CHINA CLASSIFICATION SOCIETY

RULES FOR CONSTRUCTION OF YACHTS

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CONTENTS

CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 Application

1.1.1.1 The Rules apply to yachts of new construction of less than 20 m in length.

1.1.1.2 The design categories of yachts are as follows:

Category A means sea-going yachts navigating within 20 n miles off the shore (not exceeding 10 n miles in Taiwan Strait and similar waters).

Category B means yachts navigating in the following waters:

(1) the sea area between the island and the shore and between islands with a distance of less than 10 n miles in between, which form a comparatively good sheltered condition with a little wave; or within 10 n miles off the shore, with wind scale (Beaufort) not more than 6 scale, and the visual wave height not more than 2 m;

(2) inland waters service category A[①].

Category C means yachts navigating in the following waters:

(1) within 5 n miles off the shore, with wind scale (Beaufort) not more than 6 scale, and the visual wave height not more than 1 m;

(2) inland waters service category B[①].

Category D means yachts navigating in inland waters service category C[①].

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 and navigation, etc. of yachts are to comply with the provisions of the flag State Administration relating to safety equipment and pollution prevention.

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 the Rules if the application of which might seriously impede the incorporation of its features or its service, subject to agreement of CCS.

1.1.2.2 Any fitting, material, appliance or apparatus, other than that required in the Rules, 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 the Rules.

1.1.2.3 Equivalence or substitution to those methods of calculation, criteria of evaluation, manufacturing procedures, materials, survey and test requirements specified by the Rules may be accepted subject to agreement of CCS, when relevant tests, theoretical basis, experience in application is 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 the Rules:

(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:

$$V \geqslant 3.7\nabla^{0.1667} \quad \text{m/s}$$
$$V \geqslant 25 \quad \text{kn}$$

where: ∇—— 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.

(4) Overall length L_{oa} (m) means a distance from the fore end of stem to the aft edge of stern transom plating or sternpost, excluding any other protrusions.

① In accordance with relevant provisions of CCS Rules for Construction of Inland Waters Boats.

(5) Length L (m) means the length of underwater watertight envelope of the rigid hull at full-load displacement in rest floatation, excluding appendages at or below the waterline.
(6) Full-load displacement △ (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 length (L) from the top of the plate keel (or from the lower surface of 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 middle of the length L 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 length (L) 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 the Rules 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 yacht[①] and/or a lead yacht[②], subject to satisfactory completion of approval 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 yacht[③], subject to satisfactory completion of manufacturing survey.

Table 1.2.1.2

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

Note: "X" means applicable survey items.

1.2.1.3 The applicant may apply for partial survey in accordance with some requirements of the Rules 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 1.2.4 and 1.2.5.
1.2.1.5 When CCS is authorized by the Administration to carry out statutory survey and it is found in compliance with the Rules, a statutory certificate may only be issued.

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.

1.2.2 Approval of manufacturer

1.2.2.1 The manufacturer of yachts of FRP materials is to ensure the appropriateness of the following resources and a "manufacturer approval certificate" is issued, subject to the approval 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 approval.

1.2.2.3 The approved 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 general the yacht manufacturer is to be inspected once every two years after the initial approval. Where the approval conditions are considered to be maintained on a continual basis during the second inspection, it may be agreed to carry out the inspection once every four years.

1.2.2.5 In case of any change affecting the approval 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 Assessment of manufacturer

1.2.3.1 The manufacturer of yachts of other than FRP materials is to apply for the assessment by CCS in time, in the following conditions:

(1) where the application for yacht survey is submitted for the first time;
(2) where CCS has not carried out any survey of the manufacturer for 12 consecutive months and more;
(3) where any substantial change has been made to the design or type of yachts applying for survey;
(4) where any major change has been made to the main manufacturing facilities for yacht.

1.2.3.2 The scope of assessment is same as in 1.2.2.1.

1.2.4 Approval of plans and technical documents

1.2.4.1 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 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, as appropriate;
  - 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, as appropriate;
  - ⑥ naked fire cooking equipment, materials and arrangement plan;
  - ⑦ fire-extinguishing apparatus arrangement plan;
  - ⑧ electric loading calculations (including calculations of storage battery capacity);

⑨ electric power system, marking:

a. primary rated parameters of motors, transformers, storage 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, storage batteries, switchboards, etc.);

⑪ schematic diagrams and arrangement of lighting.

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

(1) general specifications;

(2) lines;

(3) particulars of products aboard.

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

1.2.5 Prototype survey and test

1.2.5.1 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.

