to the scantlings, arrangements or equipment shown on the approved plans are also to be submitted for approval.
1.4.2.2 Where the proposed construction of any part of the hull or machinery is novel in design, or involves the use of unusual material, it is to be satisfied that it is at least as effective as that required in this PART. Special tests or examinations before and during service may be required as deemed necessary by CCS. In such cases a special notation may be assigned (see also 1.2.3.5).
1.4.2.3 The Surveyor is to review or confirm the relevant documents provided by the shipyard in preparations for building the yacht, such as documents of installing procedures of machinery, equipment and systems (excluding reasonable alignment of shafting), documents and programmes for on-site inclining test, mooring test and sea trial, etc., as well as CCS product certificates or documents.
1.4.2.4 The Surveyor is to confirm that the measurement and test equipment used for safety systems, etc., is furnished with valid certificates, and that both the operators of such equipment and company personnel on whose service results the surveys are based have recognized qualification certificates or qualification certificates approved by or acceptable to CCS.

### 1.4.3 Surveys

1.4.3.1 For yachts assigned the characters of classification referred to in Section 2 of this Chapter, from the commencement of the work until the completion of the yacht, the Surveyors are to examine the materials, manufacture process and arrangements. Any items found not to be in accordance with this PART and/or the approved plans, or any material, manufacture process or arrangement found to be unsatisfactory, are to be rectified.
1.4.3.2 The date of completion of the survey during construction of a yacht will normally be taken as the date of completion of construction to be entered in the Register of Ships. If the period between launching and completion is, for any reason, unduly prolonged, the dates of launching and completion may be separately indicated in the Register of Ships.
1.4.3.3 Survey items

(1) The survey items for hull are to be as follows:
   ① block/assembly inspections and erection inspections. When the monolithic construction survey is adopted, proper consideration is to be given to the nodes by the Surveyors;
   ② integration inspections of structures and compartments;
   ③ pressure test and tightness test;
   ④ testing for means of closing hatches and openings, including remote controls;
   ⑤ survey for steering gear, windlass and mooring equipment after installed;
   ⑥ determination of rudder centerline and propulsion shafting centerline;
   ⑦ determination of yacht's main dimensions and waterline;
   ⑧ lightweight survey;
   ⑨ inclining test, including confirmation of yacht's condition before testing;
   ⑩ survey items required for class notations;
   ⑪ mooring and sea trials;
   ⑫ other items considered necessary to be inspected by CCS.
(2) The survey items for machinery are to be as follows:
   ① confirmation that the essential machineries are all furnished with the marine products certificates accepted by CCS;
   ② confirmation of the materials for main machinery components, including partial material tests;

③ piping tests;
④ inspections and tests of essential machineries after installed, such as main engine, shafting, propeller, gear boxes, generating sets, important pumps, steering gear, windlasses, air compressors, heat exchangers, sea chests, scupper valves, etc.;
⑤ inspections and tests of systems, such as those of fuel oil, lubricating oil, bilge, ballasting, fire fighting, ventilating, measuring, heating, cooling, venting and valve remote control, etc.;
⑥ inspections and tests of mechanical automatic and remote control systems;
⑦ inspections and tests of remote control means of closing, such as quick-closing valves of oil tanks, ventilation system cut-off and closing, etc.;
⑧ survey items required for class notations;
⑨ mooring and sea trials;
⑩ other items considered necessary to be inspected by CCS.

(3) The survey items for electrical installations are to be as follows:
① confirmation that the electrical installations for essential services are all furnished with marine products certificates accepted by CCS;
② inspections and tests of main source of electrical power, main switchboards (boxes), emergency switchboards (boxes) and distribution boxes after installed;
③ check of cable specifications and inspection of the installation;
④ inspections and tests of main and auxiliary engines, steering systems (including control, safety and alarm systems);
⑤ inspections and tests of emergency power supply (including charging devices);
⑥ mooring and sea trials;
⑦ other items considered necessary to be inspected by CCS.

**1.4.4 Requirements for tests**

1.4.4.1 Tightness test for hull structure

(1) The following items are to be hose tested:
① watertight bulkheads, flats and tunnels;
② bulkhead watertight doors;
③ weathertight doors, windows and hatch covers.

(2) The following places are to be subjected to the appropriate hydrostatic test:
① fore and after peak tanks used as voids, heading up to the highest damage waterline or the bulkhead deck, whichever is the greater;
② water tanks, oil tanks, ballast tanks and peak tanks, heading up to 2.4 m above the tank top or the top of the overflow, whichever is the greater;
③ where testing using water is undesirable in dry-dock or on the building berth, water pressure testing may be carried out afloat. But the under-water body of the hull and those portions of the hull which are unable to be inspected after launching, are to be inspected with appropriate means prior to launching.

(3) During hose tests, the water-pressure of nozzle is at least to be 0.2 MPa, the maximum distance is not to be more than 1.5 m, the nozzle diameter is not to be less than 12 mm, and the moving speed of water column is not to be more than 0.1 m/s.

(4) The hydrostatic test required by (2) above may be substituted by air test. The test pressure used in air test is not to be less than 0.015 MPa.

(5) Walls for pantry, toilet, washroom and battery room are to be subjected to the filling water test whose heading is up to the top of their sills.

1.4.4.2 Tightness test for pressure vessels and piping is to be carried out after installation. The duration of test is in general to be 3 to 5 min.

1.4.4.3 Inclining test

(1) When construction is finished, each yacht is to undergo an inclining test to determine the elements of its stability, and the information thereon is to be provided to the master of the yacht, which will enable him to assess with ease the stability of his yacht in different navigation conditions. The conditions and requirements for the inclining test and the assessment of test results are to comply with the requirements of the Administration of the flag State. Where no requirements are made by the Administration of the flag State, the relevant requirements of CCS are to be complied with.
(2) The inclining test of an individual yacht may be dispensed with provided basic stability data are available from the inclining test of a series of vessels, unless otherwise provided by the Administration. The yacht is to be inclined whenever, in comparison with the data derived from the series of vessels, a deviation from the lightship displacement exceeding 2% or a deviation from the lightship longitudinal centre of gravity exceeding 1% of $L_{WL}$ is found.

**1.4.5 Documents and reports**
1.4.5.1 Manufacturers are to submit relevant inspection, testing, measuring reports and records to the Surveyors and the owners.
1.4.5.2 The Surveyors are to prepare various survey reports, records, data and relevant certificates for the yacht's hull and equipment, machinery, electrical installations, on completion of inspection, testing and examination of the reports and records submitted by the manufacturers, in the forms specified by CCS.
1.4.5.3 The plans and data, specifications, owner's manual, certificates, reports, records, stability information and other guidelines related to the yacht are to be kept on board the yacht.
1.4.5.4 The important dates for the yacht, e.g. the signing date of construction contract, the date of the keel laid, the date of launching, the date of completion of surveys and the date of delivery are to be recorded.

## Section 5 SURVEYS AFTER CONSTRUCTION

**1.5.1 General requirements**
1.5.1.1 For the purpose of maintaining the validity of certificates, various surveys after construction as specified in this Chapter are to be carried out, as appropriate.
1.5.1.2 If any damage or defect affecting the validity of certificates is found at any of the surveys, the Surveyor is to inform the owner or his representative of the recommendations in time when he deems necessary. When such recommendations are not dealt with, the Surveyor is to report this in writing to the Headquarters of CCS immediately.
1.5.1.3 It is the responsibility of the owner to apply to CCS for all surveys necessary for the maintenance of the validity of certificates and to make preparations and take safety precautions for surveys in accordance with the requirements of the Rules.
1.5.1.4 Damage and repair surveys
(1) Any damage to hull, equipment or machinery (including electrical installations), which could invalidate the conditions for which a class has been assigned, is to be reported to CCS without delay. CCS will appoint the Surveyor(s) boarding a yacht to carry out damage surveys at a suitable port where the yacht arrives on its voyage. And the scope of the survey is to be that considered by the Surveyor(s) necessary for ascertaining the extent and cause of the damage.
(2) All repairs to hull, equipment or machinery (including electrical installations) involving the yacht's class are to be made under the supervision of the Surveyor(s) in accordance with applicable rules. If repairs are effected at a place where services of a CCS Surveyor are not available, CCS is to be informed in time.
1.5.1.5 Statutory surveys as authorized
(1) For a yacht applying for class of CCS and at the same time CCS is authorized for statutory surveys of the same yacht, CCS may carry out classification survey as required by this PART in conjunction with statutory surveys.
(2) The survey requirements for stability, fire safety and its associated portable equipment are to comply with the provisions of the Administration of the flag State.

**1.5.2 Types and periods of surveys**
1.5.2.1 Initial classification surveys

(1) Initial classification surveys are to be carried out on any yacht requesting to be classed with CCS. The survey is the examination of compliance of its documentation and of the design, configuration, technical condition and management of its structure and equipment with this PART and other technical requirements recognized by it, prior to assigning CCS class and classification certificates to it for the first time.

1.5.2.2 Intermediate surveys

(1) For yachts with a five-year special survey period, intermediate surveys are to be carried out between the 2nd and 3rd anniversary date from the date of the initial classification survey or of the completion of the last special survey.

1.5.2.3 Periodical surveys of the outside of the yacht's bottom and related items

(1) There is to be a minimum of two examinations of the outside of the yacht's bottom and related items during each five-year special survey period. One such examination is to be carried out in conjunction with the special survey. In all cases the interval between any two such examinations is not to exceed 36 months. The surveys are to be carried out in accordance with relevant requirements in 1.5.6.

(2) For the intervals of examinations of the outside of the yacht's bottom and related items, attention is also to be paid that the Administration of the flag States may have additional requirements.

(3) The interval of examinations of the outside of the yacht's bottom and related items may be shortened depending on the condition of the underwater portion of the hull and the interval of special surveys.

(4) Examinations of the outside of the yacht's bottom and related items are normally to be carried out with the yacht in dry dock or on a slipway. However, consideration may be given to alternate examination while the yacht is afloat as an in-water survey, subject to provisions of Section 11, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships. Special consideration is to be given to yachts of 15 years or over before being permitted to have such examinations.

1.5.2.4 Special surveys

(1) Unless expressly provided otherwise, special surveys of hull and machinery (including electrical installations) are to be carried out and completed before the expiry date of classification certificates.

1.5.2.5 Screwshaft and tubeshaft surveys

(1) Unless expressly provided otherwise, the screwshaft and tubeshaft surveys to be carried out and the interval between the surveys are to be in accordance with the requirements of Section 12, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

1.5.2.6 Occasional surveys

(1) An occasional survey is any survey which is not a periodical survey. The survey may be defined as an occasional survey of hull, machinery, electrical installations, automatic and remote control systems, etc., depending on the part of the yacht concerned.

(2) An occasional survey is to be requested by the owner or his agent in any of the following cases:

① change of the yacht's name, port of registry, flag and the owner or operator;

② damage which affects the class of the yacht and its equipment;

③ any repair or alteration or conversion which affects class;

④ postponement or recommendation of surveys.

(3) An occasional survey may be general or partial as appropriate, and is to ensure that repairs and any renewal have been effectively carried out and that the yacht and its equipment remain fit for the intended navigation.

**1.5.3 Surveys for hull**

1.5.3.1 Intermediate surveys

(1) examination of main hull above design waterline, and superstructures, deckhouses, companionways, and all openings and their weathertight closing appliances, confirming the effectiveness of closing of stern doors (if applicable);

(2) examination of watertight integrity of watertight bulkheads in main hull and their watertight doors, indicators for closing of watertight doors;

(3) examination of side scuttles, windows and deadlights;
(4) examination of freeing ports, bulwarks, guard rails and other means for the protection of the crew;
(5) examination of ventilators and air pipes and their closing appliances;
(6) general examination of sea water ballast tanks, sea suctions in engine room, etc.;
(7) examination of anchoring and mooring equipment, partial test of slipping and hauling anchors by windlass;
(8) for yachts exceeding 5 years of age, the thickness measurement for hull plating of steel yachts may be required as deemed necessary by the Surveyor. For the allowable corrosion, see the provisions of Appendix 1, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships.

1.5.3.2 Special surveys

(1) In addition to the items listed in 1.5.3.1 above and 1.5.6 below, the following applicable items are to be examined by the Surveyor.

① Engine room, cabins and other spaces, including superstructures and deckhouses, are to be carefully examined after cleaning. Special attention is to be paid to locations likely to sustain corrosion, impact, wear, etc.
② Special attention is to be paid to locations where stress concentration is liable to occur, such as structural discontinuities, window openings in side walls of superstructures, etc.
③ Anchors and chain cables or anchor ropes are to be inspected, and the chain cables are to be ranged, examined, and the required complement and condition verified.
④ Mooring lines are to be examined.
⑤ The connection of the seats to the deck is to be examined, especially for the hull structure made of F.R.P.

(2) The following additional items are to be examined for yachts exceeding 5 years of age:

① Chain locker and all cofferdams are to be internally examined.
② Anchors and chain cables or anchor ropes are to be examined. If any length of chain cables is found to be reduced in mean diameter at its most worn part by 12% or more from its nominal diameter as required in the Rules, it is to be renewed, and when necessary, anchor ropes are to be renewed.
③ For steel yacht, thickness measurement is to be taken of the following positions: suspect areas and at least one (at special survey No.2) or two (at subsequent special surveys after special survey No.2) transverse sections within 0.5LWL amid-yacht; for aluminum alloy yacht, thickness measurement is to be carried out as deemed necessary by the Surveyor.

**1.5.4 Surveys for machinery**

1.5.4.1 Intermediate surveys

(1) Propulsion machinery, shafting and auxiliary engines for essential services are to be generally examined, and when considered necessary by the Surveyor, certain items may be required to be opened for examination.
(2) A general examination is to be carried out for machinery spaces, to confirm that there is no existence of any fire and explosion hazards in the spaces.
(3) Escape routes for machinery spaces are to be free from obstruction.
(4) Bilge pumping systems and bilge wells including operation of pumps, extended spindles and level alarms, where fitted, are to be examined as far as practicable.
(5) Pressure vessels and their safety devices are to be externally inspected.
(6) Quick-closing valves of oil tanks are to be operating tested.

1.5.4.2 Special surveys

(1) In addition to those items as required by intermediate surveys in 1.5.4.1, special surveys are also to include the following items:

① Diesel engine

a. Pistons, connecting rods, crankshaft and all bearings, crankcases, bedplates, entablatures, crankcase door fastenings and explosion relief devices, superchargers and their associated coolers, fuel pumps and fittings, camshafts and their transmitting gear together with balance weights, torsional vibration dampers or detuners, flexible couplings, clutches, reverse gears, attached pumps and cooling arrangements are to be opened for examination.

b. Selected portion of pipes in the starting air system is to be removed down for internal examination.
c. Test of engine operation and test of initial starting arrangement.
d. The survey of diesel engines with bores 300 mm or below may be carried out according to the manufacturer's scheduled maintenance program, provided the engines are maintained under the program. The records of the program, including lubrication servicing, are to be made available to the Surveyor. Periodical overhauls, required by the manufacturer's scheduled maintenance program, are to be witnessed by the Surveyor.

② Intermediate shaft, thrust shaft and their all bearings
a. Where the alignment of shafting and wear clearances of bearings are found in normal condition, the lower half bushes of the bearings are not to be turned out for examination.

③ Reduction gears are to be examined, including their wheels, pinions, racks, shafts, bearings, thrust bearings and clutches. They are to be opened up for examination as deemed necessary by the Surveyor.

④ Auxiliary engines, including air compressors and their intercoolers and safety devices, and all pumps for essential service are to be examined.

⑤ Air receivers and other pressure vessels for essential service together with their mountings, valves and safety devices are to be internally and externally examined after cleaning. Safety valves are to be adjusted.

⑥ Windlass and its driving unit are to be examined and operating tested.

⑦ Bilge system is to be examined and tested under working condition. Valves, valve chests or cocks, strainers and mud boxes are to be opened for examination as deemed necessary by the Surveyor.

⑧ Ballast system is to be examined and tested under working condition. Valves, valve chests or cocks are to be opened for examination as deemed necessary by the Surveyor.

⑨ Fuel oil, lubricating oil and cooling water systems are to examined or tested. They are to be opened for examination as deemed necessary by the Surveyor.

⑩ Propulsion machinery is to be tested under working condition. Control systems of essential machineries are to be tested for confirming that they are in good working condition.

⑪ Fuel oil tanks constructed not forming part of hull structure are to be internally and externally examined. Internal examination may be dispensed with where external examination is satisfactorily carried out at special survey No.1.

**1.5.5 Surveys for electrical installations**

1.5.5.1 Intermediate surveys

(1) Motors, switchboards (boxes), switchgear and other electrical equipment are to be generally examined. They are to be examined under operating condition as practicable.

(2) A general examination is to be carried out to see whether the precautions are taken against shock, fire and other hazards of electrical origin.

(3) All emergency power sources are to be function tested, and integrity of emergency lighting is to be checked. Where emergency power sources are provided with automatic power supply, the test is to be carried out in automatic mode.

(4) Main and auxiliary steering gears are to be running tested, and the reliability of alarms indicating failures of power supply, A.C. phase supply, etc., of steering gears are to be verified.

(5) Remote controls for stopping fans, pumps, etc., and for shutting off fuel oil supplies in machinery spaces are to be examined as far as practicable.

(6) Electrical equipment in dangerous spaces such as paint room, battery room, etc., are to be examined to confirm that they are suitable for such spaces, are in good condition and are being properly maintained.

(7) All cables are to be examined as far as practicable, and electrical installations or protective casings are to be examined to verify that they are without improper breakage. The insulation resistance of cables and main electrical equipment (such as switches, generators, heaters, lighting fixtures, etc.) is to be measured, and the measurement of insulation resistance may be carried out section after section.

1.5.5.2 Special surveys

(1) In addition to those items as required by intermediate surveys in 1.5.5.1, special surveys are also to include the following items:

① The fittings on main and emergency switchboards (boxes), section boards (boxes) and shunt fuse panels are to be examined and over-current protective devices and fuses verified to confirm the proper protection respectively.
② Air circuit breakers of generators are to be tested to verify satisfactory operation of protective devices.
③ Main generators are to be running tested separately and in parallel under work load conditions, and prime mover governors and load sharing are to be examined.
④ Motors and their controls for essential services are to be examined and if considered necessary, to be operated under working conditions in so far as practicable.

**1.5.6 Surveys for the outside of the yacht's bottom and related items**

1.5.6.1 At time of survey, the yacht's shell is to be cleaned, and necessary conditions for execution of the survey are to be provided. At survey for the outside of the yacht's bottom and related items, the following items are to be examined:

(1) shell plating, especially corrosion of shell plating at stern above propeller and close to rudder, is to be carefully examined, and extensive areas of wastage are to have thickness measurement taken, and when necessary, the renewal of plating is to be carried out, and recorded;

(2) corrosion of propeller and rudder blades, especially cavitation corrosion;

(3) sea valves, sea valve chest, discharges and their connections to the shell including fastening and the gratings at the sea inlets;

(4) examination of rudders, measuring the clearances in the rudder bearings, and examination of tightening nuts, pins and bolts for rudder blades and rudder stock; examination of horizontal flange for connecting rudder stock to rudder blades with welding and the connection of flat plate rudder to rudder stock with welding by effective means of detection;

(5) examination of propeller and other auxiliary propulsion arrangements, measuring the clearance in the propeller bearings, and inspecting the effectiveness of the oil gland;

(6) examination of shell corrosion protection system and coating including sacrificial anode-zinc slab fixing and corrosion condition;

(7) examination of earthing;

(8) careful examination of leakage of fabric reinforced plastics (FRP) shell plating due to chafing and breaking for yachts with hull made of FRP, and examination of the forebody side and bow impacted by sea waves;

(9) verification of damage or crack of shell plating in the connections of the bottom of propeller shaft bracket to the hull.

