RUSSIAN MARITIME REGISTER OF SHIPPING

RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF HIGH-SPEED CRAFT

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LIST OF CIRCULAR LETTERS AMENDING/SUPPLEMENTING NORMATIVE DOCUMENT

Rules for classification and construction of high-speed craft (2008)

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(Normative document No. and title)

Item No.	Circular letter No., date of approval	List of amended and supplemented paras
1.	010-6.2 МК-419ц dated 19.10.09	Part XVI: 2.1.2.

Rules for the Classification and Construction of High-Speed Craft have been approved in accordance with the current Regulations and came into force on 1 Fedruary 2009.

The Rules have been developed on the basis of IMO International Code of Safety for High-Speed Craft (Resolution MSC.97(73), Resolution MSC.205(81), Resolution MSC.222(82)).

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GENERAL

1 SCOPE OF APPLICATION

1.1 Rules for the Classification and Construction of High-Speed Craft* of Russian Maritime Register of Shipping** apply to:

.1 passenger ships of whatever gross tonnage which in the course of their voyage do not proceed more than 4 h distance at operational speed from a place of refuge in fully loaded condition;

.2 cargo ships of 500 gross tonnage and over which in the course of their voyage do not proceed more than 8 h distance at operational speed from a place of refuge in fully loaded condition;

.3 self-propelled ships not specified in 1.1.1 and 1.1.2 with power output of their main engines 55 kW and over.

1.2 Rules for Safety of Dynamically Supported Craft, 1990, apply to non-self-propelled air-cushion platforms with power output of their main engines 55 kW and over.

1.3 The scope of requirements for ships referred to in 1.1.3 is specified by the Register in each particular case.

1.4 The requirements of the Rules apply to ships which were under construction or in service on the date of coming into force of the Rules as far as it is reasonable and practicable.

1.5 Unless provided otherwise in the present Rules, General Regulations for the Classification and Other Activity apply to high-speed craft *** as far as they are applicable to such ships.

1.6 Rules for the Classification and Construction of Sea-Going Ships and Rules for the Equipment of Sea-Going Ships apply to HSC as far as it is specified in each Part of the present Rules.

2 DEFINITIONS AND EXPLANATIONS

2.1 For the purpose of the present Rules the following definitions have been adopted.

Administration is the Government of the State the flag of which the craft is flying.

Failure mode and effects analysis (FMEA) is an assessment of craft systems and equipment aiming at determining whether some rather probable failure mode may cause a hazardous or catastrophic effect to the craft made in compliance with Annex 4 of the IMO International Code of Safety for High-Speed Craft.

Base port is a specific port identified in the route operational manual and provided with:

appropriate facilities providing continuous radio communications with craft at all times while in ports and at sea;

means for obtaining a reliable weather forecast for the corresponding region and its due transmission to all craft in operation;

for category A craft-access to facilities provided with appropriate rescue and survival equipment;

access to craft maintenance services with appropriate equipment.

Design waterline is the waterline corresponding to the maximum operational weight of craft with no lift or propulsion machinery active.

Maximum operational weight is the overall weight up to which craft operation in the intended mode is permitted by the Administration.

Displacement of a light craft is the displacement of a craft in tonnes without cargo, oil fuel, lubricating oil, ballast water, fresh water and feed water in tanks, consumable stores, passengers and crew and their effects.

High-speed craft is a craft capable of operating at a maximum speed, in metres per second (m/s), equal to or exceeding:

$$3,7 \times \Delta^{0,1667}$$

where Δ — displacement equal to the design waterline, in m^3.

Significant wave height is the average height of the one-third highest observed wave heights over a given period.

Base port state is the State in which the base port is located.

Length of craft (L) is the overall length of the underwater watertight envelope of the rigid hull, excluding appendages, at or below the design waterline in the displacement mode with no lift or propulsion machinery active.

Flap is an element formed as an integrated part of, or an extension of, a foil, used to adjust the hydrodynamic or aerodynamic lift of the foil.

Convention is International Convention for the Safety of Life at Sea, 1974, as amended.

Foil is a profiled plate or three-dimensional construction at which hydrodynamic lift is generated when the craft is under way.

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* Hereinafter referred to as "the present Rules".

**Hereinafter referred to as "the Register".

***Hereinafter referred to as HSC.

Fully submerged foil is a foil having no lift components piercing the surface of the water in the foil-borne mode.

Place of refuge is any naturally or artificially sheltered aquatorium which may be used as a shelter by a craft under conditions likely to endanger its safety.

Muster station is an area where passengers can be gathered in case of emergency, given instructions and prepared to abandon the craft, if necessary. The passenger spaces may serve as muster stations if all passengers can be instructed there and prepared to abandon the craft.

Organisation is International Maritime Organisation.

Passenger is every person other than:

the Master and members of the crew or other persons employed or engaged in any capacity on board a craft on the business of that craft;

a child under one year of age.

Auxiliary machinery spaces are spaces containing:

diesel-generators and other essential auxiliary machinery driven by internal combustion engines of power output up to and including 110 kW;

sprinkler, drencher or fire pumps;

bilge pumps;

oil filling stations;

switchboards of aggregate capacity exceeding 800 kW;

and trunks to such spaces (see 1.3 of Part VI "Fire Protection" of the present Rules).

Auxiliary machinery spaces of little or no fire risk are spaces containing:

refrigerating machinery;

stabilizing systems;

ventilation and air conditioning machinery;

switchboards of aggregate capacity 800 kW or less;

and trunks to such spaces (see 1.3 of Part VI "Fire Protection"of the present Rules).

Cargo spaces are all spaces other than special-category spaces and ro-ro spaces used for cargo and trunks to such spaces.

Crew accommodation spaces are spaces allocated for the use of the crew, and include cabins, sick bays, offices, lavatories, lounges and similar spaces.

Machinery spaces are spaces containing internal combustion engines with aggregate total power output of more than 110 kW, generators, oil fuel units, propulsion machinery, major electrical machinery and trunks to such spaces (see 1.3 of Part VI "Fire Protection"of the present Rules).

Public spaces are spaces allocated for passengers and include kiosks, smoke rooms, main seating areas, lounges, dining rooms, recreation rooms, lobbies, laboratories and similar permanently enclosed spaces allocated for passengers.

Open vehicles spaces are spaces:

to which any passengers carried have access;

intended for carriage of motor vehicles with fuel in their tanks for their own propulsion;

either open at both ends or open at one end and provided with adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead, or from above.

Open ro-ro spaces are those ro-ro spaces:

to which any passengers carried have access; and either:

are open at both ends or

have an opening at one end and provided with permanent openings distributed in the side plating or deckhead or from above, having total area of at least 10 per cent of the total area of the space sides.

Ro-ro spaces are spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the craft in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded or unloaded, normally in horizontal direction.

Service spaces are enclosed spaces used for pantries containing food-warming equipment but no cooking facilities with exposed heating surfaces, lockers, sales shops, store-rooms and enclosed baggage rooms.

Such spaces containing no cooking appliances may contain:

.1 coffee automats, toasters, dish washers, microwave ovens, water boilers and similar appliances, each of them with the maximum power of 5 kW; and

.2 electrically heated cooking plates and hot plates for keeping food warm, each of them with the maximum power of 2 kW and a surface temperature not above 150 °C.

Special category spaces are those enclosed ro-ro spaces to which passengers have access. Special category spaces may be accommodated on more than one deck provided that the total overall area clear height for vehicles does not exceed 10 m.

Operating station is a confined area of the control station equipped with necessary means for navigation, manoeuvring and communication, and from where the functions of navigating, manoeuvring and communication, commanding, conning and lookout are carried out.

Continuously manned control station is a control station which is continuously manned by a responsible member of the crew while the craft is in normal service.

Control stations are spaces in which the craft radio or navigating equipment or the emergency source of power and emergency switchboard are located, or where the fire recording or fire control equipment is centralized, or where other functions essential to the safe operation of the craft, such as propulsion control, public address, stabilization systems, etc, are located.

Displacement mode is the regime, whether at rest or in motion, when the weight of the craft is fully or predominantly supported by hydrostatic forces.

Non-displacement mode is the normal operational regime of a craft when non-hydrostatic forces substantially or predominantly support the weight of the craft.

Transitional mode is the regime between displacement and non-displacement modes.

Operating compartment is the enclosed area from which the navigation and control of the craft is exercised.

Maximum speed is the speed achieved at the maximum continuous propulsion power at maximum operational weight and in smooth water.

Operational speed is 90 per cent of the maximum speed.

Cargo ship is any high-speed craft other than a passenger ship, which is capable of maintaining the main functions and safety systems of unaffected spaces after damage in any one compartment on board.

Category A craft is any high-speed passenger craft:

operating on a route where it has been demonstrated to the satisfaction of the Flag and Port States that there is a high probability that, in the event of an evacuation at any point of the route, all passengers and crew can be rescued safely within the least of:

the time to prevent persons in survival craft from exposure causing hypothermia in the worst intended conditions;

the time appropriate with respect to environmental conditions and geographical features of the route;

4 hours;

carrying not more than 450 passengers.

Category B craft is any high-speed passenger craft, other than a category A craft, with machinery and safety systems arranged so that, in the event of damage or flooding disabling any essential machinery and safety systems in one compartment, the craft retains the capability to navigate safely.

Air-cushion vehicle (ACV) is a craft such that the whole or a significant part of its weight can be supported, whether at rest or in motion, by a continuously generated cushion of air dependent for its effectiveness on the proximity of the surface over which the craft operates.

Passenger ship is a ship which carries more than twelve passengers.

Hydrofoil is a craft which is supported above the water surface in non-displacement mode by hydrodynamic forces generated on foils.

Ro-ro craft is a craft fitted with one or more ro-ro spaces.

Air-cushion vehicle side-wall craft is an air-cushion vehicle which cushion shalltally or partially retained by permanently immersed hard structures.

Special-purpose ship is a mechanically self-propelled ship which by reason of its function carries on board more than 12 persons of special personnel including passengers.

Flashpoint is a flashpoint determined by a test using the closed-cup apparatus referenced in International Maritime Dangerous Goods (IMDG) Code.

Critical design conditions are the limiting specified conditions, chosen for design purposes, which the craft shall keep in a displacement mode. Such conditions shall be more severe than the worst intended conditions by a suitable margin to provide for adequate safety in the survival condition.

Worst intended conditions are the specified environmental conditions within which the operation of the craft is intended. This shall take into account such parameters as the worst conditions of wind force allowable, significant wave height (including unfavourable combinations of length and direction of waves), minimum air temperature, visibility and depth of water for safe operation and such other parameters as the Register may require in considering the type of the craft in the area of operation.

Oil fuel unit is the equipment used for the preparation of oil fuel for delivery to an oil-fired boiler, or equipment used for the preparation for delivery of heated oil fuel to an internal combustion engine, and includes any oil fuel pressure pumps, filters and heaters dealing with oil fuel at a pressure of more than 0,18 N/mm^2.

Breadth of a craft (B) is breadth, in metres, of the broadest part of the moulded watertight envelope of the rigid hull, excluding appendages at or below the design waterline in the displacement mode with no lift or propulsion machinery active.

3 CONDITIONS OF SAFETY

3.1 The required level of safety of HSC in service is provided by fulfilment of the requirements of the present Rules regulating safety by technical means provided on board of the craft in combination with organisational and technical measures described in Chapter 18 of the IMO International Code of Safety for High-Speed Craft* (Resolution MSC.97(73)).

A complex of organisational and technical measures shall be provided by a shipowner.

3.2 Complex fulfilment of the requirements set forth in the present Rules and in Chapter 18 of the Code provides the level of safety of a HSC and on board the craft which is equivalent to that prescribed by the International Convention for the Safety of Life at Sea and the International Convention on Load Lines.

4 GENERAL REQUIREMENTS

4.1 The first HSC of a series shall be tested according to a programme approved by the Register, which includes inspections in the scope which is sufficient for confirmation of the craft reliability and safety of its operation under the worst intended conditions.

The programme shall provide for testing the behaviour of HSC, its machinery and systems in case of simulations of emergency situations, failures, errors in control approved by the Register as well as for determination, if necessary, of external loads for which structures are calculated. Such tests shall be carried out in the presence of the Register representatives.

4.2 Based on the test results, wave height, wind velocity under which HSC may move in the displacement mode in forced circumstances according to good marine practice shall be specified. Such parameters and recommendations on control in the displacement mode shall be indicated in the operational manual.

4.3 All cases of impairing HSC stability, i. e. abnormal angles of heel and trim, loss of controllability and other abnormal facts in the craft behaviour shall be reported by the shipowner to the Register Regional Office in charge of supervision of the craft.

4.4 Any substitution of materials, machinery, instruments and other equipment subject to technical supervision by the Register shall be agreed with the Register.

4.5 The Register may exempt HSC craft from complying with some requirements of the present Rules provided it will be proved that it hinders further improvement of the craft. In this case, the level of safety not lower than that provided by the present Rules shall be ensured.

4.6 In case a craft where some requirement of the present Rules are not met is intended for international voyages, the level of safety shall be recognized as adequate by the Register and Administration of the country at the ports of which the craft will call.

* Hereinafter referred to as "the Code".

5 DOCUMENTS

5.1 Classification Certificate, Safety Equipment Certificate, Load Line Certificate and Seaworthiness Certificate are issued by the Register to every HSC flying the RF flag.

High-Speed Craft Safety Certificate is additionally issued to craft engaged in international voyages.

5.2 A Permit to Operate High-Speed Craft is also issued to craft engaged in international commercial voyages.

5.3 Classification Certificate is the document which confirms the fulfilment of the requirements of Parts I to XV of the present Rules. The worst intended conditions under which the craft motion in the operational mode is permitted, the maximum distance allowed to proceed from places of refuge and other limitations, where necessary, shall be indicated in the Classification Certificate.

5.4 Safety Equipment Certificate is the document which confirms compliance with the requirements set forth in Parts XVI to XIX of the present Rules.

5.5 Load Line Certificate is the document which confirms compliance with the requirements of Load Line Rules for Sea-Going Ships.

5.6 The documents referred to in 5.3, 5.4 and 5.5 are issued for five years with the annual confirmation.

5.7 Availability of the valid documents referred to in 5.3, 5.4 and 5.5 is the ground for Seaworthiness Certificate issuance.

5.8 Seaworthiness Certificate is issued for five years with the annual confirmation.

A particular route, routes or aquatorium where the craft is allowed to operate with due regard for weather conditions and distance allowed to proceed from the a place of refuge as well as other limitations indicated in the Certificates referred to in 5.3 and 5.4 shall be indicated in Seaworthiness Certificate.

5.9 Availability of the valid documents referred to in 5.2 and 5.3 means the fulfilment of the Code requirements and gives grounds for High-Speed Craft Safety Certificate issuance. For craft flying a foreign flag the Certificate may be issued on behalf of the Administration of the country the flag of which the craft is flying.

5.10 Permit to Operate High-Speed Craft is the document which confirms complex fulfilment of organisational and technical measures, and operational control procedures referred to in Chapter 18 of the Code by the shipowner.

5.11 The Permit is issued by the Administration of the country the flag of which the craft is flying or by another competent organisation on behalf of the Administration.

PART I. CLASSIFICATION

1 GENERAL

1.1 The Register may assign a class to a craft after construction or may assign or renew the class to a craft in service.

1.2 Assignment of the Register class means that the Register confirms that the craft complies with the requirements imposed thereupon and is taken under the Register technical supervision for a specified period of time subject to annual surveys for confirmation of the class.

1.3 Class renewal means that the Register confirms that the technical condition of the craft is consistent with the class assigned and that the Register technical supervision is prolonged for a certain period of time.

1.4 HSC class is assigned or renewed by the Register for a period of five years but in sound cases, the Register may assign or renew the class for some other period of time.

1.5 If a craft has the valid class of the Register, it means that the craft is under the Register technical supervision, as provided in the Rules, over its technical condition and meets fully or to the extent considered adequate by the Register the requirements of the Rules applicable thereto according to the purpose, service conditions and class notation of the craft. The validity of the class is confirmed by the valid Classification Certificate available on the craft.

1.6 In case a craft was not submitted to the mandatory survey within the prescribed period of time; after an accident, provided it will not be submitted for survey, in the port where the accident took place or at the first port the craft calls after the accident; or after structural alterations not agreed with the Register and changes in the craft outfit; or after repair carried out without the Register technical supervision; or if the craft is operated with a draught which exceeds that required by the load line or under conditions not consistent with the requirements for assigning the particular class, Classification Certificate ceases to be valid, which results in withdrawal or suspension of the class.

1.7 Where cases referred to in 1.6 are discovered as well as in cases when the craft is taken out of service by the shipowner for a long time required to fulfil the requirements imposed by the Register for renewal or confirmation of the class or for any other reason, the Register Head Office may take a decision to suspend the class for a period of up to five years. In this case survey of the craft for confirmation or renewal of the class may be carried out only if permitted by the Register Head Office within the scope agreed with the Register.

1.8 Class withdrawal means that the Register ceases its technical supervision if renewal or suspension of the class is considered impossible by the Register. The class may also be withdrawn at the shipowner's discretion.

1.9 Class cancellation means cessation of the Register technical supervision of the craft because of its loss or scrapping.

2 CLASS NOTATION OF CRAFT

2.1 The character of classification of a craft built according to the Rules and under the Register technical supervision shall be **KM⍟** or **KE⍟**:

KM⍟ for self-propelled craft;

KE⍟ for non-self-propelled air-cushion platforms where machinery and equipment with power output of prime movers 55 kW and over are installed subject to technical supervision in accordance with the Rules.

2.2 Character of classification of a craft built without the Register technical supervision.

2.2.1 If a craft as a whole or its hull or its machinery installation, machinery and equipment were built according to the Rules and under the supervision of another classification body recognized by the Register and then the craft was classed by the Register, the character of classification shall be **KM★** or **KE★**:

KM★ for self-propelled craft;

KE★ for non-self-propelled air-cushion platforms where machinery and equipment with power output of prime movers 55 kW and over are installed subject to technical supervision in accordance with the Rules.

2.2.2 If a craft and its machinery installation, machinery and equipment were built without the supervision of a classification body recognized by the Register or without the supervision of any classification body and then the craft was classed by the Register, the character of classification shall be **(KM)★ (KE)★**:

(KM)★ for self-propelled craft;

(KE)★ for non-self-propelled air-cushion platforms where machinery and equipment with power output of prime movers 55 kW and over are installed subject to technical supervision in accordance with the Rules.

2.3 Subdivision distinguishing marks.

2.3.1 If a craft complies with the applicable requirements of Part V "Reserve of Buoyancy and Subdivision" of the present Rules and fully meets the requirements of Section 4 of the above-mentioned Part in case of flooding of any two or three adjacent compartments over the entire length of the craft with the assumed side damages specified in 4.3, subdivision distinguishing mark 2 or 3, respectively, is added to the character of classification of the craft.

2.3.2 Distinguishing mark 1 may be added to the character of classification only for the craft referred to in 1.1.3 and 1.2, "General" in case the Register considers it possible.

2.4 Automatic stabilization mark.

If an automatic or semi-automatic stabilization system is installed on HSC, and the craft cannot move in the operational mode without the system, letters **AUTstab** are added to the character of classification.

2.5 Designation of HSC type in the class notation.

ACV — air-cushion vehicle.

SES — surface-effect ship.

Hydrofoil craft.

SWATH — small water area twin hull ship.

MHC — multihull craft.

HSC — high-speed craft.

2.6 Descriptive notation.

A descriptive notation shows the category of the craft and is written in the following way:

passenger craft "A" — for category A passenger ship;

passenger craft "B" — for category B passenger ship.

2.7 Distinguishing marks are put in the class notation in the order given in this Section.

3 CLASSIFICATION SURVEYS OF CRAFT

3.1 Initial survey.

The initial survey is carried out for the purpose of assigning class to a craft which is submitted for classification for the first time or for class renewal of the craft which class has been withdrawn. During the initial survey the compliance of the craft and its technical condition with the present Rules shall be ascertained.

3.2 Special survey.

The special survey is carried out for the purpose of class renewal. During the special survey compliance of the technical condition of the craft with its service conditions defined by the craft class shall be ascertained.

3.3 Annual survey.

The annual survey is carried out for the purpose of class confirmation. The annual survey is held to ascertain that technical condition of the craft meets adequately the conditions of retaining the class; operation of separate machinery, arrangements and installations covered by the present Rules shall be also checked.

3.4 The scope of periodical surveys for HSC in service shall be not less than that given in Table 3.4.

3.5 The scope of initial survey is established by the Register in each particular case with regard to Table 3.4.

4 CLASSIFICATION OF HIGH-SPEED CRAFT WITH CLASS OF ANOTHER CLASSIFICATION SOCIETY

4.1 In addition to the documents listed in 5.1.3, Part II "Carrying out Classification Survey of Ships" of the Guidelines on Technical Supervision of Ships in Service, the following documents shall be submitted:

.1 longitudinal and local strength calculations; strength calculations and data on service life of hull structures, foil arrangement and skirt; vibration calculations for hull, hydrofoils and skirt;

.2 calculation of external forces acting on hull, foil arrangements and skirts;

.3 geometrical and hydrodynamic scheme of foil arrangements;

.4 structural drawings of hull, foil arrangements and their attachments in working and lifted position; skirt and its attachment;

.5 basic diagrams of automatic control and stabilization of craft and their description;

.6 drawings of stabilization controls and their machinery;

.7 drawings and characteristics of transducers in automatic control and stabilization system;

.8 drawings of lift air blowers with control machinery and attachment;

.9 torque calculations of gears to propellers and lift air blowers or full-scale measurement results;

.10 hull anti-corrosive protection system.

Note. Information on stability shall contain data for displacement, transitional and operational modes.

5 TECHNICAL DOCUMENTATION

5.1 In addition to the documents indicated in Section 3, Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships the following shall be submitted for HSC.

5.1.1 Technical design.

5.1.1.1 Hull:

.1 calculation of external forces;

.2 longitudinal and local strength calculation;

Table 3.4

SCOPE OF PERIODICAL SURVEYS OF HIGH-SPEED CRAFT

Symbols:

O — examination with provision of access, opening and dismantling where necessary;
C — external examination;
M — measurements of wears, clearances, insulation resistance, etc;
H — pressure testing (hydraulic, pneumatic);
P — testing of machinery, equipment and arrangements, their external examination;
E — verification of availability of current documents and/or brands to confirm testing of instruments by appropriate competent bodies, if they are subject thereto;
K — verification of remaining service life.

No.	Item to be surveyed	Ship survey														
		1st annual	2nd annual	3rd annual	4th annual	1st special	1st annual	2nd annual	3rd annual	4th annual	2nd special	1st annual	2nd annual	3rd annual	4th annual	3rd special
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1. Hull															
1.1	Underwater part of hull (outer side)[1,2]															
1.1.1	Stem, bilge transom, steps, recesses, rigid structures which hold or divide air cushion, skirt attachment places, rigid air channels and trunks, propeller shaft struts, landing supports, hull parts by which a craft is lifted, reinforcements in the area of such parts	C	C	C	C	O	C	C	O	C	O	O	O	O	O	O
1.1.2	Shell plating, including areas of high vibration, impact loads, foil arrangements, foil reinforcements and attachments, propeller shaft struts, angular columns, rudder stocks, foil tilting machinery, flaps, outside plating of bridges connecting hulls	C	C	C	C	OM[3]	C	C	O	C	OM[3]	O	O	O	O	OM[3]
1.1.3	Sea valve recesses and discharges	C	C	C	C	CM[3]H[4]	C	C	C	C	CM[3]H[4]	C	C	C	C	CM[3]H[4]
1.2	Above-water part of hull (outer side)[2]															
1.2.1	Stem, after bulkhead	C	C	C	C	O	C	C	C	C	O	C	C	O	C	O
1.2.2	Shell plating, including that in the areas of foil attachments, angular columns, abutments upon a bridge connecting hulls	C	C	C	C	O	C	C	O	C	O	C	C	O	C	OM[3]
1.2.3	Plating of deck bounding buoyancy compartments	C	C	C	C	OHM[3]	C	C	O	C	OHM[3]	C	C	O	C	OHM[3]
1.2.4	Plating of deck providing longitudinal strength of craft	C	C	C	C	OM[3]	C	C	O	C	OM[3]	C	C	O	C	OM[3]

Table 3.4 - continued

1.2.5	Deck and bulkheads of lavatories and accumulator battery rooms if they bound buoyancy compartments	C	C	C	C	OM[3]	C	C	O	C	OM[3]	C	C	O	C	OM[3]
1.2.6	Superstructures, deckhouses (plating, decks, bulkheads)	C	C	C	C	O	C	C	C	C	O	C	C	C	C	OM[3]
1.2.7	Hatch and ventilator coamings	C	C	C	C	O	C	C	C	C	OM[3]	C	C	C	C	OM[3]
1.2.8	Bulwark, foil arrangements skirt	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
1.3	Spaces inside hull[5,6]															
1.3.1	Forepeak, afterpeak	O	O	O	O	OH	O	O	O	O	OM[3]H	O	O	O	O	OMH
1.3.2	Dry compartments, cofferdams	O	O	O	O	OH	O	O	O	O	OM[3]H	O	O	O	O	OMH
1.3.3	Oil fuel and lube oil tanks[7]	C	C	C	C	OH[8]	C	C	C	C	OMH[8]	C	C	C	C	OMH[8]
1.3.4	Water tanks	C	C	C	C	OH[8]	C	C	C	C	OMH[8]	C	C	C	C	OMH[8]
1.3.5	Independent tanks	C	C	C	C	OH	C	C	C	C	OMH	C	C	C	C	OMH
1.3.6	Sewage tanks[8]	C	C	C	C	OH[8]	C	C	C	C	OH[8]	C	C	C	C	OH[8]
1.3.7	Machinery spaces:															
.1	main and auxiliary machinery spaces	C	O	C	O	O	C	O	C	O	OM[3]	C	O	C	O	OM[3]
.2	main and auxiliary machinery seatings	C	C	C	C	O	C	C	C	C	OM[3]	C	C	C	C	OM[3]
1.3.8	Passenger spaces	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
1.3.9	Other spaces in hull, superstructures, deckhouses					O					O					O
1.3.10	Air fan trunks, air channels, receivers	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
1.4	Corrosion protection, potential measurement[2]	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

2. Arrangements, equipment and outfit

2.1	Closing appliances															
2.1.1	Closing appliances of hatchways and manholes of open parts of decks and inside superstructures, outer doors of superstructures and deckhouses, side scuttles, covers of ventilator cowls and openings	C	C	C	C	OH	C	C	C	C	OH	C	C	C	C	OH
2.2	Steering and reverse-reduction gear															
2.2.1	Rudder blade (water, air), flaps, steering nozzles[9]	C	O	C	O	OM	C	O	C	O	OM	C	O	C	O	OM
2.2.2	Rudder stock, rudder stock bearings, pintles, fastenings[10]	CM	CM	CM	CM	OM	CM	CM	CM	CM	OM	CM	CM	CM	CM	OM
2.2.3	Steering gear (main and auxiliary) with control system, control panels and rudder blade angle indicators	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
2.3	Foil arrangements and stabilization controls[9]	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
2.3.1	Planes, stays, flaps and other stabilization controls	CM	CM	OMKH	CM	OMKH	CM	CM	OMKH	CM	OMKH	CM	CM	OMKH	CM	OMKH
2.3.2	Axles, bearings, pull rods of tilting flaps and foils, and other stabilization controls	CM	CM	OM	CM	CM	CM	CM	OM	CM	OM	CM	CM	OM	CM	OM
2.3.3	Insulation of foils from hull	CM	CM	CM	CM	CM	CM	CM	CM	CM	OM	CM	CM	CM	CM	OM
2.3.4	Tilting flap and foil machinery, and other stabilization controls as well as connections of machinery with stabilization controls	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
2.3.5	Foil attachment and reinforcement, angular columns, foil tilting machinery, angular columns and other stabilization controls	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
2.4	Skirts															
2.4.1	Skirt	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
2.4.2	Skirt attachment	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Table 3.4 - continued

No.	Item to be surveyed	Ship survey														
		1st annual	2nd annual	3rd annual	4th annual	1st special	1st annual	2nd annual	3rd annual	4th annual	2nd special	1st annual	2nd annual	3rd annual	4th annual	3rd special
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2.4.3	Skirt lifting machinery	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
2.4.4	Lifting machinery attachment and reinforcement	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
2.5	Anchor arrangement	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
2.5.1	Anchors, hawse pipes, chain cables, ropes	C	C	C	C	OM	C	C	C	C	OM	C	C	C	C	OM
2.5.2	Stoppers and chain (rope) release devices					OP					OP					OP
2.6	Mooring arrangement															
2.6.1	Bollards, fairleaders, ropes and other equipment					O					O					O
2.7	Signal masts															
2.7.1	Masts					O					OM[3]					OM[3]
2.7.2	Standing rigging					O					O					O
2.8	Emergency outfit					C					C					C
2.9	Wheelhouse window wiper	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	3. Fire protection															
3.1	Structural fire protection															
3.1.1	Fire-resisting and fire-retarding divisions and closures of openings therein					O					O					O
3.1.2	Self-closing fire doors with devices to hold them in the open position[11]	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
3.1.3	Closures of outer openings (ventilation ducts, engine room skylights, etc)[11]	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	P
3.2	Fire fighting systems															
3.2.1	Water fire main, pressure water spraying, foam fire extinguishing systems	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
3.2.2	Fluid smothering system, carbon dioxide smothering[9]	P	P	P	P	OP	P	P	P	P	OPH[12]	P	P	P	P	OP
3.2.3	Fire alarm systems	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
3.2.4	Fire outfit, spare parts and tools	C	C	C	C	CP	C	C	C	C	CP	C	C	C	C	CP
3.2.5	Instrumentation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	4. Machinery installation															
4.1	Main engine															
4.1.1	Main internal combustion engine[13, 14]	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK

Table 3.4 - continued

4.1.2	Gas turbine	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.2	Lift air blowers	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.2.1	Fixed and tilting guides with pull rods		O			O		O			O		O			O
4.3	Auxiliary machinery	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
4.3.1	Main engine-driven auxiliary machinery															
4.3.2	Auxiliary internal combustion engines[13, 14]	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.4	Instrumentation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
4.5	Spare parts					C					C					C
4.6	Shafting, gears to lift air blowers and propeller[15]	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
4.6.1	Propeller shaft and gears shafts to lift air blowers	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
.1	journals	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM
.2	stern-tube bearings	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM	OM
.3	propeller shaft glands	C	C	OH	C	OH	C	C	OH	C	OH	C	C	OH	C	OH
.4	flanged connections and couplings	C	O	C	O	O	C	O	C	O	O	C	O	C	O	O
.5	reduction gear	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.6.2	Propeller (water and air)[16]	C	C	O	C	O	C	C	O	C	O	C	C	O	C	O
.1	static balancing[17]															
.2	propeller shaft fitting (adjusting)[18]															
.3	propeller fastening[16]															
.4	pitch actuating mechanism	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.6.3	Water-jet propeller[15]	C	O	C		O	C	O	C		O	C	O	C		O
.1	propeller housing	C	OM	C		OM	C	OM	C		OM	C	OM	C		OM
.2	reversing gear	C	OM	C		OM	C	OM	C		OM	C	OM	C		OM
.3	impeller[17]		O			O		O			O		O			O
.4	propeller shaft		O			O		O			O		O			O
4.6.4	Propeller angular columns[9,15]	CK	OK	CK		OK	CK	OK	CK		OK	CK	OK	CK		OK
.1	shafts		O			O		O			O		O			O
.2	pinions			OM		OM			OM		OM			OM		OM
.3	screws			O		O			O		O			O		O
.4	clutch, lifting and tilting arrangements			O		O			O		O			O		O
4.7	Auxiliary machinery[19]															
4.7.1	Bilge pump	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
4.7.2	Fire pump	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
4.7.3	Compressors	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
.1	cylinders, crankshaft and main bearings, cylinder covers and valves					O					O					O
.2	air coolers with fittings															H
.3	safety valve	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
4.8	Steering gear	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
4.9	Anchor machinery	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
4.10	Tilting pylons	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
4.10.1	Angular gears	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.10.2	Couplings[18]	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
4.10.3	Tilting machinery	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK	PK
4.11	Heat exchangers and their fittings					OH[20]P					OHP					OH[20]P
4.11.1	Safety valves	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
4.12	Air bottles and other pressure vessels and their fittings	P	P	P	P	OH[20]P	P	P	P	P	OH[20]P	P	P	P	P	OH[20]P