1.2.5.2 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, including rudder stocks and rudder bearings;

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

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

(11) installation of piping;

(12) motors, storage 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.

1.2.5.3 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 the Rules 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.

1.2.5.4 Where any of the following changes has been made to yachts, prototype test of the same scope is to be carried out:

(1) production procedures and manufacturing technique;

(2) significant modification of design.

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 test results and the requirements of approved plans and technical documents. See 1.2.5.2 for the survey scope.

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. The manufacturer is to ensure that the internal quality control documents are available for use by the Surveyor appointed by CCS.

1.2.6.3 During the process of manufacturing survey, strength and functional tests may be required if deemed necessary, depending on the yacht type and annual production quantities.

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) category of yacht;

(4) test scope.

1.2.7.2 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 Overall length L_{oa}, 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 approval 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 service.

(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 less than 8 m in overall length Loa where the thickness of the shell is beyond strength requirements, and the shape of the hull provides a stiffening effect.

(4) 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.

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

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

(7) 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 length and L/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: σ_t——the ultimate tensile stress for the laminate of other laminating design, in N/mm².

(3) The midsection at half of yacht length (L) 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:

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

where: f——factor, $f = 0.25L + 24$;

L——length of yacht, 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:

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

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

where: L——length of yacht, in m;

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

(5) Calculation of amidship section modulus

① All continuous longitudinal members within 0.4 L 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 0.2 L but within 0.4 L 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:

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

where: E——modulus of elasticity of material at the point calculated, in 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 N/mm^2 and moment of inertia to the neutral axis of the amidship section for each member, in cm^4, respectively.

(6) For catamarans, the transverse strength and the torsional strength of connecting 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 P (kW)	Total thickness of stern transom plating (mm) (outboard motor)	Total thickness of stern transom plating (mm) (stern propelling unit)
$18 \leqslant P < 30$	30	35
$30 \leqslant P < 60$	35	40
$60 \leqslant P < 150$	40	45
$P > 150$	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 0.15 L from 1/3 L 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 be is to be taken as follows:

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

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

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:

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

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

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

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:

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

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 %;
γ_R —— specific gravity of resin after solidification , in g/cm^3;
γ_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 α_{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 α_{cg}.

(2) The relation among the designed vertical acceleration at gravity center of a yacht α_{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:

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

where: g —— acceleration of gravity, g = 9.81 m/s²;

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

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

L —— length of yacht, 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;

β —— deadrise angle at LCG, in °, β_{max} = 30°, β_{min} = 10°, see Fig. 2.1.2.1(2);

Δ —— full-loaded displacement, in t.

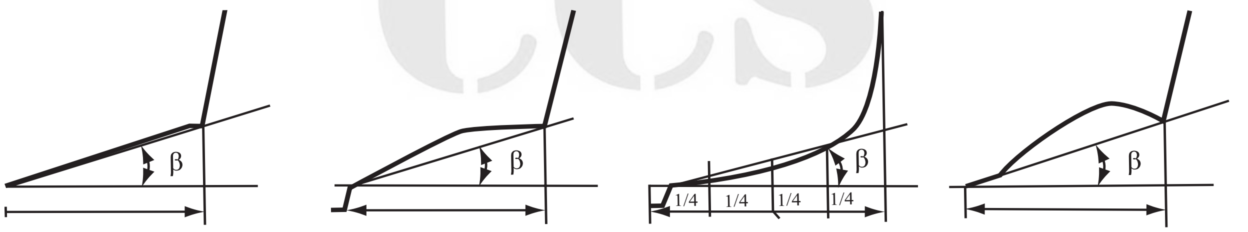

Fig. 2.1.2.1(2)

(3) The final α_{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. $H_{1/3\max}$ of different categories of yachts in service is not to be greater than those specified below:

For Category A yacht, $H_{1/3\max}$=4m
For Category B yacht, $H_{1/3\max}$=2m
For Category C yacht, $H_{1/3\max}$=1m
For Category D yacht, $H_{1/3\max}$=0.4m

2.1.2.2 Local calculated pressure

(1) The wave slamming pressure on bottom P_{sl} is to be calculated by the following formula, and is not to be less than the slamming 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 —— design load area for element considered, in m^2;
for plating, A is not to be taken greater than 2.5 S^2; where S is the spacing of the frames, in m;
for stiffener or girder, A is to be taken as the product: spacing × span;

d —— draft, in m;

Δ—— full load displacement, in t;

α_{cg} —— design vertical acceleration, in m/s^2, to be taken in accordance with that in 2.1.2.1 of this Section.