**1.5.7 Initial classification surveys for exiting yachts**

1.5.7.1 For existing yachts applying for initial classification surveys, the plans and documents indicated by * as specified in 1.3.2, Section 3 of this Chapter are to be submitted in triplicate to CCS for examination.

1.5.7.2 The survey items are to be determined in accordance with yacht age and actual conditions, but at least to be in line with the special survey items.

# CHAPTER 2 HULL STRUCTURE

## Section 1 GENERAL PROVISIONS

### 2.1.1 Application

2.1.1.1 This Chapter is applicable to yachts whose hulls are of steel, aluminum alloy or fabric reinforced plastics materials. For the requirements for cross-deck structures of those other than high speed yachts, reference may be made to the provisions of relevant rules of the Society.

2.1.1.2 For high speed yachts complying with the definition of 1.1.3.1(2), the hull structure is to comply with the relevant requirements of CCS Rules for Construction and Classification of Sea-Going High Speed Craft or Rules for Construction and Classification of Inland Waters High Speed Craft depending on the applicable navigating waters; however, when the rules above are applied for the calculation of design loads, the value of the design significant wave height corresponding to each design category is to be taken in accordance with the provisions of 2.4.2.2 of this PART, and when the design vertical acceleration $a_{cg}$ at the center of gravity of a yacht is determined by the owner or designer, its value may not be restricted by the upper limit of $a_{cg}$ given in the rules above.

2.1.1.3 For yachts of novel structure design, the FE analysis of the hull structural model is to be carried out to verify the strength of hull structure. Relevant calculation data is to be submitted to CCS for examination.

2.1.1.4 Recognized calculation software is to be adopted for direct calculation or FE analysis.

### 2.1.2 Definitions

2.1.2.1 Unless expressly provided otherwise, for the purpose of this Chapter:

(1) *Stiffeners* mean generally the stiffening members of the plates, such as longitudinals, beams, frames, bulkhead stiffeners, and stiffeners of bulkhead plating of superstructure and deckhouse etc.

(2) *Primary members* mean the primary strengthening members of the hull structure, such as keel, girders, deck web beams, plate floors, side web frames, etc.

(3) *Superstructure* means an enclosed structure on the uppermost continuous deck, extending from side to side of the yacht or with the side plating not being inboard of the shell plating more than 4% *B*.

(4) *Deckhouse* means an enclosed structure on the uppermost continuous deck or other weather decks, with the side plating being inboard of the shell plating more than 4% *B*.

(5) *Strength deck* means the uppermost continuous deck considered to be effective deck for hull girder strength of yacht.

(6) *Bulkhead deck* means the uppermost continuous deck to which all transverse watertight bulkheads within the hull extend.

(7) *Coordinate system*: the origin of the coordinate system is taken as the intersection point of the centerline of transverse section to the baseline at the aft end of the design waterline. The longitudinal *X* axis along the baseline is positive towards bow and the vertical Z axis is positive above the baseline.

## Section 2 STRUCTURAL DESIGN PRINCIPLES

### 2.2.1 General requirements

2.2.1.1 The design of hull structure is to be such as to ensure that the structural strength and watertight integrity are sufficient to withstand the design loads (including local and hull girder design loads) as specified in Section 4 of this Chapter for yachts navigating in the full-load departure condition.

2.2.1.2 Longitudinal framings are generally adopted for hull structures of yachts of more than 50 m in $L_{WL}$ and a double bottom complying with 2.2.3.4 is to be fitted. Longitudinal or transverse framings or mixed framings may be adopted for hull structures of yachts of 50 m and less in $L_{WL}$.

2.2.1.3 Longitudinal members of longitudinal framings are to be continuous. Where the longitudinal stiffeners are cut in way of transverse bulkheads, connecting brackets are to be provided at both sides of transverse bulkheads. The longitudinal stiffeners and the brackets at both sides of the transverse bulkheads are to be in line as to ensure the structural continuity.
2.2.1.4 Transverse members of transverse framings are to be continuous as far as practicable. Where the transverse stiffeners are cut in way of longitudinal bulkheads or longitudinal primary members, connecting brackets are also to be provided at both sides of stiffeners, and the stiffeners and the brackets are to be in line as to ensure the structural continuity.
2.2.1.5 Primary members are to be so arranged as to ensure effective continuity of strength, and abrupt changes of depth or section are to be avoided.
2.2.1.6 The plate floors are to be effectively connected with the side web frames and deck web beams in the same section, forming a complete ring system.
2.2.1.7 Where openings are cut in the web of primary members, openings are to have smooth edges and well rounded corners. The depth of opening is not to exceed 50% of the web depth, and the opening is to be so located that the edges are not less than 25% of the web depth from the web root or face plate. The length of opening is not to exceed the web depth or 60% of the spacing of stiffeners passing through the web, whichever is the greater, and the ends of the openings are to be equidistant from the corners of cut-outs for stiffeners. Openings are not to be cut in the vicinity of the ends of primary members.
2.2.1.8 Where the depth of openings in the web of primary members exceeds 50% of the web depth, they are to be strengthened.

### 2.2.2 Bulkhead arrangements

2.2.2.1 Transverse watertight bulkheads are, in general, to extend to the bulkhead deck.
2.2.2.2 A watertight collision bulkhead is to be provided at the fore end of the hull, which in general is to extend up to the bulkhead deck. Where a long forecastle is provided, it is to extend up to the forecastle deck. The distance $\ell$(m) of collision bulkhead aft of the forward perpendicular is to be as follows:
(1) For yachts without bulbous bow, $\ell = 0.035L \sim (3 + 0.05L)$;
(2) For yachts with bulbous bow, $\ell = (0.35L - f) \sim (3 + 0.05L - f)$.
where: $L$ — length between perpendiculars, in m;
$f$ — $G/2$ or $0.015L$, whichever is the lesser, where $G$ is horizontal distance from the forward end of bulbous bow to forward perpendicular, in m.
The watertight collision bulkhead located within the range above may be stepped or recessed.
2.2.2.3 A transverse watertight bulkhead is to be provided at each end of the engine room. The aft peak bulkhead may form the aft transverse watertight bulkhead of the engine room, where the engine room is aft.

### 2.2.3 Bottom, side and deck structures

2.2.3.1 The bottom girders are to comply with the following requirements:
(1) Bottom keel and longitudinal girders are in general to pass through transverse watertight bulkheads and extend towards bow and stern.
(2) Holes are not permitted in way of the girder ends within 1.5 times the depth of the girders from bulkheads.
(3) Girders supporting the main engine seating are in general to extend over the full length of the engine room and directly to extend from the bottom to the face plate of the engine seating. Brackets are to be fitted for strength and tripping of girders.
(4) Girders in way of the thrust bearing are to be strengthened.
2.2.3.2 The plate floors are to be fitted on each frame in the engine room, and additional strengthening is to be provided in way of the gear box and thrust bearing.
2.2.3.3 For hulls of longitudinal framing, the height of web plates of bottom floors is in general not to be less than 2.5 times that of the holes which longitudinals pass through; the height of web plates of side web frames and deck web beams is in general not to be less than 2.2 times that of the holes which longitudinals pass through.

2.2.3.4 Where a double bottom is fitted, the double bottom height is to be sufficient to ensure access to all parts and, in way of the centre girder, is to be not less than 0.7 m. Adequate tapering is to be provided between double bottom and adjacent single bottom structures. The inner bottom plating of the double bottom is to be gradually tapered to the face plate of longitudinal girders of the single bottom. Where the height of the double bottom varies, the variation is generally to be made gradually and over an adequate length but not to occur within $0.5L_{WL}$ amidships.
2.2.3.5 Where a rounded sheer strake is adopted, the radius is, in general, to be not less than 15 times the thickness of the sheer strake.
2.2.3.6 The corners of openings in the side shell plating are to be rounded. The openings are to be kept well clear of the ends of superstructure and to be compensated.
2.2.3.7 The corners of large openings in the strength deck within $0.5L_{WL}$ amidships are to be elliptical or parabolic and comply with the provisions of Figure 2.2.3.7(1). Where the corners of openings are rounded, insert plates are required, and the radius of the rounded corner is not to be less than 1/20 of the breadth of the opening. The dimensions of the insert plates are to comply with the provisions of Figure 2.2.3.7(2). The thickness of insert plates is not to be less than 1.5 times the thickness of strength deck plating.

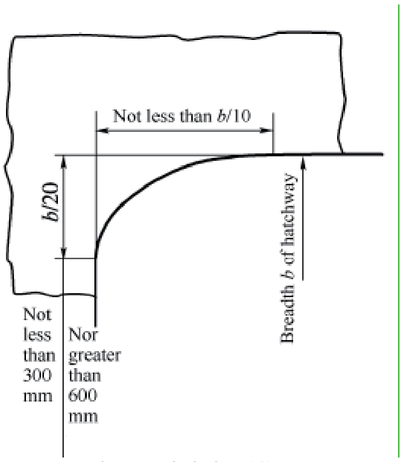



**Figure 2.2.3.7(1)**

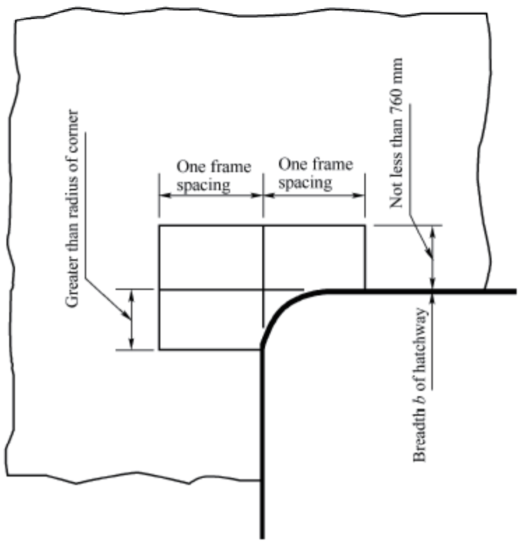



**Figure 2.2.3.7(2)**

2.2.3.8 The deck plating and supporting structure are to be suitably reinforced in way of cranes, masts or heavy units on the deck.
2.2.3.9 Where swimming pools and bathing platforms and cockpits are provided on the weather deck, they are to be watertight with care being taken to ensure continuity of strength of the surrounding deck structure, so as to avoid stress concentration due to abrupt structural changes.

### 2.2.4 Fore and aft end arrangements

2.2.4.1 Special attention is to be given to ensure continuity of structural strength and the avoidance of abrupt structural changes with regard to fore and aft end arrangements.

2.2.4.2 Where a bulbous bow is fitted, the bow crumple zone is to be forward of the collision bulkhead. At the fore end of the bulb the structure is generally consisted of horizontal diaphragm plates in conjunction with a deep centreline web. Vertical transverse diaphragm plates of bulbous bow and frames within forepeak are to be arranged in same planes.

2.2.4.3 The shell plating is to be increased in thickness at the bulb likely to be damaged by the anchors and chain cables.

### 2.2.5 Superstructures and deckhouses

2.2.5.1 The first tier superstructure/deckhouse front and aft end bulkheads above the weather deck are to be aligned with the transverse bulkheads in the deck below in so far as practicable. Where it is impracticable, the end bulkheads are to be supported by web beams or pillars. The transition in way of the first tier superstructure/deckhouse side ends is to be smooth and without local discontinuities.

2.2.5.2 The transition in way of the ends of the superstructure/deckhouse is to be smooth and without local discontinuities so as to avoid stress concentration.

2.2.5.3 Webs of the deck girders and web beams under the bulkheads of the superstructure/deckhouse are not to be provided with any openings for a distance of 0.5 m from each side of the deckhouse corners.

2.2.5.4 The structures are to be suitably reinforced in way of cranes, masts or heavy units provided on superstructure/deckhouse.

2.2.5.5 Where the hull is of steel material and the superstructure/deckhouse are of aluminum alloy material, the steel-aluminum transition joints approved by CCS are to be used for connecting the superstructure/deckhouse to the hull. Where riveting is adopted, measures for avoiding electrochemical corrosion between the two metals are to be taken.

### 2.2.6 Tank structures

2.2.6.1 The fore peak is not to be used for carrying fuel oil.

2.2.6.2 Fresh water tanks are to be separated from other tanks such as waste water tanks by cofferdams.

2.2.6.3 Lubricating oil tanks are to be separated from hydraulic oil tanks by cofferdams.

## Section 3 WATER INTEGRITY AND DOORS, WINDOWS AND COVERS

### 2.3.1 External watertight and weathertight integrity

2.3.1.1 All the external openings (including doors, external windows, hatch covers, ventilators and air pipes) above the weather deck are to be fitted with weathertight closing appliances.

2.3.1.2 Where the differences between both vertical distances of the weather deck and freeboard deck above the design waterline is at least one standard superstructure height[①], the first tier superstructure/deckhouse may be treated as the second tier superstructure/deckhouse.

2.3.1.3 Side scuttles and their closing appliances below the freeboard deck are to ensure watertightness.

### 2.3.2 Internal watertight and weathertight integrity

2.3.2.1 All openings, including doors, tubes and cables, situated on watertight bulkheads below the freeboard deck are to ensure watertightness.

2.3.2.2 Any opening in the collision bulkhead below the freeboard deck is not to be permitted. Where the collision bulkhead extends above the freeboard deck, openings on the collision bulkhead above the freeboard deck are permitted but they are to be provided with weathertight closing appliances.

2.3.2.3 Watertight doors situated below the freeboard deck may be accepted in watertight bulkhead. The doors are to be kept closed during navigation.

### 2.3.3 External doors and hatch covers

① For the standard superstructure height, reference may be made to Regulation I/3 of International Convention on Load Lines, 1966.

2.3.3.1 The closing appliances of all required weathertight external doors and watertight internal doors are to ensure corresponding tightness and the strength of doors is to be the same as their adjacent structure. The external doors are to be open outwards to provide evacuation for passengers.
2.3.3.2 The closing appliances of all required weathertight hatch covers are to ensure weathertightness and the strength of covers is to be the same as their adjacent structure.
2.3.3.3 Flush hatch covers fitted with double gaskets and drains led overboard are allowed on the weather deck. However the flush covers are not to be opened during navigation of yacht, and the words "Do not open during navigation" are to be marked on the covers.

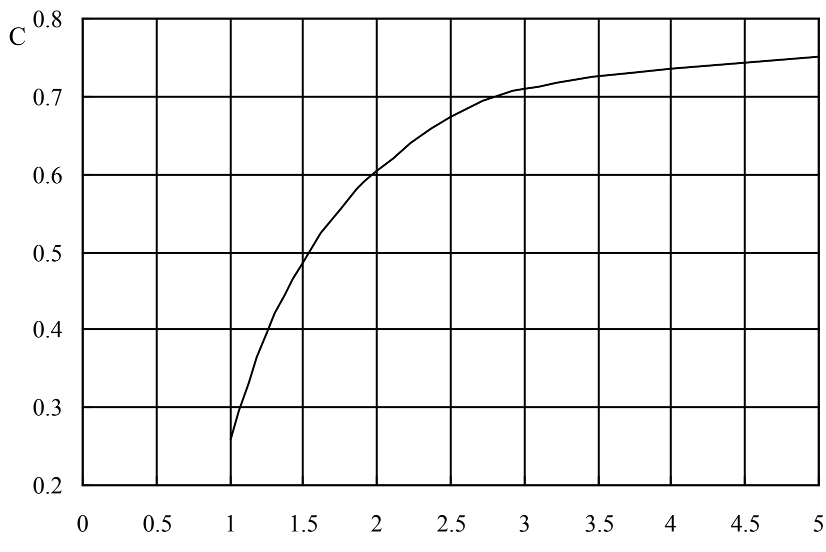
**2.3.4 Side scuttles and external windows**

2.3.4.1 The lower edge of all the windows (including side scuttles having openings with an area not exceeding 0.16 $m^2$) fitted in the hull below the freeboard deck is to be at least 500 mm or 2.5%$B$, whichever is the greater, above the design waterline. All the windows below the freeboard deck are not to be opened during navigation of yacht.
2.3.4.2 All the windows (including side scuttles) fitted in the hull below the freeboard deck are to have a structural strength of not less than the adjacent structure and be provided with permanently hinged inside deadlights so arranged that watertightness is ensured. Deadlight may be omitted for windows using the types given in 2.3.4.3(6) on yachts of design category IV and V. The windows are to be made of toughened safety glass complying with the relevant standards accepted by CCS. The thickness $t$ of glass is calculated in accordance with the following formulae, but not less than 6 mm:

$$t = 0.0056r\sqrt{P} \quad \text{mm} \quad \text{for round windows}$$

$$t = 0.005b\sqrt{CP} \quad \text{mm} \quad \text{for elliptical or rectangular windows}$$

where: $r$ — radius of round window glass, in mm;
$b$ — short side length of elliptical or rectangular window glass, in mm;
$P$ — loads on the window glass, in kN/$m^2$, to be taken according to 2.4.4 of this Chapter based on the actual position of window glass;
$C$ — coefficient taken from Figure 2.3.4.2, where $a$ is long side length of ellipse or rectangle.




Window opening aspect ratio = long side length $a$ / short side length $b$

**Figure 2.3.4.2**

2.3.4.3 All windows fitted in the superstructures or deckhouses above the freeboard deck are “external windows” of generally rectangular shape, which are to comply with the following requirements:

(1) Structures and fastening types for all external windows of superstructure and deckhouse are to ensure weathertightness. The external windows are to be made of toughened safety glass, polycarbonate glass or laminated glass complying with the relevant standards accepted by CCS, and the mechanical properties of glass materials are to be submitted to CCS.

(2) For toughened safety glass and polycarbonate glass, the thickness $t$ of external window glass is not to be less than:

$$t = \frac{b}{31.6}\sqrt{\frac{CP}{[\sigma_B]}} \quad \text{mm}$$

where: $b$ — short side length of window opening, in mm;

$P$ — loads on the window glass, in $kN/m^2$, to be taken according to 2.4.4 of this Chapter based on the actual position of window glass;

$[\sigma_B]$ — allowable bending stress of glass, in $N/mm^2$;

$[\sigma_B]$ = 50 for toughened safety glass,

$[\sigma_B]$ = 26 for polycarbonate glass;

$C$ — coefficient taken from Figure 2.3.4.2.

(3) The connections between external glass and window frame and between window frame and wall plating are to be fixed and reliable enough to subject to the possible wave impact during the normal navigation within the navigating waters. Where the external window is made of polycarbonate glass, the depth of glass inserted in the frame of window is not to be less than 0.03b. b is the short side length of window opening.

(4) The external window glass may be fastened directly to wall plating by glue joint. Where necessary, metal horizontal frames are to be provided at the lower edge of window glass to support the glass weight. The glue is to be capable of resisting ultraviolet light, low and high temperatures and cleaning chemicals. The properties of glue such as long-life joint strength and its working requirements and procedure documents are to be submitted to CCS for approval. The tensile strength of glue is not to be less than 2.5 MPa.

① The joint width $d$ is not to be less than:

$$d = \frac{2.50 P_w b l}{\sigma_t (b + l)} \quad \text{mm}$$

where: $P_W = 0.0125(50 + 0.5V)^2$ $kN/m^2$;

$V$ — maximum speed in calm water, in Kn, but not to be less than 30 kn;

$b$ — short side length of window, in m;

$l$ — long side length of window, in m;

$\sigma_t$ — minimum tensile strength of glue, in MPa.

The minimum joint width $d_{min} = 20b$ mm, and not to be less than 15 mm.

② The thickness $t$ of glue is not to be less than:

$t$ = 5l mm, for toughened safety glass;

$t$ = 8l mm, for polycarbonate glass.

The minimum glue thickness $t_{min}$ = 6 mm.

(5) External windows in front and side walls of first tier superstructure/deckhouse are to be fitted with portable deadlights, the number of which is given in Table 2.3.4.3(5). The deadlights are to be made of metal or composite material, the strength of which to be the same as their surrounding structure, and to be stowed in such a way as to provide quick mounting.