Table 3.4 - continued

No.	Item to be surveyed	Ship survey														
		1st annual	2nd annual	3rd annual	4th annual	1st special	1st annual	2nd annual	3rd annual	4th annual	2nd special	1st annual	2nd annual	3rd annual	4th annual	3rd special
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	5. Systems and piping															
5.1	Bilge system	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
5.1.1	Scuppers					O					O					O
5.2	Air, vent, overflow and sounding pipes	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
5.3	Exhaust-gas system			O		OP			O		OP			O		OP
5.4	Sewage system[2]	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
5.5	Ventilation system															
5.5.1	Ventilation ducts passing through watertight and fire divisions					O					O					O
5.6	Oil fuel system	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
5.7	Lubricating oil system	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
5.8	Water cooling system	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
5.9	Compressed air system	P	P	P	P	OP	P	P	P	P	OPH[21]	P	P	P	P	OP
5.10	Hydraulic system with machinery, tanks and instrumentation[22]	PK	PK	PK	PK	OPK	PK	PK	PK	PK	OPK	PK	PK	PK	PK	OPK
5.11	Bottom, side fittings and fittings on watertight bulkheads															
5.11.1	Fittings located under waterline[23]	O	O	O	O	OH	O	O	O	O	OH	O	O	O	O	OH
5.11.2	Fittings located above waterline	C	C	C	C	O	C	C	C	C	O	C	C	C	C	O
5.12	Instrumentation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
5.13	Water separators on air intakes of turbines	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
5.14	Ballast system	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
	6. Electrical equipment															
6.1	Power and lighting equipment[24]															
6.1.1	Main and emergency sources of power															
.1	generators	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.2	accumulator batteries	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
6.1.2	Electrical energy converting devices feeding essential consumers	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP

Table 3.4 - continued

6.1.3	Switchboards															
.1	main and emergency switchboards	P	P	P	P	OEMP	P	P	P	P	OEMP	P	P	P	P	OEMP
.2	navigation light, radio communication, navigation and automation equipment switchboards	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.3	section and group switchboards	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.4	control and monitoring panels and desks	P	P	P	P	OEMP	P	P	P	P	OEMP	P	P	P	P	OEMP
.5	protector panels	P	P	P	P	OEMP	P	P	P	P	OEMP	P	P	P	P	OEMP
6.1.4	Cabling															
.1	cables and wires	M	M	M	M	OM	M	M	M	M	OM	M	M	M	M	OM
.2	cable protection (additional), passage of cables through watertight and fire-proof bulkheads and decks	C	C	C	C	OH	C	C	C	C	OH	C	C	C	C	OH
6.1.5	Electric drives of essential arrangements and machinery as well as their control, protection, starting and regulation devices															
.1	bilge, fire, oil fuel and lubricating oil pumps	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.2	engine room ventilation	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.3	craft steering and stabilization control	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.4	anchor machinery	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.5	compressors	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.6	mooring machinery	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
.7	survival craft launching devices	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
6.1.6	Lighting															
.1	of spaces and areas important for craft safety and propulsion, and people on board	C	C	C	C	OP	C	C	C	C	OP	C	C	C	C	OP
.2	of other spaces			OP		OP			OP		OP			OP		
.3	emergency lighting	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
.4	navigation lights	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP	OP
6.1.7	Electrical heating devices to provide operation of main engines and essential machinery	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
6.1.8	Other fixed heating devices			C		C			C		C			C		C
6.2	Signalling and internal communication devices															
6.2.1	All types of craft electrical signalling and internal communication systems	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
6.3	Protective devices															
6.3.1	Lightning arresters			C		C			C		C			C		C
6.3.2	Earthing	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
6.4	Spare parts					C					C					C
6.5	Instrumentation	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
	7. Automation															
7.1	Craft automated stabilization control system[22]	PK	PK	PK	PK	OPK	PK	PK	PK	PK	OPK	PK	PK	PK	PK	OPK
7.2	All surveys referred to in item 6 of Table 3.2.3, Part I "Classification" of Rules for the Classification and Construction of Sea-Going Ships															

Table 3.4 - continued

No.	Item to be surveyed	Ship survey														
		1st annual	2nd annual	3rd annual	4th annual	1st special	1st annual	2nd annual	3rd annual	4th annual	2nd special	1st annual	2nd annual	3rd annual	4th annual	3rd special
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	8. Life-saving appliances															
8.1	Launching devices	P[25]	P[25]	P[25]	P[25]	OP[25]	P[25]	P[25]	P[25]	P[25]	OP[25]	P[25]	P[25]	P[25]	P[25]	OP[25]
8.2	Inflatable liferafts and jackets	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]	CE[26]
8.3	Lifebuoys and rigid jackets	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
8.4	Line-throfoil appliances	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
8.5	Rescue life-saving appliance	O	O	O	O	OP	O	O	O	O	OP	O	O	O	O	OP
	9. Signal means															
9.1	Navigation and flashing lights	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
9.2	Sound signal means	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
9.3	Shapes and pyrotecnical means	C	C	C	C	CK	C	C	C	C	CK	C	C	C	C	CK
	10. Radio equipment															
		MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
10.1	Main radiotelegraph transmitter	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
10.2	Main radiotelegraph receiver	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
10.3	Main radiotelephone transmitter	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
10.4	Main radiotelephone receiver	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
10.5	VHF radiotelephone station	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
10.6	Automatic device for generating radiotelegraph alarm and distress signals	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP	MP	MP	MP	MP	OMP
10.7	Automatic device for generating radiotelephone alarm signals	P	P	P	P	OMP	P	P	P	P	OMP	P	P	P	P	OMP
10.8	Radar	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
10.9	Command broadcast apparatus	OP	OP	OP	OP	OMP	OP	OP	OP	OP	OMP	OP	OP	OP	OP	OMP
10.10	Aerials	OP	OP	OP	OP	OMP	OP	OP	OP	OP	OMP	OP	OP	OP	OP	OMP
10.11	Sources of power	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
10.12	Survival craft portable radio station															

Table 3.4 - continued

	11. Navigational equipment															
11.1	Magnetic standard, steering, lifeboat compasses	CE	CE	CE	CE	OE	CE	CE	CE	CE	OE	CE	CE	CE	CE	OE
11.2	Gyrocompass	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP
11.3	Logs	P	P	P	P	OP	P	P	P	P	OP	P	P	P	P	OP

[1] Underwater part of craft hull is surveyed during a docking survey. Steering gear, shafting, propellers, foil arrangements, air-cushion skirt elements, bottom and side fittings of systems are also surveyed during a docking survey.

[2] Shipowner shall make an external examination or measurement between annual surveys of the underwater part in accordance with craft routine inspections but not less than once every three months.

[3] M – measurements of residual thickness of plates and framing members shall be made in the scope determined by a surveyor according to technical condition.

[4] Tightness tests together with fittings of systems, see 5.11 of the Table.

[5] Shell plating, deck plating, platforms, double bottom, bottom, side and underdeck framing, pillars, watertight bulkheads and enclosures, foils attachments and reinforcements, angular columns, pylons, lift air blowers, transmission reduction boxes and other loaded arrangements and machinery which may cause vibrations are surveyed from inside the spaces.

[6] M – measurements of residual thickness of plates and framing members, see footnote 3.

[7] Tests afloat using fuel oil or lubricating oil are allowed.

[8] Tests afloat are allowed, provided tests from inside are also carried afloat.

[9] Examination is carried out by a shipowner each time when the craft is lifted out of the water.

[10] Inspection and measurements (clearances in bearings and rudder sagging) are carried out during each docking.

[11] Remote control and monitoring systems shall be tested in operation.

[12] Hydraulic tests of bottles, pipelines and fittings of carbon-dioxide system, fire extinguishing liquid tanks, pipelines and fittings of fluid smothering system, starting from the second special survey and then every eight years.

[13] Inspection of high-speed engines which cannot be repaired on board is not made. Operation of such engines is allowed only within the service life specified by the Manufacturer, then the engines shall be replaced or repaired in the established order. Survey of high-speed engines by the Register shall be carried out in the scope and at intervals specified in the Manufacturer's Operation Manual. Other engines are surveyed in the scope indicated in 4.1.1 of Table 3.2.3, Part I "Classification" of Rules for the Classification and Construction of Sea-Going Ships.

[14] Checking of safety device adjustment.

[15] Checking in operation is carried out together with functional test of the main engine.

[16] O – during propeller shaft survey, see 4.6.1 of the Table.
C – during each docking.
Checking of tightening and stopping during each dismantling.

[17] M – during each repair of propeller, impeller.

[18] O – during each replacement of shaft, propeller or checking of fitting surfaces.

[19] M – results of measurements and determination of wear of essential assemblies and parts shall be submitted.

[20] H – only for vessels not accessible for internal examination.

[21] H – starting from the second special survey and then every eight years.

[22] Functional tests is carried out together with simulation of failures.

[23] H – together with tightness test of sea chests, see 1.1.3 of the Table.
O – during each docking.

[24] Insulation resistance of cables and electrical machinery and essential devices shall be measured during annual surveys.
Insulation resistance of all cables and all fixed electrical machinery and devices shall be measured during special surveys.

[25] Tests of launching devices with a test load may be requested by the surveyor in determining technical condition as regards strength. Such tests are obligatory for launching devices from the 3rd special survey.

[26] Verification of documentation on performance of periodical surveys and tests at the maintenance station of inflatable survival craft and marking of jackets, and sealing of liferafts.

.3 strength calculation of foil arrangement or skirt;

.4 structural drawings of hull and foil arrangements or skirt with indication of the material used;

.5 foils and skirt attachment to craft hull drawing;

.6 structural drawing of non-tilting stabilizers and pylons;

.7 vibration calculations of craft hull and its scantlings, foils, propeller struts;

.8 hull corrosion protection system drawing.

5.1.1.2 Arrangements, equipment and outfit:

.1 calculation of external forces acting on stabilization controls;

.2 strength and vibration calculation of stabilization controls;

.3 stabilization controls drawings;

.4 foil arrangement lifting and skirt drawings;

.5 drawings of reverse-reduction gear;

.6 scheme, description of calculation method for passenger evacuation time.

5.1.1.3 Stability and subdivision:

.1 materials on stability in displacement, transitional and operational modes;

.2 materials on stability in case of failures in automatic stabilization system, stabilization controls, machinery and power supply systems for machinery;

.3 scheme of watertight compartments providing reserve of buoyancy with indication of all watertight decks, tanks and enclosures, types of closing appliances and their drives, and heel and trim equalizing fittings (automatic and manually controlled).

5.1.1.4 Machinery installations:

.1 strength and torsional vibration calculations of gears to propellers and lift fans as well as proved data on service life of gears;

.2 drawings of gears to propellers (angular, tilting columns, tilting pylons etc.) and lift air blowers;

.3 drawings of lift air blowers, their attachment and air supply controls; blade strength calculations, proved data on their service life;

.4 drawings of air propellers with pitch actuating mechanism and blade strength calculations, proved data on their service life;

.5 stabilization control machinery installation and attachment drawings;

.6 stabilization control machinery drawings, proved data on their service life;

.7 analysis of the nature and consequences of main and essential auxiliary machinery failures.

5.1.1.5 Automation equipment:

.1 circuit and block diagrams of automatic stabilization systems;

.2 diagrams and drawings of protection system which automatically transfers the craft into the displacement or another safe mode;

.3 drawings and schemes of transducers in automatic stabilization system and their arrangement.

5.1.1.6 Systems and piping:

.1 air intake system drawing for gas turbine installations;

.2 drawings of hydraulic system, its machinery and tanks.

5.1.1.7 Electrical equipment:

.1 substantiation of electrical installation and electrical energy distribution system selection;

.2 circuit diagrams of electrical energy distribution from main and emergency sources of power;

.3 calculation results of main sources of electrical power output in all preset combinations of their independent and joint operation;

.4 calculation results of emergency sources of electrical power output;

.5 calculation results of short-circuit currents, irrespective of main sources of electrical power output;

.6 circuit diagrams of charging accumulator batteries which are main and emergency sources of electrical power and charging time calculation results.

5.1.1.8 Together with design documents, reports on model, full-scale and other tests, on the basis of which stability and subdivision calculations used for calculation of hull strength, external forces, foils, skirts and stabilization controls were made, and which confirm the effectiveness of the latter calculations shall be submitted to the Register together with the technical deign documentation.

5.1.1.9 In consideration and approval of design documents without subsequent approval of working drawings, the scope of the documents to be submitted for consideration shall be preliminarily agreed with the Register.

5.1.2 Working drawings.

5.1.2.1 Hull:

.1 drawings of foil arrangement and its attachment to the hull;

.2 drawings of skirt and its attachment to the hull;

.3 hull corrosion protection system drawings;

.4 non-tilting stabilizers and pylons drawings;

.5 weld control scheme for foil arrangement and skirt joints;

.6 calculations and drawings of hull structures by which a craft is lifted and upon which the craft is placed on a platform;

.7 skirt joint control scheme.

5.1.2.2 Arrangements, equipment and outfit:

.1 drawings of general arrangement, assemblies and parts of stabilization controls;

.2 reverse-reduction gear drawing.

5.1.2.3 Systems and piping:

.1 drawing of hydraulic system, its machinery and tanks;

.2 air intake systems drawings for gas turbine installations;

.3 exhaust gas systems drawings.

5.1.2.4 Machinery installations:

.1 drawings of gears, reduction gears, bearings, couplings;

.2 drawings of angular and tilting propellers with their machinery;

.3 drawings of tilting pylons with machinery;

.4 air propellers drawings;

.5 water-jet propellers with wheels, equalizing arrangements and nozzles, reversing devices;

.6 stabilization control machinery drawings;

.7 drawings of air blowers with air supply system and controls;

.8 reverse-reduction gear machinery drawings;

.9 stabilization control machinery drawings.

PART II. HULL STRUCTURE AND STRENGTH

1 GENERAL

1.1 Application.

1.1.1 The present Rules cover sea-going high-speed transport crafts (gliders, hydrofoil boats, air-cushion vehicles, high-speed catamarans) and set down requirements for the design and strength of such craft subject to the Register technical supervision.

1.1.2 The present Rules cover hydrofoil boats with two hydrofoils (front and aft) and with three hydrofoils (front, central and aft), as well as amphibious air-cushion vehicles and side-wall craft with a displacement up to 200 t.

The present Rules apply to hydrofoil boats and air-cushion vehicles capable of moving in the hull-borne mode on seas of forces not exceeding 5 ($h_{3\%} \leqslant 3{,}5$ m) and in the main mode (foil- or cushion-borne) on seas with $h_{3\%} \leqslant 3{,}0$ m at speeds corresponding to Froude numbers $F_{r_\Delta} \leqslant 4{,}5$.

The present Part is based on the assumption that the ratios of dimensions of hydrofoil boats and air-cushion vehicles would not exceed the following values:

length-to-breadth ratio:

$L/B > 4$ for hydrofoil boats,

$L/B > 3$ for air-cushion vehicles;

air-cushion-length-to-breadth ratio:

$2{,}5 \leqslant L_{ac}/B_{ac} \leqslant 5{,}0$;

side-wall-height-to-air-cushion-length ratio:

$0{,}068 \leqslant H_{sw}/L_{ac} \leqslant 0{,}078$;

side-wall-breadth-to-craft-breadth ratio:

$B_{sw}/B \leqslant 0{,}2$.

1.1.3 The present Rules also cover gliders of conventional hydrodynamic configuration (with cuneiform cross sections) and craft with an air pocket beneath the bottom (gliders with bottom specially shaped in the central region and in the stern in order to form an artificial air cushion in the main operating modes, which is limited by side walls). The present Rules apply to gliders whose speed corresponds to displacement - related Froude numbers $1{,}0 \leqslant F_{r_\Delta} < 5{,}0$ and the design-length-to-hull-breadth ratio amidships lies between 3,5 and 7,0.

1.1.4 The present Rules apply to high-speed catamarans with a displacement up to 2,000 t and a relative speed (Froude number $F_r = V/\sqrt{gL}$) between 0,2 and 1,2.

1.1.5 The present Rules apply to craft whose parameters are within the following limits:

length-to-depth ratio:

$5 \leqslant L/D \leqslant 20$;

hull rigidity during bending:

$I_{\otimes}/(BL^3) > 3 \times 10^{-7}$.

1.1.6 Where the above restrictions are not complied with, the applicability of the present Rules to particular craft is subject to special consideration by the Register.

1.1.7 The procedure of manufacturing the hull structures and special devices of high-speed craft shall be approved by the Register.

1.1.8 In order the strength of hull and special devices could be tested, the pilot craft of each project shall undergo trials under conditions stipulated in the technical design. The trials program stipulating the sequence and scope of the trials (including measurements as necessary), method of processing the data obtained and strength checking calculations shall be approved by the Register. The trials shall be held before the craft delivery. The results of the trials shall be submitted for the Register approval.

1.2 Definitions and explanations.

1.2.1 Definitions and explanations referring to general terminology shall be found in "General" of the present Rules and in Part II "Hull" of Rules for the Classification and Construction of Sea-Going Ships.

1.2.2 For the purpose of this Part, the following definitions have been additionally included.

H y d r o f o i l i n s t a l l a t i o n s including the front hydrofoil installation, central hydrofoil installation and aft hydrofoil installation are structures consisting of main and auxiliary (starting) lifting surfaces, stabilizers, stanchions and brackets, which serve to ensure the principal mode of the hydrofoil boat operation.

Side walls are structures fitted along the sides under bottom, which serve to seal off the high pressure zone (air cushion) and to ensure the longitudinal and transverse stability of side-wall craft and gliders with an air pocket below the bottom.

Skirt bag represents structures arranged along the pontoon perimeter and serving, together with the hinged elastic structure of flexible skirt, to seal off the air cushion, as well as for fitting the nozzles of amphibious air-cushion vehicles.

Pontoon is the main power component of the air-cushion vehicle hull.

Pylon is a structure fitted on the upper deck of an air-cushion vehicle and serving for the installation of the air propeller.

Stabilizer of an air-cushion vehicle is a structure fitted on the upper deck of the craft to ensure its course stability.

Bottom bearer is a structure fitted beneath the bottom of an air-cushion vehicle for the case of its running on a flat shore or a specially prepared platform.

Boosting trunk is a hull structure of an air-cushion vehicle, in which the boosting plant is installed to supply air into the air cushion or skirt bags.

Flexible seal is the upper part of the flexible skirt structure; it is an elastic reservoir connected to the skirt bag, with or without openings for air discharge in its lower portion.

Removable component is a readily removable part of the flexible skirt structure which is fitted low on the flexible seal and serves to reduce resistance to the air-cushion vehicle movement and to extend the life of the main flexible skirt unit.

Guy is a flexible connection between the craft hull and the flexible seal envelope, which serves to minimize the deformation of the flexible skirt and to prevent its intensive vibration.

Diaphragm is a flat air-permeable structure of an elastic material, which is fitted on the perimeter of the generatrix of the flexible seal, connecting the latter to the craft hull and serving to shape it as necessary.

Conventional framing system is a system of hull framing with web members connected directly to the shell plating and main frames passing through notches in webs and connected to them.

Floating framing system is a system of hull framing with web members lying above main framing and connected thereto, as well as to the shell plating, by means of spacers.

Cross-structures of catamarans and side-wall craft are structures used to connect catamaran hulls (side walls). They have the shape of a connecting bridge where the structure is not high, and are represented by three-dimensional structures comprising transverse and longitudinal bulkheads and the structures of decks (platforms), if there are spaces between the hulls.

Worst intended conditions are ambient conditions under which the craft operation is permitted. Such conditions are regulated by the following parameters: permissible wind force and wave height of 3 per cent exceedance level, minimal air temperature, visibility, water depth and other similar parameters set down on agreement with the Register proceeding from craft type and service area.

Critical design conditions are ambient conditions that are severer than the worst intended conditions, with the parameters agreed by the Register for a particular craft proceeding from its type and service area.

1.3 Symbols.

When interpreting the symbols the explanations below shall be considered, as well as Fig.1.3:

L = craft length, in m, between perpendiculars;

B = craft breadth, in m;

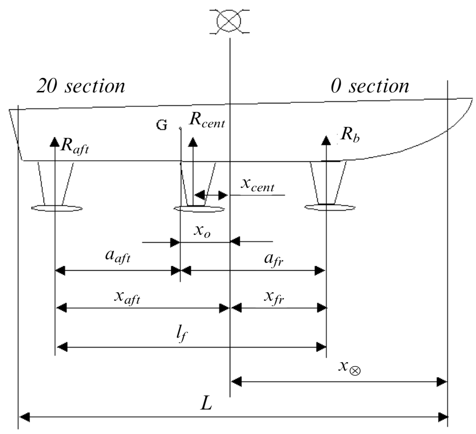
D = depth, in m;

Δ = total displacement, in t, of craft;

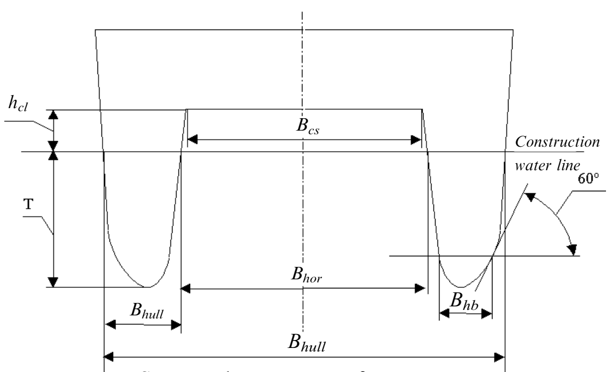
∇ = cubic displacement, in m^3, of craft;

L_{ac} = air-cushion length, in m;

B_{ac} = air-cushion breadth, in m;



Structural parameters of hydrofoil boat



Structural parameters of catamaran

Fig. 1.3

S_{ac} = air-cushion area, in m^2;
B_{sw} = side-wall breadth, in m;
H_{sw} = side-wall height, in m;
H_{fs} = flexible-skirt height, in m;
α = waterline area coefficient of fullness;
h_{cl} = vertical clearance, in m (for high-speed catamarans and side-wall craft, this is the distance between the undisturbed surface of liquid and the connecting bridge at midlength section, and for hydrofoil boats it is the distance between the undisturbed surface of liquid and the keel line);
$h_{cl} = h_{cl}/h_{3\%}$ = relative clearance of craft;
$h_{3\%}$ = wave height of 3 per cent exceedance level, in m, for which provision is made in the craft design for the relevant motion pattern and which shall be adopted on the basis of the scale currently used in the Russian Federation;
$h = h_{3\%}/\sqrt[3]{\nabla}$ = relative wave height;
l_f = distance, in m, between the front and aft foil installations;
a_{fr} = distance, in m, between the front foil installation and the mass centre of the craft;
a_{aft} = distance, in m, between the aft foil installation and the mass centre of the craft;
x = distance, in m, between the craft cross section under consideration and the transom;
x_{mid} = abscissa, in m, of the craft cross section under consideration, as measured from the midlength section;
x_g = distance, in m, between the transom and the mass centre of the craft;
$\overline{x}_g = x_g/L$ = relative distance, in m, between the transom and the mass centre of the craft;
x_{fr}, x_{cent}, x_{aft} = distance, in m, between the midlength section and the front, central and aft foil installations accordingly;
$x_{\otimes}$ = distance, in m, between the midlength section and the forward perpendicular;
l_{fr} = distance, in m, between the front foil installation and the mass centre of the craft;
x_o = distance, in m, between the mass centre of the craft and the midlength section;
m_x = craft mass per metre;
ρ_x and ρ_y = inertia radii, in m, of the craft hull mass with regard to the longitudinal and transverse axes accordingly which pass through the mass centre of the craft;
I_x and I_y = inertia moments, in kg·m^2, of the craft hull mass with regard to the longitudinal and transverse axes accordingly which pass through the mass centre of the craft;
$I_{\otimes}$ = inertia moment, in m^4, of hull cross section at midlength;
W = moment of resistance of hull cross section;
V = craft speed, in knots, in the motion pattern under consideration with the specified intensity of the sea $h_{3\%}$;
V_{hb} = craft speed, in knots, in the hull-borne mode (for air-cushion vehicles, V_{hb} will not generally exceed 3 knots proceeding from the flexible skirt strength);
V_{lift} = speed at which a hydrofoil boat reaches the condition when it is borne by the front hydrofoil installation, to be determined by the maximum resistance value;
$Fr_{\Delta} = 0{,}514V/\sqrt{g\nabla^{1/3}}$ = Froude number by displacement;
$Fr_L = 0{,}514V/\sqrt{gL}$ = Froude number by length;
$n = \ddot{y}/g$ = relative acceleration (overload);
n_g = relative acceleration at the centre of mass of the craft when it moves as a solid body;
$\ddot{y}$ = vertical acceleration, in m/s^2, in the hull sections;
$C_y^{\max}$ = maximum lifting force coefficient of foil component section, to be determined by experiment;
R_{fr}, R_{cent} and R_{aft} = forces, in t, taken by the front, central and aft foil installation respectively;
$P_{fr.st.w.}$, $P_{cent.st.w.}$ and $P_{aft.st.w.}$ = forces, in t, taken by the front, central and aft foil installation respectively when moving on still water;
C_{fr}, C_{cent} and C_{aft} = lifting force buildup coefficient for the front, central and aft foil installation respectively on the seas as compared to still water;
P_{des} = design force, in t, acting upon the foil installation as a whole and equal to, respectively:
$P_{fr}^{\max}$ for the front foil installation, in t;
$P_{cent}^{\max}$ for the central foil installation, in t;
$P_{aft}^{\max}$ for the aft foil installation, in t;
P_{comp} = design force, in t, acting upon the foil installation component in question;
S_f = horizontal-plane projection area, in m^2, of the submerged part of foil installation lifting surface;
S_{comp} = horizontal-plane projection area, in m^2, of the submerged part of the foil installation component in question;
S_{str} = projected area, in m^2, of submerged parts of stanchions and inclined components of foil installation on the centre plane;
β = dead-rise angle, in deg, of the inclined component of foil installation;
g = 9,81 m/s^2 = gravity acceleration;
ρ = 1 t/m^3 (kN·s^2/m^4) = water density;
γ = 10 kN/m^3 = seawater density;
M_{sag}, M_{hog} = design bending moments in hull cross sections during hull sagging and hogging accordingly;
$M_{st.w.}^{sag}$, $M_{st.w.}^{trans}$ = longitudinal and transverse bending moment, in tm, accordingly, on still water in the motion pattern under consideration;
M_w^{sag}, M_w^{hog}, M_w^{trans}, M_w^{tw} = wave component, in tm, of bending moment for the case of longitudinal (sagging and hogging) and transverse bending accordingly, as well as for hull twisting, in the motion pattern under consideration;

M_d^{sag}, M_d^{hog}, M_d^{trans}, M_d^{tw} = dynamic component, in tm, of bending moment for the case of longitudinal (sagging and hogging) and transverse bending, accordingly, as well as for hull twisting, in the motion pattern under consideration;

M_{des}^{sag}, M_{des}^{hog}, M_{des}^{trans}, M_{des}^{tw} = design values, in tm, of bending moment for the case of longitudinal (sagging and hogging) and transverse bending, as well as for hull twisting, in the motion pattern under consideration;

$M_{st.w}^{\otimes}$, $M_w^{\otimes}$, $M_d^{\otimes}$, $M_{des}^{\otimes}$ = relevant bending moment values, in tm, in the midlength section;

M_{cp} = centre-plane bending moment value, in tm, for the case of transverse bending of hull of a side-wall craft;

M_{ult} = ultimate bending moment, in tm;

$Q_{st.w.}^{sag}$, $Q_{st.w.}^{hog}$, $Q_{st.w.}^{trans}$ = shearing force, in t, for the case of longitudinal (sagging and hogging) and transverse hull bending, accordingly, in the motion pattern in question;

Q_w^{sag}, Q_w^{hog}, Q_w^{trans} = wave component, in t, of shearing force for the case of longitudinal (sagging and hogging) and transverse hull bending, accordingly, in the motion pattern in question;

Q_d^{sag}, Q_d^{hog}, Q_d^{trans} = dynamic component, in t, of shearing force for the case of longitudinal (sagging and hogging) and transverse hull bending, accordingly, in the motion pattern in question;

Q_{des}^{sag}, Q_{des}^{hog}, Q_{des}^{trans} = design values, in t, of shearing force for the case of longitudinal (sagging and hogging) and transverse hull bending, accordingly, in the motion pattern in question;

σ_0 = dangerous normal stresses, in kPa;

R_{p02} = yield strength, in kPa, of aluminum alloy;

R_{eH} = upper yield stress of steels, in MPa;

R_m = ultimate strength of material, in kPa;

σ_{per} = permissible normal stresses, in kPa;

σ_{cr} = critical normal stresses, in kPa;

σ_e = Euler buckling stresses, in kPa;

τ_n = shear yield strength of material, in kPa;

τ_0 = dangerous normal stresses, in kPa;

τ_{cr} = critical normal stresses, in kPa;

τ_{per} = permissible normal stresses, in kPa;

T = maximum strain of flexible skirt material, in kN/m;

R^b = breaking strengh of flexible skirt material, in kN/m;

x_t = distance, in m, between the point under consideration (hull section under consideration) and transom;

$B_{\otimes}$ = hull breadth, in m, at midlength over the bilge;

B_{tr} = transom breadth (distance between chine lines in way of aft perpendicular), in m;

B_3 = hull breadth over the bilge in way of 3d section;

β_a = dead-rise angle, in deg, for the hull section in question;

β_3 = dead-rise angle, in deg, for 3d hull section;

$\beta_{\otimes}$ = dead-rise angle, in deg, for midlength section;

β_{tr} = dead-rise angle, in deg, in way of transom;

$\beta_{av} = (\beta_{\otimes} + \beta_{tr})/2$ = average dead-rise angle, in deg;

B_{hull} = hull breadth, in m, at midlength on construction waterline level;

B_{hor} = horizontal clearance = inter-hull distance, in m, in the midlength section, as measured on the construction waterline plane;

B_{hb} = hull breadth, in m, at midlength, as measured over the waterline corresponding to hull immersion up to the bilge level;

j = section number;

B_{cs} = cross-structure breadth (inter-hull distance on the cross-structure level), in m;

S_o = area, in m^2, supported by a hull element (load removal area); for plates, the supported area shall be adopted equal to the product of the stiffener span (spacing) and the value corresponding to the greater side length of the plate or to three times the spacing (whichever is less);

T = craft draught, in m, in still water;

x_{mid} = abscissa, in m, of the point under consideration, as counted from the midlength section (a negative value where the point lies aft of midsection);

y = distance, in m, between the hull point under consideration or its longitudinal section, and the centre plane;

Z_i = distance, in m, between the point under consideration and the design waterline level;

$b(x)$ = hull breadth, in m, in the cross section under consideration with the x abscissa.