(2) For catamarans, the pressure on wet deck of connecting 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;

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

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

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

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} —— slamming pressure on bottom in way, in kN/m^2.

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

$P_d = 0.25L + 2.0$ kN/m^2, for exposed deck;
$P_d = 0.1L + 2.0$ kN/m^2, for unexposed deck;
$P_d = 3.6$ kN/m^2, for passenger accommodation deck.

For Category B, C and D yachts, the calculated pressure for exposed deck may be taken as 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:

$P_h = 8\ h$ kN/m^2, for watertight bulkheads and their stiffeners;
$P_h = 12\ h_d$ 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:

$P = 2 + 0.25\ L$ kN/m^2, for fore end bulkhead and its stiffeners;
$P = 2 + 0.1\ L$ 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 —— length of yacht, in m.

For Category B, C and D yachts, the calculated pressure for fore bulkheads and stiffeners of superstructure and deckhouse may be taken as 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:

$$t_{min} = K_0\sqrt{L} \quad \text{mm}$$

where: K_0 —— coefficient, obtained from Table 2.1.2.3(1);
L —— length of yacht, in m.

Coefficient K_o **Table 2.1.2.3(1)**

	Bottom, connecting structure	Side	Deck	Superstructure & deckhouse			Bulkhead	
				Front	Side, behind	Top	Watertight	Collision, liquid tank
K_o	1.45	1.25	1.10	1.10	0.95	0.90	1.20	1.30

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

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

where: σ_{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:

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

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

where: K_0 —— coefficient, obtained from Table 2.1.2.3(3);
L —— length of yacht, in m.

Coefficient K_o **Table 2.1.2.3(3)**

	Bottom, connecting structure	Side	Deck	Superstructure & deckhouse			Bulkhead	
				Front	Side, behind	Top	Watertight	Collision, liquid tank
K_o	0.7	0.6	0.5	0.5	0.4	0.4	0.45	0.55

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

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

where: γ —— ratio of the distance between centerlines of opposite skin laminates to the mean thickness of opposite skin laminates, $6 \leqslant \gamma \leqslant 14$;
τ_c —— ultimate shear stress of sandwich core material, in N/mm²;
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;
$K = 1$ for core of plywood;
s, P —— refer to 2.1.2.3(2) of this Section.

2.1.2.4 Stiffeners and frames

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.

(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: σ_{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.

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

	K	
	Keel, girder, web frame, plate floor, web beam	Longitudinals, floor, frame, beam, stiffener
Bottom, connecting structure	480	400
Side	480	400
Deck	480	400
Superstructure	—	400
Watertight bulkhead	—	400
Liquid tank & collision bulkhead	—	480

(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.

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:

$$A_e = 0.01\, h_w t_w \ \text{cm}^2, \text{ for no bracket at ends of girder}$$
$$A_e = 0.01\, h_w t_w + \Delta A_e \ \text{cm}^2, \text{ for bracket at ends of girder}$$

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;
ΔA_e —— additional shear area for girder with bracket at end, in cm², obtained in accordance with the horizontal angle of the bracket's face plate, refer to Fig.2.1.2.5(1).
$\Delta A_e = 0.9 f_1$, where $\theta = 45°$,
$\Delta A_e = 0$, where $\theta = 0°$,

The value ΔA_e may be obtained by linear interpolation where $\theta = 0 \sim 45°$, f1 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:

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

where: τ_u —— limited shear stress of sandwich plate, in N/mm²;
s, P, l —— refer to 2.1.2.4(1) of this Section.

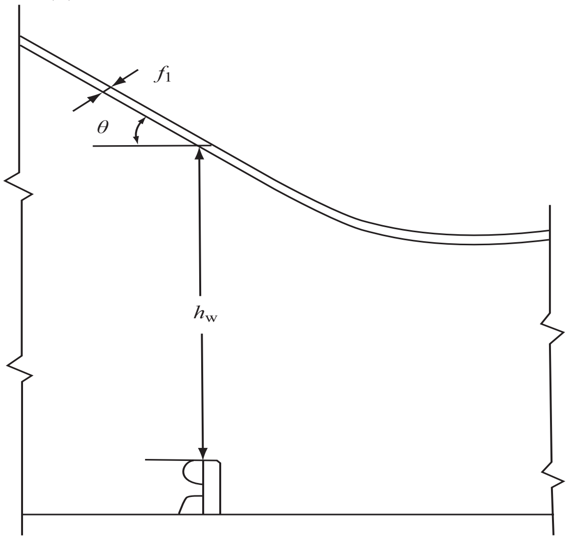

Fig. 2.1.2.5(1)

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) Spacing of short side of hull frames is not to be more than 500 mm. For longitudinal framing yachts, spacing of plate floors is not to be more than 4 frame-spaces.