**Table 2.3.4.3(5)**

| Design category | Number of portable deadlights / number of windows | |
|---|---|---|
| | Superstructure front first tier | Superstructure side first tier |
| I | 100% | 50% for interchangeable deadlights on left and right side |
| II | 100% | 50% for interchangeable deadlights on left and right side |
| III | One for each type of windows | — |
| IV, V | — | |

(6) Deadlights may be omitted for external windows using any of the following three types:

① Type 1: a double-layer glass widow made of two layers of toughened glass between which a layer of polycarbonate of 1.5 mm in thickness is glued. The thickness of each layer of toughened glass is to be calculated in accordance with 2.3.4.3(2);

② Type 2: a window made of two layers of toughened glass between which there is a 3.5 mm gap. The thickness of each layer of toughened glass is to be calculated in accordance with 2.3.4.3(2);

③ Type 3: a window made of laminated glass, of which the thickness equivalent to the toughened safety glass exceeds 30% of the thickness calculated in accordance with 2.3.4.3(2).

## Section 4 DESIGN LOADS

### 2.4.1 Definitions and symbols

2.4.1.1 The load point for calculation is to be taken as follows:

(1) For plate panels, it is to be taken at the low edge of the plate panel.

(2) For stiffeners, it is in general to be taken at the midpoint of span. For vertical stiffeners subject to linear and non-uniformly distributed loads, it is to be taken at the point where the average value of loads on both ends occurs.

(3) For primary members, it is to be taken at the midpoint of load area. Where the loads on the area are not uniformly distributed, it is to be specially considered.

(4) The longitudinal and vertical coordinates of load point are indicated by $x$ and $z$ respectively.

2.4.1.2 $d_x$ (m) means the hull draught at the transverse section of coordinate $x$.

2.4.1.3 $z_{kx}$ (m) means the vertical distance of the underside of the keel from the baseline at the transverse section of coordinate x, positive (+) for keel above baseline and negative (-) for keel below baseline.

2.4.1.4 Support girth $G_s$ (m) means the girth distance measured around the circumference of the shell plate between the tangential points of the tangents with horizontal angle of 50° or chines at the center of gravity of yacht, see Figure 2.4.1.4.

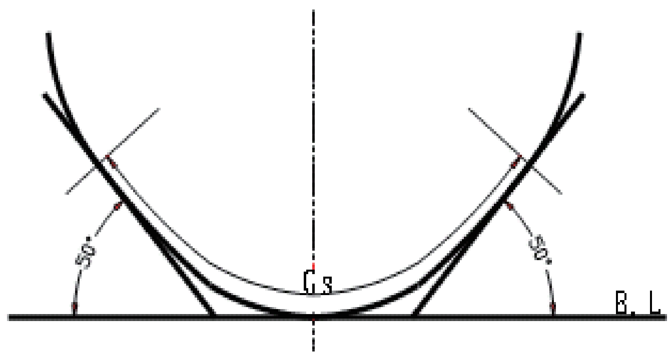



**Figure 2.4.1.4**

2.4.1.5 Bottom area means the area below the chines where the transverse section has bilge chines or the area below the tangential points formed by the round bilge line with the tangents with horizontal angle of 50° where the transverse section is of round bilge form.
2.4.1.6 Side area means the area extending from the bottom area defined in 2.4.1.5 to the uppermost complete weather deck.
2.4.1.7 $g$ means the acceleration of gravity, $g = 9.81$ m/s².

**2.4.2 Hull motion**

2.4.2.1 While a yacht navigates in wave, the relative vertical motion factor $H_{rm}$ at the transverse section of coordinate $x$ is to be calculated in accordance with the following formula:

$$H_{rm} = \frac{1 + C_m (x/L - X_m)^2}{1 + C_m (0.5 - X_m)^2} \times C_W$$

where: $C_W = 0.0771L(C_B + 0.2)^{0.3} e^{-0.0044L}$;

$C_m = \dfrac{2.25}{C_B + 0.2}$;

$X_m = 0.45 - 0.6F_r$, but not less than 0.2;

$F_r = \dfrac{0.515V_H}{\sqrt{gL}}$, where $V_H$ is the speed of yacht navigating at sea with significant wave height $H_S$, in kn,

$V_H = \dfrac{2}{3}V$.

2.4.2.2 While a yacht navigates at sea with significant wave height $H_S$ at speed $V_H$, the vertical acceleration $a_{cg}$ at center of gravity of yacht may be calculated in accordance with the following formula:

$$a_{cg} = \frac{1}{226}\left(\frac{V_H}{\sqrt{L}}\right)^2 \left(\frac{H_S}{B_{WL}} + 0.084\right)(50 - \beta)\frac{LB_{WL}^2}{\Delta} \quad \text{m/s}^2$$

where: $V_H$ — speed of yacht navigating at sea with significant wave height $H_S$, in kn, $V_H = \dfrac{2}{3}V$;

$H_S$ — value of design significant wave height within the range of significant wave heights corresponding to the design category of yacht selected by the designer or owner, in m, which is not to be less than the minimum value of significant wave height $H_{S\min}$ corresponding to the design category of yacht (see Table 2.4.2.2 below). The value is to be used as the yacht's navigation restriction and indicated in the classification certificate;

$\beta$ — deadrise angle at LCG (°), $\beta_{\max} = 30°$; $\beta_{\min} = 10°$;

The value $\beta$ refers to Figure 2.4.2.2. In the figure, (a), (b) and (c) are to be sharp bilge yacht, (d) and (e) are to be rounded bilge yacht.

**Table 2.4.2.2**

| Design category | $H_{S\min}$ (m) |
|---|---|
| I | 6.0 |
| II | 4.0 |
| III | 2.0 |
| IV | 1.0 |
| V | 0.5 |

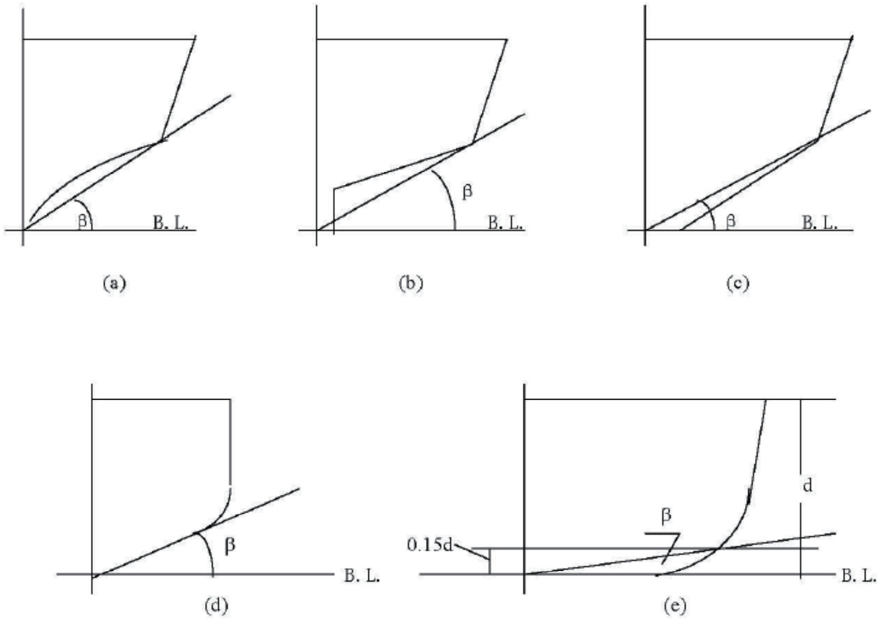



**Figure 2.4.2.2**

2.4.2.3 The vertical acceleration $a_x$ at the transverse section of coordinate $x$ may be calculated in accordance with the following formula:

$$a_x = \left[0.72 - 0.32\frac{x}{L} + 1.76\left(\frac{x}{L}\right)^2\right] \times a_{cg} \qquad \text{m/s}^2$$

where: $a_{cg}$ — vertical acceleration at the center of gravity of yacht, see 2.4.2.2.

### 2.4.3 Hull girder design loads

2.4.3.1 The hull girder design loads (including vertical bending moment and vertical shear force) are to be calculated in accordance with the loading condition of full-load displacement.

2.4.3.2 The still water vertical bending moment $M_S$ and shear force $Q_S$ are to be calculated for yachts.

2.4.3.3 The vertical wave bending moment $M_W$ at any transverse section of hull is to be determined in accordance with the following formulae:

For hogging: $$M_{WH} = 0.19\, F_M L_f C_1 L_{WL}^2 B C_B \qquad \text{kN·m}$$

For sagging: $$M_{WS} = -0.11\, F_M L_f C_1 L_{WL}^2 B(C_B + 0.7) \qquad \text{kN·m}$$

where: $F_M$ — distribution factor of bending moment, see Figure 2.4.3.3 and Table 2.4.3.3;

$L_f$ — coefficient, $L_f = 0.0412\, L_{WL} + 4$;

$C_1$ — reduction coefficient of design category, to be taken as follows:

$C_1 = 1.0$ Design category I;

$C_1 = 0.8$ Design category II;

$C_1 = 0.7$ Design category III;

$C_1 = 0.6$ Design category IV;

$C_1 = 0.5$ Design category V.

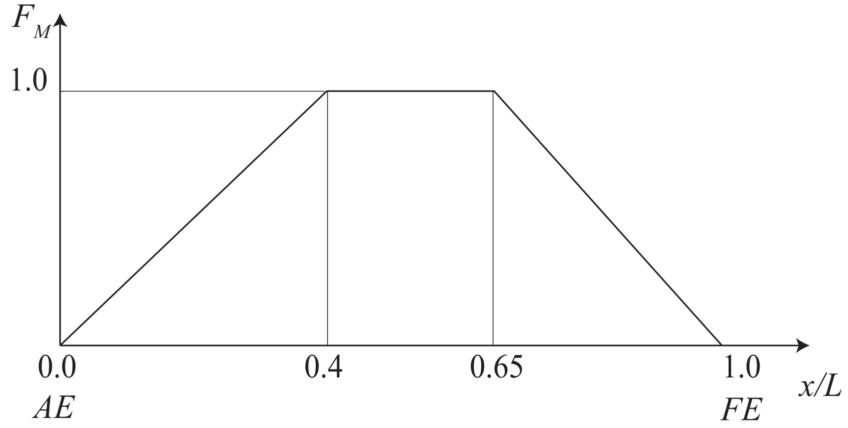



**Figure 2.4.3.3　Distribution factor of Bending Moment $F_M$**

**Distribution factor of bending moment $F_M$**　　　　**Table 2.4.3.3**

| Position of transverse section | Distribution factor $F_M$ |
|---|---|
| $0 \le x < 0.4L_{WL}$ | $2.5\frac{x}{L_{WL}}$ |
| $0.4L_{WL} \le x < 0.65L_{WL}$ | 1.0 |
| $0.65L_{WL} \le x \le L_{WL}$ | $2.86\left(1-\frac{x}{L_{WL}}\right)$ |

2.4.3.4　The dynamic vertical bending moment $M_{DW}$, due to slamming effects at any transverse section of hull is to be determined in accordance with the following formulae:

For hogging: $$M_{DWH} = 0.051\, F_M \Delta\, L_{WL} \left|16n_{cg} - 4n_{FE} - 17n_{AE} - 5\right| \quad \text{kN·m}$$

For sagging: $$M_{DWS} = -0.051\, F_M \Delta\, L_{WL} \left|16n_{cg} - 4n_{FE} - 17n_{AE} - 5\right| \quad \text{kN·m}$$

where: $F_M$ — distribution factor of bending moment, same as 2.4.3.3, see Figure 2.4.3.3;

$n_{cg}$ — vertical overload coefficient at center of gravity of yacht, $n_{cg} = a_{cg}/g$, not to be taken less than 1.0;

where: $a_{cg}$ — vertical acceleration at center of gravity of yacht, see 2.4.2.2;

$n_{FE}$, $n_{AE}$ — vertical overload coefficient at forward end and aft end of design waterline of yacht respectively, $n_{FE} = a_{FE}/g$, $n_{AE} = a_{AE}/g$, where $a_{FE}$ and $a_{AE}$ are vertical acceleration at forward end and aft end of design waterline respectively, in m/s², which may be calculated in accordance with 2.4.2.3. But during calculation, $a_{cg}$ in the formula of 2.4.2.3 is not to be taken less than 9.81 m/s².

2.4.3.5　For checking the hull girder strength, the design value of vertical bending moment $M_R$ at any transverse section, is to be taken as the greater of $(M_W + M_S)$ and $M_{DW}$.

2.4.3.6　The vertical wave shear force $Q_W$ at any transverse section of hull is to be determined in accordance with the following formula:

$$Q_W = 0.3\, F_Q L_f C_1\, L_{WL}\, B(C_B + 0.7) \quad \text{kN}$$

where: $F_Q$ — distribution factor of positive and negative shear forces, see Figure 2.4.3.6 and Table 2.4.3.6, where $A = \frac{190C_B}{110(C_B + 0.7)}$;

$L_f$, $C_1$ — same as 2.4.3.3.

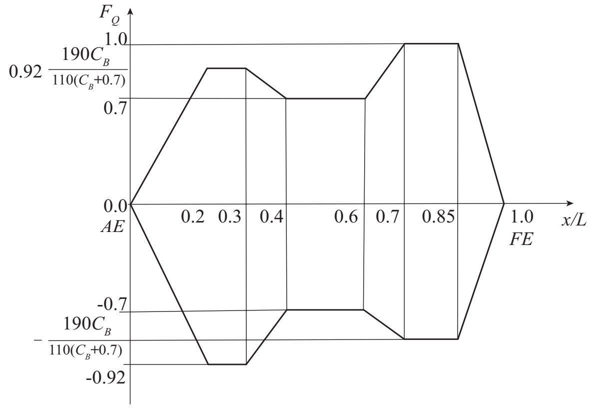



**Figure 2.4.3.6 Distribution factor of Shear Force $F_Q$**

**Distribution factor of positive and negative shear forces Table 2.4.3.6**

| Position of transverse section | Distribution factor $F_Q$ | |
|---|---|---|
| | Positive shear force | Negative shear force |
| $0 \le x < 0.2L_{WL}$ | $4.6A\frac{X}{L_{WL}}$ | $-4.6\frac{X}{L_{WL}}$ |
| $0.2L_{WL} \le x \le 0.3L_{WL}$ | $0.92A$ | -0.92 |
| $0.3L_{WL} < x < 0.4L_{WL}$ | $(9.2A-7)(0.4-\frac{X}{L_{WL}})+0.7$ | $-2.2(0.4-\frac{X}{L_{WL}})-0.7$ |
| $0.4L_{WL} \le x \le 0.6L_{WL}$ | 0.7 | -0.7 |
| $0.6L_{WL} < x < 0.7L_{WL}$ | $3(\frac{X}{L_{WL}}-0.6)+0.7$ | $-(10A-7)(\frac{X}{L_{WL}}-0.6)-0.7$ |
| $0.7L_{WL} \le x \le 0.85L_{WL}$ | 1 | -A |
| $0.85L_{WL} < x \le L_{WL}$ | $6.67(1-\frac{X}{L_{WL}})$ | $-6.67A(1-\frac{X}{L_{WL}})$ |

2.4.3.7 The dynamic vertical shear force $Q_{DW}$, due to slamming effects at any transverse section of hull is to be determined in accordance with the following formula:

$$Q_{DW} = 0.204\, F_Q \Delta \left|16n_{cg} - 4n_{FE} - 17n_{AE} - 5\right| \quad \text{kN}$$

where: $F_Q$ — distribution factor of shear force, same as 2.4.3.6;

$n_{cg}$, $n_{FE}$, $n_{AE}$ — same as 2.4.3.4.

2.4.3.8 For checking the hull girder strength, the design value of vertical shear force $Q_R$ at any transverse section, is to be taken as the greater of ($Q_W + Q_S$) and $Q_{DW}$.

2.4.3.9 For checking the hull girder strength of yachts only navigating in inland waters, the vertical wave bending moment $M_W$ as specified in 2.4.3.3 and the vertical wave shear force $Q_W$ as specified in 2.4.3.6 may be determined in accordance with the relevant provisions of CCS Rules for Construction and Classification of Inland Waters Steel Ships.

#### 2.4.4 Local design loads

2.4.4.1 The design load PR acting on the shell may be determined in accordance with the position of load point for calculation as follows:

(1) Bow area between $x = 0.75L_{WL}$ and $x = 1.0L_{WL}$:

For load point in the bottom area below the design waterline: $P_R = 1.07\max\left[P_{bs}, P_1, C_2P_{fs}\right]$ kN/m²

For load point in the side area below the design waterline: $P_R = 1.07\max\left[P_1, C_2P_{fs}\right]$ kN/m²

For load point in the side area above the design waterline: $P_R = 1.07C_2P_{fs}$ kN/m²

(2) Area between $x = 0$ and $x = 0.75L_{WL}$:

For load point in the bottom area below the design waterline: $P_R = 1.07\max\left[P_{bs}, P_1\right]$ kN/m²

For load point in the side area below the design waterline: $P_R = 1.07P_1$ kN/m²

For load point in the side area above the design waterline: $P_R = 1.07P_2$ kN/m²

where: $C_2$ — reduction coefficient of design category, to be taken as follows:

$C_2 = 1.25$ Design category I;
$C_2 = 1.00$ Design category II;
$C_2 = 0.85$ Design category III;
$C_2 = 0.75$ Design category IV;
$C_2 = 0.60$ Design category V;

$P_1$ — water pressure acting on the bottom and side areas of hull below the design waterline, in kN/m², to be determined in accordance with 2.4.4.2;

$P_2$ — water pressure acting on the side area outside the bow above the deign waterline (between $x = 0$ and $x = 0.75L_{WL}$), in kN/m², to be determined in accordance with 2.4.4.5;

$P_{bs}$ — bottom impact pressure due to slamming, in kN/m², to be determined in accordance with 2.4.4.3;

$P_{fs}$ — impact pressure due to slamming acting on the side area in the bow (between $x = 0.75L_{WL}$ and $x = 1.0L_{WL}$), in kN/m², to be determined in accordance with 2.4.4.4.

2.4.4.2 The water pressure $P_1$ acting on the bottom and side areas of hull below the design waterline is to be determined by the following formula:

$$P_1 = 10\left[d_x - (z - z_{kx})\right] + P_W \quad \text{kN/m}^2$$

where: $z$ — z coordinate of load point;

$P_W$ — hydrodynamic wave pressure at load point due to relative vertical motion of hull, which may be obtained by the following formula:

$$P_W = 10F_zH_{rm} \quad \text{kN/m}^2$$

where: $H_{rm}$ — relative vertical motion factor at the transverse section of coordinate $x$, to be calculated in accordance with 2.4.2.1;

$F_z$ — vertical distribution factor of hydrodynamic wave pressure at the transverse section of coordinate $x$, to be calculated in accordance with the following formula:

$$F_z = e^{-u} + (1 - e^{-u})\left(\frac{z - z_{kx}}{d_x}\right), \text{ where } u = \frac{2\pi d_x}{L_{WL}}.$$

2.4.4.3 The bottom impact pressure $P_{bs}$ due to slamming is to be determined by the following formula:

$$P_{bs} = \frac{54F_{bs}\Delta\left(1 + n_{cg}\right)}{G_SL_{WL}} \quad \text{kN/m}^2$$

where: $F_{bs}$ — longitudinal distribution factor of bottom impact pressure, to be taken as follows:

$F_{bs} = 0.5$ at $x = 1.0\,L_{WL}$;

$F_{bs} = 1.0$ between $x = 0.5\,L_{WL}$ and $0.75\,L_{WL}$;

$F_{bs} = 0.5$ at $x = 0$;

$F_{bs}$ in other areas are obtained by linear interpolation;

$n_{cg}$ — vertical overload coefficient at center of gravity of yacht, $n_{cg} = a_{cg}/g$, where $a_{cg}$ is calculated in accordance with 2.4.2.2.