1.4 Scope of technical supervision.

To be submitted to the Register is technical documentation in the number stipulated in Section 5, Part I "Classification" of Rules for the Classification and Construction of Sea-Going Ships. Besides, structural drawings and strength analyses shall be submitted for hydrofoil installations, flexible skirts and hull strengthening of these devices, as well as the strength analysis of the pilot (experimental) project, which shall be made on the basis of sea trials results.

1.5 Materials of hull and special devices.

Hull materials of high-speed craft and foil installations of hydrofoil boats shall be in accordance with the requirements of Part XIII "Materials" of Rules for the Classification and Construction of Sea-Going Ships.

The Rules provide for aluminum-magnesium alloys to be used for hull structures, for stainless steels and titanic alloys to be used for foil installations, and for rubber cloth or other polymer materials up to 6 mm thick to be used for flexible skirt. For auxiliary (take-off) components of foil installations, which ensure passing to the foil-borne mode, aluminum-magnesium alloys may be used.

On agreement with the Register, non-metallic materials may be used for hull structures.

Material grades for flexible skirts shall be chosen on the basis of strength analysshall be carried out in accordance with 5.7 of Part XIV "Welding" of Rules for the Classification and Construction of Sea-Going Ships, as well as of laboratory tests of static strength of specimens produced by the procedure and under conditions used by the manufacturer, and they shall be certified by the Register.

1.6 Welding.

1.6.1 The welding of structures in dynamically supported craft shall be carried out in accordance with the requirements of Part XIV "Welding" of Rules for the Classification and Construction of Sea-Going Ships. On agreement with the Register, resistance spot welding and resistance seam welding of aluminum alloys may be permitted for supporting structures where the components are up to 3 mm thick.

1.6.2 Stainless steel shall be welded in accordance with the requirements of Part XIV "Welding" of Rules for the Classification and Construction of Sea-Going Ships, and with the standards approved by the Register.

The technical documentation submitted for the Register approval shall stipulate:

cutting procedures and conditions for components, as well as edge preparation for welding;

bending and straightening procedures and conditions for components (hot or cold);

straightening procedures and conditions for welded structures;

welding conditions and procedures, types of welded joints;

surface finishing procedures and norms for welded joints;

welding consumables, their properties, storage and application conditions;

permissible level of weld quality;

removal and repairing procedures for weld lengths with impermissible defects;

types of weld tests;

required mechanical properties of welds;

types of weld heat treatment and its indispensability before or after welding.

Welding consumables, such as electrodes, welding wire, flux and shielding gases shall be certified by the Register.

The chemical composition of deposited metal and the mechanical properties of welds shall comply with standards approved by the Register.

The application of welding procedures not stipulated in the present Rules or standards to new materials is subject to the Register approval.

1.6.3 Welds in foil installations shall undergo non-destructive testing to the extent agreed with the Register.

2 HULL DESIGN PRINCIPLES

2.1 General.

2.1.1 This Part of the present Rules covers hull structures and special devices produced by welding (electric arc, gas-shielded, resistance welding, etc.), riveting, glued riveting and pressure-contact glued welding.

2.1.2 When designing the hull structures of high-speed craft, requirements shall be considered for their strength and life providing a minimal weight and optimal construction procedure. These requirements shall be complied with during all stages of the craft design.

2.1.3 For hull-structural design, provision shall be made for all-pressed and glued-welded panels to be used as widely as practicable, and the components, units and sections forming the hull shall be standardized and typified. As far as practicable, panels (structural blanks) having the largest dimensions shall be used to reduce the number of welded and, in particular, riveted joints in hull structures.

Generally, welded hull structures shall be stipulated in the design. The main welding procedure shall be fusion welding. Riveted joints and spot welds may be used where welding is not feasible or inexpedient due to technical or structural reasons, especially when joining non-weldable or limited-weldable materials, or those which may involve impermissible structural deformations during welding. In welded structures, riveted joints may be applied as barriers (stoppers) for limiting crack propagation. In structures below the waterline, riveting may be applied subject to the Register agreement (proceeding form integrity ensuring conditions).

2.1.4 With all-pressed and glued-welded panels, the floating (longitudinal or transverse) framing system shall be applied to get the utmost of the structural and technical advantages afforded by using the panels. In areas to which considerable concentrated forces are applied, the main framing shall be fitted directly on the shell plating or be aligned with panel stiffeners.

2.1.5 Within the hull, transition from the floating to the conventional framing system shall be effected in way of main framing (stringers, web frames, bulkheads, platforms, etc.).

2.1.6 Along the length and breadth of the hull, a smooth transition of sectional dimensions and plate thickness may be effected in conjunction with the variation of forces due to the total longitudinal and transverse bending of the hull, which shall be substantiated by a relevant strength analysis.

2.1.7 No abrupt variation of plate thickness and section depth is permitted. The difference of butted plates shall not exceed 40 per cent by thickness (except specially strengthened areas, in way of opening angles, for instance).

Provision for a smooth section depth variation shall generally be made at intersections with web framing members (stringers, frames, bulkheads, etc.).

2.1.8 All rectangular hull openings and those of other shapes shall have their corners rounded.

For longitudinal hull members, the angle rounding radii shall be at least as follows (whichever is greater):

5 member web thicknesses;

0,15 of the length of the shorter opening side;

30 mm.

2.1.9 For bearing structures, the spot and seam welding may be permitted for components up to 3 mm thick.

2.1.10 For bearing structures with the thickness $S \geqslant 5{,}0$ mm, indirect deep penetration welding of butt welds may be permitted. Indirect welding shall not be applied in areas of intensive vibration.

2.1.11 During hull structures manufacture it shall be possible to apply the maximum number of mechanized welding procedures and to make the majority of welds in the downhand position.

2.1.12 The Rules consider standard joints of structural components. When designing new projects, the standard structural components recommended may be optimized and corrected proceeding from the requirements for the particular structure.

2.1.13 Where main hull structures include components essentially different from the standard ones, the former shall undergo full-scale testing in accordance with a program approved by the Register.

2.1.14 For decks, bottom, sides, longitudinal bulkheads, skirt bags and solid superstructures, the longitudinal (conventional or floating) framing system shall generally be applied. For the hull, mixed framing system is permissible, as well as transverse framing system for the superstructure.

For additional framing members, a transition from one system to the other is permitted.

In areas to which considerable concentrated forces are applied, web framing members shall be attached directly to the shell plating.

2.1.15 Hull member scantlings shall be determined on the basis of the overall and local strength analysis. The scantlings to be determined by the overall strength analysis for the midlength hull section shall be observed within $0{,}4L$ ($0{,}2L$ forward and aft of midlength) of the midlength region.

2.1.16 Ensuring the continuity of longitudinal bulkheads is mandatory. Where longitudinal members terminate, provision shall be made to ensure smooth variation of their scantlings together with other measures aimed at reducing stress concentration. Where the continuity of members is impaired, including an abrupt change of their direction, a relevant structural solution shall be provided.

2.1.17 Not more than two main longitudinals of decks, sides and bottom (carlings and stringers), symmetrical to the centreline plane, shall terminate in the same hull cross section.

2.1.18 Unless expressly stipulated otherwise in the Rules, provision shall be made for the depth of main longitudinal members of decks, sides and bottom (centreline girder, side and bottom stringers and carlings) to be recluced over a length $\geqslant 1{,}5$ of the member depth where these members terminate.

Longitudinal member ends shall be led to the nearest transverse member and connected thereto.

2.1.19 In areas of intensive vibration, as well as in tanks where penetrated by girders or where brackets rest upon tight structures, provision shall be made for stiffeners, shelves or other structural elements to prevent hard spot formation in welded structures.

2.1.20 Openings shall be avoided in strength deck, skirt bag, carlings, centreline girder and stringers. If openings are made in the above members, the latter shall be strengthened. The design of strengthening shall allow for lost area compensation together with reducing the stress concentration. The edges of the openings shall be smooth.

2.1.21 The openings for air supply in the deck plating and cross-structure of side-wall craft shall be strengthened with vertical fillets along their contour, and the plating proper shall be thickened.

2.1.22 Rectangular openings in deck, sides and longitudinal bulkheads shall be arranged with their greater side along the ship's length.

For small rectangular openings (where the opening breadth or the total breadth of openings in a particular ship cross-section would not exceed half the ship breadth), the angle rounding radius shall not be less than:

0,15 of the lesser side of the opening;

10 times the shell plating thickness;

50 mm.

2.1.23 The plate edges shall lie not nearer than 1/3 of the opening length to the opening edge, but in any case the distance shall not be less than $2r$ where r is the rounding radius of opening.

2.2 Girder attachment.

2.2.1 For longitudinals, pressed symmetrical bulb and tee-sections shall be used, or pressed panels with symmetrical ribs of bulb or tee-cross-sections.

In structures incorporating riveted, glued-riveted or glued-welded joints, pressed or bent sections of other shapes may be used (angle bulbs, angles, Z-sections).

For bottom, side and deck longitudinals (including superstructures and deckhouses), skirt bag and side walls, unsymmetrical bulb sections and angles may be used. With the floating framing system, the torsion rigidity of unsymmetrical section girders shall be ensured.

It is recommended that web framing members (web frames, floors, side wall brackets, carlings, web beams, stringers, etc.) are made of pressed sections and panels. Welded sections may also be used.

With the conventional framing system, tee-sections shall be mainly used for web members, and with the floating system, I-sections shall be used.

2.2.2 Framing members shall be butt-welded. No lap welding is permitted.

2.2.3 In welded-section butts, the distance between flange butts and web butts shall be adopted not less than half the girder depth.

2.2.4 The web beam depth variation shall take place in way of rigid members (bulkheads, stringers, web frames, beams, etc.) where brackets shall be fitted (Fig. 2.2.4-1).

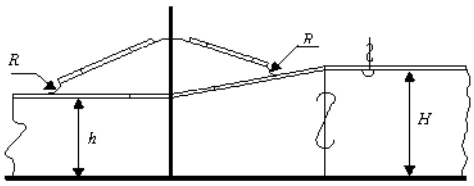
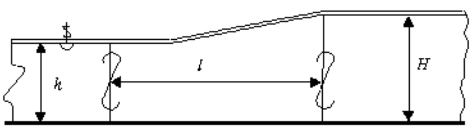


Fig. 2.2.4-1

Where the transitional depth $5(H-h) \geqslant l$ (Fig. 2.2.4-2), the sectional depth between rigid members may be varied.



$l \geqslant 5\ (H-h)$
Fig. 2.2.4-2

2.2.5 The dimensions of brackets connecting the frames in welded structures shall be chosen on the basis of directions contained in the figures of the present Part. The bracket thickness shall be chosen equal to the minimal section web thickness of the frame(s) connected (fixed). Deviation from recommended thickness shall be well grounded in each case.

Where necessary, free bracket edges shall be strengthened with face plates which shall be 1 mm thicker than the brackets. Forward-bent flanges may also be used.

The free ends of bracket face plates or flanges shall be snipped on a length equal to 1,5 the bracket face plate (flange) breadth. The blunting length shall be adopted not greater than three times the face plate (flange) thickness. The distance between the face plate end and the blunted bracket shall not be less than two times the bracket thickness. In the case of highly stressed structures working under alternating loads, the above blunted edges shall be rounded to a radius (Fig. 2.2.5).

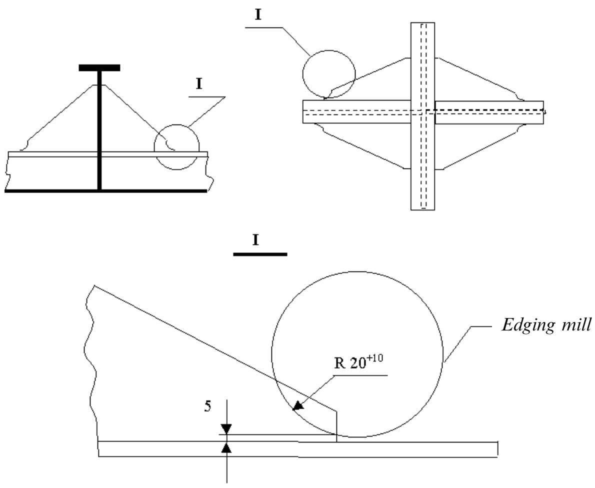


Fig. 2.2.5

2.2.6 Brackets, section webs and other permeable plate structures shall be cut in accordance with Fig. 2.2.6.

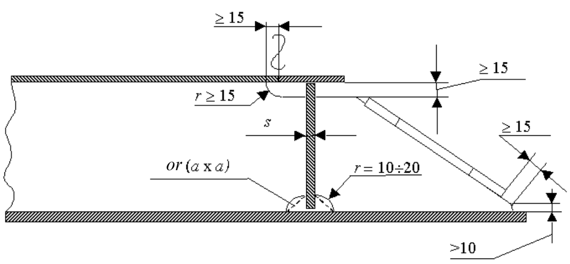


Fig. 2.2.6

N o t e . In non-essential structures, an out with a side size $a = r$ is permitted instead of a cut on the radius r for weld passage.

2.2.7 Where girders terminate, the flanges and webs of the latter shall be snipped over a length equal to 1,5 flange breadths or 1,5 web depth accordingly, with an unbevelled edge area (blunting) to be left on the free end, equal to three times the flange thickness for flanges and to three times the web thickness at least for webs. Provision shall be made for leaving a distance between the flange end and the girder web end of two times the web thickness at least or 15 mm, whichever is greater (Fig. 2.2.7).

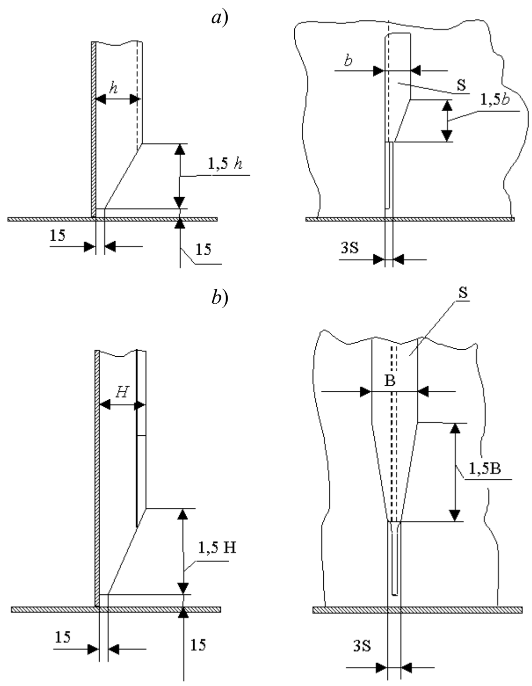


Fig. 2.2.7

2.2.8 The edges of brackets, section webs and connecting plates shall be boxed and shall have no craters.

2.2.9 Where the floating or conventional framing system is applied, the main longitudinal hull members shall be continuous between transverse bulkheads. If the longitudinal and transverse girders of conventional framing have equal depth, the longitudinal girders may be intercostal in way of floors.

The vertical stiffeners of transverse and longitudinal bulkheads shall be continuous between the bottom and deck, as well as between decks. Stiffeners may be terminated on the additional shelf.

2.2.10 Main longitudinal hull members shall be connected to transverse watertight bulkheads and floors in conformity with Figs. 2.2.10-1 and 2.2.10-2. Web girders shall be connected to plate edges in conformity with Fig. 2.2.10-3.

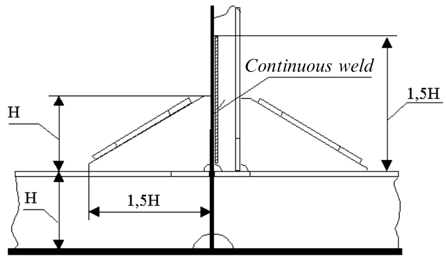


Fig. 2.2.10-1

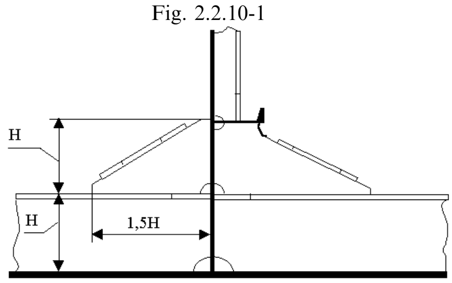


Fig. 2.2.10-2

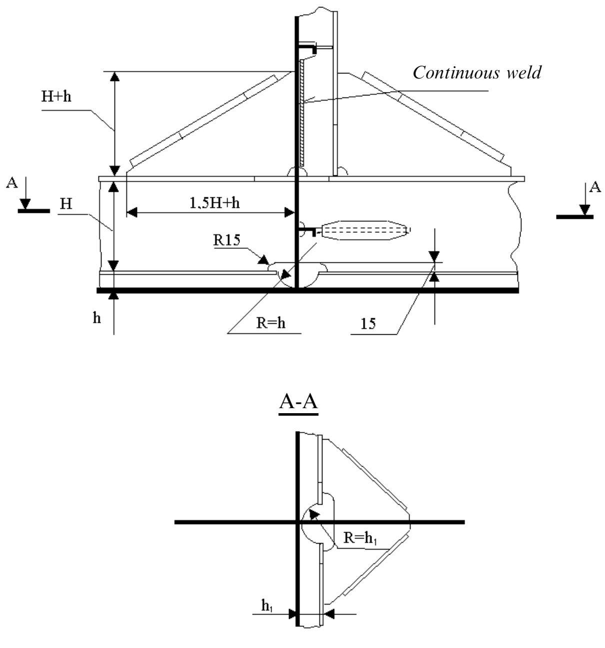


Fig. 2.2.10-3

2.2.11 With the floating framing system, longitudinal frames, except the centreline girder (see 2.2.9), whose depth is equal to that of transverse frames shall be intercostal frames. Connecting assemblies shall be in compliance with Fig. 2.2.11-1.

Assemblies connecting main longitudinal frames to transverse frames of lesser depth shall be in conformity with Figs. 2.2.11-2 and 2.2.11-3. Where the difference in the depth of a longitudinal member is small as compared to that of a cross girder, the connecting assembly may include brackets (see Fig. 2.2.11-4) or restraints (Fig. 2.2.11-5).

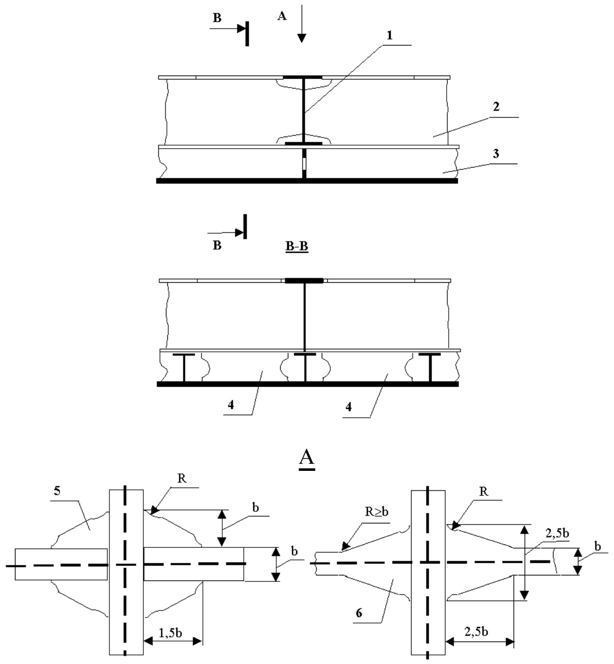


Fig. 2.2.11-1
1-floor, 2-bottom stringer, 3-bottom longitudinal,
4-connecting plate, 5-horizontal bracket, 6-face plate expansion

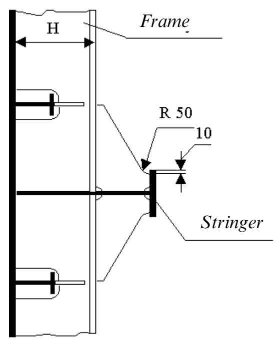


Fig. 2.2.11-4

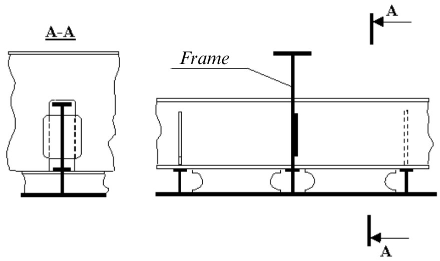


Fig. 2.2.11-5

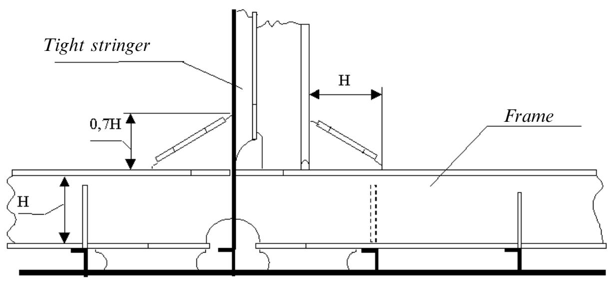


Fig. 2.2.11-2

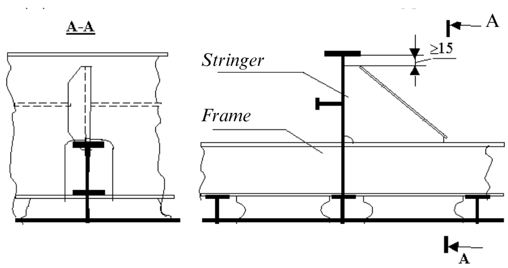


Fig. 2.2.11-3

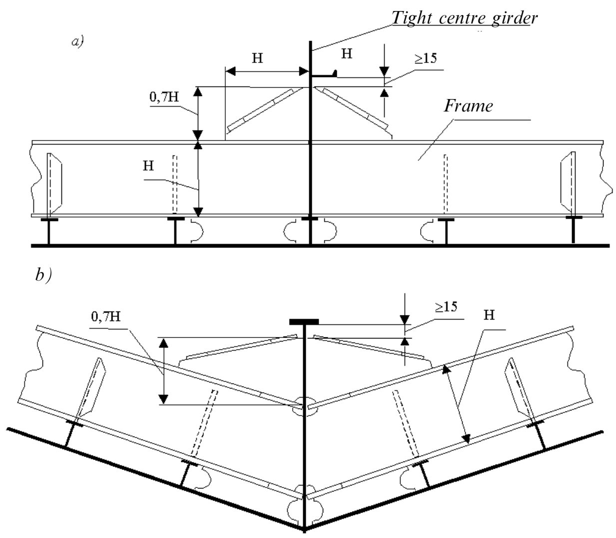


Fig. 2.2.12-1

2.2.12 With the floating framing system, floors shall be connected to the centre girder in accordance with Fig. 2.2.12-1 or 2.2.12-2 (flat or raised bottom) proceeding from their relative depth.

2.2.13 With the conventional framing system, web frames shall be connected to floors in accordance with Fig. 2.2.13-1, and with the floating framing system, in accordance with Fig. 2.2.13-2. The distance between the member web edge and the opening therein for longitudinals shall not be less than 100 mm. With a small spacing of panel stiffeners (below 200 mm), this distance may be reduced (and it is recommended that all sections between edges and openings are equal).

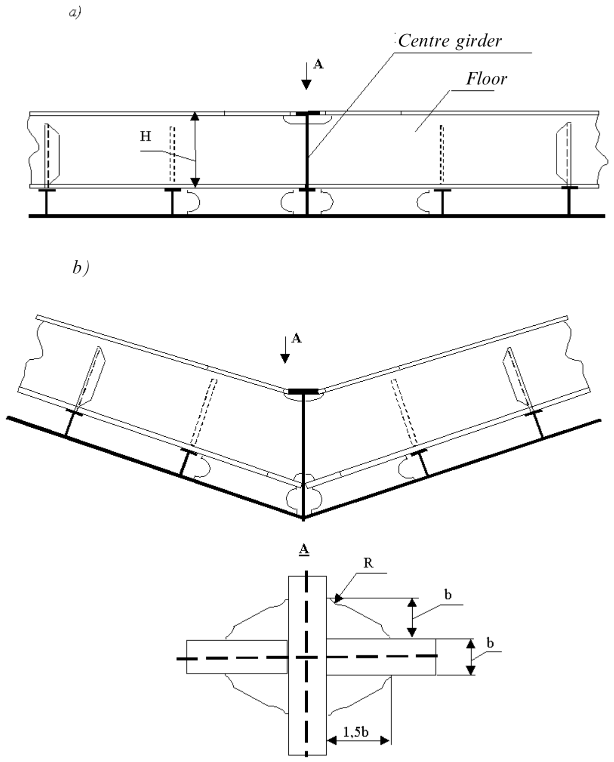


Fig. 2.2.12-2

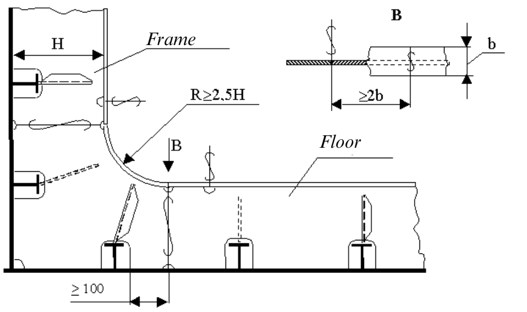


Fig. 2.2.13-1

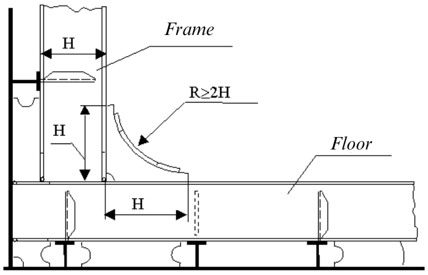


Fig. 2.2.13-2

With floor depth below 200 mm, the connecting assemblies of web frames shall be in accordance with Fig. 2.2.13-3 where conventional framing system is applied.

The connecting assemblies of continuous web frames and the web beams of decks and platforms at

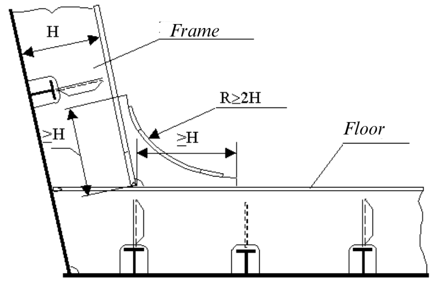


Fig. 2.2.13-3

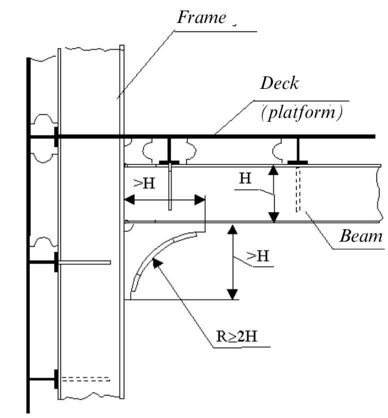


Fig. 2.2.13-4

penetrations through the latter shall be in conformity with Fig. 2.2.13-4, while the connecting assemblies of web frames that are intercostal in way of decks and platforms, and the web beams of decks and platforms shall be in conformity with Fig. 2.2.13-5.

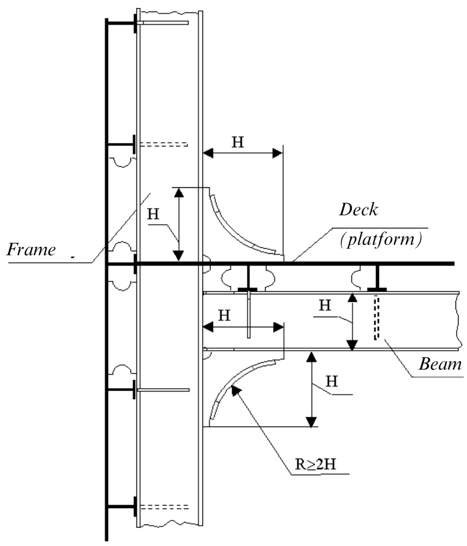


Fig. 2.2.13-5

The connecting assemblies of web frames and the web beams of superstructure deck shall be in conformity with Fig. 2.2.13-6.

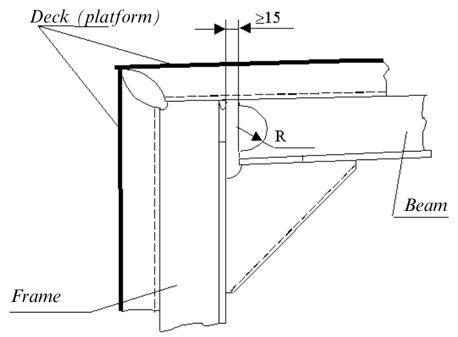
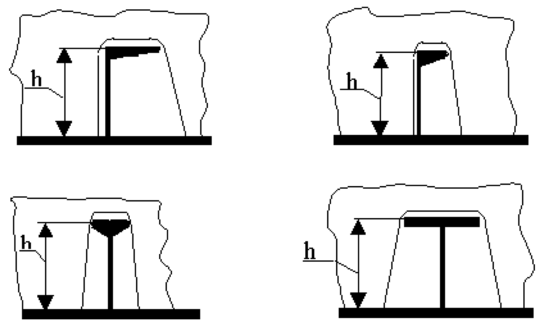
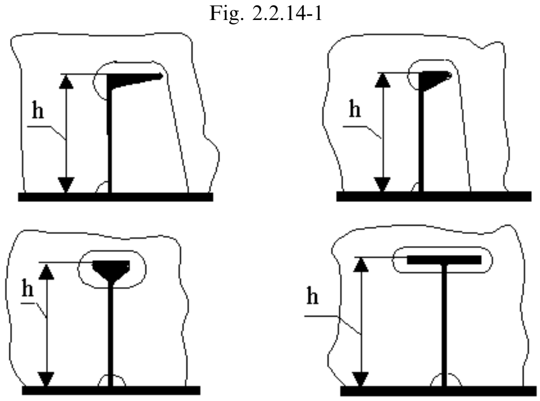


Fig. 2.2.13-6

2.2.14 For assemblies by which the penetration of longitudinal girders through non-tight structures is ensured, either clear openings (Fig. 2.2.14-1) or openings where the girder web is welded directly to the opening edge by double-side welding (Fig. 2.2.14-2) shall be used proceeding from the girder height.



$h < 80$ mm
Fig. 2.2.14-1



$h \geqslant 80$ mm
Fig. 2.2.14-2

2.2.15 For non-tight structures, welding of effective flanges of girders to opening edges is not permitted. The angles of openings shall be rounded to a radius not less than three times the wall thickness of the structure in which the opening is made, or 10 mm, whichever is greater.

2.2.16 In web members, the separation of any opening edge from the edge of the opening for girder penetration shall equal the girder height at least, unless a greater value is specified proceeding from the strength conditions.

2.2.17 With the floating framing system, no openings in centre girder or floors are permitted.

In carlings and stringers, openings for frames are permitted, which shall not exceed 1/2 the member web height in the section under consideration.

Where this is not feasible, the web strength deterioration shall be compensated by its thickening, fitting of restraints or in another way.