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

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

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

(8) For yachts of less than 6 m in Overall length L_{oa}, the hull scantlings may be verified by means of drop test of real yacht①.

(9) 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.

(10) 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.

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.

① Refer to ISO 12215-5 Small craft -- Hull construction and scantlings-- Design pressures, design stresses, scantlings determination for details.

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:

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

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

L —— length of yacht, in m.

Coefficient K_0 **Table 2.2.2.3(1)**

Item		K_0
Bottom plating		1.4
Wet deck of connecting 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
Bottom in way of rudder and shaft brackets, etc.		2.8

(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 aspect ratio of plate field; $C_2 = (1.1 - 0.25S/\ell)^2$, where: ℓ is span of stiffeners and frames, in m. Where no bracket is provided at the ends of stiffeners and frames, span point may be at their ends; where bracket is provided at the ends of stiffeners and frames, span point may be at half of the bracket length;

P —— design pressure, to be taken as required by 2.1.2.2 of this Chapter;

σ_s —— yield stress of material, in N/mm^2.

Coefficient K_1 **Table 2.2.2.3(2)**

Item		K_1		
		Within 0.1L from F.P.	Within 0.4L at amidship	Within 0.1L from A.P.
Bottom, wet deck of connecting 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 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 21.8 for transversely framing	25.0	20.5 for longitudinally framing 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:

$$W = K_2 \frac{\ell^2 SP}{\sigma_S} \quad \text{cm}^3$$

where: K_2 —— coefficient, to be obtained from Table 2.2.2.4(1);

ℓ ,P, S, σ_S —— same as in 2.2.2.3(3) of this Section.

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 connecting structure		136	150		150
Side		128	150		150
Deck, including superstructure/ deckhouse top		Deck: 136 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:

$$A_{e\,\min} = 22.67 \frac{(\ell - S)SP}{\sigma_S} \quad \text{cm}^2$$

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, σ_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:

$$A_{e\,\min} = 13.5\frac{S\ell P}{\sigma_S} \quad \text{cm}^2$$

The shear area A_e is to be calculated as follows:

$A_e = 0.01h_w t_w$ cm², for no brackets at ends of girder;
$A_e = 0.01h_w t_w + \Delta A_e$ cm², 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, σ_S —— same as in 2.2.2.3(2) of this Section;
ΔA_e —— additional shear area at end of girder with bracket, obtained according to the horizontal angle θ of the bracket's face plate, see Fig. 2.1.2.5(1) of this Chapter;
$\Delta A_e = 0.9f_1$ where $\theta = 45°$; $\Delta A_e = 0$ where $\theta = 0°$; ΔA_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 cm².

Section 3 ALUMINUM YACHTS

2.3.1 General requirements

2.3.1.1 This Section applies to yachts whose hull structures are of aluminum 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 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:

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

where: K_0 —— coefficient, to be obtained from Table 2.3.4.1;
L —— length of yacht, in m.

Coefficient K_0 **Table 2.3.4.1**

Item		K_0
Bottom plating		1.55
Wet deck of connecting 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
Bottom in way of rudder and shaft brackets, etc.		3.10

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

$$t = K\ C_1 C_2 S\sqrt{\frac{P}{\sigma_{SW}}} \quad \text{mm}$$

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; $C_1 = 1 - 0.5S/r$, where: r is radius of curvature, in m;

C_2 —— correction factor for aspect ratio of plate field. $C_2 = 1.0$ for $S/\ell < 0.5$, $C_2 = 0.92$ for $S/\ell = 1.0$, may be obtained by linear interpolation, where: ℓ is span of stiffeners and frames, in m. Where no bracket is provided at the ends of stiffeners and frames, span point may be at their ends; where bracket is provided at the ends of stiffeners and frames, span point may be at half of the bracket length;.

P —— design pressure, to be taken as required by 2.1.2.2 of this Chapter;

σ_{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, σ_{sw} in the formula may be taken as the yield stress of material σ_s. Where riveting structure is used, σ_{sw} is to be taken as 0.9 σ_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 connecting 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:

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

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

ℓ, P, S —— same as in 2.3.4.2 of this Section.

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

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

(2) the yield stress σ_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 primary 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 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. For a yacht of less than 10 m in length, one sea inlet may be fitted only if the water supply can be ensured.

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 the Rules.

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.

(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:

$$A = 3{,}300\,\ell_n (V/0.14)$$

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;

ℓ_n —— natural logarithm.