2.4.4.4 The bow impact pressure $P_{fs}$ due to slamming (from $x = 0.75L_{WL}$ to $x = 1.0L_{WL}$) is to be determined as follows:

at $x = 1.0L_{WL}$, the greater of $P_{fs}$ calculated by the following formula and $P_{bs}$ calculated in accordance with 2.4.4.3:

$$P_{fs} = 0.94L_{WL}\left(0.8 + 0.15\frac{V_H}{\sqrt{L_{WL}}}\right)^2 \quad \text{kN/m}^2$$

at $x = 0.75L_{WL}$, Pbs is to be calculated in accordance with 2.4.4.3;

between from $x = 0.75L_{WL}$ and $x = 1.0L_{WL}$, $P_{fs}$ may be obtained by linear interpolation.

where: $V_H$ — speed of yacht navigating at sea with design significant wave height $H_S$, in kn, $V_H = \frac{2}{3}V$.

2.4.4.5 The water pressure $P_2$ acting on the side area outside the bow above the deign waterline (between $x = 0$ and $x = 0.75L_{WL}$) is to be determined by the following formula:

$$P_2 = (10H_{rm} - P_{Rd}/1.07)\frac{z_{dx} - z}{z_{dx} - d} + P_{Rd}/1.07 \quad \text{kN/m}^2$$

where: $H_{rm}$ — relative vertical motion factor at the transverse section of coordinate $x$, calculated in accordance with 2.4.2.1;

$P_{Rd}$ — design loads on upper weather deck at the transverse section of coordinate $x$, to be taken according to the value of PR in 2.4.4.6(1);

$z_{dx}$ — vertical distance, in m, measured from baseline to the upper weather deck beams at side at the transverse section of coordinate $x$.

2.4.4.6 The design load $P_R$ on weather deck and superstructure/deckhouse is to be determined as follows:

(1) The water pressure on the upper weather deck is taken as design load $P_R$, and to be calculated in accordance with the following formula:

$$P_R = 1.07C_2\left[F_d(0.01L_{WL} + 5)(1 + 0.5n_{cg}) + \frac{0.08L_{WL} + 0.7}{D - d}\right] \quad \text{kN/m}^2$$

where: $C_2$ — reduction coefficient of design category, see 2.4.4.1;

$F_d$ — longitudinal distribution factor, to be taken as follows:

between $x = 0$ and $x = 0.5\,L_{WL}$, $F_d = 1.0$;

at $x = 1.0\,L_{WL}$, $F_d = 1.5$;

between $x = 0.5L_{WL}$ and $x = 1.0L_{WL}$, $F_d$ may be obtained by linear interpolation;

$n_{cg}$ — vertical overload coefficient at center of gravity of yacht, same as 2.4.3.4, not to be less than 1.0.

(2) The design load $P_R$ on superstructure/deckhouse is to be determined by the following formula:

$$P_R = KP_{d1f} \quad \text{kN/m}^2$$

where: $P_{d1f}$ — design load on the upper weather deck in way of fore end wall of first tier superstructure/deckhouse, in kN/m², to be taken according to $P_R$ in 2.4.4.6(1). The longitudinal distribution factor $F_d$ is to be determined by interpolation according to the longitudinal location of fore end wall;

$K$ — location factor, to be taken according to the position of load point:

$K$ = 1.50 for fore end wall of first tier superstructure/deckhouse within $L_{WL}/3$ from bow;

$K$ = 1.30 for fore end wall of first tier superstructure/deckhouse outside $L_{WL}/3$ from bow;

$K$ = 1.00 for fore end wall of second tier superstructure/deckhouse;

$K$ = 0.80 for all side walls of superstructure/deckhouse;

$K$ = 0.65 for top, aft wall and other areas of superstructure/deckhouse.

(3) Where a heavy unit is provided or carried on the weather deck, the influence of its inertial force due to the vertical acceleration $a_x$ of yacht on the deck is to be considered, as well as the weight of the unit and the water pressure $P_R$ on the deck calculated according to 2.4.4.6(1). For calculation of inertial force of the heavy unit, the vertical acceleration of it may be taken as $0.5a_x$. The vertical acceleration $a_x$ of yacht in way of the heavy unit may be calculated in accordance with 2.4.2.3.

2.4.4.7 The design load $P_R$ on interior decks and bulkheads is to be determined as follows:

(1) Unexposed decks or platforms: $P_R = 1.07(0.01\,L_{WL}+5)\,(1+0.5n_{cg})$ kN/m²

where: $n_{cg}$ — vertical overload coefficient at center of gravity of yacht, same as 2.4.3.4, not to be less than 1.0.

(2) Watertight bulkheads: $P_R = 10\,h$ kN/m²

where: $h$ — vertical distance from load point to the highest point of the bulkhead deck, in m.

(3) Collision bulkheads: $P_R = 12.5\,h$ kN/m²

where: $h$ — vertical distance from load point to the highest point of the bulkhead deck, in m.

(4) For the design load $P_R$ on the tank bulkheads, the greatest of the following is to be taken:

$$P_1 = 10\,h(1+0.5\,n_x) \quad \text{kN/m}^2$$

$$P_2 = 6.7\,hP \quad \text{kN/m}^2$$

$$P_3 = 10(h+1) \quad \text{kN/m}^2$$

where: $n_x$ — vertical overload coefficient of yacht at center of gravity of tank at the transverse section of coordinate $x$, $n_x = a_x/g$, where ax is the vertical acceleration of yacht at the transverse section of coordinate $x$, in m/s², to be calculated according to 2.4.2.3;

$h$ — vertical distance from load point to top of tank, in m;

$h_P$ — vertical distance from load point to top of the air pipe, in m.

## Section 5 SCANTLINGS OF HULL STRUCTURE MADE OF ALUMINUM OR STEEL

### 2.5.1 General provisions

2.5.1.1 For the hull structure made of aluminum alloy and steel, in addition to the requirements of this Section, the scantlings of structural members are to comply with the related requirements of Hull Girder Strength in Section 7 and Stability of Structural Members in Section 8 of this Chapter.

2.5.1.2 For plates with thickness equal to or greater than 4 mm, where the decimal part of the calculated plate thickness is 0.25 mm or less, it may be neglected; where it is greater than 0.25 mm but less than 0.75 mm, it is to be taken as 0.5 mm; where it is 0.75 mm or more, a round number of 1.0 mm is to be taken. For plates with thickness less than 4 mm, where the decimal part is 0.15 mm or less, it may be neglected; where it is greater than 0.15 mm but less than 0.65 mm, it is to be taken as 0.5 mm; where it is 0.65 mm or more, a round number of 1.0 mm is to be taken.

### 2.5.2 Symbols and definitions

2.5.2.1 Unless expressly provided otherwise, for the purpose of this Section:

(1) Local design load $P_R$ (kN/m²): the load determined in accordance with 2.4.4 of this Chapter;

(2) Rule plate thickness $t$ (mm);

(3) Spacing of members $s$ (m): the spacing of adjacent stiffeners for stiffeners, and the average breadth of supporting load area for primary members;

(4) Span of members $l$ (m): Where there is no end bracket for stiffeners, the span point is to be taken at the end of the stiffener. Where end brackets are fitted, the span point may be taken at the middle of length of the end bracket. Where end brackets are generally fitted for primary members, the span point is to be taken at the point distant $k_e$, from the end of the member as shown in Figure 2.5.2.1(4). $k_e$ is calculated in accordance with the following formula:

$$k_e = k_b\left(1-\frac{d_w}{d_b}\right)$$

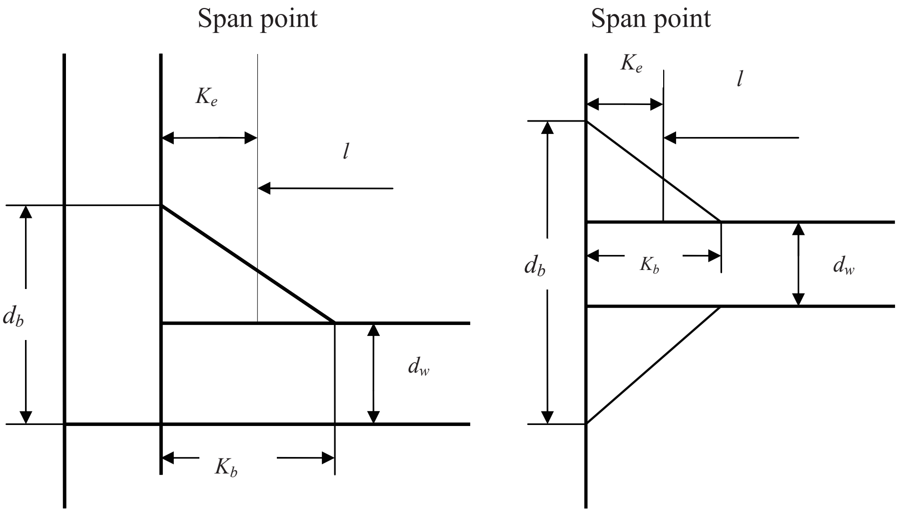



**Figure 2.5.2.1(4)**

Where primary members are supported by pillars, the supporting point of pillar may be taken as the span point of the member.

(5) Rule section modulus $W$ (cm$^3$): During calculation, the attached plating with effective width $b_e$ determined by (6) below is to be considered. The thickness of attached plating is to be taken as the average of plate thickness within the effective width of attached plating.

(6) Effective width of attached plating $b_e$ (m):

For stiffeners, $b_e = s$, but not to be greater than $l/5$;

For primary members, $b_e = 0.3\left(\frac{l}{s}\right)^{\frac{2}{3}} s$, but not to be greater than $l/5$.

(7) Yield stress of material $\sigma_s$(N/mm$^2$): For steel, see the relevant provisions of CCS Rules for Materials and Welding. $\sigma_s$ = 235 N/mm$^2$ for normal steel intended for hull structure. For aluminum alloy, $\sigma_s = \sigma_{p0.2}$, see the relevant provisions of CCS Rules for Materials and Welding.

(8) Yield stress of material after welding $\sigma_{sw}$(N/mm$^2$): For steel, $\sigma_{sw} = \sigma_s$. $\sigma_{p0.2}$ is to be taken as the yield stress of the material in annealed condition for aluminum, see the relevant provisions of CCS Rules for Materials and Welding.

### 2.5.3 Minimum scantlings

2.5.3.1 Minimum thickness $t_{min}$ of plating is to be calculated in accordance with the following formula:

$$t_{\min} = K_0\sqrt[3]{L_{WL}} \qquad \text{mm}$$

where: $K_0$ — coefficient, obtained from Table 2.5.3.1.

**Coefficient $K_0$** **Table 2.5.3.1**

| Item | | $K_0$ | |
|---|---|---|---|
| | | Steel | Aluminum |
| Bottom | | 1.40 | 1.55 |
| Side* | | 1.30 | 1.40 |
| Strength deck | | 1.10 (not less than 3mm)<br>1.30 (transversely framed) | 1.40<br>1.50 (transversely framed) |
| Unexposed deck | | 0.90 | 1.16 |
| Watertight bulkhead<br>Tank bulkhead | | 1.00 | 1.16 |
| Superstructure and deckhouse | Front | 1.20 | 1.30 |
| | Side, behind | 0.86 | 0.92 |
| | Top | 0.86 (not less than 2 mm) | 0.80 |
| Main engine seating | | 1.90 | 1.90 |

* The coefficient of minimum thickness of side shell plating within 0.15 m above the design waterline is to be taken according to the value of coefficient of minimum thickness of bottom shell plating.

2.5.3.2 Built-up sections of bottom, including engine seating, are to comply with the following requirements:

(1) The minimum thickness $t_{min}$ of the face plate is not to be less than the value obtained from the following formula:

$$t_{min} = \frac{b}{16} \quad \text{mm}$$

where: $b$ — face plate width, in mm.

(2) The minimum thickness $t_{min}$ of the web is not to be less than the value obtained from the following formulae:

$$t_{min} = \frac{h}{65} \geq 2.5 \quad \text{mm} \quad \text{for steel}$$

$$t_{min} = \frac{h}{50} \geq 3.0 \quad \text{mm} \quad \text{for aluminum alloy}$$

where: $h$ — web depth, in mm.

2.5.3.3 Deck pillar is to comply with the following requirements:

(1) The minimum wall thickness for tubular pillar or built-up pillar is not to be less than 4 mm.

(2) The steel pillars are to comply with the appropriate requirements of CCS Rules for Classification of Sea-going Steel Ships.

(3) The allowable load $P$ of aluminum deck pillar is to be calculated according to the following formula:

$$P = A(6 - 0.0349\frac{l}{r})\sigma_s 10^{-2} \quad \text{kN}$$

where: $A$ — cross-section area of pillar, in $cm^2$;

$l$ — length of pillar, in cm;

$r$ — minimum radius of inertia of the cross-section of pillar, in cm.

### 2.5.4 Thickness of plating

2.5.4.1 The thickness of plating $t$ determined by bending strength of plating is to be calculated in accordance with the following formula:

$$t = K_1 C_1 C_2 s \sqrt{\frac{P_R}{\sigma_{sw}}} \quad \text{mm}$$

where: $C_1$ — curvature correction factor, $C_1$ = 1 - 0.5$s/r$, where $r$ is radius of curvature, in m;

$C_2$ — correction factor for panel aspect ratio of long side $\ell$ to short side $s$, to be taken as follows:

$$C_2 = \frac{\ell}{s}(1 - 0.25\frac{\ell}{s}) \quad \text{for } \ell/s \le 2;$$

$$C_2 = 1.0 \quad \text{for } \ell/s > 2;$$

$K_1$ — coefficient determined according to different areas:

$K_1$ = 24.3 for all bottom area and side area in the bow region (forward of $x = 0.75L_{WL}$);

$K_1$ = 22.4 for watertight bulkhead and collision bulkhead;

$K_1$ = 27.8 for bulkhead of deep oil and water tank and the fore end bulkhead of first tier superstructure/deckhouse;

$K_1$ = 25.8 for other areas.

2.5.4.2 The shell plating is also to comply with the following additional requirements:

(1) The thickness of plate keel is to be increased by 2 mm over the adjacent bottom shell plating. The width of plate keel is not to be less than 0.1$B$.

(2) The bilge plate thickness is not to be less than that of adjacent bottom shell plating required to satisfy strength requirements.

(3) The thickness of the stern or transom is to be not less than that required for the adjacent bottom shell plating.

(4) The shell plating over the propeller and in way of the rudder post at stern is to be suitably strengthened.

(5) Where a forecastle is fitted, the plating thickness of weather deck is to be increased by 20% in way of the end of the forecastle if this occurs at a position aft of $0.25L_{WL}$ from the forward perpendicular. No increase is required if the forecastle end bulkhead lies forward of $0.2L_{WL}$ from the forward perpendicular. The increase at intermediate positions of the forecastle end bulkhead is to be obtained by interpolation.

**2.5.5 Section modulus of members**

2.5.5.1 The section modulus $W$ determined by the bending strength is to be calculated in accordance with the following formula:

$$W = K_2 \frac{l^2 s P_R}{\sigma_{sw}} \quad \text{cm}^3$$

where: $K_2$ — coefficient determined according to different areas:

$K_2$ =115 for stiffeners of all bottom area and side area in the bow region (forward of $x = 0.75L_{WL}$);

$K_2$ =133 for stiffeners of side area outside the bow region (between $x = 0$ and $x = 0.75L_{WL}$);

$K_2$ =130 for longitudinal stiffeners of strength deck;

$K_2$ =142 for longitudinal stiffeners of other decks (including top plate of superstructure/deckhouse);

$K_2$ =110 for vertical stiffeners and primary members of watertight bulkhead;

$K_2$ =150 for vertical stiffeners of bulkheads of deep oil or water tank;

$K_2$ =133 for vertical stiffeners of superstructure/deckhouse wall;

$K_2$ =150 for all primary members (other than those on watertight bulkheads) and transverse stiffeners of transverse framing (other than those of side area between $x = 0$ and $x = 0.75L_{WL}$);

$\sigma_{sw}$ — yield stress of material after welding, see 2.5.2.1(8). For determination of the section modulus of primary members of hull structures made of aluminum alloy, the yield stress $\sigma_s$ of material before welding may be used for primary members in areas other than the bottom area.

**2.5.6 Effective shear area at end of members**

2.5.6.1 The effective shear area $A_e$ at end of stiffeners determined by shearing strength is not to be less than $A_{e\,min}$ obtained from the following formula:

$$A_{e\min} = 22.67\frac{(l-s)sP_R}{\sigma_{sw}} \quad \text{cm}^2$$

$A_e$ is calculated as follows:

$$A_e = 0.01ht \quad \text{cm}^2$$

where: $h$ — web depth of stiffeners, in mm;

$t$ — web thickness of stiffeners, in mm.

2.5.6.2 The effective shear area $A_e$ at end of primary members determined by shearing strength is not to be less than $A_{e\,min}$ obtained from the following formula:

$$A_{e\min} = 13.5\frac{slP_R}{\sigma_{sw}} \quad \text{cm}^2$$

$A_e$ is calculated as follows:

$$A_e = 0.01h_w t_w \quad \text{cm}^2 \quad \text{for no bracket at end}$$

$$A_e = 0.01h_w t_w + \Delta A_e \quad \text{cm}^2 \quad \text{for bracket at end}$$

where: $h_w$ — net web height after deduction of cutouts in the cross section considered;

$t_w$ — web thickness, in mm;

$\triangle A_e$ — additional shear area at end of primary members with bracket, in cm², obtained according to the horizontal angle of the bracket's face plate, see Figure 2.5.6.2.

$\triangle A_e$ =0.9$f_1$, where $\theta$ = 45°; $\triangle A_e$ = 0, where $\theta$ = 0; $\triangle A_e$ may be obtained by interpolation where $\theta$ = 0°- 45°; $f_1$ is area of the bracket's face plate in the cross section considered, in cm².

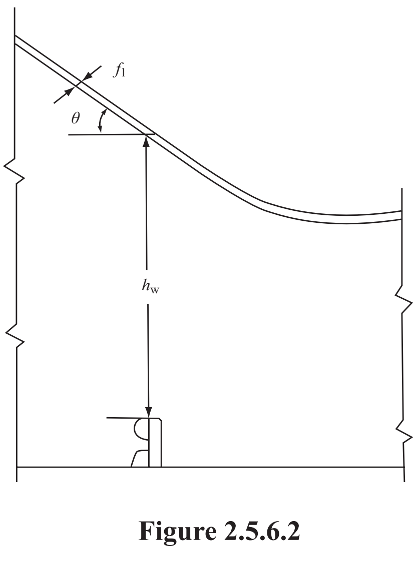



**Figure 2.5.6.2**

## Section 6 SCANTLINGS OF HULL STRUCTURE MADE OF FRP

### 2.6.1 General provisions

2.6.1.1 For the hull structure made of fabric reinforced plastics, in addition to the requirements of this Section, the scantlings of structural members are to comply with the related requirements of Hull Girder Strength in Section 7 and Stability of Structural Members in Section 8 of this Chapter.

2.6.1.2 The scantlings of structural members specified in this Section are only applicable to yachts of 60 m and below in $L_{WL}$.

2.6.1.3 The difference in elastic modulus in the two principal directions is not to be more than 20%, which is the basic condition to determine the members' scantlings specified in this Section.

2.6.1.4 The mechanical properties of test specimen of FRP for a yacht's hull are not to be less than that as required in Chapter 2, PART TWO of CCS Rules for Materials and Welding.

2.6.1.5 This laminated plate moulded by lay-out with chopped strand mat (CSM) and biaxial woven rovings (BIAXIAL) alternately is recommended.