2.2.18 With the conventional framing system, non-tight structures with clear openings and two brackets (fitted on each side of the supporting structure) measuring not less than $2h$ (h being girder section height) shall be applied where the girder height is below 80 mm. When the girder height equals or exceeds 80 mm or when the girders are intercostal in way of web girders and are welded to the webs of the latter, the brackets size shall not be less than $1{,}5h$.

Where the distance between the effective flange of a longitudinal and the girder flange of web framing is less than:

$2{,}0h$ with the girder height < 80 mm,

or $1{,}5h$ with the girder height $\geqslant 80$ mm,

the brackets shall be welded to the effective flange of web framing girder.

When applying both framing systems, continuous girders may be connected to web framing girders of bottom, sides and decks by means of brackets fitted in staggered rows. Where $h < 80$ mm, brackets may be fitted in accordance with Fig. 2.2.21.

2.2.19 The connecting assemblies between longitudinals and transverse tight bulkheads or floors shall be executed in conformity with Figs. 2.2.19-1 (variant 1) or 2.2.19-2, and where pressed panels are used to connect the beams of continuous panels, in conformity with Figs. 2.2.19-3 and 2.2.19-4 (variant 1).

The possibility of applying variants 2 of connecting assemblies (Figs. 2.2.19-1 and 2.2.19-4) shall be substantiated by the assembly service life analysis.

2.2.20 If pressed panels are used in structures, the main longitudinal hull members shall be welded to the flanges of longitudinals, and if welded panels are used, they shall be welded directly to the plating.

2.2.21 With the floating framing system, connecting plates (brackets) shall be fitted in way of crossover assemblies between the main members (panel sections) and intersecting members (web framing) of the hull (including the bilge area and the intersections of the side with platforms and deck)

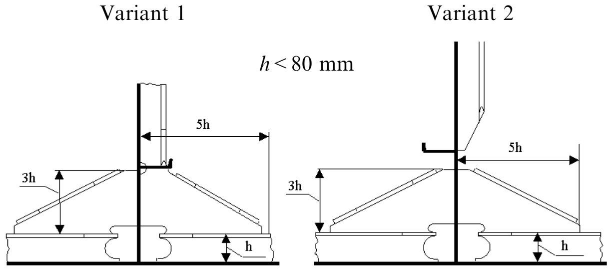


Fig. 2.2.19-1

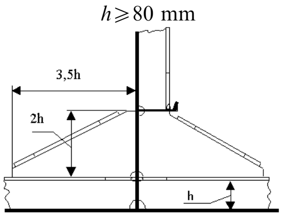


Fig. 2.2.19-2

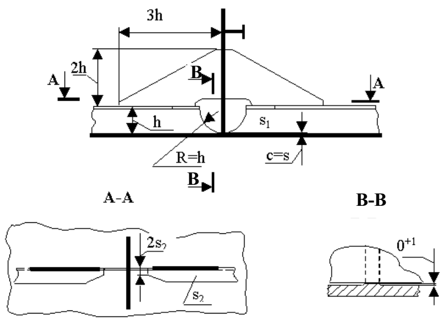


Fig. 2.2.19-3

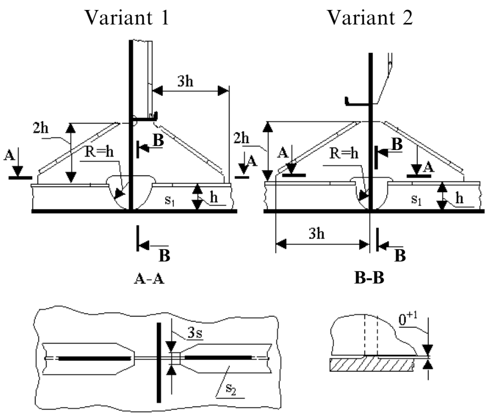


Fig. 2.2.19-4

on the planes of the web plates of the intersecting members. Where the panel section height exceeds 70 mm, the connecting plate edges shall be rounded on a radius (Fig. 2.2.11-1).

At girder intersections, the effective flanges of panel sections and web members shall be connected by welding with brackets fitted in staggered rows (Fig. 2.2.21). If the effective flange thickness of panel sections is less than 50 mm, brackets alone would suffice.

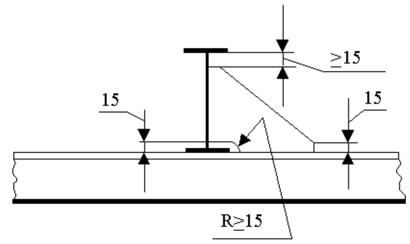


Fig. 2.2.21

2.2.22 When pressed panels are used, the connecting assemblies between framing members and adjacent structures shall be in conformity with Figs. 2.2.22-1 and 2.2.22-2, and the connecting assembly between deck girders and the longitudinal bulkhead girders shall be in conformity with Fig. 2.2.22-3.

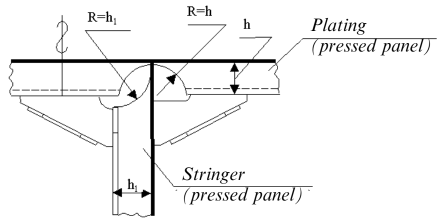


Fig. 2.2.22-1

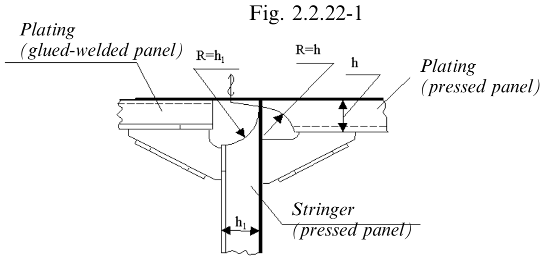


Fig. 2.2.22-2

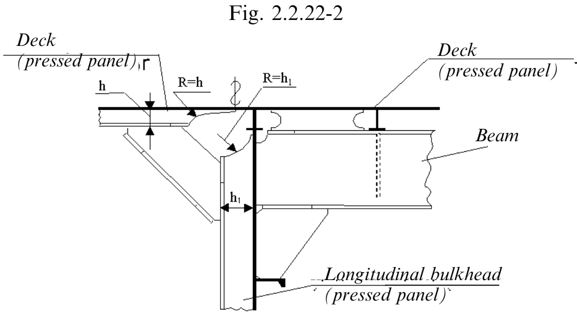


Fig. 2.2.22-3

2.3 Components of welded structures.

2.3.1 The free edges of girder webs and flanges, brackets, etc. shall undergo mechanical treatment and shall not be rough. When brackets, knees, stiffeners, etc. are welded to the effective flanges of girders being stiffened, they shall not reach the effective flange edge by a margin of 15 mm or double thickness, whichever is greater. The flanges of knees and brackets fitted to stiffen web girders (longitudinal bed-plate girders included) shall be snipped.

2.3.2 The right angles of brackets with which the connecting assemblies of girders are stiffened shall be executed so that the cut edge is removed from the contour of the opening for girder passage through web member by 15 mm at least (Fig. 2.3.2).

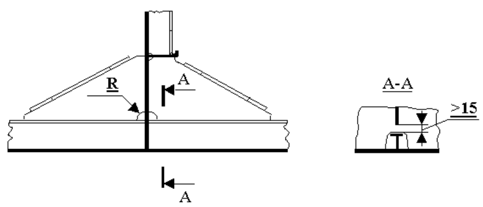


Fig. 2.3.2

2.3.3 Welding of bed-plate girder flanges to bottom plating or to transverse bulkhead plating is not permitted. In the above areas, the flanges shall be snipped.

2.4 Weld location.

2.4.1 Welds shall be located in the most unstressed sections of the structure and shall, as far as practicable, be parallel to forces applied and be removed to the maximum extent possible from areas of abrupt change of member scantlings, opening diameter, and from other stress concentrators.

2.4.2 Clusters of welds, their intersection at right angles and location of parallel butt welds or fillet welds (tee welds) and butt welds in close proximity shall be avoided.

Butt welds in plate structures shall be removed from each other by 100 mm at least on the length within sections and assemblies, if made earlier than the welds with which they intersect.

In case of construction welds, the minimal distance between butt welds and fillet welds parallel thereto shall not be less than 100 mm or 10 times the plate thickness, whichever is greater. Where the above welds are shorter than 2 m, they shall be removed from each other by 50 mm at least.

The angle between two butt welds shall not be less than 45° (Fig. 2.4.2).

2.4.3 It is recommended to arrange the effective flange butts of web framing members (stringers,

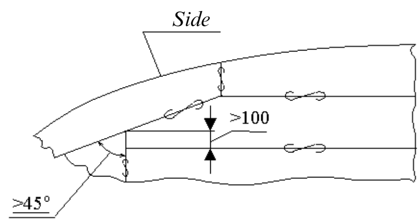


Fig. 2.4.2

calrings, floors, beams) at an angle of 45° to the longitudinal axis of the member.

2.5 Welds.

2.5.1 Butt welds.

2.5.1.1 It is recommended that welds in supporting structures having a thickness of 4 mm or above shall be made with edge preparation.

In components up to 10 mm in thickness, welds are permitted without edge preparation on condition automatic indirect welding is used to ensure weld-root formation.

2.5.1.2 When plates of different thickness are abutted, the difference in their thickness is generally not to exceed 40 per cent of the thicker plate thickness. This does not apply to thickened plates fitted under hawse pipes, pylons, bottom supports, etc. The thicker plate edge shall be bevelled until it reaches the thickness of the thinner plate (Fig. 2.5.1.2).

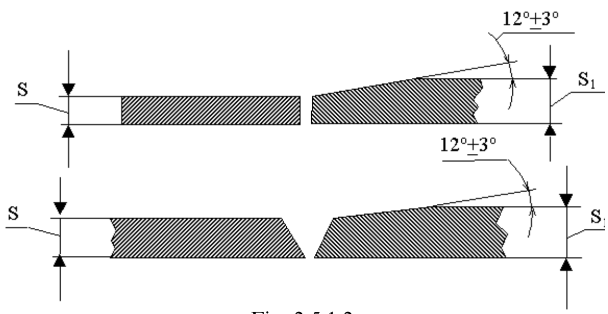


Fig. 2.5.1.2

2.5.1.3 Butt joints in girders shall be welded by direct welding using runoff blocks. Strapped lap joints are not permitted. In hard-to-reach areas, indirect welding on removable backing is permitted (also using runoff blocks).

2.5.2 Tee joints.

2.5.2.1 The leg length of tee welds in hull structures will be determined on the basis of strength analysis, but it shall not be less than stated in Table 2.5.2.1.

2.5.2.2 Welds in tee joints made by direct welding with edge preparation shall be used where the thickness of plates (components) is 4 mm or above in:

Table 2.5.2.1

Welded plate thickness (web/flange), in mm	3/3÷15	4/4÷15	6/6	6/8÷15	8/8÷15	8/15	10/10	10/15	15/15
Minimal leg length, in mm	3^{+1}	3^{+1}	4^{+1}	5^{+1}	5^{+1}	6^{+1}	6^{+1}	7^{+1}	7^{+1}

connecting assemblies of main hull girders, namely, web frames and stringers, floors and web frames, stringers and bulkheads, etc., as well as in bracket joints, flange joints and girder stiffeners;

structures and stiffeners coming under dynamic and vibration loads (pylon footings, machinery seatings, bottom supports, etc.).

2.5.2.3 Continuous welds in tee joints made by direct welding without edge preparation may be used in connecting assemblies of web members (stringers, carlings, web frames, etc.) and shell or plating except for members coming under alternating loads.

2.5.2.4 Welds not less than 50 mm in length made on the opposite side of the wall of the component being welded by indirect continuous welding in tee joints arranged 150—200 mm from each other (Fig. 2.5.2.4) are permitted for welding longitudinals to shell plating and to deck and platform plating, for welding bulkhead stiffeners to bulkhead plating and for welding flanges to welded section walls, etc., except for areas of longitudinals and web framing intersection and intensive vibration areas, only when the stress level is low in the structure.

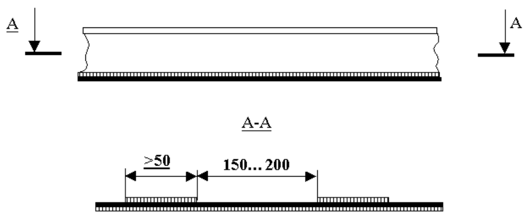


Fig. 2.5.2.4

When joints of this kind are used, the member ends shall be boxed on a length not less than 1,5 of the section height.

2.5.2.5 Intermittent welds made by direct welding with bead overlapping on the opposite side by 20 mm at least, the beads being 150 — 200 mm long (Fig. 2.5.2.5), are permitted in tee joints of small thickness (less than 3 mm) outside of intensive vibration areas. In any case, girders shall be welded to shell plating and plating in way of supports and girder ends by using continuous direct welding. The weld length to each side of the support (girder end) shall be equal at least 1,5 times the bracket height or that of the higher girder being connected, whichever is greater.

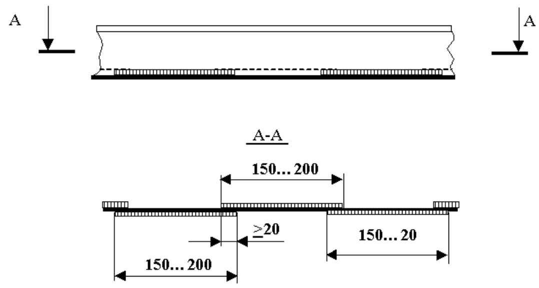


Fig. 2.5.2.5

2.6 All-pressed panel joints.

2.6.1 All-pressed panels shall be generally connected by welding.

For panels less than 3,0 mm in thickness, riveting or glueing and riveting is recommended.

In panel connections, the seams on the surface and edges shall be made on the same plane.

2.6.2 It is recommended that the panel length shall be adopted equal to the length of one or several compartments.

Panels shall be used whose edges have a symmetrical bulb or tee section.

2.6.3 For panels with unsymmetrical edges, the torsional rigidity of stiffeners shall be increased, where necessary, by the fitting of brackets proceeding from the stiffener web thickness in accordance with Fig. 2.6.3-1 (the thickness being not less than 3 mm) or with Fig. 2.6.3-2 (the thickness being less than 3 mm).

2.6.4 The butt joints of panels, except low-loaded structures in which the section height is not greater than 90 mm, shall be strengthened with stiffeners (Figs. 2.6.4-1, 2.6.4-2a, 2.6.4-2b).

The cross-sectional area of stiffeners shall not be less than 0,5 of the cross-sectional area of panel edges. A deviation from this requirement or from recommendations for executing the connecting assemblies (Figs. 2.6.4-1, 2.6.4-2a, 2.6.4-2b) is only permissible where it is substantiated by test results obtained on panel connecting assemblies and by calculations.

Where necessary, tee sections shall be used to increase the plane bend resistance of connecting assemblies.

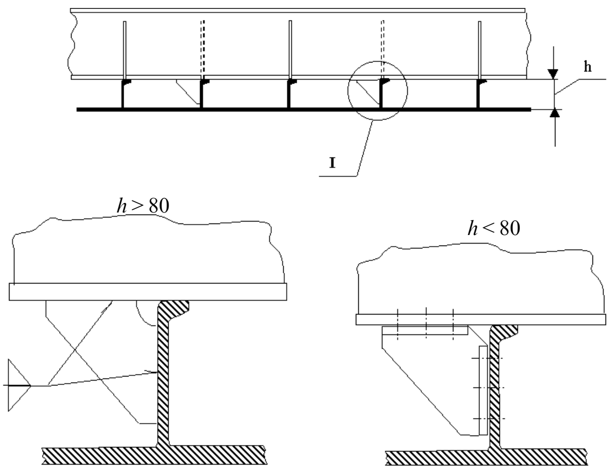


Fig. 2.6.3-1 Fig. 2.6.3-2

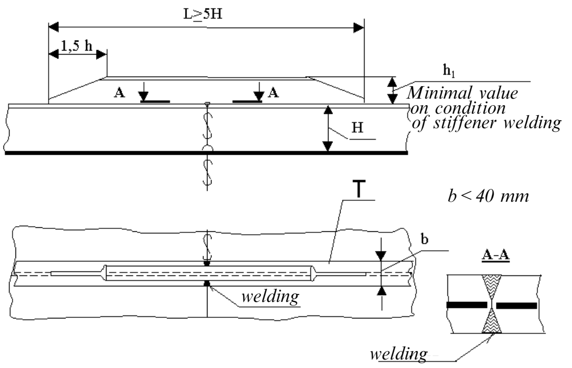


Fig. 2.6.4-1

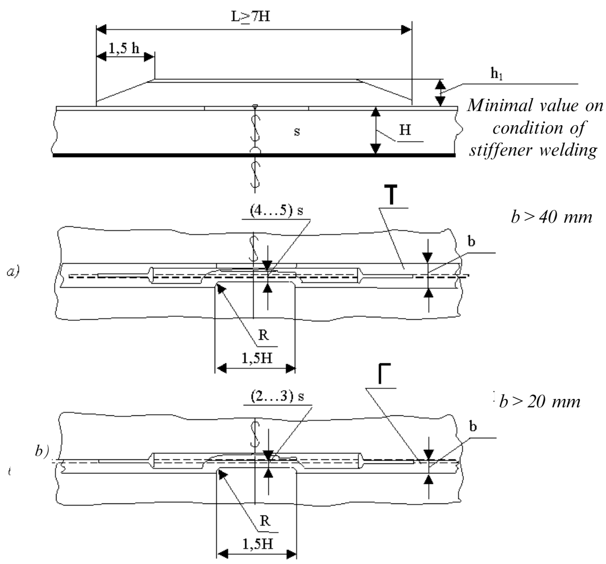


Fig. 2.6.4-2

2.6.5 Solid panels shall be connected to watertight bulkheads, floors and stringers in accordance with Figs. 2.2.19-3 and 2.2.19-4.

Combined connecting assemblies inside blocks or between sections of pressed panels shall be executed in conformity with Figs. 2.6.5-1, 2.6.5-2 and 2.2.22-1, 2.2.22-2, 2.2.22-3, and similar assemblies between pressed panel blocks shall be executed in conformity with Fig. 2.6.5-3. The cross-sectional area of a bracket fitted above the panel joint shall not be less than 0,7 of the edge cross-sectional area. A deviation from these recommendations is only possible if

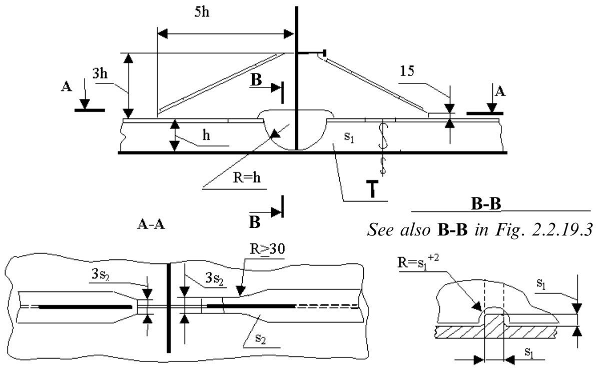


Fig. 2.6.5-1

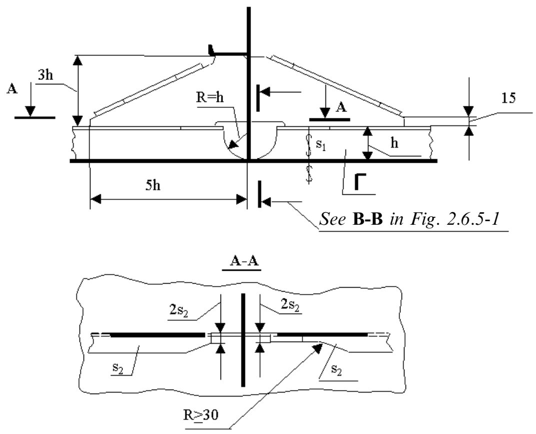


Fig. 2.6.5-2

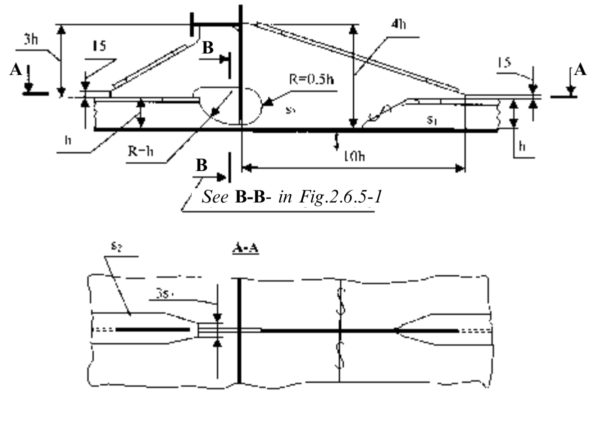


Fig. 2.6.5-3

substantiated by assembly test results and calculations.

Where the bracket cannot be abutted or welded to the shelf, this shall be substantiated by assembly durability analysis.

2.6.6 When connecting structural components composed of all-pressed panels, one shall also be guided by 2.2.20, 2.2.22, 2.12.5.

2.7 Riveted and glued-riveted joints.

2.7.1 The present requirements apply to hull structures manufactured by riveting and glueing-riveting.

Glued-riveted joints are recommended for structures manufactured from glued-riveted billets (panels), as well as for structures exposed to vibrations.

2.7.2 For the design rivet diameter, the nominal rivet body diameter shall be adopted.

2.7.3 Riveting shall be carried out using cold rivets.

2.7.4 Riveted and glued-riveted joints may be executed in overlap and end-to-end on strips.

2.7.5 The rivet material shall be chosen proceeding from the grade of aluminum alloy from which the structure is manufactured.

2.7.6 The rivet types and kinds of glue to be used shall comply with the current standards.

2.7.7 The riveted and glued-riveted joint diameters for plates shall be chosen on the basis of Table 2.7.7.

Table 2.7.7

Design component thickness, in mm	Rivet diameter, in mm	
	recommended	permissible
0,5	2	2,6÷3
1,0	2	2,6÷3
1,5	3	2,6÷4
2,0	4	3÷5
2,5	5	4÷6
3,0	6	5÷8

Notes: 1. For the design thickness, the lesser thickness of components being connected shall be adopted.
2. Where the joints are made on strips, the thickness of the latter shall not be taken into consideration.

When plates are riveted, the minimal overlapped width for single-row joints shall be $4d$, $6d$ for double-rivet joints and $8d$ for three-rivet joints.

2.7.8 The margin between rivet axis and plate edge shall be at least $2d$.

2.7.9 The parameters of riveted and glued-riveted joints to be used in butts, slots and other structural assemblies shall be chosen on the basis of strength analysis proceeding from forces to be applied and the purpose of the joint. For the purpose of strength analysis, the glue interlayer shall be disregarded, i. e. glued-riveted joint parameters shall be adopted as for riveted joints.

2.7.10 Recommended values of the rivet pitch t, spacing and number of rivet rows are given in Table 2.7.10.

Table 2.7.10

Type of joint	Joint parameters in connection with rivet diameter			Rivet arrangement
	Rivet joint pitch	Rivet row spacing	Minimal number of rows	
Strength	6÷7	2÷5	1 for framing, 2 for butts and slots,	Staggering and chainlike
Composite	3,5÷5,5	2	2÷3 for butts and framing,	Staggering
Tight	3,5÷5	2	2 for butts and framing	Staggering

Notes:
A strength joint is one for which strength, but not tightness is required.
A tight joint is one for which tightness is required.
A composite joint is one for which strength and tightness are required.

2.7.11 If rivets up to 8 mm in diameter are made of aluminum alloys, their stud length shall be chosen from Table 2.7.11.

Table 2.7.11

Closing head type	Countersunk	Raised countersunk	Hat	Cup
Stud length, in mm	S + 0,d	$S + 1{,}1d$	$S + 1{,}2d$	$S + 1{,}d$

Notes:
S is the total thickness, in mm, of components being joined, including the strip, if fitted.
d is the rivet diameter, in mm.

2.7.12 It is recommended that holes for rivets shall be made by drilling.

2.7.13 The diameter, in mm, of rivet holes shall be determined from the formula:

$$d_r = d_0 + \Delta_1, \qquad (2.7.13)$$

where d_0 is rivet diameter, in mm;
Δ_1 = 0,1 where d_0 = 2—5 mm;
Δ_1 = 0,2 where d_0 = 6—8 mm.

2.7.14 All defective rivets (wear ones with eccentric and cracked heads, with heads loose on the plate surface or section flange, with improperly closed up or small-sized heads, etc.) shall be replaced.

2.8 Glued-welded joints.

2.8.1 The present requirements cover hull structures manufactured using glued-welded joints.

Glueing-welding process is recommended for connecting girders to the plating of skirt bag, recesses, etc., except for sections of these structures coming under loads strong enough to tear the framing from the plating.

2.8.2 The weld types and glue quality to be used shall comply with the current standards.

2.8.3 The glued-welded joint parameters shall be determined by calculation proceeding from forces applied and the thickness of plates to be joined.

The optimal values of welded point diameter (*d*), spacing of point centres in a row (*t*), spacing of point row aces (*c*) and welded flange (flanging) breadth (*a*) are given in Table 2.8.3.

Table 2.8.3

Design components thickness *S*, in mm	Welded point diameter *d*, in mm	Spacing of point centres in a row, *t*, in mm	Spacing of point row aces, *c*, in mm	Flanging breadth (breadth of flange edge), *a*, in mm
0,5	3,0	10	12	10
0,8	3,5	13	15	12
1,0	4,0	15	18	14
1,2	5,0	17	20	16
1,5	6,0	20	24	18
2,5	8,0	30	36	22
3,0	9,0	35	42	26
2,0	7,5	25	30	20

Notes: 1. For the design diameter of welded points, the diameter *d* shall be adopted.
2. For the design thickness *S*, the smaller thickness of components being joined shall be adopted.
3. The thickness ratio of components being welded shall be not greater than 2:1 for category II structures or 3:1 for category III structures.

2.8.4 The margin between the extreme row axis and the flange edge (flanging) shall not be less than 8,0 mm where the plate thickness is 0,5 — 1,5 mm or less than 15 mm where the thickness is 2,0 — 3,0 mm.

2.8.5 In the free ends of stiffeners, the welds shall be made on a length equal to twice the stiffener height where the spacing of point centres in a row is 0,5*t*. Rivets may be fitted in free ends (Fig. 2.8.5).

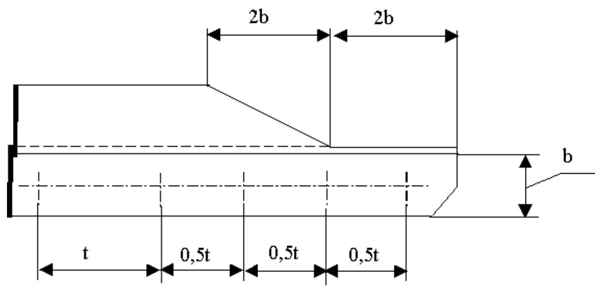


Fig. 2.8.5

2.9 Glued-welded panel joints.

2.9.1 It is recommended that the butt joints of glued-welded panels shall be executed using glueing-riveting procedure. The butts may be manufactured by riveting.

In glued-welded panel joints, the panel surfaces and edges shall be arranged on the same planes.

2.9.2 The panel length shall be adopted equal to that of a compartment or section. Panels shall be used having edges of bulb angular or Z section.

For secondary structures, other sections (angles, etc.) may be used.

2.9.3 The connecting assemblies between glued-welded panels shall be preferably executed in conformity with Fig. 2.9.3-1.

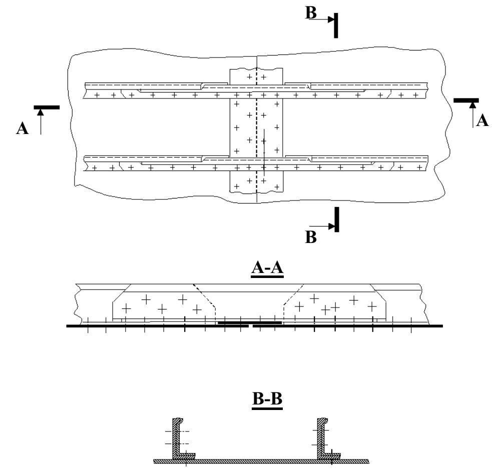


Fig. 2.9.3-1

A recommended structure of a composite connecting assembly between panels and a transverse bulkhead is shown in Fig. 2.9.3-2.

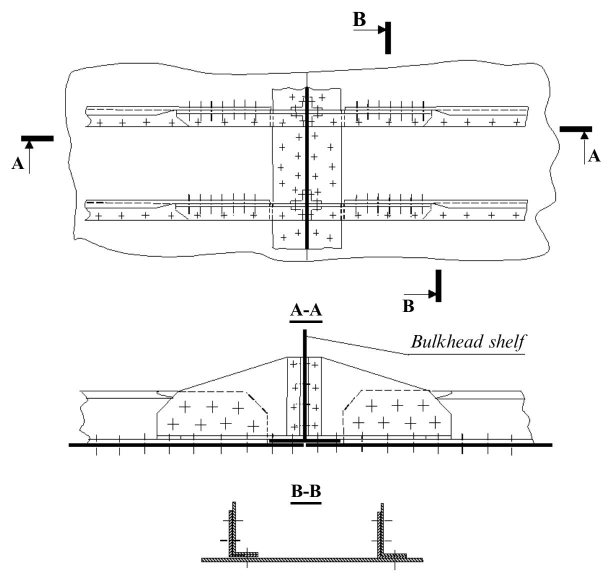


Fig. 2.9.3-2

2.10 Deck and shell plating.

2.10.1 The thickness of the deck stringer and (if the ratio of ship design length to breadth is less than

5,0) the thickness of deck plating adjacent to longitudinal bulkheads shall be 20 per cent greater than thickness of deck plating. The breadth (in meters) of deck stringer and thickened plates near by longitudinal bulkheads shall be not less than the value determined by the formula:

$$b = 0{,}014L + 0{,}1. \qquad (2.10.1)$$

In the ship's ends as well as for the lower decks (pontoon plating) increment of the thickness of deck stringers and plates adjacent to the longitudinal bulkheads is not required.

2.10.2 Connection of the sheer strake to the deck stringer and strengthened deck plates to longitudinal bulkheads shall be made by the double-sided welds.

It is recommended to round connection of the sheer strake to the deck stringer. Sheer strake rounding radius shall be equal to at least its 20 thicknesses.

2.10.3 If deck is discontinued in any compartment (for instance, engine room) then side stringers of increased height shall be mounted in the plane of deck along side. Connection of side stringers to the deck continuation (and transverse bulkheads) is recommended to apply to Figs. 2.10.3-1 and 2.10.3-2.

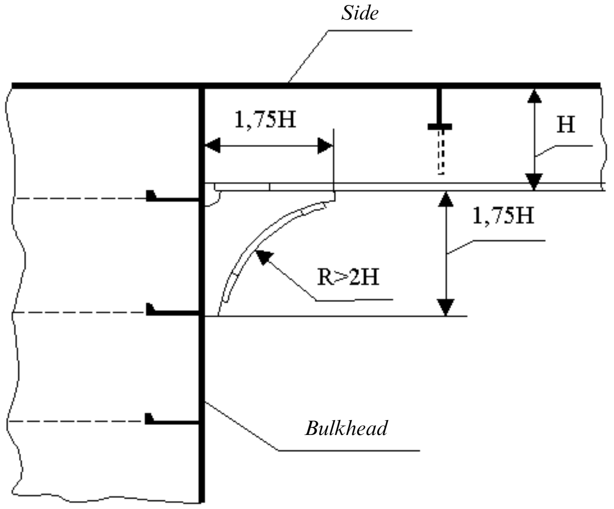


Fig. 2.10.3-1

2.10.4 Shell plates and deck plating in the fixing points of bottom bearers, pylons, stanchions, shaft brackets, stabilizers and hydrofoil installations shall be 20 per cent greater while shell plates exposed to significant mechanical wear shall be 40 per cent greater than thickness of adjacent plates outside the area of increased wear.