① Refer to ISO 8846.

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
$1 \leqslant V \leqslant 3$	$1.5 \times V$
$V > 3$	$0.5 \times V + 3$

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 service 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/mm^2, it is to be taken as 760 N/mm^2; for propeller shaft and tube shaft, if $R_m > 600$ N/mm^2, it is to be taken as 600 N/mm^2. If alloy steel or stainless steel is used, for intermediate shaft, propeller shaft and tube shaft, if $R_m > 800$ N/mm^2, it is to be taken as 800 N/mm^2.

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 0.08d.

② For over a length of at least 0.2d 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 0.0125d.

③ For over a length of at least 0.2d 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 0.3d.

④ For over a length of at least 0.3d 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 0.8d, width more than 0.1d and inside diameter less than 0.8d. 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:

$$BL \geqslant \frac{d^3}{2.6d_m} \quad \text{mm}^2$$

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/mm^2;
R_{mb}——tensile strength of the fitted coupling bolts material taken for calculation, in N/mm^2.
where: $R_m \leqslant R_{mb} \leqslant 1.7\ R_m$, but not higher than 1,000 N/mm^2, in N/mm^2.

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, they are to be flat glasses and 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.
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.
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.

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

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 length. At least one power bilge pump is to be provided for a yacht of more than 12 m in length. 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 length, 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**

Length of yacht L(m)	Total displacement of bilge pump (m^3/h)
$L \leqslant 6$	0.6
$6 < L \leqslant 12$	1.0
$L > 12$	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 a bilge alarm of high water level.
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 Visual and audible alarms for bilge water high level 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 corresponding 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 are 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: Connected to batteries during charging Not connected to batteries during charging	Voltage	 +30～-25 +20～-25	—	—

4.1.2.3 All electrical equipment are 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 service 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 sea water corrosion-resisting metal, 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 in way of power source, i.e. the secondary earthing for generator, power transformer onboard. The neutral point of shore power supply is to be earthed by cable of shore power supply and not on 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 mast and it 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 operational 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 yachts navigating without electrical power, 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 at least to be capable of supplying the electrical equipment to maintain the safety navigation of yachts within a period corresponding to the whole voyage.

4.2.1.5 For Category C and D 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 safety 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 such as reasonable surplus of rated 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) D.C.

two-wire insulated system;

two-wire system with negative pole earthed.

(2) A.C.

single-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.

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

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-inter-changeable 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 are 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.

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 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 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 studs, 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 standards[1] 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.

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 covers form part of the ignition-protection enclosure, a permanent warning tag is to be affixed to the component, or the component is to be permanently and visibly marked with appropriate language or symbols, indicating that the cover must be in place when the engine is ready for use.

4.6.2.4 Ignition distributors are to comply with the following requirements:

(1) The distributor, when in operation, is to meet the ignition-protection requirements. Means used to secure distributor caps is 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 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) The watertight seal 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) The watertight seal 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) The watertight seal 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.

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[1] Refer to ISO 8846.

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 the Rules.

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 operational 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 overall length and waterline length of yachts, multiplied by the following coefficient *k*:

Category A yachts: $k = 1$
Category B yachts: $k = 0.9$
Category C yachts: $k = 0.85$
Category D yachts: $k = 0.80$

Anchoring, cables and ropes **Table 5.2.2.1**

$(L_{oa} + L)/2$	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
17	26	10	14	35	32
18	28	10	16	35	32
19	31	12	16	40	32
20	34	12	16	40	32

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 overall length 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 operational conditions. 2 mooring ropes are in general to be provided on yachts of more than 12 m in length. The length and breaking strength of every rope for mooring is to be obtained 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, operational conditions and structural configuration; however, the minimum number is to be as follows:
(1) For yachts having an overall length L_{oa} 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 an overall length L_{oa} 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 cables.
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 the Rules.

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 GB.
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 which is 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 GB[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.

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.

① Refer to GB 17259.

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 non-combustible 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 Provision of 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
$P \leqslant 37.5$	One dry powder fire extinguisher with a capacity not less than 2 kg
$37.5 < P \leqslant 150$	Two dry powder fire extinguisher with a capacity not less than 2 kg each
$150 < P \leqslant 300$	Two dry powder fire extinguisher with a capacity not less than 3 kg each
$300 < P \leqslant 450$	Two dry powder fire extinguisher with a capacity not less than 4 kg each

6.6.2.2 At lest 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 Operation requirements

6.7.2.1 Yacht's safety certificate and operation manual of LPG power-driven system, etc. required in the Rules 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 service 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.