2.6.2 Symbols and definitions

2.6.2.1 Unless expressly provided otherwise, for the purpose of this Section:

(1) Local design load $P_R$ (kN/m$^2$): the load determined in accordance with 2.4.4 of this Chapter;

(2) Rule plate thickness $t$ (mm);

(3) Spacing of members $S$ (m): the spacing of adjacent stiffeners for stiffeners, and the average breadth of supporting load area for primary members;

(4) Span of members $l$ (m): Where there is no end bracket for stiffeners, the span point is to be taken at the end of the stiffener. Where end brackets are fitted, the span point may be taken at the middle of length of the end bracket. For primary members, the span point is generally to be taken where the structure is fixed against rotation or displacement subject to load. Where end brackets are fitted for primary members, the span point is to be taken as shown in Figure 2.5.2.1(4).

### 2.6.3 Minimum scantlings

2.6.3.1 The minimum thickness $t_{min}$ of single skin laminates is to be determined in accordance with the following formula:

$$t_{\min} = K_0 \sqrt{L_{WL}} \quad \text{mm}$$

where: $K_0$ — coefficient, obtained from Table 2.6.3.1;

$L_{WL}$ — waterline length, in m.

**Coefficient $K_0$** **Table 2.6.3.1**

| Location | Bottom | Side* | Deck | Superstructure/deckhouse | | | Bulkhead | |
|---|---|---|---|---|---|---|---|---|
| | | | | Front | Side, behind | Top | Watertight | Collision, liquid tank |
| $K_0$ | 1.30 | 1.15 | 1.00 | 1.00 | 0.85 | 0.85 | 1.10 | 1.20 |

* The coefficient of minimum thickness of side shell plating within 0.15 m above the design waterline is to be taken according to the value of coefficient of minimum thickness of bottom shell plating.

2.6.3.2 The minimum thickness $t_{min}$ of each skin laminate on structural sandwich panels is to be determined in accordance with the following formulae:

$t_{\min} = K_1 \sqrt{L_{WL}}$ mm, but not less than 2.0 mm, for exposed skin laminate①

$t_{\min} = K_1 \sqrt{L_{WL}} - 0.5$ mm, but not less than 1.5 mm, for protected skin laminate②

① "Exposed skin" means the skin laminate subjected to liquid continuously or milling of machine or impacting load.

② "Protected skin" means the laminate not subjected to the above load.

where: $K_1$ — coefficient, obtained from Table 2.6.3.2;
$L_{WL}$ — waterline length, in m.

**Coefficient $K_1$** **Table 2.6.3.2**

| Location | Bottom | Side | Deck | Superstructure/deckhouse | | | Bulkhead | |
|---|---|---|---|---|---|---|---|---|
| | | | | Front | Side, behind | Top | Watertight | Collision, liquid tank |
| $K_1$ | 0.6 | 0.5 | 0.45 | 0.45 | 0.35 | 0.35 | 0.40 | 0.45 |

**2.6.4 Thickness of laminate**

2.6.4.1 The thickness $t$ of single skin laminate is not to be less than the value obtained from the following formula:

$$t = 44.8 C_1 C_2 s \sqrt{\frac{P_R}{\sigma_{fnu}}} \quad \text{mm}$$

where: $C_1$ — curvature correction factor, $C_1 = 1 - 0.5s/r$, where r is radius of curvature, in m;
$C_2$ — correction factor for panel aspect ratio of long side $\ell$ to short side $s$, to be taken as follows:

$$C_2 = \frac{\ell}{s}(1 - 0.25\frac{\ell}{s}) \quad \text{for } \ell/s \le 2;$$

$$C_2 = 1.0 \quad \text{for } \ell/s > 2;$$

$\sigma_{fnu}$ — ultimate bending stress of laminate, in N/mm$^2$.

2.6.4.2 The total thickness $t$ of a structural sandwich panel is not to be less than the value obtained from the following formula:

$$t = \frac{1.428}{K}(1 + \frac{1}{\gamma})\frac{sP_R}{\tau_C} \quad \text{mm}$$

where: $\gamma$ — ratio of the distance between centerlines of opposite skin laminates to the mean thickness of opposite skin laminates, $6 \le \gamma \le 14$;
$\tau_c$ — ultimate shear stress of sandwich core material, in N/mm$^2$;
$K$ — coefficient:
$K = 1.86 - 0.06\,\gamma$ and $K \nless 1$, for core of PU cellular plastic;
$K = 1.95 - 0.079\,\gamma$ and $K \nless 1$, for core of PVC cellular plastic;
$K = 1.0$ for core of plywood;
$K$ is to be specially considered for core of other material.

2.6.4.3 The width of plate keel is not to be less than $0.1B$ ($B$ is breadth of yacht). The thickness of plate keel is to be increased by 2 mm over the adjacent bottom plate and is to keep constant within the whole length as practicable as possible.

2.6.4.4 The thickness of the stern or transom is to be not less than that required for the bottom shell plating.

2.6.4.5 The shell plating over the propeller and in way of the rudder post at stern is to be suitably strengthened.

**2.6.5 Bending strength for stiffeners and frames**

2.6.5.1 The section modulus $W$ of stiffeners and frames is not to be less than the value obtained from the following formula:

$$W = K\frac{l^2 sP_R}{\sigma_{fnu}} \quad \text{cm}^3$$

where: $\sigma_{fnu}$ — ultimate bending stress of laminate, in N/mm$^2$;
$K$ — coefficient, obtained from Table 2.6.6.1.

**Coefficient $K$** **Table 2.6.5.1**

| Location | $K$ | |
|---|---|---|
| | Girder, web frame, plate floor, web beam | Longitudinals, floor, frame, beam, stiffener |
| Bottom | 480 | 400 |
| Side | 480 | 400 |
| Deck | 480 | 400 |
| Superstructure | 480 | 400 |
| Watertight bulkhead | 480 | 400 |
| Liquid tank & collision bulkhead | 480 | 480 |

2.6.5.2 The rule section modulus of stiffeners and frames are the minimum section modulus of them with their effective flange. The width of effective attached plating of members is to be taken as follows.

(1) Where the attached plating is a single skin panel, the lesser of following is to be taken:

$$b_e = S \quad \text{mm}$$
$$b_e = 23t + b_s \quad \text{mm}$$

(2) Where the attached plating is a structure sandwich panel:

① For ineffective core such as cellular plastic or balsa wood, etc., the lesser of following is to be taken:

$$b_e = S \quad \text{mm}$$
$$b_e = 11d \quad \text{mm}$$

② For effective core such as plywood, etc., the lesser of following is to be taken:

$$b_e = S \quad \text{mm}$$
$$b_e = 35d \quad \text{mm}$$

where: $t$ — total thickness of the attached plating, in mm;

$d$ — distance between centrelines of opposite skin laminates of a sandwich panel, in mm;

$b_s$ — net width of stiffener, in mm.

2.6.5.3 Where the effective material such as pine or plywood is employed as core of the member, the core affection is to be taken into account in calculating the section modulus. The section area of the core is to be reduced by the ratio of its bending modulus of elasticity to the bending modulus of elasticity of the member's laminate.

2.6.5.4 The main engine seating is to be of ample strength and rigidity. The longitudinal girders of the seating are to be strengthened according to the main engine horse power. The longitudinal girders are to be fitted with transverse bracket plates and tripping brackets in line with every floor, to ensure the effective support.

**2.6.6 Shearing strength for girders**

2.6.6.1 The effective web plate area of girders $A_e$ is to be calculated in accordance with the following formula:

$$A_e = 0.01 h_w t_w \quad \text{cm}^2 \quad \text{for no bracket at end}$$

$$A_e = 0.01 h_w t_w + \Delta A_e \quad \text{cm}^2 \quad \text{for bracket at end}$$

where: $t_w$ — total thickness of FRP web plate, in mm;

$h_w$, $\Delta A_e$ — are the same as in 2.5.6.2 of this Chapter.

2.6.6.2 The effective web plate area $A_e$ calculated in accordance with the requirements of 2.6.6.1 above is not to be less than $A_{e\min}$ obtained from the following formula:

$$A_{e\min} = \frac{25.5 s l P_R}{\tau_u} \quad \text{cm}^2$$

where: $\tau_u$ — ultimate shear stress of sandwich plate, in N/mm$^2$.

### 2.6.7 Pillar

2.6.7.1 Aluminum alloy or steel is permitted to be used for deck pillars, see 2.5.3.3 of this Chapter. Other materials may be used subject to agreement of CCS.

## Section 7 HULL GIRDER STRENGTH

### 2.7.1 General provisions

2.7.1.1 The hull girder strength is to be checked in the following cases:

(1) yachts of more than 40 m in $L_{WL}$;

(2) yachts having large openings in strength decks within 0.4 $L_{WL}$ amidships, whose width is more than half of the width of strength decks.

2.7.1.2 The full load departure condition is to be taken for checking the hull girder strength.

### 2.7.2 Checking sections of hull girder

2.7.2.1 The following three transverse sections of hull girder are at least to be taken for checking the longitudinal strength:

(1) The midsection at the weakest part of the structure within ±20% $L_{WL}$ amidships is to be taken for checking the bending strength of hull girder.

(2) The forward section with the maximum vertical shear force is to be taken for checking the shear strength of hull girder.

(3) The aft section with the maximum vertical shear force is to be taken for checking the shear strength of hull girder.

2.7.2.2 Considerations are also to be given to the sections in way of large openings in strength decks and of abrupt changes areas of hull girder structures.

### 2.7.3 Strength characteristics of hull girder sections

2.7.3.1 The hull girder sections are to be considered to consist of members contributing to the longitudinal strength of hull girder, including strength decks and all the continuous longitudinal members below, taking into account the requirements of 2.7.3.2 and 2.7.3.3.

2.7.3.2 The longitudinal members having a length greater than moulded depth $D$ on both sides of the checking section may be taken into account in the hull girder sections. However where openings having a depth greater than 25% of that of the web plate are cut in them, the sectional areas of these openings are to be deducted. Engine seating and bilge keel are not to be taken into account in the hull girder sections.

2.7.3.3 Within $0.25L_{WL}$ to $0.75L_{WL}$ from aft, where the first tier superstructure/deckhouse having a length greater than $0.15L_{WL}$ and more than 6 times its own height is supported on at least 3 transverse bulkheads and the flexible connection is not adopted, it may be taken into account in the hull girder sections.

2.7.3.4 The superstructure or deckhouse not satisfying any of the conditions above is not to be considered to make contribution to the longitudinal strength and is not to be taken into account in the hull girder sections. Where part of it is considered to make contribution to the longitudinal strength, it is to be determined by direct calculations.

2.7.3.5 Where there are a large amount of openings on the side walls of superstructure / deckhouse and the sum of length of all openings on each side wall exceeds half of the structure length or the flexible connection between the superstructure/deckhouse and the main hull is adopted, the structure is not to be considered to make contribution to the hull girder strength.

### 2.7.4 Openings of strength deck

2.7.4.1 During the calculation of checking sections of hull girder, elliptical openings of more than 2.5 m in length or more than 1.2 m in width and round openings of more than 0.9 m in diameter in the strength deck at the section are to be deducted from the sectional areas of hull girder.

### 2.7.5 Section modulus of hull girder

2.7.5.1 At the hull section as defined in 2.7.2.1(1) of this Chapter, the section modulus $Z_A$ of any point (with vertical coordinate $z$) below the strength deck is to be calculated in accordance with the following formula:

$$Z_A = \frac{I_Y}{|z - N|} \quad \text{m}^3$$

where: $I_Y$ — moment of inertia for the hull section to its horizontal neutral axis, in m$^4$;

$N$ — vertical distance from the horizontal neutral axis of hull section to the baseline, in m;

$z$ — vertical coordinate of the point calculated, in m.

2.7.5.2 At the hull section as defined in 2.7.2.1(1) of this Chapter, the section modulus $Z_{AK}$ and $Z_{AD}$ in way of bottom keel and strength deck are to be calculated in accordance with the following formulae respectively:

$$\text{Bottom keel:} \quad Z_{AK} = \frac{I_y}{|z_{kx} - N|} \quad \text{m}^3$$

$$\text{Strength deck:} \quad Z_{AD} = \frac{I_y}{z_D - N} \quad \text{m}^3$$

where: $Z_{AK}$ — see 2.4.1.3, x is the ordinate of the hull section;

$Z_{AD}$ — $z$ coordinate of the edge line of strength deck in way of the hull section as defined in 2.7.2.1(1) of this Chapter;

$I_Y$ and $N$ — see 2.7.5.1.

2.7.5.3 At the section of hull structure of composite material, the section modulus $Z_A$ of any point (with vertical coordinate $z$) below the strength deck is to be calculated in accordance with the following formula:

$$Z_A = \frac{\sum (E_i I_i)}{E_z |z - N|} \quad \text{m}^3$$

where: $I_i$ — moment of inertia to the neutral axis of the section for each member at the section, in m$^4$;

$E_i$ — modulus of tensile or compressive elasticity (subject to the tensile or compressive condition as appropriate) for each member's material composing of the section, in N/mm$^2$;

$E_z$ — modulus of tensile or compressive elasticity (subject to the tensile or compressive condition as appropriate) for material of the point calculated, in N/mm$^2$;

$Z$ and $N$ — see 2.7.5.1.

### 2.7.6 Static moment of height z above the baseline

2.7.6.1 Static moment $S$ of height $z$ above the baseline is the static moment to the horizontal neutral axis for all members above the point calculated where the point is above the horizontal neutral axis or the static moment to the horizontal neutral axis for all members below the point calculated where the point is below the horizontal neutral axis.

### 2.7.7 Stress of hull girder

2.7.7.1 The normal stress $\sigma_1$ due to vertical bending moment is to be calculated as follows:

(1) For any point (with vertical coordinate $z$) below the strength deck at the checking section:

$$\sigma_1 = \frac{M_R}{Z_A} \times 10^{-3} \quad \text{N/mm}^2$$

where: $Z_A$ — section modulus calculated according to 2.7.5.1, in m³;

$M_R$— design value of vertical bending moment at midsection according to 2.4.3.5, in kN·m.

(2) In way of the plate keel of bottom at the checking section (with vertical coordinate $z_{kx}$):

$$\sigma_1 = \frac{M_R}{Z_{AK}} \times 10^{-3} \qquad \text{N/mm}^2$$

where: $Z_{AK}$ — section modulus in way of bottom keel calculated according to 2.7.5.2, in m³;

$M_R$ — design value of vertical bending moment at midsection according to 2.4.3.5, in kN·m.

(3) In way of the strength deck at the checking section:

$$\sigma_1 = \frac{M_R}{Z_{AD}} \times 10^{-3} \qquad \text{N/mm}^2$$

where: $Z_{AD}$ — section modulus in way of strength deck calculated according to 2.7.5.2, in m³;

$M_R$ — design value of vertical bending moment at midsection according to 2.4.3.5, in kN·m.

2.7.7.2 For the forward and aft sections with the maximum vertical shear force, the shear stress $\tau_1$ due to the vertical shear force acting on the shell platings at sides and longitudinal bulkheads at the two sections are to be checked respectively. The shear stress $\tau_1$ in way of the point calculated (of height z above the baseline) is to be calculated in accordance with the following formula. $\tau_1$ is to calculated by selecting several calculated points vertically and the maximum shear stress is to be checked:

$$\tau_1 = \frac{Q_R S}{I_y t} \qquad \text{N/mm}^2$$

where: $Q_R$ — design value of vertical shear force calculated according to 2.4.3.7, in kN;

$t$ — the summation of the thickness of shell platings at sides and longitudinal bulkheads platings in way of the point calculated of height $z$ above the baseline, in mm;

$S$ — static moment in way of the point calculated of height $z$ above the baseline according to 2.7.6.1, in m³;

$I_y$ — moment of inertia for the checking section to its horizontal neutral axis, in m⁴, see 2.7.5.1.

### 2.7.8 Criteria for checking the yield strength of hull girder

2.7.8.1 The normal stress $\sigma_1$ due to vertical bending moment calculated according to 2.7.7.1 is to comply with the following formula in both hogging and sagging conditions:

$$\sigma_1 \le [\sigma_1] \qquad \text{N/mm}^2$$

where: $[\sigma_1]$ — allowable normal stress, in N/mm²;

for hull structures of aluminum or steel: $[\sigma_1]=0.72\sigma_{SW}$, where: $\sigma_{SW}$ —yield strength after welding of material, in N/mm², see 2.5.2.1(8);

for hull structures of FRP:

for tension, $[\sigma_1] = 0.25\sigma_{SW}$, where: $\sigma_{SW}$ — ultimate tensile strength of FRP, in N/mm²;

for compression, $[\sigma_1] = 0.25\sigma_{SW}$, where: $\sigma_{pnu}$ — ultimate compressive strength of FRP, in N/mm².

2.7.8.2 For the shear stress $\tau_1$(positive or negative) due to the vertical shear force calculated according to 2.7.7.2, the absolute value is to comply with the following formula:

$$\tau_1 \le [\tau_1] \qquad \text{N/mm}^2$$

where: $[\tau_1]$ — allowable shear stress, in N/mm²;

for hull structures of aluminum or steel: $[\tau_1] = 0.72\tau_{SW}$, where: $\tau_{SW}$— shear strength after welding of material, $\tau_{SW} = \sigma_{SW}/\sqrt{3}$ N/mm², where $\sigma_{SW}$ is given in 2.5.2.1(8);

for hull structures of FRP: $[\tau_1] = 0.25\tau_{nu}$, where: $\tau_{nu}$ — ultimate shear strength of material, in N/mm².

## Section 8 STABILITY OF STRUCTURAL MEMBERS

### 2.8.1 General requirements

2.8.1.1 For yachts for which the hull girder strength is to be checked in accordance with 2.7.1.1 of this Chapter, the stability in the general longitudinal bending condition for bottom, deck, side shell plating and the longitudinals is to be checked.

2.8.1.2 The stability of a sandwich panel exposed to compress for a F.R.P yacht is to be checked.

### 2.8.2 Symbols and definitions

2.8.2.1 Unless expressly provided otherwise, for the purpose of this Section:

(1) Modulus of elasticity of material $E$ (N/mm²): see relevant provisions of CCS Rules for Materials and Welding.

(2) Length of short side of panel $s$ (mm).

(3) Plate thickness $t$ (mm).

(4) Yield stress of material $\sigma_s$(N/mm²): For steel, see the relevant provisions of CCS Rules for Materials and Welding. $\sigma_s$ = 235 N/mm² for normal steel intended for hull structure. For aluminum alloy, $\sigma_s = \sigma_{p0.2}$, see the relevant provisions of CCS Rules for Materials and Welding.

### 2.8.3 Rectangular metal plating

2.8.3.1 The ideal elastic buckling stress $\sigma_E$ for a rectangular plate of bottom or deck may be taken as:

$$\sigma_E = 0.9K_c E\left(\frac{t}{s}\right)^2 \qquad \text{N/mm}^2$$

where: $E$ — modulus of elasticity of material:

$E = 0.69 \times 10^5$ in N/mm², for aluminum plate;

$E = 2.06 \times 10^5$ in N/mm², for steel plate;

$t$ — plate thickness, in mm;

$s$ — length of short side of panel, in mm;

$K_c$ — coefficient, calculated according to the direction of compressive stress:

$K_c$ = 4.0 for the long side of panel parallel to compressive stress;

$K_c = C\left[1+\left(\frac{s}{l}\right)^2\right]^2$ for the long side of panel perpendicular to compressive stress;

where: $l$ — length of long side of panel, in mm:

$C$ = 1.21 where secondary members of long side of panel are angle steel / aluminum or T-sections;

$C = 1.10$ where secondary members of long side of panel are bulb flats/aluminum;
$C = 1.05$ where secondary members of long side of panel are flat bars/aluminum.

2.8.3.2 The ideal elastic buckling stress $\sigma_E$ for a rectangular plate of the side shell plating may be taken as:

$$\sigma_E = \frac{7.56}{\varphi + 1.1} E\left(\frac{t}{s}\right)^2 \qquad \text{N/mm}^2$$

where: $\varphi$ — coefficient of stress distribution ($\sigma$ for the stress on upper edge of the plate, $\varphi\sigma$ for one on the lower edge), $0 \leq \varphi \leq 1$.