If all-pressed boards are used for the shell plating the said thickening of plating is allowed to be made

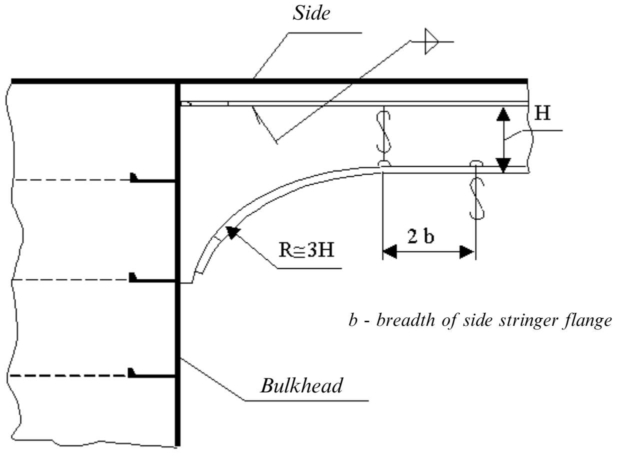


Fig. 2.10.3-2

by installation of superimposed plates welded by perimeter.

2.11 Superstructures and deckhouses.

2.11.1 Superstructures which length is three times greater than their height and deckhouses which are supported at least by 3 rigid transverse members (bulkheads, transverse frames supported by cross ties etc.) are treated as a solid one.

2.11.2 Reduction of the superstructure (deckhouse) contribution to the total bending of ship hull is allowed due to:

use of movable (expanding, flexible or sliding) joints along perimeter of the deckhouse section;

supporting of deckhouse by two rigid transverse members of hull (transverse bulkheads, web beams supported by cross ties etc.).

2.11.3 Stanchions of the superstructure walls and deckhouses shall be located in the plane of deck framing and fixed to the deck by brackets. If stanchions do not coincide with deck framing, stiffeners or other structures ensuring unload of a moment at a support shall be provided under brackets.

2.11.4 Superstructure or deckhouse end bulkheads shall be supported by transverse bulkheads. Otherwise rounded brackets of sufficient size ensuring transmission of loads to the sides and pontoon shall be fitted under end bulkheads.

2.11.5 Door openings in longitudinal walls (including longitudinal bulkheads of superstructures and deckhouses located within 0,6*L* amidships) shall be supported by thickened plates above and below opening.

Rounding of the opening corners is sufficient if the distance between expanding and sliding joints is less than three heights of superstructure (deckhouse).

Upper and lower edges of the side-scuttle openings shall be enforced by strengthened longitudinal members remoted from the opening edge at least by 10*S* where *S* is the thickness of the superstructure (fast deckhouse) plating; meanwhile, opening corners shall be additionally strengthened (Fig. 2.11.5).

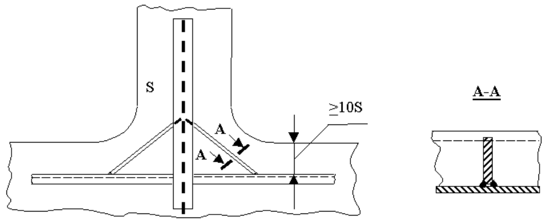


Fig 2.11.5

2.11.6 If the window span in superstructure or deckhouse is less than window width (for two or more windows) plate thickness in the area of window shall be enlarged by 40 per cent as opposed to adjacent superstructure plates.

2.12 Bulkheads.

2.12.1 Arrangement of longitudinal and transverse bulkheads shall be agreed with arrangement of stringers and floors. Longitudinal bulkheads shall be strengthened by horizontal members.

2.12.2 Stanchions of transverse and longitudinal bulkheads as well as walls of superstructures and deckhouses shall be located in the plane of bottom and deck framing.

Lower ends of stanchions shall be fixed on the horizontal stiffener (Figs. 2.2.10-2 and 2.2.19-2) for the floating framing system and conventional framing system of side-walls (with dead-rise of lines).

If local operating loads are symmetrical relative to the bulkhead and it is impossible to fix lower ends of stanchions on the horizontal stiffener, it is allowed to leave them unattached provided horizontal stiffener is mandatorily mounted on the opposite side of bulkhead plating (variant 2 on Figs. 2.2.19-1 and 2.2.19-4).

2.12.3 Ends of the longitudinal bulkhead stanchions above stringers shall be fixed in accordance with Figs. 2.2.10-3 and 2.12.3-1.

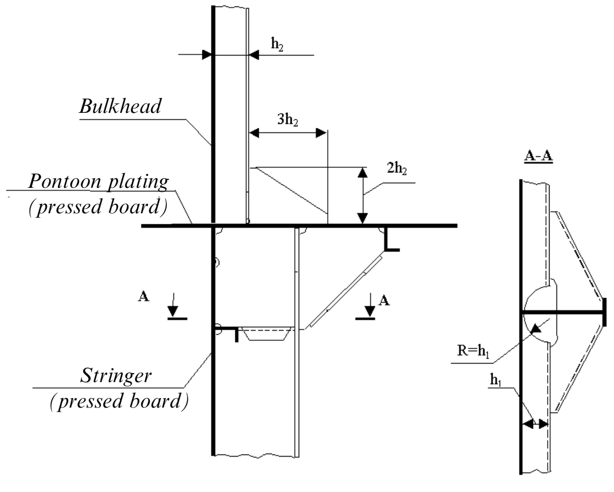


Fig. 2.12.3-1

Ends of stanchions above carlings and beams shall be fixed in accordance with Fig. 2.12.3-2.

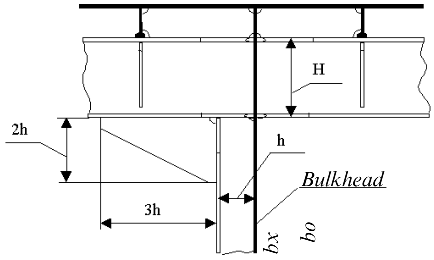


Fig. 2.12.3-2

2.12.4 Upper ends of the bulkhead stiffeners located outside area of intensive vibration (excluding tank bulkheads) are allowed to snip.

2.12.5 Stanchions of transverse and longitudinal bulkheads in the passages through permeable decks and platforms shall be continuous. These passages shall be made in accordance with Fig. 2.12.5-1.

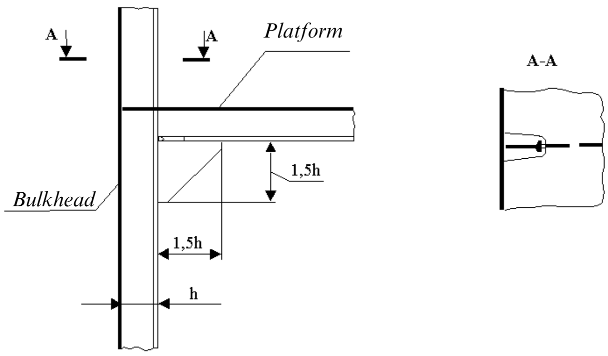


Fig. 2.12.5-1

It is recommended to make intercostal vertical bulkhead stiffeners on the watertight decks (platforms) and secure them to the deck (Fig. 2.12.5-2).

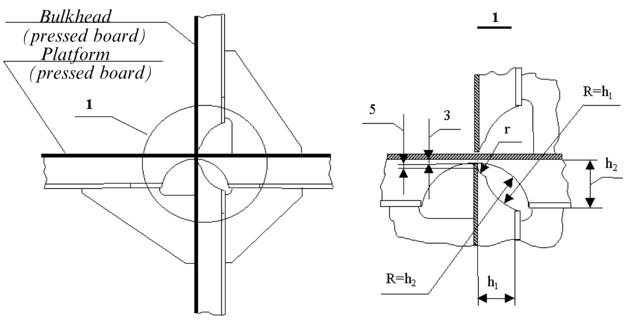


Fig. 2.12.5-2

2.12.6 The thickness of the bulkhead plating adjacent to the bottom shall be increased by 1 mm. If pressed boards are applied it is allowed not to increase thickness.

2.12.7 Longitudinal bulkheads shall end on the transverse bulkheads. They shall end by rounded brackets (Fig. 2.12.7) connecting longitudinal bulkhead to the main deck and bottom longitudinals located in its plane (bottom stringers, carlings).

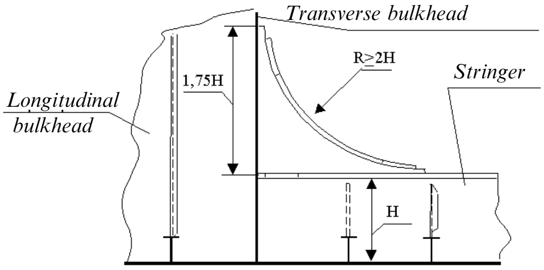


Fig. 2.12.7

2.13 Bulwark.

2.13.1 Bulwark shall be fitted in places specified in Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

Height of the bulwark measured from the upper edge of the gunwale shall comply with the requirements of Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

2.13.2 Thickness of the bulwark plates, in mm, shall be not less than the value determined by the formula:

$$S = 0{,}05L + 1{,}5. \qquad (2.13.2)$$

2.13.3 The thickness of the gunwale of bulwark made of strip or section material shall be at least by 1 mm thicker that the bulwark plates. It is allowed to use light-wall tubes as a bulwark.

2.13.4 The bulwark shall be strengthened by stanchions at a distance not more than 1,2 m one from another.

Thickness of stanchions shall be at least by 1 mm greater than thickness of the bulwark plates. Width of the lower end of stanchion shall be not less than the width of the gunwale.

The width of the stanchion flange shall be not less than 60 mm.

If there are openings in the bulwark, then stanchions adjacent to such openings shall be strengthened.

2.13.5 Stanchions shall be located in the plane of underdeck framing, bulkheads or specially mounted strengthenings and be secured to the deck, bulwark and gunwale by welding or riveting.

2.14 Machinery foundation.

2.14.1 Foundations for ship machinery (engines, reduction gears, supercharging blowers etc.) shall have stable and rigid structure ensuring reliable mounting of machinery to rigid hull members. Rigidity of machinery foundations and grillages on which they are mounted shall comply with the requirements, technical standards applied to mounting and operation of such machinery.

2.14.2 Structural components and foundation members shall be manufactured from the same material as the main case. Foundation and case shall be connected by welding or riveting (see 2.5 and 2.7).

2.14.3 Foundation longitudinals under main machinery shall be aligned with bottom stringers or there shall be provided additional members ensuring smooth transmission of loads to hull.

2.14.4 Ends of foundation longitudinals shall be connected with transverse bulkheads or reinforced floors and to finish by brackets located in the area of longitudinals and be attached to the transverse member (floors and web frames).

2.14.5 Webs of foundation longitudinals shall be by 40 per cent thicker than webs of bottom stringers. Deviation from these requirements is allowed if it is justified by foundation strength and rigidity calculation.

2.14.6 Horizontal face plates made of continuous strips which thickness shall be by 40 per cent greater than thickness of plates of foundation wall shall be mounted on the upper edge of foundation longitudinals.

Horizontal face plates of foundation longitudinals in the area of securing bolts shall be strengthened by vertical brackets. Vertical size of these brackets shall be not less than two times larger than their horizontal size while thickness shall be equal or by 1 mm less than thickness of the foundation walls.

2.14.7 Foundation longitudinals shall be strengthened at each floor by transverse brackets connecting longitudinals together and by brackets mounted on the outer side of longitudinals beginning from the center line of shaft. The width of brackets shall be not less than their height while thickness — 20 per cent greater than thickness of floor webs. Free edges of brackets for the length exceeding 40 thicknesses of brackets shall have a face plate or flange. Ends of face plates shall be snipped.

2.14.8 There may be lightening openings in brackets.

2.14.9 It is allowed to make openings in the web plate of foundation longitudinals. Openings shall be strengthened.

2.14.10 Foundation girders under the hovercraft reducing gear transmitting rotation are subject to the Register special consideration.

2.14.11 Foundations of small auxiliary machinery may be made as a bracket fixed on framing. Foundations shall be located on the least strained parts of members in such a way that foundation supporting components are mounted in the plane of web plate of framing.

2.15 Platforms.

2.15.1 Scantlings of the platform framing shall be assigned on the basis of strength calculations.

Aluminium allows with inferior mechanical properties as opposed to the main case material are allowed for use in platforms as well as three layer boards with aluminium and polymeric base layers.

It is recommended to align platform stiffeners with vertical framing (frames, bulkhead stiffeners).

2.15.2 It is recommended to use zee, bulb angle, angle beams as the platform stiffeners.

2.16 Enclosures.

2.16.1 The following requirements refer to the strengthened enclosures which support web frames.

2.16.2 Thickened plates shall be provided in the lower and upper parts of enclosures. Their width shall be not less than two heights of frames passing through them and thickness:

equal to the thickness of frame webs passing through the lower part of framing — for the upper part;

increased by 1—2 mm relative to frame webs — for the lower part.

2.16.3 Plating of enclosures shall be strengthened by zee, bulb angle, angle stiffeners. Stanchions may be affixed to plating by glued-welded joint, glued-riveting joint, seam welding or riveting.

Bending (clamping) of vertical edges of plates may substitute metal sections. Connection of plates throughout bulkhead width shall be made by riveting or contact welding of bent edges.

It is allowed to use horizontal or vertical box-shaped or wavy corrugated bulkheads and three-layer boards.

2.16.4 Door openings in enclosures shall be strengthened by thickened plate or additional stiffeners.

2.17 Structural features of connecting bridges of speed catamarans and side-wall hovercraft.

2.17.1 Main structures of connecting bridge shall be all-welded from plates, section and all-pressed boards. Plates of structures shall be strengthened by transverse frames (web frames or brackets).

2.17.2 Structures of the connecting bridge in the bow end within 0,35L shall be made in accordance with the conventional framing system.

2.17.3 It is recommended to connect transverse frames of connecting bridge with web frames as shown in Figs. 2.17.3-1 and 2.17.3-2.

2.17.4 It is recommended to fit together connecting bridge to the transverse bulkheads by means of thickened plates in the area of transition of connecting bridge plating to the bulkhead plating or elongation of reinforced web of the bridge frame and its smooth transition to the bulkhead plating (Figs. 2.17.4-1 and 2.17.4-2).

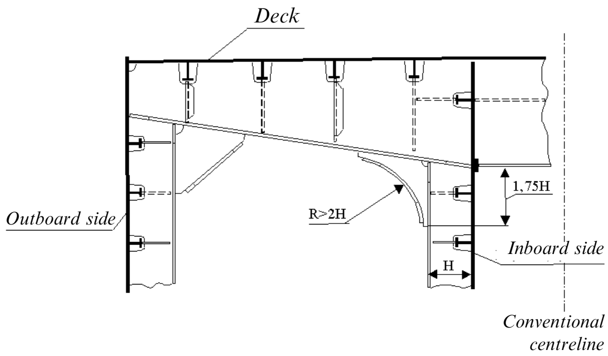


Fig. 2.17.3-1

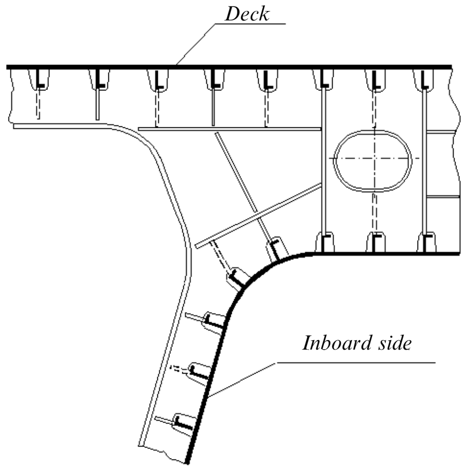


Fig. 2.17.3-2

It is allowed to use web permeable bridge structures amidships (within 0,25L to both ends from the midship section) (Fig. 2.17.4-2).

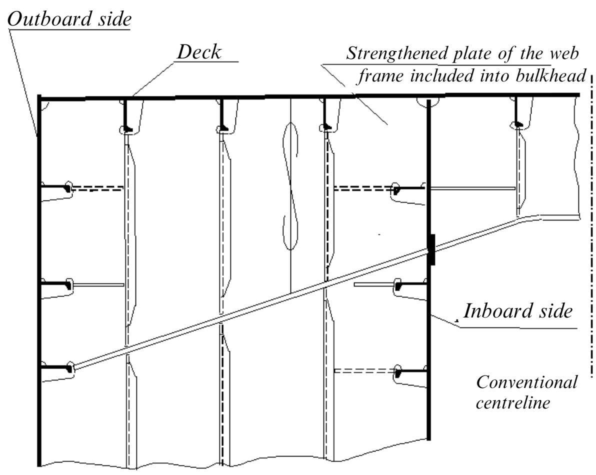


Fig. 2.17.4-1

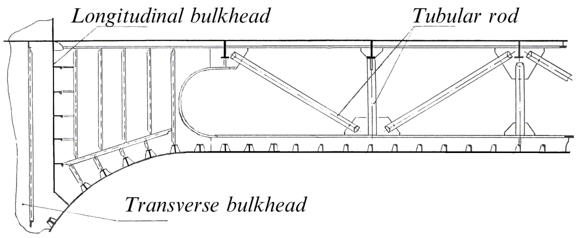


Fig. 2.17.4-2

2.18 Special features of the hovercraft hull structures.

2.18.1 Apron.

2.18.1.1 Usually apron is made of the all-welded plates, sections and all-pressed boards.

2.18.1.2 The thickness of the apron plating is chosen on the basis of the strength properties and it shall be taken not less than the deck thickness designed for wheeled cars.

2.18.1.3 Dimensions of the apron members are assigned on the basis of strength calculations.

2.18.2 Skirt bag.

2.18.2.1 Usually skirt bag is riveted of plates, sections and boards.

Upon the Register approval it is allowed to weld skirt bag or make it from non-metal materials.

It is recommended to use bulb angle and zee beams as longitudinals.

2.18.2.2 The thickness of the skirt bag plates adjacent to side which is not less than 300 mm shall be 20 per cent greater than thickness of the rest skirt bag thickness.

Strengthened skirt bag plate is connected to the side by welding.

2.18.2.3 Part of skirt bag made of the pressed boards shall be strengthened by web beams.

2.18.2.4 Flexible skirt shall be continuously secured along length of skirt bag.

2.18.3 Side-walls.

2.18.3.1 Side-walls shall be made of welded plates, sections and pressed boards. Parts of side-walls exposed to hydrodynamic blows shall be made according to the conventional framing system.

2.18.3.2 Boards (welded, pressed boards) of side-walls shall be strengthened by brackets or web frames.

2.18.3.3 Bottom and side plating of side-walls are connected by the double-sided welds.

2.18.4 Pylons.

2.18.4.1 Pylons shall be riveted (glued-riveted) from the plates, sections and all-pressed boards.

2.18.4.2 Boards of pylons (riveted boards with the stiffeners of bulb angle and zee beams) shall be strengthened by horizontal (rib) and vertical (spar) brackets.

Vertical brackets shall be continuous.

2.18.4.3 Thickness of pylon plating adjacent to the foundation under pylon shall be at least 40 per cent greater than the thickness of pylon plating.

Pylon shall be connected to the engine gondola and foundation on casing by riveting (bolts).

2.18.5 Air trunks.

2.18.5.1 It is recommended that air trunks shall be glued-riveted from plates, sections and all-pressed boards. It is allowed to weld or rivet trunk structure.

It is recommended to use bulb angle and zee stiffeners as vertical stanchions.

2.18.5.2 Thickness of trunk shell ring adjacent to the plating shall be 10 — 20 per cent greater than thickness of plates of shell ring.

2.18.5.3 Recommended structural scheme of the air trunk is set forth in Fig. 2.18.5.3.

Trunk shell ring shall be strengthened by horizontal framing (rings) located on the outer side of the shell ring.

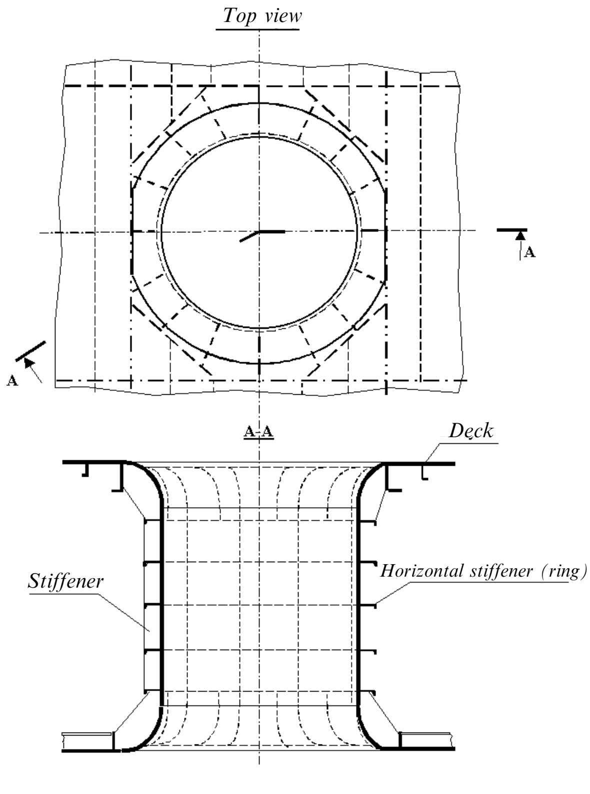


Fig. 2.18.5.3

2.19 Hull structural features of the hydrofoils and gliders.

2.19.1 Stem.

2.19.1.1 Usually, stems are riveted from plates.

2.19.1.2 Thickness of the welded stem plates (in mm) shall be at least:

$$S = 1{,}2\ (0{,}05L + 3). \qquad (2.19.1.2)$$

Accepted thickness of the stem plates shall be not less than the thickness of the horizontal keel in the spot of its connection to the stem.

The width of the stem transverse section, in mm, measured in the waterline plane in the water displacement mode shall be at least $(2,5L+200)$.

2.19.1.3 Usually, stem plates shall be strengthened by horizontal brackets mounted at most each 0,5 meter. Arrangement of brackets throughout stem height shall be, if possible, accorded with the hull framing. If distance between brackets is reduced to 0,3 m it is allowed to reduce stem plates thickness by 20 per cent as opposed to the value given in 2.19.1.2. However, in all cases thickness of stem plates shall be not less than the thickness of adjacent shell plating.

2.19.1.4 Thickness of brackets shall be equal to the thickness of shell plating adjacent to the stem.

2.19.1.5 Brackets shall overlap butts between stem and shell plating by the value of at least 10 thicknesses of the latter and, if possible, reach the nearest frame and be welded to them. Brackets which cannot be connected to the framing shall have edge which ends on the shell plating which is shaped by smooth curve.

2.19.1.6 The stiffener (plate) with face plate on the free edge shall be mounted in the centreline from keel to the deck. Thickness of web and flange of stiffener shall be not less than the value adopted for transverse brackets.

2.19.2 Strengthening of hull in the area of struts and brackets of hydrofoil installations and shafts.

2.19.2.1 Usually, at least one longitudinal and two transverse members (stringers, web frames or floors, bulkheads) shall be under each strut or bracket of hydrofoil installation and shaft.

Additional members under struts and brackets may be required in some cases.

2.19.2.2 Shell plating in the area of struts and brackets of hydrofoil installations and shafts shall have an increased thickness in accordance with 2.10.4.

2.19.2.3 Strengthened openings for examination and painting of a hard-to-reach area are allowed in strengthenings.

2.19.2.4 Floating framing system in the area of strengthenings, floors and web frames shall be welded to the shell plating (see 2.1.14).

2.19.2.5 Welding of superimposed plates made of the hull material is allowed from the outer side of shell plating in the areas of strengthening of brackets of hydrofoil installations and shafts. Thickness of plates shall be at least double thickness of the shell plating in the area of the installation.

Plate thickness shall be such that the distance between a plate weld and flange edge shall be not less than three thicknesses of a plate.

Insulating gaskets shall be used when steel brackets are connected to plates if brackets are made of steel.

3 REQUIREMENTS FOR HYDROFOIL INSTALLATION DESIGN

3.1 General.

3.1.1 The general arrangement of a hydrofoil installation, location and dimensions of main and auxiliary planes, stabilizers, brackets, and stanchions, as well as the shape of hydrofoil installation component cross-sections shall be chosen with due regard for ensuring the required hydrodynamical characteristics. The most rational structural layout for the hydrofoil installation shall be adopted in order to ensure its strength.

3.1.2 The main plane and lower stanchion and stabilizer sections adjoining thereto shall be generally made solid.

In the surfaces of non-tight hydrofoil components, two openings shall be drilled, one in the upper surface and the other in the lower surface.

In the hollow, tight hydrofoil installation components, drain plugs shall be provided for water discharge.

3.1.3 Hydrofoil installation components of solid structure shall be made of a single plate. Auxiliary (take-off) components of the hydrofoil installation shall be manufactured from aluminum-magnesium alloys, and they shall be solid.

3.1.4 Hollow components of hydrofoil installations whose structure is tight shall be tightness-tested by filling with water with a head of 50 kPa or by air blowing under an over pressure of 20 kPa.

3.2 Main plane.

3.2.1 The main plane shall be continuous along the span and shall not be intercostal in way of stanchions. When the dead-rise angle of main plane or the setting angles of its components are modified, the plane may be partitioned in way of stanchions (Fig. 3.2.1).

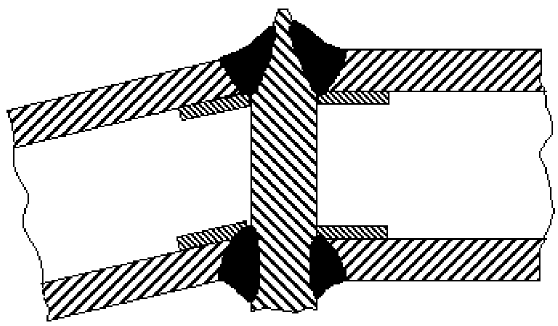


Fig. 3.2.1

3.2.2 Where the hydrofoil is of a hollow structure, the stiffeners shall be arranged along its span (Fig. 3.2.2-1).

Stiffeners may be used which are fitted along the hydrofoil chord (Fig. 3.2.2-2). Each stiffener shall be welded to the upper or lower section of hydrofoil plating.

Stiffeners fitted along the span shall be connected to the upper plating of main plane and to the lower plating of the take-off plane without use of the transition shaller (Fig. 3.2.2-1).

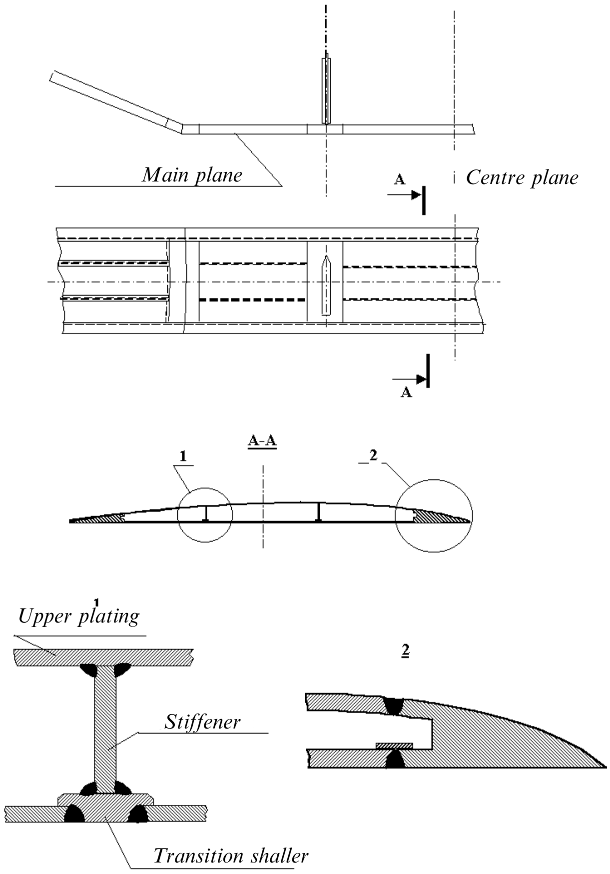


Fig. 3.2.2-1

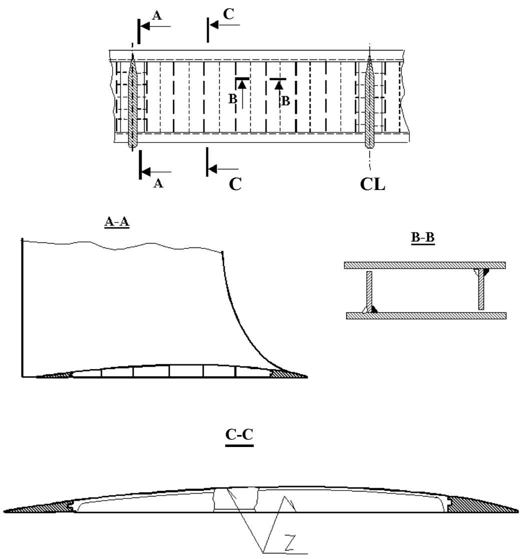


Fig. 3.2.2-2

3.2.3 Where a hollow hydrofoil is adjoined by other structures (stanchions, stabilizers), provision shall be made for solid inserts in the hydrofoil, made of thick plates or forgings (Fig. 3.2.3-1), and in the adjoing structures provision shall be made for thickened plates (Fig. 3.2.3-2).

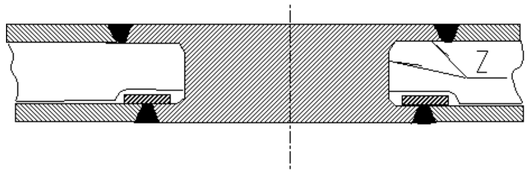


Fig. 3.2.3-1

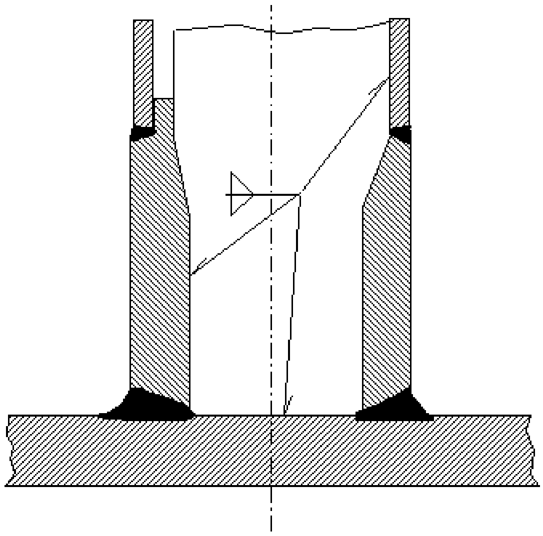


Fig. 3.2.3-2

Thickened plates strengthened with additional stiffeners or brackets (Fig. 3.2.3-3) shall be used instead of solid inserts.

The plates shall be fitted symmetrically with regard to the neutral axis of the hollow component plating.

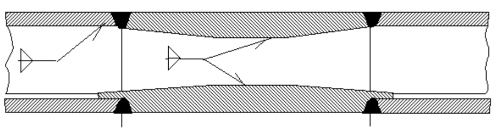


Fig. 3.2.3-3

3.3 Stabilizers, stanchions and brackets.

3.3.1 All the requirements of 3.2 apply to the design of stabilizers and stanchions.

The lower sections of hollow structures of stabilizers and stanchions adjoining the main plane shall be strengthened with solid inserts or with thickened plates reinforced with additional stiffeners or brackets.

3.3.2 The stiffeners of a hollow stabilizer shall be arranged along its span. In case there is no solid insert between the main plane and stabilizer, the stabilizer stiffeners shall be arranged in such a way as to form a continuation of the main plane stiffeners, as shown in Fig. 3.3.2.

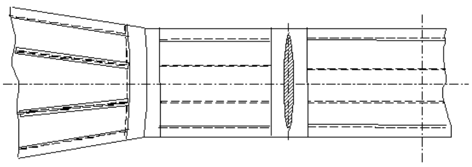


Fig. 3.3.2

3.3.3 The stiffeners of the hollow section of a stanchion shall be arranged along the stanchion. The stiffeners shall be attached to the shell plating in accordance with the requirements of 3.2.2.

3.3.4 A stanchion shall be attached to the hull by means of a vertical, horizontal or inclined flange. The input edge of the stanchion shall be rounded where the stanchion is attached to the main plane and flange to ensure a smooth transition in way of abutments (Fig. 3.3.4).

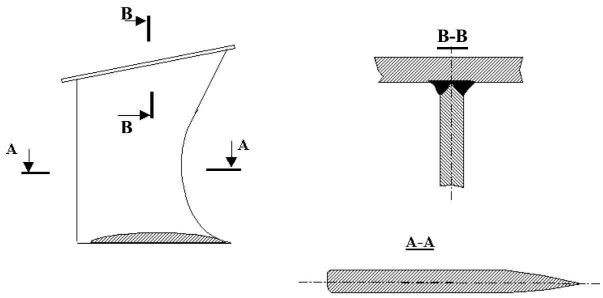


Fig. 3.3.4

3.3.5 Side brackets shall have a hollow structure.

The stiffeners of side brackets shall be arranged along the length of the latter. The stiffeners shall be attached to the shell plating as stipulated in 3.2.3. On the input and emergent edges of the bracket, connecting elements of solid cross-section shall be fitted.

3.4 Welded joints.

3.4.1 General.

3.4.1.1 In hydrofoil installations, the welded joint assemblies shall be located in areas with the lowest stresses.

3.4.1.2 The weld types and structural elements of edge preparation for welding shall be in accordance with the standards agreed with the Register.

3.4.1.3 On water-washed surfaces, the butt-weld strengthening shall be machined flush with the base metal and ground.

3.4.1.4 On water-washed surfaces, fillet welds shall be ground so as to ensure a smooth transition to the base metal.

3.4.2 Butt welds.

3.4.2.1 The butt welds in solid components of hydrofoils shall be made using direct welding with double-groove edge preparation.

3.4.2.2 The plates of hollow hydrofoils shall be connected to each other and to other elements of external hydrofoil surface by means of butt welds with edge preparation (direct or indirect welding with a backing run). Where the opposite side is inaccessible for welding, butt welds shall be made on a permanent backing or halved (Fig. 3.4.2.2). The backing material shall be of the same grade as the base metal.

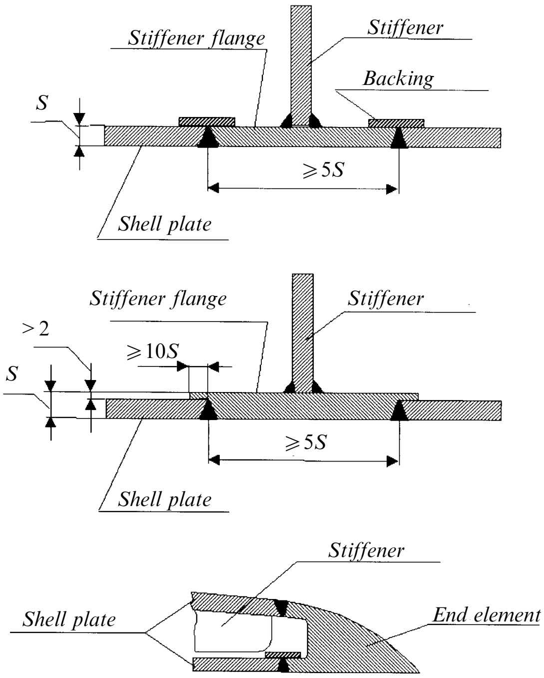


Fig. 3.4.2.2

The upper plating of main plane and the lower plating of the take-off surface of a hydrofoil shall be connected to the end elements (fillers) by means of direct butt welds.

3.4.2.3 The stiffener flanges forming a part of the hollow-hydrofoil shell plating shall be connected to the shell plating in conformity with Fig. 3.4.2.2.

3.4.3 Tee joints.

3.4.3.1 The tee and fillet joints of solid hydrofoil components shall be made by double-groove welding with full penetration. If the plate being joined is more than 1,5 times thicker than the plate to which it is joined and its thickness is equal to or greater than 40 mm in a tee joint, double-groove welding without full penetration shall be used. In this case, the design cross-section of the weld shall not be less than 0,7 times the thinner plate thickness.

3.4.3.2 The tee joints of internal stiffeners and hydrofoil plating, side brackets and flanges shall be made using continuous direct welding. In side bracket structures, stiffeners shall be connected to shell plating by tonguing (see Fig. 3.4.3.2).

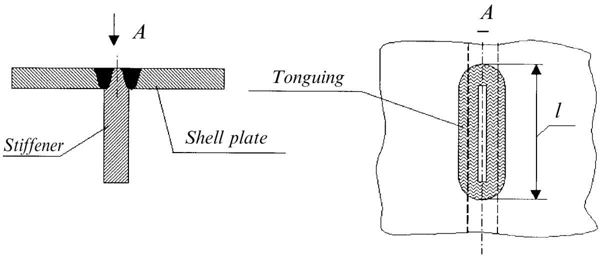


Fig. 3.4.3.2

4 REQUIREMENTS FOR FLEXIBLE SKIRT DESIGN

4.1 General.

4.1.1 The requirements below apply to the flexible skirts of amphibious and side-wall craft which are made from fabric-backed materials or other materials approved by the Register, having a thickness ($s \leqslant 6$ mm), and in which glued, glued-punched, bolted or other joints are used.

4.1.2 The type of flexible skirt and its structural layout shall be set down on the initial design stages proceeding from the conditions of ensuring the required nautical, navigational and other service qualities of air-cushion vehicles.

4.1.3 The choice of dimensions, design and type of the principal joints and components of flexible skirts shall be made with due regard for the experience accumulated during the design and operation of similar craft, and also proceeding from the results of laboratory strength tests of pilot specimens manufactured under the Register technical supervision by the procedure and under conditions specified by the manufacturer. The list of components subject to laboratory testing and the types of required tests shall be agreed with the Register.

4.1.4 In the absence of a pilot specimen, the joint and component dimensions for the flexible skirt shall be set down proceeding from the condition of ensuring strength equal to that of the base metal under static tension.

4.1.5 The results of laboratory strength testing of components shall be submitted to the Register.

4.1.6 Where satisfactory experience of operating a similar pilot specimen is available, the laboratory tests of materials, joints and components of flexible skirts shall be omitted partially or completely. The resolution concerning the omission or reduction of the scope of laboratory testing shall be agreed with the Register.

4.1.7 The total scope of testing shall be determined considering the degree of novelty and structural continuity of the flexible skirts being developed with regard to existing ones. In the case of flexible skirt designs in which principally new technical solutions are implemented, new structural materials are used or where new service conditions are anticipated, provision shall be made for a pilot set of flexible skirt components to be manufactured and tested.

4.1.8 The pilot set of flexible skirt components shall be tested under operating conditions during the prescribed service time and in accordance with a program agreed with the Register. In well-grounded cases, the manufacture and testing of two or more pilot sets of flexible skirt components or pilot assemblies shall be advisable in order to choose the optimal design. The resolution concerning the necessity of flexible skirt testing during pilot specimen operation shall be taken on agreement with the Register.

4.1.9 During pilot specimen operation, the results of periodical examinations of the technical condition of flexible skirt equipment shall be drawn up into relevant reports containing recommendations on its servicing and further elaboration of design. The periodicity of the examinations shall be agreed with the Register. The report on the results of testing the pilot set of flexible skirt equipment, which contains data on the actual performance characteristics of the structure, shall be submitted to the Register.

4.1.10 To increase the reliability of the flexible skirt, preference shall be given to materials, when choosing the material quality, whose properties are stable under service conditions (long immersion in water, exposure to oil products, solar radiation, low temperatures, etc.). The material properties deterioration as a result of water absorption for a long time shall not exceed 20 per cent.

4.2 Main types of assemblies and joints in flexible skirt.

4.2.1 The main structural assemblies of a flexible skirt (Fig. 4.2.1) are as follows:

erection joint assembly (sectional connection);

assembly by which the flexible skirt is attached to the hull of the air-cushion vehicle;

plate connection assembly (connecting joints);

other assemblies (connecting guys, diaphragms and coamings to plates and plates to openings; connecting assemblies of removable components).

4.2.2 The flexible skirt assembly design shall be chosen proceeding from the conditions of ensuring its serviceability within the prescribed service life in accordance with the requirements of 4.1.3, 4.1.4.

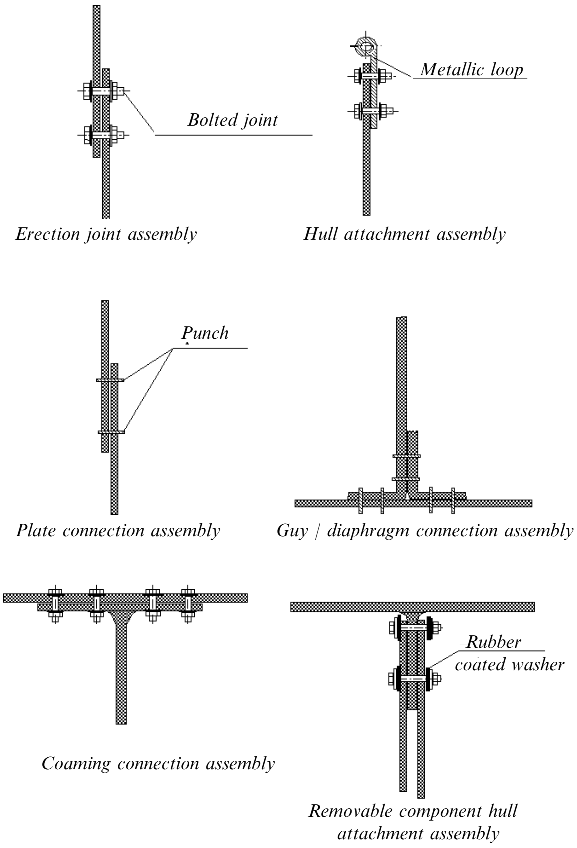


Fig. 4.2.1

4.2.3 Aluminium rivet joints are recommended instead of punched joints for highly loaded flexible skirt assemblies made of high-strength materials (breaking strength of 4,000 N/m or above).

4.3 Flexible skirt design.

4.3.1 The design of the flexible skirt shall ensure its reliable operation under any service conditions and under the service factors specified in the request for proposal.

4.3.2 To ensure the serviceability and repairability of the flexible skirt during its service life it shall be so designed as to make replacement of components possible which are subject to accelerated wear.

4.3.3 The connecting assemblies shall not involve damage to adjacent flexible-skirt components. The metal components of flexible-skirt connecting assemblies shall be made of corrosion-resistant materials or shall have a corrosion-resistant coating.

4.3.4 All materials applied in the flexible-skirt structure shall comply with specified service conditions and loads and shall have the smallest mass possible.

4.3.5 The flexible-skirt structure shall, as far as practicable, be simple, producible, easy to operate and to maintain, to assemble and to disassemble and shall provide the possibility to make replacement of worn components from the outside and repair work aboard the craft possible.

In well-grounded cases, the flexible skirt structure shall incorporate erection joints in order to facilitate its manufacture, assembly, disassemble and repair. As far as practicable, the flexible-skirt sections shall be standardized.

4.3.6 Openings for air supply from the flexible seal to the removable components of the flexible skirt shall, as far as practicable, be as small as possible. An increase in the number of openings is recommended to provide the necessary air-flow area.

4.3.7 The request for proposal made in connection with the flexible skirt development shall contain technical requirements for the flexible skirt design, taking into consideration the structural peculiarities and anticipated service conditions of the craft.

5 STRENGTH NORMS

5.1 General.

5.1.1 The present norms set requirements put forward by the Register for the strength and reliability of hull structures and special devices of the high speed crafts (including dynamically supported ships) as well as for performance verification strength calculations.

The strength norms are obligatory in design, construction and conversion of ships which are covered by these norms and technical projects submitted to the Register.

5.1.2 Deviation from the present strength norms or application of other methods of calculation of main hull structures shall be allowed by the Register if sufficient justifications are available.

5.1.3 Strength calculations performed in accordance with the present norms shall be available for the exhaustive verification of all initial data contained therein. After approval of the project by the Register, responsibility still rests with the design bureaus for possible consequences which shall take place as a result of calculation errors or other omissions.

Note: If strength calculations are made on PCs, software used for such calculations shall be certified by the Register.

5.1.4 Strength calculations of hull structures and special arrangements shall check finally determined dimensions of these structures at a given nominal thickness of applied plates, panels, materials.

5.1.5 Strength calculations submitted to the Register shall include:

external force calculations for general and local hull strength;

external force calculations for special arrangements strength;

general hull strength calculation;
local hull strength calculation;
calculation of strength of special arrangements;
results of experimental strength research of components and joints of hull and special arrangements (if such researches are stipulated);
strength conclusion made upon results of testing of the prototype (experimental) ship.

5.1.6 Calculations of the general and local hull strength, strength of special arrangements shall confirm that if design loads are applied, maximum normal and tangential stresses as well as maximum strain in flexible skirt do not exceed allowed limits given in 5.2 as well as sufficient strength margin for ultimate loads.

5.1.7 Besides verification of structure resistance to stresses, rigidity of the whole structure and of its components shall be tested, if this is required by the present norms and structure operating condition.

5.1.8 Stability of superstructure, bottom and side wall deck longitudinals as well as carlings, bottom stringers and vertical keel in grillage shall be ensured with at least two times safety margin as opposed to design calculation of general bending of hull corresponding to design section under review.

For hovercrafts and high speed catamarans with such margin strength, resistance of frames and beams to design stresses caused by transverse general bending of hull shall be ensured.

5.1.9 Loss of resistance of shell plating and deck plating of superstructure is allowed if design stresses are caused by general bending of hull.

5.1.10 When making calculation of frames rigidity it is necessary to consider influence of variation of the material elasticity by the value of critical normal stress (Fig. 5.1.10); this consideration is not applied to plates.

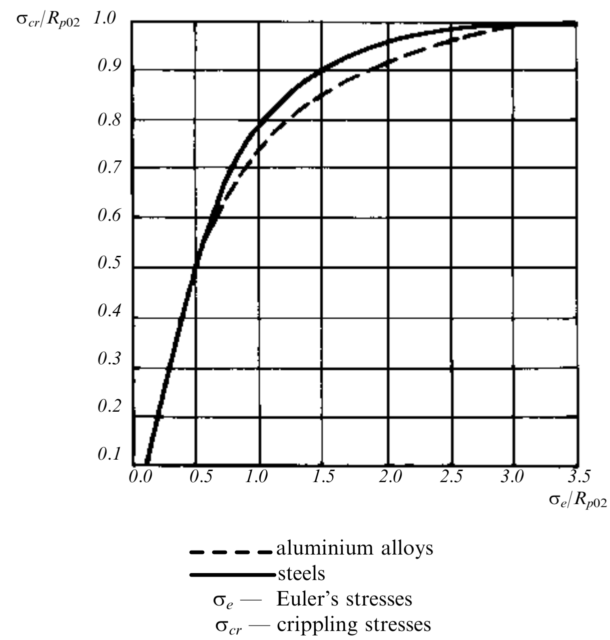


Fig. 5.1.10

5.1.11 Generally, strength calculation shall include the following:
determination of the value and character of design loads;
determination (in relation to the stressed condition) of maximum normal and tangential stress in sections of structures for the given design loads;
assignment of norms for dangerous stresses;
assignment of the required safety margin, norms of permissible stresses and verification of strength conditions.

5.1.12 External loads applied to ship hull and its separate structures shall be determined for the hardest operational conditions. Maximum external forces expected over the whole service life shall be taken for design loads.

5.1.13 Verification of strength conditions and resistance shall be carried out for the maximum normal and tangential stresses depending on the stressed condition of structure.

5.1.14 When stresses are calculated in the structural sections, loss of rigidity by some plates shall be considered by introduction of appropriate reducing coefficients.

When tangential stresses are determined, plates which have lost rigidity due to shift shall be introduced with the reducing coefficient:

$$\varphi = 0,65. \quad (5.1.14)$$

5.1.15 Scantlings of members which are not calculated by the norms shall be chosen in accordance with recommendations set forth in Sections 2—4 of the present Rules.

5.1.16 Required duration of operating life of main (type) components and joints determined in accordance with 5.2.18 shall be ensured for hull and special arrangements.

For structures differing from typical ones, their operating life determined by the technical request for the design shall be supported not only by safety margins but by thorough fitting components of these structure, assessment of their operating life keeping due note of experimental researches as well as performance of periodical surveys and repairs during operation.

5.2 Norms for permissible stresses.

5.2.1 Values of permissible stresses in general and local hull strength calculations shall be taken in accordance with 5.2.8, 5.2.14 as a proportion of dangerous stresses.

5.2.2 Dangerous condition of structures during assessment of its strength is considered such state when design stresses or deformations reach values at which destruction of the whole structure, violation of integrity or appearance of abnormal deformations become possible. The value of dangerous stresses (deformations) is evaluated while destruction testing of components and structural joints.

Attainment of dangerous states while verification calculations is deemed inadmissible.

N o t e : Norms of admissible deformations are designated on the basis of conditions of normal operation of hydrodynamical system and mechanisms.

5.2.3 Dangerous normal stresses for welded structures of hydrofoil installations made of steel are taken equal to the material yield point $\sigma_0 = R_{eH}$.

5.2.4 Dangerous normal stresses for welded structures made of aluminium are taken for the proportion of the material yield point:

$$\sigma_0 = KR_{p02} , \qquad (5.2.4)$$

where K is chosen in accordance with Table 5.2.4.

T a b l e 5.2.4

Alloy category	1530, 1550, 1561	1561H, 1575
K	0,90	0,85

For riveted structures made of aluminium alloys, dangerous stresses are taken equal to $\sigma_0 = 0{,}9R_{p02}$.

Dangerous normal stresses used for general strength assessment of the welded and riveted structures made of light alloys shall not exceed R_{p02}, minimal for this category of material with no regard for the condition of delivery.

5.2.5 Dangerous shearing force T_0 and breakout power Q_0 of weld nugget for structures produced by spot welding or glued-welded joint shall be taken from Table 5.2.5.

T a b l e 5.2.5

Alloy category (alloy grade)	Thickness of connected plates (mm)	Weld nugget dangerous force	
		T_0 shear, kN, to the weld nugget	Q_0 breakout, kN, from the weld
nugget	1530 1550 1561	2÷2	4,4
	1561H 1575	3÷3	7,4

5.2.6 The following is taken for dangerous tangential stresses of welded and riveted structures:

$$\tau_0 = 0{,}57R_{p02}. \qquad (5.2.6)$$

5.2.7 The following is taken for dangerous stresses for compressed parts of structure:

normal stresses — stresses causing loss of frame rigidity determined considering variation of normal elasticity modulus (see 5.1.10);

tangential stress ($\tau_{cr} \leqslant \tau_n$)

$$\tau_0 = K\,\frac{R_m + \tau_{cr}}{2} , \qquad (5.2.7)$$

where K is taken from Table 5.2.4.

5.2.8 Permissible stresses σ_{per} while calculation of general longitudinal (all types of ships) and transverse (hydrofoils, high speed catamarans) of hull strength when bending moments arise while foil motion (hydrofoil), air cushion and staying on bearers (hovercraft) as well as water displacement regime are taken equal to:

$$\sigma \leqslant \sigma_{per} = n_s\sigma_0 , \qquad (5.2.8)$$

where n_s is the safety factor taken from Fig. 5.2.8.

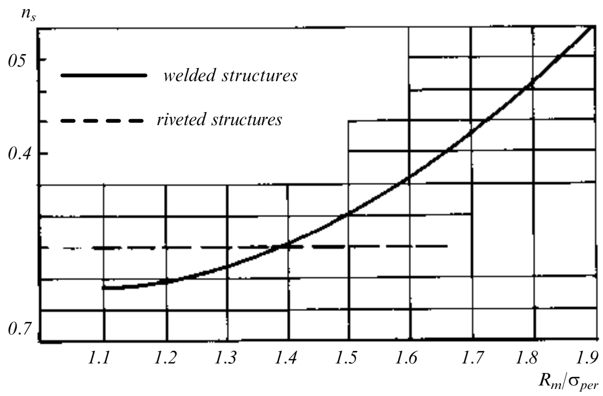


Fig. 5.2.8
Safety margins for hull (aluminium alloys)

5.2.9 Verification of longitudinal general strength shall show that ratio of ultimate moment to the design bending moment at motion in seaways and staying on bearers (hovercraft) complies with the following requirement:

$$M_{ult}/M_{des} \geqslant n_s;$$

$$M_{ult} = \sigma_0 W_0 , \qquad (5.2.9)$$

where σ_0 is the value of dangerous stresses taken in accordance with 5.2.3 - 5.2.7;

W_0 is the transverse section modulus which estimation is based on assumption that stresses in end fibers are equal to dangerous ones;

n_s is the safety margin taken from 5.3.10.5 (for hydrofoils and gliders) and from 5.3.11.2 (for high speed catamarans and hydrofoils).

5.2.10 Stresses permissible for structures of high speed catamarans and hydrofoils arising due to tangential stresses arising in longitudinal and transverse hull bending as well as influence of longitudinal torsion torque while motion at seaways and staying on bearers are taken equal to:

$$\tau_{per} = 0{,}30R_{p02} . \quad (5.2.10)$$

5.2.11 Stresses permissible at calculation of local strength of bottom, side, side wall plating (high speed catamarans and hovercrafts) on plate contour for loads set forth in 5.4 are taken equal to:

$$\sigma_{per} = \sigma_0 . \quad (5.2.11)$$

5.2.12 Stresses permissible at verification of local strength of framing of bottom structures, side, deck plating, superstructure deck, superstructure sides, bulkheads, platforms as well as rigid skirt bags, side walls (hovercraft) and inside plate contours for application of loads set forth in 5.4 are taken equal to:

$$\sigma_{per} = 0{,}8\sigma_0 . \quad (5.2.12)$$

5.2.13 Stresses permissible for application of normal stresses in carrying components of foils, struts, stanchions, stabilizers, brackets are taken equal to:

$$\sigma_{per} = n_s\sigma_0 , \quad (5.2.13)$$

where n_s is the safety margin taken from Fig. 5.2.13.

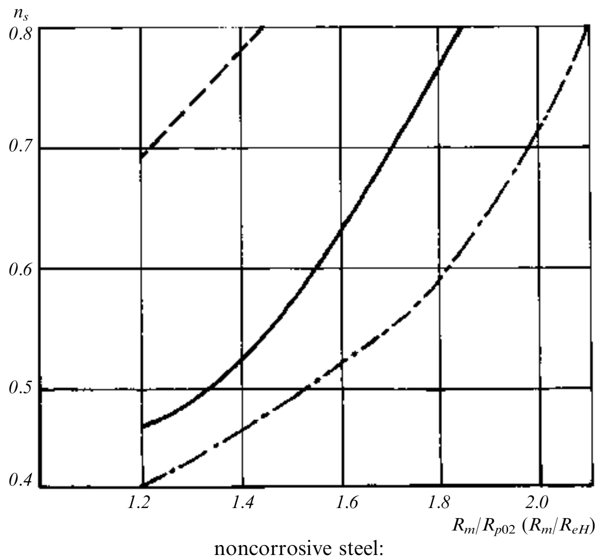


Fig. 5.2.13

5.2.14 Stresses permissible for calculation of influence of shell plating strength and framing of hollow components of hydrofoil installations on the hydrodynamic pressure arising due to flow about foil are taken equal to:

$$\sigma_{per} = 0{,}5\sigma_0 . \quad (5.2.14)$$

5.2.15 See 5.5.1.7 and 5.5.1.9 for stability factor of stanchions, framing and plating of hollow components by normal stresses.

5.2.16 Flexible skirt shall comply with the following strength conditions:

$$KT \leqslant R^b , \quad (5.2.16)$$

where K is the safety factor assigned in accordance with Table 5.2.16.

Table 5.2.16

Design case	Safety factor (K)
1. Flexible skirt general strength	
Vaporing above surface without motion	14 (15)*
Motion in specification seaways conditions	7 (5)
Motion in seaways conditions exceeding specification parametres	3,5
2. General strength of removable components	
Motion in specification seaways conditions	10—15
3. General strength of guys and diaphragms	
Motion in seaways conditions exceeding specification parametres	5—7
* safety factor for flexible skirt of the side-wall hovercraft is given in brackets.	

5.2.17 Refinement of safety factor as regards specific project is carried out at the flexible skirt operation testing stage of head complex.

5.2.18 Strength norms are based on respective strength margin considering specific working conditions and responsibility of each structure under review.

Structural requirements in conjunction with special measures are aimed to ensure fatigue life of a large number of fatigue cracks in main (standard) joints and components over the whole period of ship service life.

5.2.19 Strength norms of permissible and dangerous stress accepted in cases which are not provided by the present Rules shall be justified and agreed with the Register.

5.3 Hull general strength calculation.

5.3.1 General.

5.3.1.1 Hull general strength shall be verified during following types of stressed/strained conditions:

general longitudinal bending (all types of ships);

general transverse bending (high speed catamarans and hydrofoils);

torsion (high speed catamarans and hydrofoils).

The following motion regimes shall be reviewed:

navigation in water displacing state on seaways designed in the project;

hydrofoil motion (hydrofoils), motion at air cushion (hovercraft), gliding (gliders) at design speed at design seaways.

5.3.1.2 The scope of general strength calculations shall be defined by the designer depending on the architectural and design peculiarities of the ship and shall be agreed with the Register.

5.3.1.3 Verification of general strength shall be carried out for the full ship displacement for the most representative from the strength standpoint transverse (all types of ships) and longitudinal (hydrofoils and catamarans) hull sections: in the areas of maximum bending, torsion torque (hydrofoils and catamarans) and cutting forces; in the areas of large openings in deck, superstructure etc. at least in three transverse and two longitudinal hull sections (hovercraft and high speed catamarans) where large stresses may be expected.

Number of sections verified lengthways and breadthways (hovercraft and high speed catamarans) of hull shall be justified in strength calculations submitted to the Register.

5.3.1.4 Weight and external forces distribution diagram as well as calculation of bending moments and cutting force made in accordance with consecutive chapters of the Rules shall be carried out by the number of ordinates which shall be not less than the number of theoretical spacings assuming that distribution of loads is equal along each area between such ordinates provided the latter is not conditioned separately.

The weight of ship ends lying beyond end ordinates shall be fully considered as regards its value and moment.

Non-closure of bending moment diagrams shall not exceed 5 per cent of maximum ordinates of these diagrams.

5.3.1.5 The maximum moment applied amidships at a distance of 5 per cent to the fore and aft end from the section where maximum bending moment is effecting shall be taken for the design moment.

For the ship sections located beyond above-mentioned 10 per cent of ship length, the design bending moment is the maximum bending moment effecting in the section located 5 per cent of ship length away from the section under review.

5.3.1.6 Carlings, stringers and other carrying longitudinal beams of bottom, side walls, decks, sides, skirt bags, etc. shall be fully included into calculation of hull girder. If plates lose rigidity while compression and shear, the area of their section shall be reduced.

5.3.1.7 Rigidity of grillage during compression and shear shall be tested in general and of each component separately: frames, brackets, plates etc. This shall ensure sufficient rigidity of members supporting structure affected by compressing and shearing loads.

As regards elongated grillage without bulkheads across its length it is allowed to consider variation of compressing loads over its length.

5.3.1.8 Vertification of the general strength for permissible stresses shall be carried out by comparison of design normal stresses in end members of hull girder with permissible stresses as well as the maximum tangential stresses against respective permissible stresses.

5.3.1.9 The values of bending moments applied to the hydrofoil installation components, forces as well as overloads are usually determined upon results of testing respective models (tow elastic and self-propelled ones).

Experimental data shall be compared with the results of calculation following analytical dependencies given in the present Rules.

Modelling shall be carried out following principles of Froude scaling.

Correction of results of model tests and strength calculations in order to specify strength and structural life of series ships shall be carried out upon results of sea-keeping tests of prototype ship strength on which basis technical and operational ship characteristics are finally determined.

5.3.1.10 Processing of model test data is carried out by means of statistical methods. Meanwhile, the design value of the strength parameter with probability of 0,975 and reliability of 0,950 shall exceed any value of strength parametre of 5 per cent provision obtained during tests.

N o t e: Strength parameter in this case means peak values of structural load level (bending moment, stresses, forces, overload etc).

5.3.1.11 Dimensions of self-propelled models and their water displacement as well as program of model tests shall be submitted to the Register in the technical design documentation.

N o t e s:

1. During testing the model shall pass at least 200 waves at each regime.
2. The number of regimes is at least 30.
3. During testing of elastic models on the open water space such testings are deemed valid at which realisation the height of 3 % exceedance level was at least 80 mm.

5.3.2 Evaluation of bending moments and cutting forces applied to hydrofoil hull during navigation.

5.3.2.1 Navigation regime is the hydrofoil motion with a speed of $V_{hb} \leqslant V_{lift}$ on seaways in the water displacing position specified in the technical design.

5.3.2.2 The value of the maximum bending moment amidships while sagging and hogging of ship hull is calculated according to the following formulae (the value of the bending moment is deemed positive at sagging and negative at hogging):

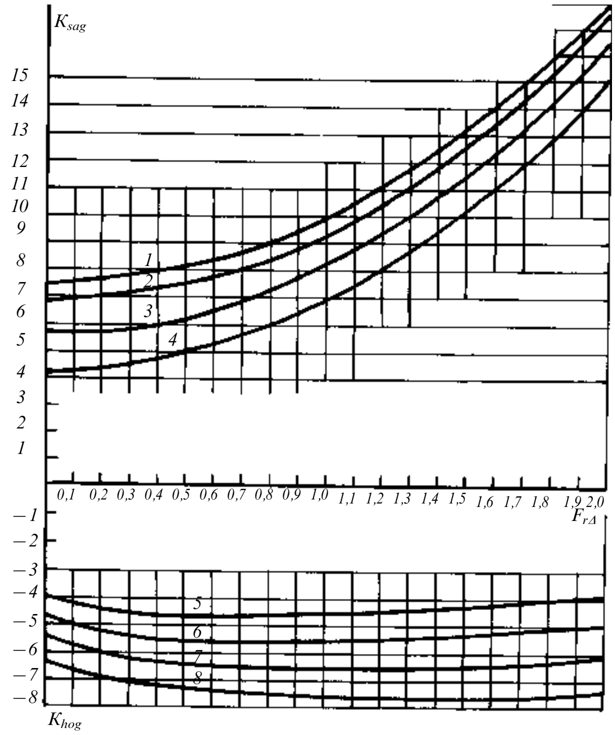
$$M_{des}^{sag} = M_w + M_d^{sag}\,; \qquad (5.3.2.2\text{-}1)$$

$$M_{des}^{hog} = M_w + M_d^{hog}, \qquad (5.3.2.2\text{-}2)$$

where $M_d^{sag} = 0{,}01 K_{sag} \Delta L$;

$M_d^{hog} = 0{,}01 K_{hog} \Delta L$;

Bending moment M_w is evaluated by means of static wave simulation; coefficients K_{sag} and K_{hog} are taken from Fig.5.3.2.2.