2.8.3.3 The critical buckling stress $\sigma_{cr}$ of plate may be taken as:

$$\sigma_{cr} = \sigma_E \qquad \sigma_E \leqslant \frac{\sigma_s}{2}$$

$$\sigma_{cr} = \sigma_s\left(1 - \frac{\sigma_s}{4\sigma_E}\right) \qquad \sigma_E > \frac{\sigma_s}{2}$$

where: $\sigma_E$ — ideal elastic buckling stress, in N/mm2, see 2.8.3.1.

2.8.3.4 The compressive stress $\sigma_1$ of a plate calculated according to 2.7.7.1 is not to be greater than the allowable critical buckling stress $[\sigma_{cr}]$ obtained from the following formula:

$$[\sigma_{cr}] = \eta\sigma_{cr} \qquad \text{N/ mm}^2$$

where: $\eta$ — safety factor on stability,
$\eta = 0.8$ when $S/t = 60$;
$\eta = 0.9$ when $S/t = 120$;
the intermediate value may be obtained by interpolation.

2.8.3.5 For panels with ideal elastic buckling stress $\sigma_E < \sigma_S/2$, the compressive stress $\sigma_1$ of a plate calculated according to 2.7.7.1 is permitted to exceed the critical buckling stress $\sigma_{cr}$, but not to be greater than 80% of the mean ultimate compressive stress $\sigma_u$ obtained from the following formula:

$$\sigma_u = (1 - 2C)\sigma_E + C\sigma_s$$

where: $\sigma_E$ — ideal elastic buckling stress of panel, in N/mm$^2$, see 2.8.3.1 and 2.8.3.2;
$C$ — coefficient, calculated according to the following:
$C = 0.375$ for the long side of panel parallel to compressive stress;
$C = 0.75/(l/S+1)$ for the long side of panel perpendicular to compressive stress.

### 2.8.4 Metal stiffener and girder

2.8.4.1 The ideal elastic buckling stress $\sigma_E$ for stiffener or girder with attached plating is to be taken as:

$$\sigma_E = C\frac{\pi^2 E}{l^2}\frac{I}{A} \qquad \text{N/mm}^2$$

where: $I$ — moment of inertia of section for stiffener or girder with attached plating, in cm$^4$;
$A$ — area of section for stiffener or girder with attached plating, in cm$^2$;
$l$ — span of longitudinals or girders when exposed to longitudinal compress, in cm;
$C$ — constraining coefficient for ends of stiffener or girder. The end will be considered fixing if there is a bracket provided with sufficient size, while the end will be considered simple supporting if there is no bracket provided.
$C = 1$ for two ends of simple supporting;
$C = 2$ for one end with simple supporting and the other one fixed supporting;
$C = 4$ for two ends of fixing.

50% of sectional area of longitudinals on effective breadth of attached plating of primary longitudinal members is to be taken into account in the calculation of the moment of inertia of section $I$ and the area of section $A$ of primary members in this Section.

2.8.4.2 In the calculation of moment of inertia $I$ and area $A$ of section for stiffener or girder with attached plating as specified in 2.8.4.1, the reduced effective breadth $b_e$ of attached plating for the stiffeners and primary members is to be calculated respectively by the following formulae:

(1) For the effective breadth $b_e$ of attached plating of stiffeners:

$$b_e = (0.44 + 0.56\frac{[\sigma_{cr}]}{\sigma_s})s \qquad \text{mm, but not to be greater than } 0.8s$$

where: $[\sigma_{cr}]$ — to be obtained from $\sigma_{cr}$ in 2.8.3.3 multiplied by 0.8, $\sigma_E$ in the formula to be taken as:

$$\sigma_E = 11.5E(\frac{t}{s})^2 \qquad \text{N/mm}^2$$

(2) For the effective breadth $b_e$ of attached plating of primary members:

$$b_e = Cb \qquad \text{mm}$$

where: $b$ — mean breadth of load area for primary members, in mm;

$C$ — coefficient as given in Table 2.8.4.2(2).

**Coefficient *C*** **Table 2.8.4.2(2)**

| $r$ \ $a/b$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | >7 |
|---|---|---|---|---|---|---|---|---|
| ≥ 6 | 0.00 | 0.38 | 0.67 | 0.84 | 0.93 | 0.97 | 0.99 | 1.00 |
| 5 | 0.00 | 0.33 | 0.58 | 0.73 | 0.84 | 0.89 | 0.92 | 0.93 |
| 4 | 0.00 | 0.27 | 0.49 | 0.63 | 0.74 | 0.81 | 0.85 | 0.87 |
| ≤ 3 | 0.00 | 0.22 | 0.40 | 0.52 | 0.65 | 0.73 | 0.78 | 0.80 |

Note: $r$ — numbers of evenly spaced point loads on the span of the primary member;

$a$ — calculated span of the primary member, in mm;

$a = l - h$, for simple supported ends;

$a = 0.6(l - h)$, for fixed ends;

where: $h$ — web height of the primary member, in mm;

$l$ — span of the primary member, in mm.

The boundary of above end may be determined as specified in 2.8.4.1.

2.8.4.3 The ideal elastic buckling stress $\sigma_E$ for the face plate and the web plate of the primary members is to be calculated respectively by the following formulae:

(1) For face plate:

$$\sigma_E = 0.38E(\frac{t_f}{b_f})^2 \qquad \text{N/mm}^2$$

where: $t_f$ — thickness of face plate of primary members, in mm;

$b_f$ — breadth of face plate of primary members, in mm.

For T-sections, half of the breadth is to be taken. Where the face plate of primary members is too long, the tripping bracket is to be provided within the span and the ideal elastic buckling stress $\sigma_E$ is to be calculated by the following formula:

$$\sigma_E = 0.38E\left(\frac{t_f}{b_f}\right)^2 + 0.9E\left(\frac{t_f}{l_f}\right)^2 \qquad \text{N/mm}^2$$

where: $l_f$ — face plate span between brackets, in mm.

(2) For web plate:

$$\sigma_E = 3.8E\left(\frac{t}{h}\right)^2 \qquad \text{N/mm}^2$$

where: $t$ — thickness of web plate of primary members, in mm;

$h$ — height of web plate of primary members, in mm.

2.8.4.4 The critical buckling stress $\sigma_{cr}$ of stiffeners, primary members and the face plate and web plate of primary members is to be calculated by the following formulae:

$$\sigma_{cr} = \sigma_E \qquad \sigma_E \leqslant \frac{\sigma_s}{2}$$

$$\sigma_{cr} = \sigma_s\left(1 - \frac{\sigma_s}{4\sigma_E}\right) \qquad \sigma_E > \frac{\sigma_s}{2}$$

where: $\sigma_E$ — ideal elastic buckling stress, in N/mm², to be calculated according to 2.8.4.1 and 2.8.4.3.

2.8.4.5 The allowable critical buckling stress $[\sigma_{cr}]$ for stiffeners and the face plate and web plate of primary members is to be calculated by the following formula:

$$[\sigma_{cr}] = 0.8\sigma_{cr} \qquad \text{N/mm}^2$$

2.8.4.6 The allowable critical buckling stress $[\sigma_{cr}]$ for primary members is to be calculated by the following formula:

$$[\sigma_{cr}] = \eta\sigma_{cr} \qquad \text{N/mm}^2$$

where: $\sigma_{cr}$ — critical buckling stress, see 2.8.4.4;

$\eta$ — safety factor of stability, to be calculated as follows:

$$\eta = \frac{K}{1 + \frac{l}{r}}$$

but $\eta$ is not to be less than 0.3.

where: $K$ — coefficient,

= 0.7, in general;

= 0.6, when design loads are primarily dynamic;

$r$ — radius of inertia of section of primary members, in cm;

$l$ — span of primary members, in m.

2.8.4.7 The compressive stress $\sigma_1$ of member calculated according to 2.7.7.1 is not to be greater that the allowable critical buckling stress $[\sigma_{cr}]$ as defined in 2.8.4.5 and 2.8.4.6.

**2.8.5 Sandwich panels of F.R.P**

2.8.5.1 For a sandwich panel with PU cellular plastics core, the critical local buckling stress $\sigma_{cr}$ of its skin laminate is to be taken as the smaller according to the following formulae:

$$\sigma_{cr} = 0.5(E_f E_c G_c)^{1/3} \quad \text{N/mm}^2$$
$$\sigma_{cr} = 1.39\gamma^{0.639} G_c \quad \text{N/mm}^2$$

where: $E_f$ — compressing modulus of elasticity of skin laminate, in N/mm²;
$E_c$ — compressing modulus of elasticity of core material, in N/mm²;
$G_c$ — shearing modulus of elasticity of core material, in N/mm²;
$\gamma$ — ratio of the distance between centerlines of opposite skin laminates to the mean thickness of opposite skin laminates, $6 \le \gamma \le 14$.

2.8.5.2 For a sandwich panel with PVC cellular plastics core, the critical local buckling stress $\sigma_{cr}$ of its skin laminate is to be taken as the smaller according to the following formulae:

$$\sigma_{cr} = 0.5\left(E_f E_c G_c\right)^{1/3} \quad \text{N/mm}^2$$
$$\sigma_{cr} = 1.52\gamma^{0.585} G_c \quad \text{N/mm}^2$$

where: $E_f$, $E_c$, $G_c$, $\gamma$ the same as 2.8.5.1.

2.8.5.3 The calculated compressive stress of above-mentioned both panels is not to be greater than $0.3\sigma_{cr}$ calculated according to 2.8.5.1 and 2.8.5.2, and $0.3\sigma_{pnu}$, $\sigma_{pnu}$ is the ultimate compressive stress of its skin laminate.

2.8.5.4 For a sandwich panel with plywood core, the ultimate compressing stress $\sigma_{pnu}$ is to be calculated as follows:

$$\sigma_{pnu} = 0.15(E_f E_c G_c)^{1/3} \quad \text{N/mm}^2$$

where: $E_f$, $E_c$, $G_c$ the same as 2.8.5.1.

2.8.5.5 The calculated compressing stress $\sigma_1$ of a sandwich panel with plywood core is not to be more than $0.6\sigma_{pnu}$.

## Section 9 DIRECT CALCULATION

### 2.9.1 General provisions

2.9.1.1 Where the scantlings of hull structural members of yachts are verified by means of direct calculation, they are to comply with the minimum plate thickness as specified by the rules.

2.9.1.2 The meshing of FE model is to be taken in accordance with the stiffener spacing of hull. The shell plating and webs of prime members are to be simulated as shell element; the faceplates of stiffeners and girders are to be simulated as beam element.

### 2.9.2 Direct calculation of a part of hull

2.9.2.1 The integrated calculation of structures of deck, side and bottom plated grillages is to be carried out by a part of hull model.

2.9.2.2 The calculation conditions and loads of a part of hull model are to be determined in accordance with Table 2.9.2.2 below.

**Calculation conditions and loads of the part of hull** **Table 2.9.2.2**

| Condition | Load on the upper weather deck | Load on the bottom and side | Bulkhead |
|---|---|---|---|
| 1 | See 2.4.4.6(1) | See 2.4.4.1(1) | See 2.4.4.7 |
| 2 | See 2.4.4.6(1) | See 2.4.4.1(2) | See 2.4.4.7 |

2.9.2.3 For the modeling extent of the part of hull, the length of model is to be extended from the part of hull both forward and aft by half or full length of the adjacent holds; the transverse extent is to be the entire breadth of the ship; the vertical extent is to be the entire moulded depth, covering the deck, side, bottom and bulkhead structures within the part of hull.

2.9.2.4 The boundary conditions of the part of hull model are to be taken as symmetrical for length of model extending from the part of hull both forward and aft by half length of the adjacent holds or simple support for length of model extending from the tank both forward and aft by full length of the adjacent holds. The transverse and vertical linear displacement of the intersection line of bulkheads and sides is to be zero.

**2.9.3 Strength criteria for direct calculation**

2.9.3.1 Where the local structural strength of yachts of metallic hulls are checked by direct calculation, the allowable stress is to be taken as follows:

Allowable equivalent stress: $[\sigma] = 0.76\sigma_{sw}/k$ N/mm$^2$

Allowable shearing stress: $[\tau] = 0.4\sigma_{sw}/k$ N/mm$^2$

where: $k$ — material factor, $k$ = 1.0 for normal strength steel and aluminum alloy; $k$ = 0.78 for HT32 steel; $k$ = 0.72 for HT36 steel.

## Section 10 OTHER STRUCTURES

**2.10.1 Shaft brackets**

2.10.1.1 For twin-strut and single-strut shaft brackets, arched/wing sections with a breadth to thickness ratio of about four to five are generally used for the arms. The scantlings of the arms of such shaft brackets are to comply with the requirements of 2.10.1.2 to 2.10.1.6.

2.10.1.2 For single-strut shaft bracket, a section modulus at root to its longer axis x-x, $Z_{xx}$, is not to be less than that determined from the formula:

$$Z_{xx} = 2.23Kd_S^2 l \times 10^{-5} \quad \text{cm}^3$$

where: $K$ — material factor of shaft bracket, $K = 400/\sigma_t$, where $\sigma_t$ is the tensile strength of shaft bracket material;

$d_S$ — Rule diameter of screwshaft, in mm, to be calculated as follows:

$$d_S = 128\sqrt[3]{\frac{N_e}{n_e}}$$

where: $N_e$ — rated power transmitted by the screwshaft, in kW;

$n_e$ — revolutions per minute of the screwshaft at $N_e$, in r/min;

$l$ — the length of the arm to be measured from the centre of the section at the root to the centerline of the shaft boss, in mm.

2.10.1.3 Along the length of the single-strut shaft bracket, any cross-sectional area of the bracket is to be not less than 60% of the area of the bracket at the root.

2.10.1.4 Where twin-strut shaft brackets are used, the angle between two arms is to be not less than 50°. The thickness $t$ of any arched/wing section of the struts is not to be less than that obtained from the following formula:

$$t = 2.24K^{0.5}d_S\left[1+\left(1+\frac{0.0112l^2}{Kd_S^2}\right)^{0.5}\right]^{0.5} \times 10^{-2} \quad \text{cm}$$

where: $l$ — the length of the longer arm of twin-strut, in mm, to be measured from the centre of the section at the root to the centerline of the shaft boss;

$K$, $d_S$ the same as 2.10.1.2.

2.10.1.5 Any arched/wing section of two arms of twin-strut shaft brackets is to have a section modulus to its longer axis x-x, $Z_{xx}$, of not less than that determined from the formula:

$$Z_{xx} = 0.45t^3 \quad \text{cm}^3$$

where: $t$ — thickness of section obtained from the formula of 2.10.1.4.

2.10.1.6 For shaft brackets having hollow arms, the cross-sectional areas at the root and the boss are to be not less than that required for a solid arm which satisfies the requirements for section modulus above.

2.10.1.7 For twin-strut or single-strut shaft brackets, the scantlings of shaft bossing are not to be less than as given below:

Thickness of shaft bossing: $t = 0.2d_w(K_1 + 0.23)$ mm

Length of shaft bossing: $l = 3.0d_w$ mm

where: $d_w$ — diameter of propeller shaft at shaft bracket, in mm;

$K_1 = \sigma_{tw}/\sigma_{tb}$, $\sigma_{tw}$ is the tensile strength of propeller shaft material, $\sigma_{tb}$ is the tensile strength of shaft bossing material.

2.10.1.8 For twin-strut and single-strut shaft brackets, where bracket arms are carried through the shell plating, they are to be attached to floors or girders. Where twin-strut shaft brackets are adopted, the thickness of the shell plating in way of the positions where bracket arms are carried through is to be at least 1.5 times that of the adjacent shell plating. Where single-strut shaft brackets are adopted, the thickness of the shell plating in way of the positions where bracket arms are carried through is to be at least 2 times that of the adjacent shell plating. Where the shaft bracket is attached to the hull by means of other methods, they are to be approved by CCS.

2.10.1.9 For single-strut shaft brackets, the approximate calculation methods in CCS Guidelines for Shipboard Vibration Control may be used to calculate the natural vibration frequency of shaft brackets, which is to be higher than the propeller blade frequency by 80%. Where FEM is used for the calculation, the natural frequency of the first transverse resonance of shaft brackets is to be higher than the propeller blade frequency by 20%.

**2.10.2 Thruster unit installation details**

2.10.2.1 The thruster unit is to be fitted in a separate watertight compartment.

2.10.2.2 The tunnel tube of the thruster unit is to have a structural strength equivalent to that of the surrounding shell plating. The wall thickness of the tunnel tube is not to be less than:

(1) For steel hulls, the thickness of the adjacent shell plating plus 10% or 2 mm whichever is the greater, subject to a minimum of 7 mm.

(2) For aluminium hulls, the thickness of the adjacent shell plating plus 10% or 1 mm whichever is the greater, subject to a minimum of 8 mm.

(3) For FRP hulls, the thickness of the adjacent shell laminate plus 25% subject to a minimum of 8 mm.

2.10.2.3 For connections of metallic tubes of the thruster unit to the metallic hull, the welding is to be by full penetration welding. The shell plating thickness is to be locally increased by 50% in way of tunnel thruster connections.

2.10.2.4 For FRP tubes attached by bonding, measures are to be taken so that the tube is bonded internally and externally to the shell laminate. Prior to bonding in situ the areas to be bonded are to be thoroughly abraded and degreased.

## Section 11 WELD DESIGN FOR METAL HULL STRUCTURES

**2.11.1 General requirements**

2.11.1.1 This Section applies to the weld design for normal hull structures and structural members of yacht made of metal materials, special structures will be subject to individual consideration.

2.11.1.2 The weld design for hull structures of steel yacht is to comply with the relevant provisions in Section 4, Chapter 1, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

2.11.1.3 The weld design for normal hull structures of aluminum yacht is to comply with the following provisions in this Section, special structures will be subject to individual consideration. The welding procedures for hull structures are to comply with the relevant requirements of CCS Rules for Materials and Welding.
2.11.1.4 For yachts of composite construction where the hull is of steel material and the superstructure/deckhouse are of aluminum alloy material, the steel-aluminum transition joints approved by CCS are to be used for connecting the aluminum superstructure/deckhouse wall to the upper deck of the steel hull.

**2.11.2 General design principle of welded aluminum alloy structure**

2.11.2.1 The arrangement of the weld seams is to take into account the structural continuity, and the restraint of the whole structure is to be minimized. Also, the weld seams are to be so arranged as to be convenient for the operation and inspection of welding.
2.11.2.2 The weld seams of hull structures are not to be arranged in the areas of maximum stress or areas liable to stress concentration. Sufficient transitional areas are to be arranged at positions where the section changes suddenly, and excessive concentration of weld seams are to be avoided.
2.11.2.3 Generally, double side continuous weld is to be used in the following structures:
(1) joint seams of keel girder and plate keel;
(2) joint seams of machinery sub-structure and supporting structure;
(3) joint seams of the boundaries of oiltight and watertight structures;
(4) joint seams of all structures of the steering gear;
(5) bottom and bow structural seams within areas subject to impact;
(6) joint seams of supporting and ends of stiffeners, pillars, cross ties and girders;
(7) joint seams of all structures within the area above the propeller with a radius at least 1.5 times the diameter of the propeller;
(8) joint seams of bracket plates and adjacent girders or other structural members;
(9) joint seams of ends of girder webs subject to greater shearing stress;
(10) joint seams of bracket plates and bulkhead plates.
2.11.2.4 Where steel-aluminum transition joints are used, the load capacity of the joints is to be considered so as to reduce the normal stress level of the joints as far as practicable.
2.11.2.5 The strength, plasticity and corrosion resistance of filler material used in aluminum alloy welding are to be compatible with the parent material.