1 — $\bar{h}$=0,8; 2 — $\bar{h}$=0,7; 3 — $\bar{h}$=0,6; 4 — $\bar{h}$=0,5
5 — $\bar{h}$=0,5; 6 — $\bar{h}$=0,6; 7 — $\bar{h}$=0,7; 8 — $\bar{h}$=0,8

Fig. 5.3.2.2

5.3.2.3 The value of cutting forces is calculated according to the following formulae:

$$Q_{des}^{sag} = 4|M_c^{sag}|/L; \;\; Q_{des}^{hog} = 4|M_c^{hog}|/L\,. \qquad (5.3.2.3)$$

5.3.2.4 Distribution of bending moments and cutting forces along ship hull is taken from Fig. 5.3.2.4.

5.3.3 Evaluation of design forces during hydrofoil motion on foils.

5.3.3.1 General hull strength against external forces arising at foil motion and speed motion

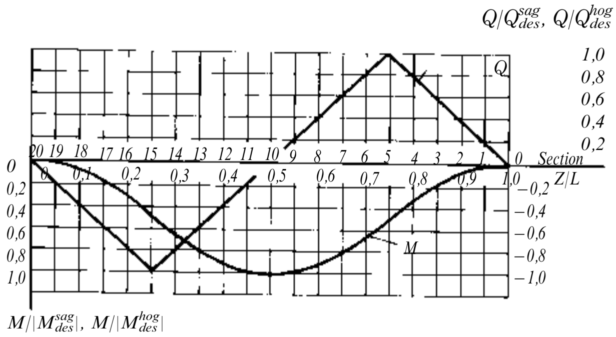


Fig. 5.3.2.4

specified in design technical request shall be verified for total displacement of the ship.

5.3.3.2 Hull general strength is tested for resistance to weight, hull and equipment mass moments of inertia as well as lifting forces arising in foil system and transmitted to hull in the form of concentrated forces.

5.3.3.3 Design values of cutting forces and bending moments are determined according to the following formulae:

$$Q_{des} = \int_0^x m_x g(n_g+1)d_x + \sigma(x_{\otimes} - x_{fr})R + \sigma(x_{\otimes} - x_{cent})R_{-\text{p}} + \\ + \sigma(x_{\otimes} - x_{aft})R_{aft}; \qquad (5.3.3.3\text{-}1)$$

$$M_{des} = \int_0^x\int_0^x m_x g(n_g+1)d_x d_x + \sigma(x_{\otimes} - x_{fr})R_{fr}(x + x_{fr} - x_{\otimes}) + \\ + \sigma(x_{\otimes} - x_{cent})R_{fr}(x - x_{cent} - x_{\otimes}) + \\ + \sigma(x_{\otimes} - x_{aft})R_{aft}(x + x_{aft} - x_{\otimes}), \qquad (5.3.3.3\text{-}2)$$

where $\sigma(x)$ is Hevyside's unit function.

5.3.3.4 While determination of the inertial forces of hull and carried cargoes, the value of the acceleration is taken from Fig. 5.3.3.4-1. The maximum design values of overloads which determine inertial forces are calculated for the bow

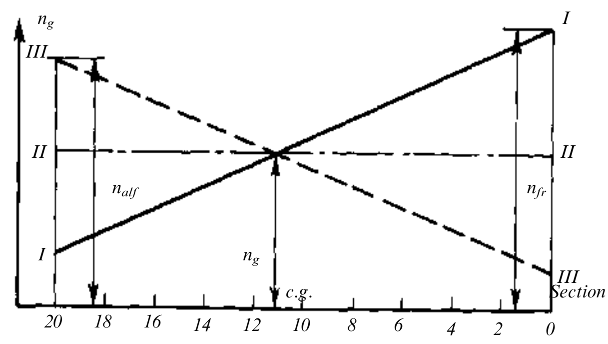


Fig. 5.3.3.4-1

perpendicular — n_{fr}, center of mass — n_g and 20 sections — n_{aft} respectively according to the formulae:

$$n_{fr} = 1 + 2{,}7P_{fr.s.w}/\Delta; \quad (5.3.3.4\text{-}1)$$

$$n_g = 0{,}55 + 0{,}57P_{fr.s.w}/\Delta + \Delta n_g; \quad (5.3.3.4\text{-}2)$$

$$n_{aft} = 1{,}40, \quad (5.3.3.4\text{-}3)$$

where Δn_g is taken from Fig. 5.3.3.4-2.

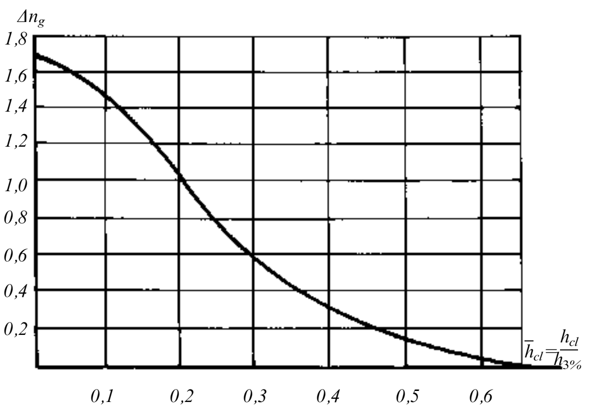


Fig. 5.3.3.4-2

If the hydrofoil automatic control system is available, overloads reduce:

for the ships with the surface piercing foil system — by 10 per cent;

for the ships with the completely immersed foil system — by 20 per cent.

N o t e . The value of the relative acceleration may be revised upon the results of experimental researches.

5.3.3.5 While ship motion on still water lifting forces acting upon the foils are:

for hydrofoils with double foil arrangement scheme ($P_{cent.st.w} = 0$) are calculated according to the following formulae):

$$P_{fr.st.w.} = \Delta a_{aft}/l_f\,; \quad (5.3.3.5\text{-}1)$$

$$P_{aft.st.w} = \Delta a_{fr}/l_f\,. \quad (5.3.3.5\text{-}2)$$

5.3.3.6 Hydrodynamic loads acting upon hull are determined keeping due note of dependencies:

$$R_{fr} + R_{cent} + R_{aft} = \Delta(n_g + 1); \quad (5.3.3.6\text{-}1)$$

$$R_{fr}(x_{fr} - x_0) + R_{cent}(x_{cent} - x_0) + R_{aft}(x_{aft} - x_0) = \frac{I_y}{x_{fr} - x_0}(n_{fr} - n_g). \quad (5.3.3.6\text{-}2)$$

5.3.3.7 Verification of hull general strength to cutting forces and bending moments is carried out in accordance with 5.3.3.3 — 5.3.3.6. While doing this three design load cases are reviewed:

maximum acceleration is acting in the bow end and distribution of accelerations along hull length is taken in accordance with the line I—I (Fig. 5.3.3.4-1); for the double foil arrangement scheme $R_{cent} = 0$ and for three foil arrangement scheme it is taken $R_{fr} = P_{fr}^{\max} + 0{,}3\Delta$; hull inertial forces are calculated in accordance with distribution of accelerations accepted for such case;

equal distribution of accelerations along hull length — the line II—II (Fig.5.3.3.4-1); for the double foil arrangement scheme $R_{cent} = 0$ and for three foil arrangement scheme it is taken $R_{cent} = P_{cent}^{\max} + 0{,}3\Delta$; hull inertial forces are calculated in accordance with distribution of accelerations accepted for such case;

maximum acceleration is acting in aft end and distribution of accelerations along hull length is taken in accordance with the line III—III (Fig. 5.3.3.4-1); for the double foil arrangement scheme $R_{cent} = 0$ and for three foil arrangement scheme it is taken $R_{aft} = P_{aft}^{\max} + 0{,}3\Delta$; hull inertial forces are calculated in accordance with distribution of accelerations accepted for such case.

5.3.3.8 Maximum value of lifting forces acting in the foil system are calculated by the formulae:

$$P_{fr}^{\max} = K_{fr}P_{fr.st.w}; \; P_{cent}^{\max} = K_{cent}P_{cent.st.w}; \; P_{aft}^{\max} = K_{aft}P_{aft.st.w}. \quad (5.3.3.8)$$

where K_{fr}, K_{cent}, K_{aft} are coefficients which are calculated according to the formulae:

$$K_{fr} = 1{,}68 + 1{,}26h_{3\%}/\sqrt[3]{\nabla} - 0{,}42P_{fr.st.w.}/\Delta;$$

$$K_{cent} = 1{,}02 + 0{,}7h_{3\%}/\sqrt[3]{\nabla} - 0{,}14l_{fr}/\sqrt[3]{\nabla}\,;$$

$$K_{aft} = 1{,}20 + 0{,}56h_{3\%}/\sqrt[3]{\nabla} + 0{,}24\frac{P_{fr.st.w.}}{P_{aft.st.w.}} \times \frac{P_{cent.st.w.}}{\Delta}\,.$$

5.3.3.9 Cutting forces and bending moment diagrams for the whole hull length are plotted for each case of loading upon results of the calculation.

General strength is verified for sagging of hull for the double foil arrangement scheme. Envelope curve plotted upon maximum values obtained for all design cases of load in accordance with 5.3.3.7 is taken for the design diagram.

Additionally, hull strength verification shall be performed in case of hogging due to bending moment equal to $M_{des}^{hog} = 0{,}5M_{des}^{sag}$.

Verification of the general strength of the three foil arrangement scheme is carried out for the two following cases:

sagging; values of the envelope curve of the two diagrams obtained for the first and third design case if they correspond to 5.3.3.7 are taken for the design bending moments. Additionally, verification of the general strength is carried out for hogging if maximum bending moment modulus is applied, it is calculated by the following equations:

$$M_{des}^{hog} = 0{,}5M_{des}^{sag}\ ; \quad (5.3.3.9\text{-}1)$$

$$M_{des}^{hog} = M_{st.w.} - 0{,}8(M_{des}^{sag} - M_{st.w.}); \quad (5.3.3.9\text{-}2)$$

hogging; the diagram obtained for the second design case in accordance with 5.3.3.7 is taken for the design one. Additionally, verification of the general strength is carried out for sagging if maximum bending moment modulus is applied, it is calculated by the following equations:

$$M_{des}^{sag} = 0{,}5M_{des}^{hog}\ ; \quad (5.3.3.9\text{-}3)$$

$$M_{des}^{sag} = M_{st.w.} - 0{,}8(M_{des}^{hog} - M_{st.w.}). \quad (5.3.3.9\text{-}4)$$

5.3.4 Determination of design forces in water displacing position of hovercraft motion and during staying on bearers.

5.3.4.1 General hull strength to impact of external forces arising in water displacing position at seaways and speed of motion specified in technical design request shall be verified in full water displacing position.

5.3.4.2 Hull general strength is verified for longitudinal and transverse bending as well as torsion against weight forces, thrust forces initiated by propulsive device; lifting force, hull and equipment mass moments of inertia, hydrodynamic pressure emerging at bow slamming and aerodynamic pressure in the air cushion and hollows of flexible skirt conditioned by interaction of flexible skirt with waves.

5.3.4.3 Design value of bending moments at longitudinal hull bending is determined by the formulae:

sagging

$$M_{des}^{sag} = M_{st.w.} + M_w + M_d; \quad (5.3.4.3\text{-}1)$$

hogging

$$M_{des}^{hog} = M_{st.w.} - M_w - 0{,}1M_d\ , \quad (5.3.4.3\text{-}2)$$

where $M_w = 1{,}1 \times 10^{-3} \rho g \alpha B L^3 K_M^w\ f$; (5.3.4.3-3)

$M_d = K_y^{des}(3{,}04 - 4{,}25\overline{x}_g) \times (1 + m_z)\Delta L K_M^d\ n_g$; (5.3.4.3-4)

f = 1,0 with, $h_{3\%}/L \geqslant 0{,}06$;

f = $32{,}2h_{3\%}/L - 259(h_{3\%}/L)^2 - 0{,}21\sin(52{,}36h_{3\%}/L)$,

with $h_{3\%}/L < 0{,}06$;

K_M^w is the coefficient determined in accordance with Fig. 5.3.4.3-1;

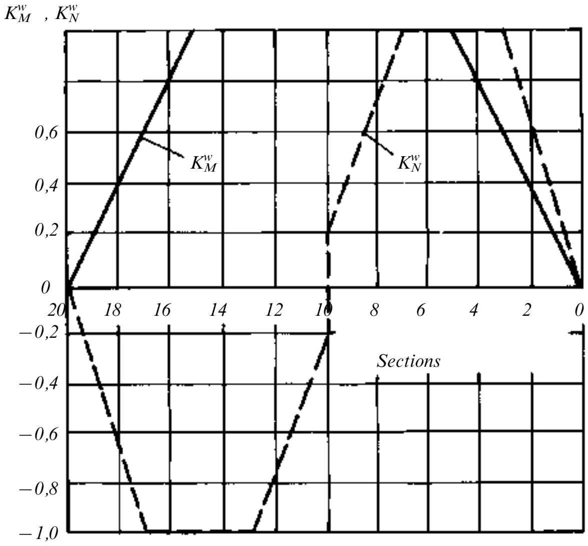


Fig. 5.3.4.3-1

$$K_{x,y}^{des} = 0{,}322 - 0{,}833\overline{\rho}_{x,y}; \quad (5.3.4.3\text{-}5)$$

$$\overline{\rho}_y = \frac{\rho_y}{L}\sqrt{\frac{1 + m_\psi}{1 + m_z}}\ ; \quad (5.3.4.3\text{-}6)$$

$$m_\psi = \frac{\pi}{48}\eta_1^2 \rho g \frac{B^2 L^3}{\Delta \rho_y^2} \frac{a^2}{(3 - 2\alpha)(3 - \alpha)}\ ; \quad (5.3.4.3\text{-}7)$$

$$m_z = \frac{\pi}{4}\eta_1 \rho g \frac{B_2 L}{\Delta} \cdot \frac{\alpha 2}{1 + \alpha}\ ; \quad (5.3.4.3\text{-}8)$$

$$\eta_1 = \frac{1}{\sqrt{1 + (B/L)^2}}\left[1 - \frac{0{,}425B/L}{1 + (B/L)^2}\right]; \quad (5.3.4.3\text{-}9)$$

K_M^d is the coefficient determined in accordance with Fig. 5.3.4.3-2;

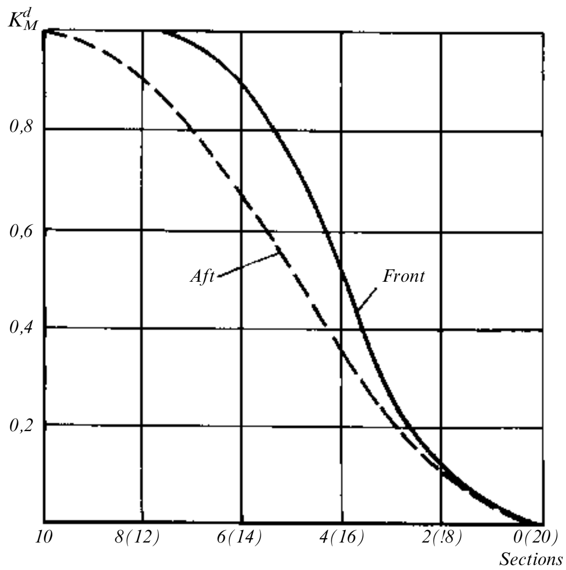


Fig. 5.3.4.3-2

$$n_g = (0{,}074 + 0{,}515 Fr_L) f^{1,3}\ . \qquad (5.3.4.3\text{-}10)$$

When the Froude number Fr_L is calculated, speed (V) is taken equal to the speed of ship motion in the navigation regime at a given $h_{3\%}$ but not less than 3 knots.

5.3.4.4 Design value of cutting forces at longitudinal hull bending is determined by the formulae:

sagging

$$Q_{des}^{sag} = Q_{st.w.} + Q_w^{sag} + Q_d^{sag}; \qquad (5.3.4.4\text{-}1)$$

hogging

$$Q_{des}^{hog} = Q_{st.w.} - Q_w^{hog} - Q_d^{hog}\ , \qquad (5.3.4.4\text{-}2)$$

where $Q_w^{sag,\ hog} = \dfrac{3{,}5 M_w^{\otimes}}{L} K_N^w\ ;$ (5.3.4.4-3)

$Q_d^{sag} = \dfrac{5{,}8 M_d^{\otimes}}{L} K_N^d\ ;$ (5.3.4.4-4)

$Q_d^{hog} = 0{,}1 Q_d^{sag}\ ;$ (5.3.4.4-5)

K_N^w and K_N^d are coefficients determined in accordance with Figs. 5.3.4.3-1 and 5.3.4.4.

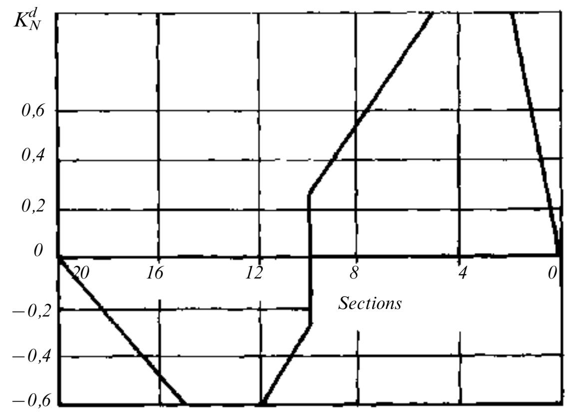


Fig. 5.3.4.4

5.3.4.5 Design value of bending moment at transverse hull bending is determined by the formula:

$$M_{des}^{trans} = M_{s.w.}^{trans} + M_w^{trans} + M_d^{trans}, \qquad (5.3.4.5\text{-}1)$$

where $M_w^{trans} = 2{,}1 \times 10^{-3} \rho g B^3 L K_M^{trans};$ (5.3.4.5-2)

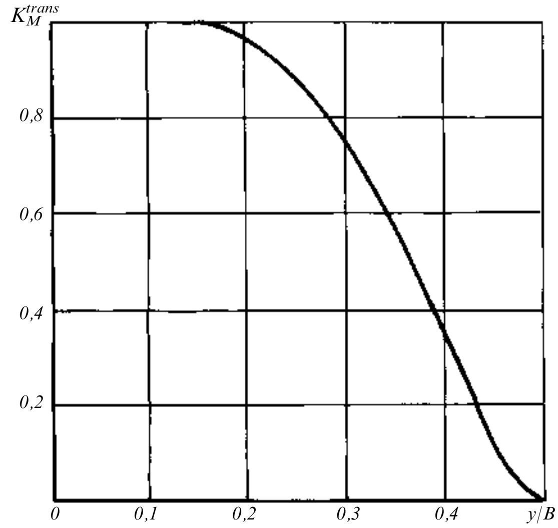
$M_d^{trans} = 0{,}6 K_x^{\rho} \Delta (1 + m_z) B n_g K_M^{trans};$ (5.3.4.5-3)

K_M^{trans} is the coefficient determined in accordance with Fig. 5.3.4.5;

K_x^{ρ} is the coefficient determined by the Formula (5.3.4.3-5);

$$\bar{\rho}_x = \frac{\rho_x}{B}\sqrt{(1 + m_Q)/(1 + m_z)}; \qquad (5.3.4.5\text{-}4)$$

$$m_Q = \frac{\pi}{96}\ \frac{\left[1 - \dfrac{0{,}425 L/B}{1 + (L/B)^2}\right]^2}{1 + (L/B)^2}\ \rho g\ \frac{B^3 L^2}{\Delta \rho_x^2}\ . \qquad (5.3.4.5\text{-}5)$$



y is the distance between section and CL

Fig. 5.3.4.5

5.3.4.6 Design value of cutting force at transverse hull bending is determined by the formula:

$$Q_{des}^{trans} = Q_{st.w.}^{trans} + Q_w^{trans} + Q_d^{trans}\ , \qquad (5.3.4.6\text{-}1)$$

where $Q_w^{trans} = \dfrac{3{,}5 M_{wCP}^{trans}}{B} K_N^{trans}\ ;$ (5.3.4.6-2)

$Q_d^{trans} = \dfrac{5{,}8 M_{dCP}^{trans}}{B} K_N^{trans}\ ;$ (5.3.4.6-3)

K_N^{trans} is the coefficient determined in accordance with Fig. 5.3.4.6 provided $y^*/B = 0{,}4$;

M_{wCP}^{trans} and M_{dCP}^{trans} are wave and dynamic bending moments respectively acting in longitudinal hull section along CL.

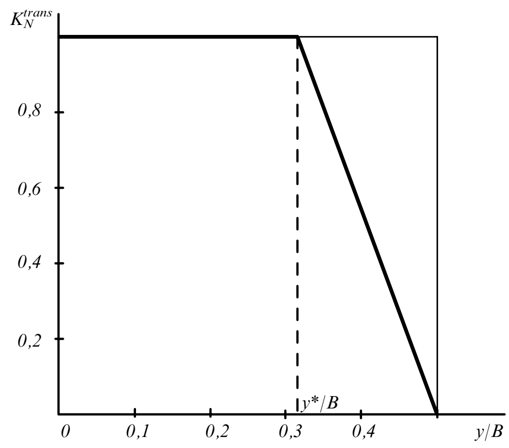


Fig. 5.3.4.6

5.3.4.7 Design value of torsion torque acting in transverse hull section is determined by the formula:

$$M_{des}^{tor} = M_w^{tor} + M_d^{tor}, \qquad (5.3.4.7\text{-}1)$$

where $M_w^{tor} = (1{,}8 - 1{,}5\ \varepsilon/D)10^{-2}\rho gfLB^3K_w^{tor}$; (5.3.4.7-2)

$M_d^{tor} = 3{,}5 \times 10^{-2} n_g \Delta B f^{1,3}(1 + m_z)K_d^{tor}$; (5.3.4.7-3)

ε is the distance between center of twist of the transverse section and base plane;

f is the function calculated in accordance with 5.3.4.3;

K_w^{tor} and K_d^{tor} are coefficients determined in accordance with Fig. 5.3.4.7

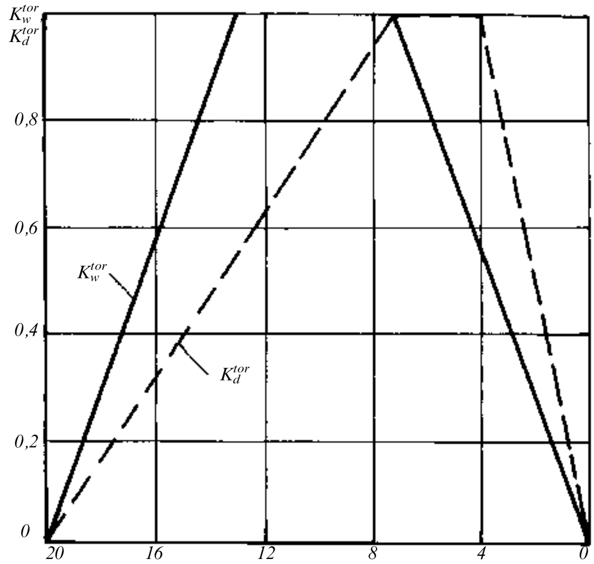


Fig. 5.3.4.7

5.3.4.8 Calculation of longitudinal and transverse bending moments and torsion torques and cutting forces while staying of a ship on bearers is carried out in the same manner as staying of hull on two bottom bearers located cornerwise (Fig. 5.3.4.8). Calculation is made for the hull sagging.

While assessment of the reaction of bearers from the statics equation and the value of bending moment and torsion torques, the weight of ship is increasing in proportion to the amplification factor which is taken equal to $K_d = 1{,}50$ for all cases.

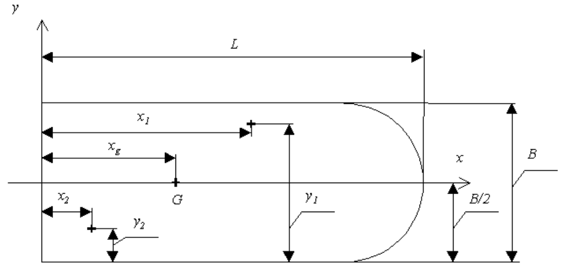


Fig. 5.3.4.8

5.3.4.9 Design values of longitudinal and transverse bending moments, cutting forces and torsion torques are calculated by integration of the ship weight increased in proportion to the amplification factor and external load-reaction of bearers treated as concentrated forces.

5.3.5 Calculation of design forces while hydrofoil motion on the air cushion and during emergency water landing.

5.3.5.1 Design value of the bending moment during bending of hull transversely while hydrofoil motion on the air cushion is determined by the formulae:

sagging of hull

$$M_{des}^{sag} = M_{st.w.} + M_d^{sag}\ ; \qquad (5.3.5.1\text{-}1)$$

hogging of hull

$$M_{des}^{hog} = M_{st.w.} - M_d^{hog}, \qquad (5.3.5.1\text{-}2)$$

where $M_d^{sag,hog} = K_y^{\rho}(3{,}04 - 4{,}25\bar{x}_g)\Delta LK_M^d \times n_g^{sag,hog}$; (5.3.5.1-3)

$K_{x,y}^{\rho} = 0{,}286 - 0{,}75\bar{\rho}_{x,y}$; (5.3.5.1-4)

$\bar{\rho}_y$ is determined according to the Formula (5.3.4.3-6).

The value of relative acceleration $n_g^{sag,hog}$ shall be determined upon results of tests of dynamically similar model of ship in accordance with 5.3.1.9 and 5.3.1.11. In absence of such data the value may be determined by the formulae:

sagging of hull

$$n_g^{sag} = (0{,}7Fr_L + 0{,}21)f^{1,3}\ \frac{0{,}16 + 0{,}66h_{3\%}/H_{fs} + 0{,}08(h_{3\%}/H_{fs})^2}{2{,}57 + 170h_{3\%}/L + 332(h_{3\%}/L)^2}\ \frac{L}{H_{fs}}\ ; \qquad (5.3.5.1\text{-}5)$$

hogging of hull

$$n_g^{hog} = \begin{cases} (0{,}41Fr_L + 0{,}23)Fr_L f^{1,3}, & \text{if } n_g^{hog} < 0{,}8n_g^{sag}; \\ 0{,}8n_g^{sag}, & \text{if } n_g^{hog} \geqslant 0{,}8n_g^{sag}. \end{cases} \qquad (5.3.5.1\text{-}6)$$

5.3.5.2 Design value of cutting forces at longitudinal bending during hydrofoil motion on the air cushion is determined by the following formulae:

sagging of hull

$$Q_{des}^{sag} = Q_{st.w.} + Q_d^{sag}\ ; \qquad (5.3.5.2\text{-}1)$$

hogging of hull

$$Q_{des}^{hog} = Q_{st.w.} + Q_d^{hog}, \qquad (5.3.5.2\text{-}2)$$

where Q_d^{sag} is calculated by the Formula (5.3.4.4-4) in which
$M_d^{\otimes}$ is the moment amidships determined by the Formula (5.3.5.1-3);
Q_d^{hog} is calculated by the Formula (5.3.4.4-5).

5.3.5.3 Design value of bending moment at transverse bending during hydrofoil motion on the air cushion is determined by the following formula:

$$M_{des}^{trans} = M_{st.w.}^{trans} + M_d^{trans}, \qquad (5.3.5.3\text{-}1)$$

where $M_d^{trans} = 0{,}8K_x^{\rho}\Delta BK_M^{trans} \times n_g^{sag}$; (5.3.5.3-2)

K_x^{ρ} и K_M^{trans} are determined in accordance with the Formula (5.3.5.1-4) and Fig. 5.3.4.5 respectively.

5.3.5.4 Design value of cutting forces at transverse bending during hydrofoil motion on the air cushion is determined by the following formula:

$$Q_{des}^{trans} = Q_{st.w.}^{trans} + Q_d^{trans}, \qquad (5.3.5.4)$$

where Q_d^{trans} is determined by the Formula (5.3.4.6-3).

5.3.5.5 Design value of torsion torque during hydrofoil motion on the air cushion is determined from the formula:

$$M_{des}^{tor} = n_g^{sag}\Delta\Big[0{,}23B(1-0{,}24Fr_L)f^{1,3}K_d^{tor} - \frac{0{,}375H_{fs}L}{S_{ac}}(0{,}5H_{fs}+\varepsilon)K_w^{tor}\Big], \qquad (5.3.5.5)$$

where K_d^{tor}, K_w^{tor} are determined in accordance with Fig. 5.3.4.7;
ε — see 5.3.4.7.

5.3.5.6 Design values of integral characteristics of external forces acting during emergency water landing are determined by the load conditioned by the blow of hull against water.

The value of the dynamic component of longitudinal bending moment emerging at blow of hull against water for the sagging and hogging of hull are determined by the Formula (5.3.5.1-3). The value of coefficient at hull sagging is determined by formula (5.3.4.3-5), at hull hogging — by the formula:

$$K_{x,y}^{\rho} = 0{,}49\bar{\rho}_{x,y} - 0{,}017. \qquad (5.3.5.6\text{-}1)$$

The value of relative acceleration is calculated by the following equation:

$$n = \frac{0{,}1K_{\psi}vV}{(\Delta/g)(1+\bar{l}_y^2)^2}\ , \qquad (5.3.5.6\text{-}2)$$

where K_{ψ}, $\bar{l}_y$ and v are equal parametres:

a) sagging

$K_{\psi} = 1{,}4$;

$\bar{l}_y = 0{,}9$;

$v = v_o + v_n$;

$$v_o = 2{,}5\frac{h_{3\%}}{h_{3\%}+1{,}2}\ ; \qquad (5.3.5.6\text{-}3)$$

$$v_n = \frac{1}{S_{ac}}\ \Big(Q_{min} + n_{tr}\varepsilon_{tr}S_{tr}\sqrt{\frac{2\Delta}{\rho_{air}S_{ac}}}\ \Big), \qquad (5.3.5.6\text{-}4)$$

where S_{ac} is the area of air cushion, in m[2];
Q_{min} is the minimum airflow charged to the air cushion by fans which ensures ballooning of removable components of flexible cushion seal (this airflow corresponds to the end of motion "on the bubble" to the motion "on the cushion", in m[3]/sec;
n_{tr} is the number of air trunks;
S_{tr} is the calculated (minimal) area of air duct cross-section of air trunk, in m[2];
ε_{tr} is the coefficient of air outflow to the atmosphere through the vent trunk (in absence of more exact data it is taken for ε_{tr} = 0,5);
ρ_{air} is the air density at the atmospheric pressure, in t/m[3];

b) hogging

$K_{\psi} = 1{,}0$;

$\bar{l}_y = 0{,}5$;

$v = v_n$;

v_n is determined by the Formula (5.3.5.6-4).