**2.11.3 Design of butt welds**

2.11.3.1 Butt welds are generally to be full penetration welds. For structures subject to low stress level and double side welding is impracticable, single side welding with backing may be used provided that the quality is guaranteed and prior agreement of CCS is obtained.
2.11.3.2 Where full penetration welds are arc welded, plates with thickness under 5 mm may be welded ungrooved; plates with thickness over 8 mm are to be groove welded with a groove angle of generally 60° to 90°, the root face to be 1.5 to 3 mm and the gap to be 0 to 4 mm.

**2.11.4 Design of lap welds and tack welds**

2.11.4.1 In general, lap welds are not to be used as the structural joints that transmit tensile or compression loads. Where the lap welds in such structures are unavoidable, there is to be sufficient lap width.
2.11.4.2 The spacing of tack welds is generally not to be greater than 20 times the plate thickness, and the length of the weld is to be at least 4 times the plate thickness. Tack welds are to be avoided at positions such as corners, ends, or positions subject to high load or stress concentration.

**2.11.5 Design of fillet welds**

2.11.5.1 Fillet welds may be of T shape or cross shape joints, and are generally to be the double side welds (as shown in Figure 2.11.5.1(a)). These two joint types may be sub-divided into double side continuous welding, double side intermittent welding and staggered intermittent welding (as shown in Figure 2.11.5.1(b)).

2.11.5.2 For fillet welds subject to high stress level, deep penetration welding with vertical beveled plate may be used, or even the full penetration double side welding is to be used. For fillet welds subject to medium stress level, chain intermittent welding or staggered intermittent welding may be allowed. The application of single side fillet welding is to be subject to agreement of CCS.
2.11.5.3 For fillet welds where double side continuous welding is required, the throat depth $h$ is not to be less than the value given by the following formula:

$$h = Wt \quad \text{mm}$$

where: $W$ — welding parameter. Welding parameters for hull structures are given in Table 2.11.5.3;
$t$ — minimum thickness of structure, in mm. It denotes the thickness of the thinner plate of the components of the fillet weld joints.

Where deep penetration welding is used, the throat depth may be 10% less, but the depth reduced is not to be greater than 1.5 mm.

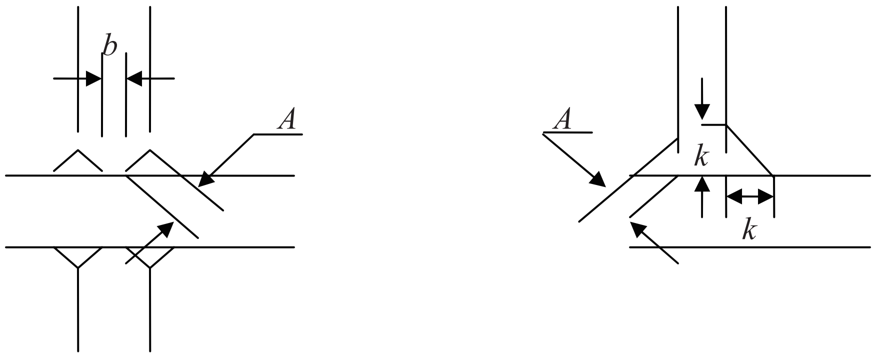



**Figure 2.11.5.1(a)**

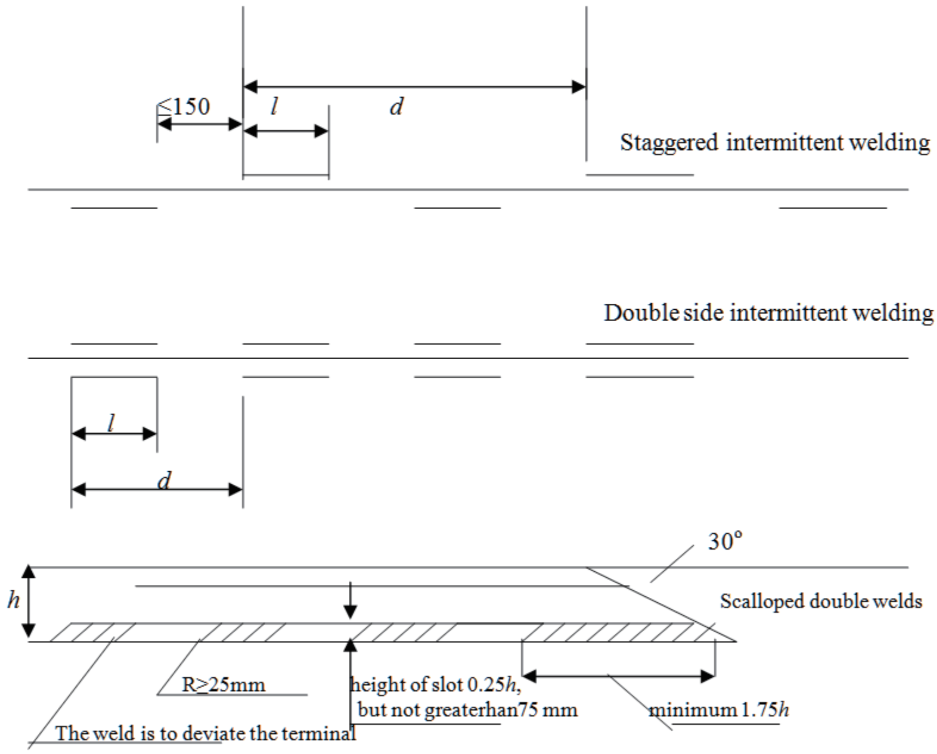



**Figure 2.11.5.1(b)**

**Welding parameter** **Table 2.11.5.3**

| Item | Welding parameter | Note |
|---|---|---|
| I. General structures | | |
| Watertight or oiltight boundaries | | |
| Non-sealing plate boundaries | 0.34 | Intermittent welding is permitted |
| General lap joint welds | 0.13 | |
| Welds of stringers, frames, and other stiffeners with shell plates, decks | 0.27 | |
| and bulkhead plates | 0.10 | 0.13 at liquid tank<br>0.21 at terminals |
| II. Bottom structures | | |
| Non-sealing centre girders with decks | 0.27 | |
| with bed plates | 0.21 | No slot |
| Boundaries of non-sealing floor plates, side girders and bracket plates | 0.21 | |
| Inner-bottom longitudinal or main engine foundation girder | | |
| with face plate | 0.44 | Continuous welding |
| with hull structure | 0.44 | Continuous welding |
| Propeller boss | 0.27 | |
| III. Hull frame | | |
| webs and girders of web frame with shell plates | 0.13 | |
| with face plates | 0.13 | |
| IV. Deck and supporting structure | | |
| Weather deck with shell plate | 0.44 | Continuous welding |
| Other decks with shell or bulkhead plates (except boundaries of liquid tank) | 0.21 | Continuous welding |
| Girder webs with decks and terminal brackets with decks | 0.10 | |
| Girder webs with decks at terminal brackets | 0.21 | Continuous welding |
| Girder face plates with webs | 0.10 | |
| V. Superstructure, deckhouse and enclosures | | |
| Outer casing walls with decks | 0.34 | |
| Inner casing walls | 0.13 | |

2.11.5.4 Where intermittent welding is used, the throat depth $h_1$ is to be calculated by the following formula:

$$h_1 = hd/l \quad \text{mm}$$

where: $d$ — pitch of welds, in mm, denotes the length from the beginning of a weld to the beginning of the next weld;

$l$ — length of weld, denotes the continuous length of weld, however, it is not to be less than 15 times the plate thickness or 75 mm, whichever is less;

$h$ — throat depth obtained from the formula of 2.11.5.3, in mm.

2.11.5.5 The height of leg of fillet weld $k$ is not to be less than the value calculated by the following formula:

$$k = \sqrt{2}h \quad \text{mm}$$

where: $h$ — throat depth obtained from the formula of 2.11.5.3, in mm.

No matter which weld type and welding method are used, $k$ is not to be less than 3 mm, however, it is also not necessary to be greater than 1.5 times the thickness of the thinner plate. The height of the leg of the intermittent weld is not necessary to be greater than 7 mm.

2.11.5.6 Where intermittent welding is used, the corner flange welds within the specified length of the following positions are to be double side continuous fillet welds:

(1) the length of corner flange weld at bracket toe is not to be less than the height of connecting frame, and is neither to be less than 75 mm;

(2) section terminals, especially when short sections are end sloped, the length of corner flange weld is to be the height of sections or not to be less than the length of the sloped part, whichever is greater;

(3) various kinds of holes, cut ends and cross parts of all joint structures that are vertical to each other are to have a length not less than 75 mm.

2.11.5.7 Where structural components pass through liquid tank bulkheads, there is to be a double side full penetration fillet weld of not shorter than 75mm on both sides of the bulkhead.

# CHAPTER 3 OUTFITTING

## Section 1 RUDDERS

### 3.1.1 General requirements

3.1.1.1 The requirements of this Section apply to ordinary streamlined rudders, single plate rudders and flap-type rudders.

3.1.1.2 In addition to the provisions of this Section, rudders are also to comply with the applicable requirements of Section 1, Chapter 3 of PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

### 3.1.2 Materials

3.1.2.1 For rudders made of steel, the material factor $K$ is to be taken in accordance with 3.1.1.5, PART TWO of CCS Rules for Classification of Sea-going Steel Ships. For stainless steel or other materials not affected by corrosion, it is to be taken as $K/0.9$.

3.1.2.2 For rudders made of aluminum alloy, the material factor $K$ is to be taken as follows:

$$K = \sigma_{P0.2}/100$$

where: $\sigma_{P0.2}$ — yield strength of the aluminum alloy in the annealed condition, in N/mm$^2$, see relevant provisions of CCS Rules for Materials and Welding.

In case of welding of two different aluminium alloys, the material factor $K$ to be taken for the scantling is to be taken as the lesser value.

### 3.1.3 Rudder scantling

3.1.3.1 The scantling of rudder made of steel is to be calculated in accordance with 3.1.2 to 3.1.14, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

3.1.3.2 The scantling of rudder made of aluminium alloy is to be calculated in accordance with the requirements of 3.1.3.1 above, taking into account the following requirements:

(1) When direct calculation is used for checking the rudder stock strength in way of and below the lower bearing, the equivalent stress $\sigma_e$ on the rudder stock is not to be greater than $58K$, and the corresponding allowable shearing stress is to be $32K$, in N/mm$^2$ ($K$ being the material factor of rudder stock, see 3.1.2.2 of this Section).

(2) The diameter of rudder stock in way of the tiller is to be $1.3/\sqrt{K}$ times that required by 3.1.5.1, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

(3) The diameter of rudder stock in way of and below the lower bearing is to be $1.3/\sqrt{K}$ times that required by 3.1.5.4, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

(4) Under the bending moment and shear force of rudder blades, the stress at the horizontal section of the box structure is to comply with the following requirements:

For rudder blades with no cuts:

Bending stress $\sigma \leq 52K$ N/mm$^2$

Shearing stress $\tau \leq 23K$ N/mm$^2$

Equivalent stress $\sigma_e = \sqrt{\sigma^2 + 3\tau^2} \leq 56K$ N/mm$^2$

For rudder blades with cuts:

Bending stress $\sigma \leq 35K$ N/ mm$^2$ (for section in way of cut)

Shearing stress $\tau \leq 23K$ N/mm$^2$

Equivalent stress $\sigma_e = \sqrt{\sigma^2 + 3\tau^2} \leq 47K$ N/mm$^2$

(5) The thickness $t$ of side, top and bottom plating of rudders is not to be less than that obtained from the following formula:

$$t = 8.2 s\beta \sqrt{d + \frac{F}{A} \times 10^{-4}} / \sqrt{K} \quad \text{mm}$$

where: $d$ — draught, in m;

$F$ — rudder force, in N;

$A$ — area of rudder blade, in m²;

$\beta = \sqrt{1.1 - 0.5\left(\frac{s}{b}\right)^2}$ , where $s$ and $b$ are respectively the short side length and the long side length of panels, in m, $\beta$ to be taken as 1 if $\frac{b}{s} \geq 2.5$;

The thickness of top and bottom plating of rudders is not to be less than that of the rudder side plating;

$K$ — material factor of rudder stock, see 3.1.2.2 of this Section.

## Section 2 ANCHORING AND MOORING EQUIPMENT

### 3.2.1 General requirements

3.2.1.1 The anchoring equipment required in this Section is intended for temporary mooring of a yacht within or near a harbour, or in a sheltered area, and is assumed to hold a yacht in good holding ground where the conditions are such as to avoid dragging of the anchor.

3.2.1.2 For the anchoring equipment required in this Section, it is assumed that under normal circumstances a yacht will use one anchor (head anchor) only.

### 3.2.2 Equipment number

3.2.2.1 Equipment number $N$ is to be calculated as follows:

$$N = \Delta^{2/3} + 2(aB + \sum b_i h_i \sin\theta_i) + 0.1A$$

where: $\Delta$ — full-load displacement, in t;

$a$ — vertical distance amidships, in m, from the waterline corresponding to $\Delta$ to the upper weather deck;

$B$ — breadth, see 1.1.3.1(9), in m;

$h_i$ — height, in m, of each tier of superstructures/deckhouses having a breadth greater than $B/4$ above the upper weather deck;

$b_i$ — breadth, in m, of each tier of superstructures/deckhouses having a breadth greater than $B/4$ above the upper weather deck;

$\theta_1$ — angle of inclination with the horizontal axis aft of each front bulkhead of the tier of superstructures/deckhouses corresponding to height $h_i$, in °;

$A$ — area, in m², in profile view, of the parts of the hull and each tier of superstructures/deckhouses which have a breadth greater than $B/4$ above the waterline corresponding to $\Delta$.

3.2.2.2 Screens or bulwarks of 1.5 m or more in height of the open bridge of yacht having a breadth greater than $B/4$ are also to be included in the $\sum b_i h_i \sin\theta_i$ and $A$ of the formula above.

### 3.2.3 Anchoring equipment

3.2.3.1 High holding power anchors of an approved type for yachts are to be provided in accordance with Table 3.2.3.1, based on the equipment number $N$ derived from 3.2.2.1. The actual weight of each anchor may vary by ± 7% with respect to that shown in Table 3.2.3.1.

3.2.3.2 When ordinary stockless anchors are used, the weight per anchor is not to be less than 1.33 times that shown in Table 3.2.3.1. When “very high holding power” anchors are used, the weight of the anchors may be equal to 70% of that shown in Table 3.2.3.1.

**Table 3.2.3.1**

| Equipment number N | | Number of high holding power anchor | Weight of single high holding power anchor (kg) | Diameter of stud chains (mm) | | | Length of chains or ropes (m) | Mooring ropes | |
|---|---|---|---|---|---|---|---|---|---|
| exceed | not exceed | | | AM1 | AM2 | AM3 | | Number × length (m) | Breaking strength (kN) |
| 30 | 35 | 1 | 37 | 8 | — | — | 82.5 | 2×40 | 26 |
| 35 | 40 | 1 | 44 | 8 | — | — | 82.5 | 2×45 | 31 |
| 40 | 45 | 1 | 52 | 8.5 | — | | 110 | 2×50 | 31 |
| 45 | 50 | 1 | 59 | 9 | — | — | 110 | 2×55 | 31 |
| 50 | 70 | 1 | 80 | 9.5 | — | — | 137.5 | 2×60 | 33 |
| 70 | 90 | 1 | 117 | 11 | — | — | 165 | 2×70 | 33 |
| 90 | 110 | 1 | 140 | 11 | — | — | 165 | 2×80 | 35 |
| 110 | 130 | 1 | 160 | 14 | 12.5 | — | 192.5 | 3×80 | 37 |
| 130 | 150 | 1 | 180 | 14 | 12.5 | — | 192.5 | 3×90 | 39 |
| 150 | 175 | 1 | 200 | 16 | 14 | 11 | 192.5 | 3×90 | 43 |
| 175 | 205 | 1 | 230 | 16 | 14 | 11 | 220 | 3×90 | 47 |
| 205 | 240 | 1 | 260 | 17.5 | 16 | 12.5 | 220 | 4×90 | 51 |
| 240 | 280 | 1 | 310 | 17.5 | 16 | 12.5 | 220 | 4×90 | 55 |
| 280 | 320 | 1 | 360 | 19 | 17.5 | 14 | 247.5 | 4×110 | 59 |
| 320 | 360 | 1 | 410 | 20.5 | 17.5 | 14 | 247.5 | 4×110 | 62 |
| 360 | 400 | 1 | 460 | 22 | 19 | 16 | 247.5 | 4×110 | 70 |
| 400 | 450 | 1 | 520 | 22 | 19 | 16 | 275 | 4×110 | 78 |
| 450 | 500 | 1 | 580 | 24 | 20.5 | 17 | 275 | 4×110 | 86 |
| 500 | 550 | 1 | 640 | 26 | 22 | 20.5 | 275 | 4×130 | 98 |
| 550 | 600 | 1 | 700 | 26 | 22 | 20.5 | 302.5 | 4×130 | 105 |
| 600 | 660 | 1 | 770 | 28 | 24 | 22 | 302.5 | 4×130 | 118 |
| 660 | 720 | 1 | 840 | 30 | 26 | 24 | 302.5 | 4×130 | 118 |
| 720 | 780 | 1 | 910 | 30 | 26 | 24 | 330 | 4×130 | 126 |
| 780 | 840 | 1 | 980 | 32 | 28 | 24 | 330 | 4×140 | 150 |
| 840 | 910 | 1 | 1060 | 32 | 28 | 24 | 357.5 | 4×140 | 160 |
| 910 | 980 | 1 | 1150 | 34 | 30 | 26 | 357.5 | 4×140 | 173 |
| 980 | 1060 | 1 | 1260 | 36 | 32 | 28 | 357.5 | 4×140 | 184 |

3.2.3.3 The head anchor is to positioned ready for use at bow.

3.2.3.4 The diameter and length of stud chains in association with anchors are not to be less than the values obtained from Table 3.2.3.1 using the equipment number N. The chains are to be made of materials of Grade 1 chains (AM1), Grade 2 chains (AM2) and Grade 3 chains (AM3) given in CCS Rules for Materials and Welding. Grade 1 chains (AM1) are generally not to be used in association with "high holding power" anchors; Grade 1 chains (AM1) are not to be used with "very high holding power" anchors.

3.2.3.5 The chains may be substituted by steel wire or synthetic fibre rope approved by CCS, where one of the following cases is complied with:

(1) where the equipment number $N < 440$, the stud chains may be substituted by the steel wire rope of equivalent breaking strength;

(2) where the equipment number $N < 80$, the stud chains may be substituted by the fiber rope of equivalent breaking strength.

In these cases, a short length of chains is to be fitted between the anchor and the rope. The length is to be taken at least as the distance between anchor in stowed position and windlass, and not to be less than $0.2L_{WL}$.

3.2.3.6 Where stud chains are substituted by rope, the breaking strength of the rope is not to be less than that of the stud chains. The breaking strength of stud chains may be obtained from the following formula based on the diameter of chains:

AM2: breaking strength $=13.73 d_c^2 (44-0.08 d_c) 10^{-3}$ kN

AM3: breaking strength $=19.61 d_c^2 (44-0.08 d_c) 10^{-3}$ kN

where: $d_c$ — diameter of stud chains, in mm, obtained from Table 3.2.3.1.

3.2.3.7 The anchoring arrangements are to be such that any surfaces against which the chains may chafe (for example, hawse pipes and hull obstructions) are designed to prevent the chains from being damaged and folded, and the possibility of the anchor and chains damaging the hull structure during normal operation is minimized.

3.2.3.8 Where the weight of single anchor exceeds 50 kg, the windlass driven by power is to be fitted.

3.2.3.9 The windlass is to be fitted in a suitable position in order to ensure an easy lead of the chain cables to and through the hawse pipes; the deck in way of the windlass is to be suitably reinforced. A suitable stopping device is to be fitted in order to prevent the anchor from shifting due to movement of the yacht.

### 3.2.4 Mooring equipment

3.2.4.1 The number, length and breaking strength of mooring ropes for yachts are to be obtained from Table 3.2.3.1, based on the equipment number *N* derived from 3.2.2.1. The mooring ropes are to be made of steel, plant fibre or synthetic fibre. The diameter of mooring ropes is not to be less than 15 mm.

3.2.4.2 Suitable number of bitt bollard, bitt or cleat is to be fitted respectively on stem, stern and both sides onboard. The hull structure in way of the installation places of bitt bollard, bitt or cleat is to be strengthened.

# CHAPTER 4 MACHINERY INSTALLATIONS

## Section 1 GENERAL PROVISIONS

### 4.1.1 General requirements

4.1.1.1 Unless otherwise provided by this Chapter, main propulsion and auxiliary machinery installations together with their associated equipment, boilers, pressure vessels, pumping and piping systems, and gearing fitted in yachts are to comply with the applicable requirements of PART THREE of CCS Rules for Classification of Sea-going Steel Ships or the applicable requirements (for yachts navigating in inland waters only) of PART TWO of CCS Rules for Construction of Inland Waters Steel Ships.
4.1.1.2 Main propulsion and auxiliary machinery installations together with their associated equipment, boilers, pressure vessels, pumping and piping systems, and gearing fitted in high speed yachts are to comply with the relevant requirements of CCS Rules for Construction and Classification of Sea-Going High Speed Craft or the relevant requirements (for high speed yachts navigating in inland waters only) of CCS Rules for Construction and Classification of Inland Waters High Speed Craft as appropriate.

## Section 2 MAIN AND AUXILIARY MACHINERY INSTALLATIONS AND PIPING SYSTEMS

### 4.2.1 General requirements

4.2.1.1 All main and auxiliary engines of 100 kW and above in rated power are to comply with the applicable requirements of PART THREE of CCS Rules for Classification of Sea-going Steel Ships or the applicable requirements (for yachts navigating in inland waters only) of PART TWO of CCS Rules for Construction of Inland Waters Steel Ships. Special consideration may be given to main and auxiliary engines demonstrating satisfactory service experience for the intended service. Main and auxiliary engines of less than 100 kW in rated power may be designed and manufactured in accordance with recognized standards, and accepted by the Surveyor according to the satisfactory effectiveness test after onboard installation.
4.2.1.2 For yachts of 48 m and less in $L_{WL}$, the boilers and pressure vessels may be designed and manufactured in accordance with the standards accepted by CCS.
4.2.1.3 Main and auxiliary engines are to be installed on board in accordance with the installation guidelines of the equipment manufacturer.

### 4.2.2 Oil fuel system

4.2.2.1 For yachts of 48 m and less in $L_{WL}$, the service tank may be omitted for the main and auxiliary engines.
4.2.2.2 Where an oil fuel booster pump is fitted for the main diesel engine and its transmission gearing, one main supply pump of sufficient capacity is to be provided for the main engine at its maximum continuous output and one standby pump of sufficient capacity is to be provided for normal navigation of the yacht. Such a standby pump is to be independently power driven and capable of being ready for immediate use.
Where two or more main engines are fitted, each with its own booster pump, only one complete spare pump may be accepted, provided that it is readily accessible and can easily be installed.
For Category II to V yachts of 48 m and less in $L_{WL}$, the standby pump or spare pump may be omitted.
4.2.2.3 Oil fuel filters are to be fitted in the oil fuel supply lines to the diesel engines, and their arrangement are to be such that any filter can be cleaned without interrupting the supply of filtered oil fuel to the engines.
Where two or more main and auxiliary engines are fitted, each with its own filter, only one filter may be fitted in the oil fuel supply system.

### 4.2.3 Lubricating oil system

4.2.3.1 Main engines are to be provided with a main lubricating oil pump of sufficient capacity to maintain supply of lubricating oil at the maximum continuous output of the machinery and a standby pump of sufficient capacity to supply lubricating oil under normal navigating condition are to be provided. The standby pump is to be of independently power-driven type and to be connected ready for use.
For ships fitted with more than one main engine, where each main engine is fitted with a built-in lubricating oil pump, a complete spare pump available for installation and connection may be accepted.

For Category II to V yachts of 48 m and less in $L_{WL}$, the standby pump or spare pump may be omitted.
4.2.3.2 Provision is to be made for the efficient filtration of the lubricating oil. For main propulsion machinery, the filters are to be capable of being cleaned without interrupting normal supply of filtered oil required in normal navigation of yachts. For generating sets, the filters are to be capable of being cleaned without interrupting normal supply of filtered oil required by generating sets under normal work load.
Where two or more main and auxiliary engines are fitted, each with its own filter, only one filter may be fitted in the lubricating oil system.

### 4.2.4 Cooling system

4.2.4.1 For yachts, where only one main engine is fitted, a main cooling pump of sufficient capacity to maintain supply of water at the maximum continuous output of the machinery and a standby cooling pump of sufficient capacity to supply cooling water under the normal navigating condition are to be provided. The standby pump is to be of independently power-driven type and to be connected ready for use.
Where more than one main engine is fitted, each with its own cooling water pump, a complete spare pump available for installation and connection may be accepted as a standby cooling water pump.
For Category II to V yachts, the required standby cooling water pump may be replaced by other pumps of sufficient capacity or a complete spare pump available for installation and connection.
For Category II to V yachts of 48 m and less in $L_{WL}$, the standby pump or spare pump may be omitted.
4.2.4.2 Category II to V yachts of 48 m and less in $L_{WL}$ may be provided with only one sea inlet. The sea inlet is to be so arranged that it is immerged in the water in all navigating conditions.
4.2.4.3 Strainers are to be provided to the suctions of sea water cooling systems of main and auxiliary engines and essential equipment. The strainers are to be in parallel or so arranged that they can be cleaned without interrupting the cooling water supply.
Where two or more main and auxiliary engines are fitted, each with its own strainer, only one strainer may be fitted in the cooling system.

### 4.2.5 Exhaust gas system

4.2.5.1 Exhaust pipes of several engines are not to be connected together and are to be run separately to the atmosphere unless arranged to prevent the return of gases to an idle engine. Exhaust pipes from oil burning units (e.g. incinerators, boilers) are not to be connected to those of engines.
4.2.5.2 Exhaust gas systems are to be so designed that pressure losses in the exhaust lines do not exceed the maximum values permitted by the engine manufacturer.
4.2.5.3 For exhaust outlets discharging through the shell below the freeboard deck, efficient means are to be fitted to prevent flooding in case of exhaust system damage. For Category I and II yachts, a forward closing device is to be fitted. The system is to be of a construction equivalent to that of the side shell structure where the closing device is located. For Category III to V yachts, where it is impracticable to fit a forward closing device, the exhaust gas arrangements are to be looped. The overboard outlet is to be above the waterline when the yacht has a list of 10° and the construction is to be equivalent to the shell structure.

### 4.2.6 Steering gear

4.2.6.1 Where the main steering gear is a mechanical steering gear not operated by power, the auxiliary steering gear may be omitted.

## Section 3 OTHER PIPING SYSTEMS

### 4.3.1 Bilge system

4.3.1.1 The bilge system is to be provided in accordance with the applicable requirements of PART THREE of CCS Rules for Classification of Sea-going Steel Ships or the applicable requirements of PART TWO of CCS Rules for Construction of Inland Waters Steel Ships. For yachts of 48 m and less in $L_{WL}$, the bilge system may be provided as follows.
4.3.1.2 The suctions and means for drainage are to be so arranged that any water within any compartment of the ship, or any watertight section of any compartment, can be pumped out through at least one suction when the ship is on an even keel and is either upright or has a list of not more than 5°. The bilge suctions may be arranged for different spaces as follows:

(1) Main and auxiliary engine rooms: one branch bilge suction and one direct bilge suction are to be provided.
(2) Other spaces: one branch bilge suction is to be provided for shaft tunnel (where applicable), pipe tunnel (where applicable), fore peaks, aft peaks, void tanks, cofferdams and chain lockers.
4.3.1.3 At least two power bilge pumps, one of which may be driven by the main engine, are to be provided. All power bilge pumps are to be of the self-priming type.
4.3.1.4 The capacity of bilge pumps is to comply with the requirements of PART THREE of CCS Rules for Classification of Sea-going Steel Ships or PART TWO of CCS Rules for Construction of Inland Waters Steel Ships.
4.3.1.5 Where each compartment is provided with an individual bilge pump of a submersible type, the following requirements are to be complied with:
(1) The total capacity $Q_t$ of the pumps is not to be less than that required by 4.3.1.4 multiplied by 2.4. The capacity $Q$ of the individual bilge pump of each compartment is to be calculated in accordance with the following formula, but not to be less than 8 $m^3/h$:

$$Q_n = Q_t / (N - 1) \quad m^3/h$$

where: $Q_n$ — capacity of the individual pump of each compartment, in $m^3/h$;
$Q_t$ — total capacity of pumps of all compartments, in $m^3/h$;
$N$ — number of individual bilge pumps on board.
(2) In addition to the submersible pump, the main engine room is also to be provided with a bilge pump having a capacity complying with the requirements of 4.3.1.4.
(3) A second bilge pump is to be provided on board, which can be used for each compartment and the capacity of which complies with the requirements for the individual bilge pump of (1) above.
4.3.1.6 The diameters of the bilge main and branch bilge suction pipes are to comply with the requirements of PART THREE of CCS Rules for Classification of Sea-going Steel Ships or PART TWO of CCS Rules for Construction of Inland Waters Steel Ships. The minimum diameter is not to be less than 40 mm.
4.3.1.7 Each bilge suction is to be provided with an effective strainer.
4.3.1.8 The connections at the bilge pumps are to be such that at least one of the pumps may continue in operation when the other pumps are being opened up for overhaul. The bilge pipes are to be connected to prevent the possibility of one watertight compartment being placed in communication with another.
4.3.1.9 Bilge level alarms are to be provided for unattended propulsion machinery room and other compartments generally inaccessible to personnel. Audible and visual alarms are to be given in the captain's cabin and the navigation bridge.

**4.3.2 Air, overflow and sounding pipes**
4.3.2.1 For yachts of 48 m and less in $L_{WL}$, at least one air pipe is to be provided for each watertight compartment and fitted at the highest part of the compartment. The internal diameter of the air pipe is not to be less than 25 mm. The air pipe is to be led to the open space.
In the case of all tanks which can be pumped up, the total cross-sectional area of the air pipes to each tank is not to be less than 25% greater than the effective area of the respective filling pipes. Where the compartment is provided with overflow pipes with the cross-sectional area not less than 1.25 times the cross-sectional area of the respective filling pipes, the internal diameter of air pipes need not exceed 25 mm.
4.3.2.2 For yachts of 48 m and less in $L_{WL}$, sounding pipes for flammable liquids are to terminate in the open air, and not to terminate in passenger or crew spaces. Where it is impracticable, termination of sounding pipes are to be remote from the ignition source and fitted with self-closing devices.
4.3.2.3 For yachts of 48 m and less in $L_{WL}$, the openings of overflow pipes (other than those of oil tanks) discharging overboard are to be placed above the deepest load waterline and are to be fitted with non-return valves on the plating. For category II to V yachts, where it is impracticable, the overboard opening is to be above the waterline when the yacht has a list of 10° and the construction is to be equivalent to the shell structure.
4.3.2.4 The opening of filling pipes of flammable liquids is to be located in the open deck. The leakage is not to flow into the internal space of yacht or suitable coamings and drains are to be provided to collect any leakage resulting from filling operations.

# CHAPTER 5 ELECTRICAL INSTALLATIONS

## Section 1 GENERAL PROVISIONS

### 5.1.1 General requirements

5.1.1.1 Unless otherwise provided, the provisions of this Chapter apply to yachts of 48 m and less in $L_{WL}$. Yachts of more than 48 m in $L_{WL}$ are to comply with the relevant requirements of PART FOUR of CCS Rules for Classification of Sea-going Steel Ships or the relevant requirements (for yachts navigating in inland waters only) of PART THREE of CCS Rules for Construction of Inland Waters Steel Ships as appropriate.

5.1.1.2 In addition to the provisions of this Chapter, the operating conditions, design, construction and installation of electrical equipment are to comply with the applicable requirements of PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

5.1.1.3 In addition to the requirements of 5.1.1.1, yachts of more than 48 m in $L_{WL}$ are to comply with the requirements of Section 3 of this Chapter.

## Section 2 SOURCE OF ELECTRICAL POWER AND DISTRIBUTION

### 5.2.1 Main source of electrical power

5.2.1.1 Where the main source of electrical power is necessary for propulsion of the yacht, it is to consist of at least two generating sets. The number and ratings of these generating sets are to be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide normal operational conditions of propulsion and steering[①] and essential for ensuring the safety of the yacht. Furthermore, minimum comfortable conditions of habitability are also to be ensured.

5.2.1.2 Where the electrical power is not necessary for various auxiliary engines for the main engine, oil pumps of steering gears, fire pumps and bilge pumps, at least one generating set is to be provided.

5.2.1.3 Where one generating set is provided, it is to be of sufficient capacity to supply the electrical installations of the yacht and to charge the accumulator battery to 80% of rating within 10 h.

### 5.2.2 Emergency source of electrical power

5.2.2.1 Yachts are to be provided with a self-contained emergency source of electrical power.

5.2.2.2 The emergency source of electrical power may be a generating set or an accumulator battery.

5.2.2.3 The emergency source of electrical power is not to be located in the same space as the main source of electrical power and is to be located above the uppermost continuous deck as far as practicable.

5.2.2.4 The capacity of the electrical power is at least to supply the following services for a period of 12 h for Category I yachts, 6 h for Category II yachts and 3 h for other categories of yachts:

(1) lighting at every embarkation station of survival crafts, in all alleyways, stairways and exits and control stations;
(2) internal communication equipment (e.g. telegraph etc.) required in emergency;
(3) navigation lights and signal lights (e.g. not under command light);
(4) radio communications;
(5) other equipment required in emergency (e.g. fire detection and fire alarm system, bilge pump and emergency fire pump etc.).

5.2.2.5 For all yachts (including those of more than 48 m in $L_{WL}$), where the main source of electrical power is located in two or more compartments which are not contiguous, each of which has its own self-contained system, including power distribution and control systems, completely independent of each other and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, an emergency source of electrical power may be omitted.

---

① Where the main source of electrical power is necessary for propulsion and steering of the yacht.

### 5.2.3 Distribution of electrical power

5.2.3.1 The following systems of distribution may be used:

(1) DC

two-wire insulated system;

two-wire system with negative pole earthed.

(2) AC single phase

two-wire insulated system;

two-wire system with one pole earthed.

(3) Three phase AC

three-wire insulated system;

four-wire system with neutral earthed.

Other distribution systems than those mentioned above are to be subject to special approval by CCS.

5.2.3.2 Other distribution systems than those mentioned above are to be subject to special approval by CCS, except for the following hull return systems of distribution:

(1) limited and locally earthed systems;

(2) impressed current cathodic protective systems;

(3) insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable condition.

5.2.3.3 Final sub-circuits are to be suitably protected against over-currents including short circuits, and other electric faults. The arrangement of the protective devices is to comply with the provisions of Section 5, Chapter 2, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships.

## Section 3 REMOTE CONTROL, ALARM AND SAFETY SYSTEMS

### 5.3.1 Control system

5.3.1.1 Any failure in any part of automatic or remote control system is to be capable of sending out audible and visual alarms, and is not to interfere with the normal manual control.

### 5.3.2 Alarm system

5.3.2.1 Alarms are to be provided at the main console in the following cases:

(1) activation of the fire detection system;

(2) over-speeding of the main engine;

(3) bilge-water high level;

(4) faults of navigation lights (side light, masthead light or stern light).

### 5.3.3 Safety system

5.3.3.1 Engines are to be provided with safety devices to prevent over-speeding, loss of pressure of lubricating oil, breaking and high temperature of cooling medium, faults of moving parts and overloading etc. Except for the hazards of complete breakdown or explosion, the safety device is not to lead to shutdown in case alarms are not sent out in advance.

## Section 4 MISCELLANEOUS

### 5.4.1 Lighting

5.4.1.1 Final sub-circuits for lighting are not to supply heating and power appliances, except for small galley equipment (e.g. toasters, mixers, coffee makers), small motors (e.g. desk and cabin fans, refrigerators), and similar items.

5.4.1.2 The lighting point supplied by each final sub-circuit of rating of more than 16 A for lighting distribution board is not to exceed one. The number of lighting points supplied by each final sub-circuit of rating 16 A or less at the lighting distribution board is not to exceed:

10 for circuits of rating 55 V or less;

14 for circuits of rating 56 ~ 120 V circuits;

24 for circuits of rating 121 ~ 250 V circuits.

In final sub-circuits for cornice lighting, panel lighting and electrical signs where lampholders are closely grouped, the number of points supplied is unrestricted provided that maximum operating current in the sub-circuit does not exceed 10 A.

5.4.1.3 The lighting for engine rooms, public spaces, passageways and stairways is to be supplied by at least two final sub-circuits, one of which may be the final sub-circuit for emergency lighting.

### 5.4.2 Accumulator batteries

5.4.2.1 Accumulator batteries are to be adequately enclosed. The spaces (battery room, box, locker) containing accumulator batteries are to be well ventilated.

5.4.2.2 The acid accumulator batteries are to be placed in different battery room, box or locker apart from that for the alkaline accumulator batteries. Acid accumulator batteries are not to be installed in the accommodation space.

5.4.2.3 Prime mover starter batteries are to be installed as close as practicable to the primer mover served. Adequate ventilation is to be ensured for the installation space.

5.4.2.4 Any surface of dedicated battery rooms, boxes, lockers and associated ventilation ducts, etc., liable to corrosion, by the electrolyte or by the gas escaped from the electrolyte, are to be protected against corrosion.

5.4.2.5 The exhaust gas emitted $Q$ from the gas-permeability battery rooms, boxes or lockers is not to be less than:

$$Q = 0.11In \quad \text{m}^3/\text{h}$$

where: $I$ — the maximum charging current during the production of gas, but not less than 25% of the maximum charging current output by the charger, in A;

$n$ — number of battery cells.

5.4.2.6 The exhaust gas emitted from the valve-regulated sealed battery rooms, boxes or lockers may be reduced to 25% of that required in 5.4.2.5.

### 5.4.3 Cables

5.4.3.1 Cables are to be selected according to the provisions of Section 12, Chapter 2, PART FOUR of CCS Rules for Classification of Sea-going Steel Ships, but the requirements of 2.12.3.4, 2.12.3.5 and 2.12.3.6 need not be satisfied.

### 5.4.4 Lightning protection

5.4.4.1 A protective system need not be fitted to a yacht of metallic construction. A protective system is to be fitted to any yacht having a substantial number of non-metallic structural members.

5.4.4.2 The protective system is to be comprised of air terminal, down conductor and earth termination.

5.4.4.3 Air terminals of the protective system are to comply with the following requirements:

(1) An air terminal is to be fitted to each non-metallic mast.
(2) Air terminals are to be made of copper or copper alloy conducting bar of not less than 12 mm diameter, and are to project at least 300 mm beyond the top of the mast.

5.4.4.4 Down conductors of the protective system are to comply with the following requirements:
(1) Down conductors are to be made of copper, or copper alloy tape or cable. Cable is preferred as both the insulation and the circuit shape inhibit surface discharge.
(2) Down conductors of copper are to have a minimum cross-section of 70 $mm^2$, be firmly secured to the structure and be run as straight as possible between the air terminal and the earth termination. Bends, where necessary, are to have a minimum radius of at least 10 times the equivalent diameter of the conductor.

5.4.4.5 For a yacht with metallic hulls, the ends of down conductors are to be reliably bonded to the earth terminations of the metallic construction of the yacht nearby.

5.4.4.6 Yacht with non-metallic hulls is to be provided with a metallic ground plate with cross sectional area not less than 0.25 $m^2$ and thickness not less than 2 mm. The position of the ground plate is to be such that it is to be immersed in water in any navigation conditions of the yacht. The earth termination of the protective system is to be bonded to the ground plate.