5.3.5.7 Design values of the transverse bending moment are determined by the Formula (5.3.5.3-2) with the use of the relative acceleration conditioned by bow slamming against water which is calculated by the Formula (5.3.5.6-2) for sagging of hull.

5.3.5.8 Cutting forces at hull bending longitudinally and transversely are calculated by the Formulas (5.3.4.4-1) and (5.3.4.6-3).

5.3.5.9 Design value of torsion torque is determined by the following formula:

$$M_d^{tor} = 0{,}035DBnK_d^{tor}, \qquad (5.3.5.9)$$

where n is the relative acceleration conditioned by bow slamming during emergency landing (Formula (5.3.5.6-2), sagging of hull);
K_d^{tor} is the coefficient determined in accordance with Fig. 5.3.4.7.

5.3.6 Determination of design forces in a water displacing regimes of hydrofoil motion.

5.3.6.1 Calculation of the hull strength shall consider two cases (sagging and hogging of hull).

5.3.6.2 The value of longitudinal bending moment amidships is determined by the formulae:

sagging

$$M_{des}^{sag} = M_{st.w.} + M_w + M_d \; ; \qquad (5.3.6.2\text{-}1)$$

hogging

$$M_{des}^{hog} = M_{st.w.} - M_w - 0{,}6M_d \qquad (5.3.6.2\text{-}2)$$

where $M_w = 0{,}0036\alpha\pi g f B_{sw} L^3 K_M^w$; (5.3.6.2-3)

f is the function calculated in accordance with Fig. 5.3.7.1-1;

B_{sw} is the largest width of side wall in the waterline plane in the water displacing position, in m;

K_M^w is the coefficient determined in accordance with Fig. 5.3.4.3-1;

α is the side wall waterline area coefficient;

$$M_d = K_M^d \; M_d^{\otimes} \; ; \qquad (5.3.6.2\text{-}4)$$

K_M^d is the coefficient determined in accordance with Fig.5.3.4.3-2;

$$M_d^{\otimes} = K_y^{\rho} K_\tau (3{,}04 - 4{,}25\bar{x}_g)\Delta \times (1 + m_z) L n_g ; \qquad (5.3.6.2\text{-}5)$$

$$K_{x,y}^{\rho} = 0{,}322 - 0{,}833\bar{\rho}_{x,y} ; \qquad (5.3.6.2\text{-}6)$$

$$\bar{\rho}_y = \frac{\rho_y}{L}\sqrt{(1 + m_\psi)/(1 + m_z)} \; ; \qquad (5.3.6.2\text{-}7)$$

$$m_\psi = \frac{\pi}{2}\rho g \frac{\alpha^2}{(3 - 2\alpha)(3 - \alpha)} \times \frac{B_{sw}^2 L^3}{\Delta\rho_y^2} \; ; \qquad (5.3.6.2\text{-}8)$$

$$m_z = \frac{\pi}{2}\rho g \frac{\alpha^2}{1 + \alpha} \times \frac{B_{sw}^2 L^3}{\Delta} \; ; \qquad (5.3.6.2\text{-}9)$$

K_τ is the coefficient determined in accordance with Fig. 5.3.6.2;

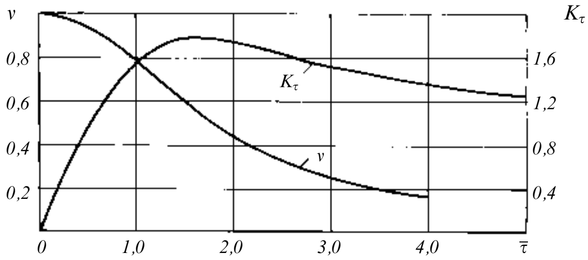


Fig. 5.3.6.2

$$\bar{\tau} = \frac{0{,}2}{\pi}\omega_1\sqrt{(\sqrt[3]{\nabla}/g)}\, n_g ; \qquad (5.3.6.2\text{-}10)$$

$$\omega_1 = \left(\frac{0{,}43}{\bar{\rho}_y - 0{,}183} + 16{,}2\right)\sqrt{\frac{EJ_{\otimes} g}{(1 + m_z)\Delta L^3}} \; ; \qquad (5.3.6.2\text{-}11)$$

$J_{\otimes}$ is the moment of inertia of the hull transverse cross-section amidships.

The value of the relative acceleration n_g shall be calculated upon results of model tests of designed ship in compliance with 5.3.1.9 and 5.3.1.11. In absence of such data the value of the relative acceleration may be approximately calculated by the formula:

$$n_g = [0{,}5 + (0{,}31 + 0{,}72f^2)Fr_L]f^{1,5}. \qquad (5.3.6.2\text{-}12)$$

5.3.6.3 The values of cutting force in transverse hull cross-sections are calculated by the following formulae:

sagging

$$Q_{des}^{sag} = Q_{st.w.} + Q_w + Q_d^{sag} ; \qquad (5.3.6.3\text{-}1)$$

hogging

$$Q_{des}^{hog} = Q_{st.w.} - Q_w - Q_d^{hog} , \qquad (5.3.6.3\text{-}2)$$

where $Q_w = \dfrac{4M_w^{\otimes}}{L} K_N^w$; (5.3.6.3-3)

K_N^w is the coefficient which is calculated in accordance with Fig. 5.3.4.3-1;

$$Q_w^{sag} = 5{,}8\frac{M_d^{\otimes}}{L} K_N^d \; ; \qquad (5.3.6.3\text{-}4)$$

$$Q_d^{hog} = 0{,}6 Q_d^{sag} ; \qquad (5.3.6.3\text{-}5)$$

K_N^d is the coefficient which is calculated in accordance with Fig. 5.3.4.4.

5.3.6.4 For calculation of the general transverse strength of side-wall hovercraft during sailing, bending moments are calculated by the formula:

$$M_{des}^{trans} = M_{st.w.}^{trans} + M_d^{trans} , \qquad (5.3.6.4\text{-}1)$$

where $M_d^{trans} = K_M^{trans} \times M_d^{CP}$; (5.3.6.4-2)

K_M^{trans} is the coefficient determined in accordance with Fig. 5.3.4.5;

$$M_d^{CP} = \bar{M}_{trans}\Delta(1 + m_z)B n_g \; ; \qquad (5.3.6.4\text{-}3)$$

$$\bar{M}_{trans} = -2/3\bar{\rho}_x + 0{,}18B_{ac}/B + 0{,}165 ; \qquad (5.3.6.4\text{-}4)$$

$$\bar{\rho}_x = \frac{\rho_x}{B}\sqrt{(1 + m_Q)(1 + m_z)} \; ; \qquad (5.3.6.4\text{-}5)$$

B_{ac} is the inner distance between side walls in the plane of design waterline, in m;

$$m_Q = \frac{1}{16} m_z \left(\frac{B + B_{ac}}{\rho_x}\right)^2 . \qquad (5.3.6.4\text{-}6)$$

5.3.6.5 Cutting forces acting in transverse sections of side wall hydrofoils are determined by the formula:

$$Q_{des}^{trans} = Q_{st.w.}^{trans} + Q_d^{trans} , \qquad (5.3.6.5\text{-}1)$$

where $Q_d^{trans} = \dfrac{1{,}25B_{ac}/B - 0{,}155}{\bar{M}_{trans}} \times \dfrac{M_d^{CP}}{B} K_N^{trans}$; (5.3.6.5-2)

K_N^{trans} is the coefficient taken from Fig. 5.3.4.6 at the value of relative kink ordinate $y^*/B = 0{,}11 + 0{,}38B_{ac}/B$.

5.3.6.6 Design values of torsion torque in transverse hull cross-sections are taken equal to:

$$M_{des}^{tor} = M_d^{tor} + M_w^{tor} . \qquad (5.3.6.6\text{-}1)$$

Wave component of torsion torque M_w^{tor} is determined by means of skew positioning of a ship on the wave hollow.

Dynamic component of torsion torque M_d^{tor} is determined by the following formulae:

within 0 to 2 sections

$$M_d^{tor} = (-49 + 100\overline{x} - 50\overline{x}^2 + f_m)r, \qquad (5.3.6.6\text{-}2)$$

where $\overline{x} = 1 - j/20$ is the number of section;

$$r = \frac{\Delta(1+m_z)n_g y_R}{1+\kappa}; \qquad (5.3.6.6\text{-}3)$$

y_R is the parameter which is taken equal to $0{,}25(B + B_{ac})$ for side-wall hovercraft;

$\kappa = 0$ motion of ship in the navigation regime;

$$f_m = -a\overline{x} - b\overline{x}^2/2 + \frac{c}{\pi}\cos\pi\overline{x} - c/\pi; \qquad (5.3.6.6\text{-}4)$$

$$b = 6(2\overline{x}_g - 1); \qquad (5.3.6.6\text{-}5)$$

$$c = 43{,}7(\frac{4+b}{12} - \overline{\rho}_y^2 - \overline{x}_g^2); \qquad (5.3.6.6\text{-}6)$$

$$a = 1 - b/2 - 2c/\pi, \qquad (5.3.6.6\text{-}7)$$

within 2 to 4 sections

$$M_d^{tor} = r(32 - 80\overline{x} + 50\overline{x}^2 + f_m), \qquad (5.3.6.6\text{-}8)$$

within 4 to 20 sections

$$M_d^{tor} = rf_m. \qquad (5.3.6.6\text{-}9)$$

Wave component is calculated according to the formula:

$$M_w^{tor} = 0{,}32\Delta B(3\overline{x}_g - 1)\sin\pi\overline{x}. \qquad (5.3.6.6\text{-}10)$$

5.3.7 Determination of design forces during motion of hovercraft on the air cushion.

5.3.7.1 Design value of the longitudinal bending moment is determined in accordance with the formulae:

sagging

$$M_{des}^{sag} = M_{st.w.} + M_w + M_{d1} + 0{,}8M_{d2}; \qquad (5.3.7.1\text{-}1)$$

hogging

$$M_{des}^{hog} = M_{st.w.} - M_w - 0{,}6M_{d1} - 0{,}5M_{d2}, \qquad (5.3.7.1\text{-}2)$$

where $M_w = 0{,}0044\alpha(1 + 2{,}2Fr_L - 0{,}33Fr_L^3)(0{,}8 - 4{,}9B_{sw}/L) \times$
$\times (1{,}9 - 0{,}15L_{ac}/B_{ac})\rho g B_{sw} L^3 f K_M^w$; (5.3.7.1-3)

f is the function which is determined in accordance with Fig. 5.3.7.1-1;

K_M^w is the coefficient determined in accordance with Fig. 5.3.4.3-1;

B_{sw} is the width of side wall in the waterline area plane during motion on the air cushion, in m;

M_{d1} is the dynamic bending moment caused by the blow of connecting bridge (bottom in the area of air cushion) against wave;

M_{d2} is the dynamic bending moment caused by the blows of side walls against wave.

The value of the dynamic bending moment M_{d1} is determined by the Formulae (5.3.6.2-4) and (5.3.6.2-5).

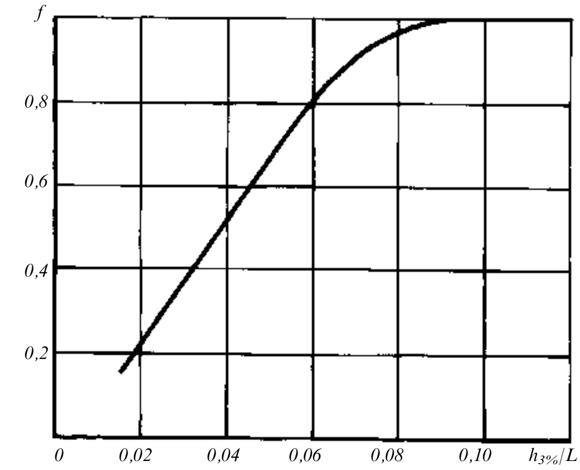


Fig. 5.3.7.1-1

Meanwhile, the value of the vertical relative acceleration n_g is calculated by the following formula:

$$n_g = n_1(1 - k_g) + n_2 k_g, \qquad (5.3.7.1\text{-}4)$$

where $k_g = 3\overline{h}_1^2 - 2\overline{h}_1^3$; (5.3.7.1-5)

$\overline{h}_1 = f - 6{,}5H_{ac}/L$;

$n_1 = (0{,}33Fr_L^2 + 0{,}165Fr_L + 0{,}05)(5{,}7h_2 - 0{,}81h_2 + 0{,}16) + 0{,}42h_2$; (5.3.7.1-6)

$$h_2 = 0{,}077\frac{L}{\sqrt[3]{\Delta}}f;$$

$$n_2 = [0{,}5 + (0{,}34 + 0{,}72f^2)Fr_L]f^{1,5}. \qquad (5.3.7.1\text{-}7)$$

The value of the dynamic bending moment M_{d2} is determined by the formula:

$$M_{d2} = 0{,}052\rho B_5^2 L^2 \frac{\omega_1}{\rho_y}[0{,}42a\sqrt{\frac{g}{L}}(2{,}5Fr_L + 1) + 0{,}023V]vK_M^b, \qquad (5.3.7.1\text{-}8)$$

where B_5 is the side wall width in the waterline plane which corresponds to its immersion to the bilge in the area of the 5th section, in m;

v is the coefficient determined in accordance with Fig. 5.3.6.2;

$a = 0{,}045(3{,}1 - 0{,}39Fr_\Delta - 0{,}12L_{ac}/B_{ac} + 0{,}02Fr_\Delta L_{ac}/B_{ac} \times$

$\times (1{,}17 - 0{,}66\rho_y/L)(2{,}5 - 5{,}8B_{sw}/B)fL$; (5.3.7.1-9)

$$\overline{\tau} = 0{,}13\frac{\omega_1 T_2}{\sqrt[a]{(g/\mathrm{L})(2{,}5Fr_L + 1)}}; \qquad (5.3.7.1\text{-}10)$$

T_2 is the side wall draught immersed to the bilge in the area of the 2nd section, in m.

5.3.7.2 Cutting forces acting in the transverse sections of side wall hovercraft are determined by the formulae:

$$Q_{des}^{sag} = Q_{st.w.} + \frac{1}{L}[4M_w^{\otimes}K_N^w + 5{,}8M_{d1}^{\otimes}K_N^d + 3{,}2M_{d2}^{\otimes}K_N^w]; \qquad (5.3.7.2\text{-}1)$$

$$Q^{hog}_{des} = Q_{st.w.} - \frac{1}{L}[4M^{\otimes}_{w}K^{w}_{N} + 3{,}5M^{\otimes}_{d1}K^{d}_{N} + 1{,}6M^{\otimes}_{d2}K^{w}_{N}]. \quad (5.3.7.2\text{-}2)$$

5.3.7.3 While calculation of the general transverse strength of side wall hovercraft, calculations of transverse bending moments and cutting forces shall be carried out in accordance with 5.3.6.4 and 5.3.6.5. While calculation of bending moment by the Formula (5.3.6.4-3) the following value shall be taken for the design relative acceleration:

$$n_g = 29M_{d2}\bar{\rho}_y/L\bar{\tau}\Delta(1+m_z). \quad (5.3.7.3)$$

5.3.7.4 Design values of torsion torque acting in the transverse sections of side wall hovercrafts are determined in accordance with recommendations of 5.3.6.6. Parameter κ is taken equal to 0,2 and value of the relative acceleration is determined by the Formula (5.3.7.3).

5.3.8 Calculation of loads which determine strength of gliders.

5.3.8.1 Determination of design acceleration.

Vertical acceleration a used during evaluation of inertial forces transmitted by cargoes to the hull structure are determined for two cases of ship bow slamming against head sea: strike against bow end (in the area of the 3rd section) and strike amidships (to the after end off the 3rd section) by the formula:

$$a/g = \frac{f_h f_V(1+k_a)(4{,}83 - 0{,}176\beta_a + 0{,}002\beta_a^2)[0{,}67L/B_{\otimes} - 0{,}08(L/B_{\otimes})^2 - 0{,}35]}{k_p(1+m_z)}, \quad (5.3.8.1)$$

where $f_h = 13\{1-\exp[-(17h_{3\%}/L - 2{,}9)^2]\}h_{3\%}/L$, if $h_{3\%}/L \leqslant 0{,}095$;

$$f_h = 1{,}0, \text{ if } h_{3\%}/L > 0{,}095;$$

$$f_V = [0{,}96 + 0{,}48\exp(2{,}5Fr_c - 2{,}5)]/[2{,}27 + 17{,}7\exp(-1{,}1Fr_{\Delta})]$$

$$Fr_c = 0{,}514V/\sqrt{gc};$$

$$c = B^4_{\otimes} \; l^4_G/(\Delta/\gamma)^{7/3};$$

$$Fr_{\Delta} = 0{,}514V/\sqrt{g\nabla^{1/3}};$$

$$n = 0{,}5 + 0{,}8\varphi_V;$$

$$\varphi_V = \exp[-0{,}75(Fr_{\Delta} - 0{,}9)^2];$$

$$k_a = \frac{A}{\rho_y^2 L}(x - x_g), \text{ but not less than 0;}$$

$$A = 0{,}539 + 0{,}311\varphi_V - x_g/L \text{ — at strike against ship bow end;}$$

$$A = \varphi_a[3{,}27 - 0{,}205\lambda - (0{,}707 - 0{,}032\lambda)Fr_{\Delta} + (0{,}0707 - 0{,}003\lambda)Fr^2_{\Delta}]\rho^2_y \; L/B_{\otimes},$$

but not less than 0 and not greater than $0{,}65x_G/L$ — at strike amidships;

$$\varphi_a = [1 + (\beta_{\otimes}/30 - 0{,}5)(-0{,}071 + 0{,}067Fr_{\Delta} - 0{,}002Fr^2_{\Delta})]k_T,$$

λ is the value taken equal to equation L/B (or 5,0 depending whichever is greater);

k_T = 1,0 — 1,0 for gliders with the usual hydrodynamic arrangement;
1,07 — for the ships with the bottom air cavity;

$$\rho^2_y = \frac{I_y(1+m_{\psi})}{\nabla L^2(1+m_z)};$$

$$m_z = 1{,}3\gamma B^2_{\otimes} \; l_G(1-\beta_a/180)\frac{a^2}{1+a} \; k\zeta^2/\Delta;$$

$$m_\psi = 0{,}39\gamma B_\otimes^2 \ l_G^3\ (1-\beta_a/180)\frac{a^2}{(3-2a)(3-a)}\ k\zeta^2/I_y\ ;$$

$$a = 0{,}5(1 + B_{tr}/B_\otimes);$$

$$\zeta = [1-0{,}425\eta/(1+\eta^2)]\eta/(1+\eta^2)^{0,5};$$

$$\eta = 3{,}4l_G/(B_\otimes + B_{tr});$$

$k =$ 1,0 — for gliders without planing steps,
0,85 — for gliders with planing steps,
0,5 — for the ships with the bottom air cavity;
$k_p =$ $(0{,}285-0{,}737\rho_y+0{,}047r)/(1+r)$ — at strike against bow end
$0{,}36\exp(-0{,}168Fr_\varDelta)$ — at strike amidships and the Froude number $Fr_\Delta < 4{,}0$,
0,184 — at strike amidships and the Froude number $Fr_\Delta < 4{,}0$;
$r =$ $0{,}8(1-\varphi_V)$;
β_a is the deadrise angle of the transverse hull section (at wave strikes against the bow end the 3rd section is viewed, at wave strikes amidships the distance of $x = l_G + AL$ from transom is viewed).

5.3.8.2 Loads determining general hull strength.

5.3.8.2.1 Bending moments and cutting forces acting in the transverse hull sections at sagging and hogging refer to the loads which determine general hull strength of the glider. Distribution of bending moments and cutting forces over ship length is taken in accordance with 5.3.2.4.

5.3.8.2.2 The values of sagging and hogging moments amidships are determined by the formula:

$$M_{sag(hog)} = M_{st.w.} \pm k_M \varDelta L a_G/g, \qquad (5.3.8.2.2)$$

where $M_{st.w.}$ is the bending moment amidships at ship motion on still water;
a_G is the value of the vertical acceleration a which is calculated for the centre of ship gravity in accordance with 5.3.8.1 (at the value of $k_a = 0$);
k_M = k_p at wave strike against bow end and sagging of hull.
0,07 at wave strike amidships and hogging of hull.

5.3.8.2.3 Design values of cutting forces at sagging and hogging of hull is determined by the following formula:

$$Q_{sag(hog)} = 4{,}5M_{sag(hog)}/L\ . \qquad (5.3.8.2.3)$$

5.3.9 Loads determining strength of high speed catamarans.

5.3.9.1 Determination of design accelerations.

Design vertical accelerations a which are used for assessment of pressure and forces transmitted by cargoes to the hull structures are determined by the formula:

$$a/g = [1{,}4 + 3{,}4Fr_L\exp(-2{,}7Fr_L)](1+2{,}5Fr_L)^2 \times$$

$$\times f\sqrt{1+48(x_M/L+0{,}075)^2} + F, \qquad (5.3.9.1)$$

where g is the gravitational acceleration;
x_M is the abscissa of the point in question which is counted off the midship section (negative if located to the end bow from the midship);

$$f = \{1-\exp[-(17h_{3\%}/L-2{,}9)^2]\}h_{3\%}/L,$$

if $h_{3\%}/L \geqslant 0{,}095$,

$f = 0{,}077$, if $h_{3\%}/L \geqslant 0{,}095$;

$$F = (1 + \frac{0{,}9-l_G/L}{\rho_y^{-2}L}\ x_M)n,\ \text{but not less than 0;}$$

l_G is the distance between the centre of gravity and transom (from the aft perpendicular);

$$\rho_y^{-2} = (J_y g1 + m_\psi)/(\varDelta L^2 1 + m_z);$$

J_y is the central moment of inertia of ship mass about transverse axis;
$\varDelta$ is the deep displacement;

$$m_z = 1{,}57\rho g\ \frac{B_{hull}^2 L a^2}{D(1+a)};$$

$$m_\psi = 0{,}131rg\ \frac{B_{hull}^2 L}{\Delta\rho^2}\ \frac{\alpha^2}{(3-2\alpha)(3-\alpha)}\ ;$$

ρ is the density of sea water;
B_{hull} is the hull width amidships in the plane of the construction waterline;
α is the water-plane coefficient;

$$n = n_1(1-k_g) + n_2k_g,$$

where $k_g = 3h_1^2 - 2h_1^3$;

$$h_1 = 13f - 6{,}5h_{cl}/L;$$

$$n_1 = (0{,}33Fr_L^2 + 0{,}165Fr_L + 0{,}05)\times$$

$$\times(5{,}7h_2^2 - 0{,}81h_2 + 0{,}16) + 0{,}42h_2;$$

$$n_2 = [24 + (16 + 5700f^2)Fr_L]f^{1,5}\ ;$$

$$h_2 = \frac{L}{\sqrt[3]{\nabla}} f;$$

h_{cl} is the hull clearance (distance between unperturbed water surface and connecting bridge in the midship section).

5.3.9.2 Loads determining hull general strength.

Bending moments and cutting forces as well as torsion torques acting in the transverse and longitudinal hull sections refer to the loads which determine hull general strength.

These loads are determined by the formulae given below or by test results of the elastic models equipped with dynamometer sensors (see 5.3.1.10 and 5.3.1.11).

5.3.9.2.1 The value of the longitudinal bending moment in the transverse section of hull is determined by the following formulae:

sagging

$$M_{des}^{sag} = M_{st.w.} + M_w + M_d \text{ , t·m,} \qquad (5.3.9.2.1\text{-}1)$$

hogging

$$M_{des}^{hog} = M_{st.w.} - M_w - 0{,}6M_d, \text{ t·m,} \qquad (5.3.9.2.1\text{-}2)$$

where $M_w = 0{,}059a\rho g(0{,}8 - 4{,}9B_kL)(1 + 2Fr_L - 0{,}3Fr_L^3)B_kL^3fk_M^b$, t·m;

$M_{st.w.}$ is the bending moment acting in the transverse section in question during ship motion on still water (positive at sagging);

f is the function which is determined in accordance with 5.3.9.1;

k_M^b is the coefficient characterising distribution of the wave component of the moment along ship length and which is determined in accordance with Fig. 5.3.4.3-1;

M_d is the dynamic component of the bending moment.

Dynamic component of the bending moment is determined by the formula:

$$M_d = k\rho_y(3{,}04 - 4{,}25l_G/L)\Delta(1 + m_z)Lnk_M^q \text{ , t·m,}$$

where parameters m_z and n are determined in accordance with 5.3.9.1 and coefficient k_M^q is in compliance with Fig. 5.3.4.3-2.

k_{ρ_y} is the coefficient determined by the formula:

$$k_{\rho_y} = 0{,}322 - 0{,}833\overline{\rho}_y,$$

where parameter $\overline{\rho}_y$ is determined according to 5.3.9.1.

5.3.9.2.2 The values of the cutting force in the transverse hull sections are calculated by the following formulae:

sagging

$$Q_{des}^{sag} = Q_{st.w.} + Q_w + Q_d^{sag} \text{ , t,} \qquad (5.3.9.2.2\text{-}1)$$

hogging

$$Q_{des}^{hog} = Q_{st.w.} - Q_w - 0{,}6Q_d^{hog}, \text{ t,} \qquad (5.3.9.2.2\text{-}2)$$

where $Q_w = 4(M_w^{\otimes}/L)k_N^w$; t,

$Q_d^{sag} = 5{,}8(M_d^{\otimes}/L)k_N^d$; t.

$M_w^{\otimes}$ and $M_d^{\otimes}$ are the wave and dynamic components of the bending moment acting in the midship section of hull;

k_N^w and k_N^d are the coefficients determined in accordance with Figs. 5.3.4.3-1 and 5.3.4.4.

5.3.9.2.3 Design values of the bending moment at symmetrical transverse hull bending are calculated by the following formulae:

sagging

$$M_{trans}^{sag} = M_{st.w.}^{trans} + M_{trans} \text{ , t·m;} \qquad (5.3.9.2.3\text{-}1)$$

hogging

$$M_{trans}^{hog} = M_{st.w.}^{trans} - M_{trans} \text{ , t·m,} \qquad (5.3.9.2.3\text{-}2)$$

where $M_{st.w.}^{trans}$ is the bending moment acting in the transverse hull section during ship motion on still water (positive at sagging);

$$M_{trans} = [0{,}12\Delta(1 + m_z)Bn + 0{,}0021\rho gB^3L]k_M^{trans}, \quad \text{t·m,}$$

B is the width amidships;

m_z and n are parameters determined by 5.3.9.1;

k_M^{trans} is the coefficient determined in accordance with Fig. 5.3.4.5.

5.3.9.2.4 Cutting forces acting in longitudinal hull sections are determined by the formula:

$$Q_{des}^{trans} = (5{,}2M_{trans}^{sag(hog)}/B)\, k_N^{trans}, \text{ t,} \qquad (5.3.9.2.4)$$

where k_N^{trans} is the coefficient determined in accordance with Fig. 5.3.4.6 if relative ordinate in taken

$$y^*/B = 0{,}11 + 0{,}38B_h/B \text{ ;}$$

B_h is the horizontal hull clearance — distance between hulls in the midship section measured in the plane of construction water line.

5.3.9.2.5 Design values of bending moment at skew-symmetrical bending of connecting structures of catamaran are determined by the formula:

$$M_{trans}^{as} = N\{[a_1(\overline{y} + 1/2) + (b - a_1)/4] + (a + \frac{B - a_1}{2}) \times$$

$$\times (2\overline{y}^3 - \frac{3}{2}\overline{y} - 1/2)\}(1 - k_\psi), \text{ t·m,} \qquad (5.3.9.2.5)$$

where $k_\psi = 0{,}25(1 - B_k/B)^2\left\{m_z + \frac{B_k}{B}\Big(\big[15 - 12\cos\pi(0{,}5 - B_k/B)\big] \times \times(\overline{\rho}_x - 0{,}288) + 1\Big)/[\overline{\rho}_x^2\,(1 + m_\psi)]\right\}$;

$N = 0{,}5\Delta n$, T,

$\overline{\rho}_x = \frac{1}{B}\sqrt{J_x/\Delta}$;

Jx is the central moment of inertia of the ship's mass about longitudinal axis;

y is the distance between section in question and longitudinal centre plane;

B_M is the distance between hulls at the level of connecting structures.

Design value of the cutting force is taken equal to N.

5.3.9.2.6 Design values of torsion torques in the transverse hull sections are taken equal to:

$$M_{des}^{tor} = \Delta B[0{,}32(3\bar{l}_G - 1)\sin\pi\overline{x} + \overline{M}_d(\overline{x})], \text{ t·m,} \qquad (5.3.9.2.6)$$

where $\bar{x} = 1 - j/20$ (j — number of section);
$\bar{l}_G = l_G/L$ is the relative distance between the gravity centre and transom (from the aft perpendicular).

Function $\overline{M}_d(\bar{x})$ is determined by the following dependencies:

a) within 0 and 2 section

$$\overline{M}_d(\bar{x}) = (-49 + 100\bar{x} - 50\bar{x}^2 + f_m)r,$$

where $r = 0{,}25\Delta(1 + m_z)(B + B_{hor})n$;

$$f_m = -\bar{a}\,\bar{x} - b\bar{x}^2/2 + \frac{c}{\pi}\cos\pi\bar{x} - c/\pi;$$

$$b = 6(2\bar{l}_G - 1);$$

$$c = 43{,}7(\frac{4+b}{12} - \bar{\rho}_y^2 - \bar{l}_G^2);$$

$$\bar{a} = 1 - b/2 - 2c/\pi,$$

b) within 2 and 4 section

$$\overline{M}_d(\bar{x}) = r(32 - 80\bar{x} + 50\bar{x}^2 + f_m),$$

c) within 4 and 20 section

$$\overline{M}_d(\bar{x}) = rf_m.$$

5.3.9.2.7 Transverse torsion torque (in the longitudinal section of connecting structures by the inboard side) is determined by the following formula:

$$M_{trans}^{tor} = (0{,}1n + 1{,}2f)\Delta L, \text{ t·m.} \qquad (5.3.9.2.7)$$

5.3.10 Verification of the hydrofoil and glider general strength.

5.3.10.1 General hull strength shall be verified:

for permissible normal and tangential stresses;

for marginal state.

5.3.10.2 Design values of normal stresses in end members of hull girder shall satisfy the following conditions:

$$\sigma_u = \alpha_u M_{des}/W_u > \sigma_{per} = n_s\sigma_0\,; \qquad (5.3.10.2\text{-}1)$$

$$\sigma_l = \alpha_l M_{des}/W_l \leqslant \sigma_{per} = n_s\sigma_0, \qquad (5.3.10.2\text{-}2)$$

where σ_u and σ_l are the design stresses in the upper (superstructure) and lower (bottom) members of hull girder accordingly;
M_{des} is the design bending moment at sagging and hogging acting in the design section and determined in accordance with 5.3.3.3-5.3.3.9, 5.3.8.2.2;
W_u and W_l are the section moduluses for the upper and lower members of hull girder accordingly;
α_u and α_l are coefficients considering superstructures contribution to the general hull bending which is taken equal to $\alpha_u = 0{,}85$ and $\alpha_l = 1{,}4$ (in absence of regularly located window openings in superstructures coefficients $\alpha_u = \alpha_l = 1$);
n_s is the safety margin taken in accordance with Fig. 5.2.8.

Distribution of normal stresses along height of hull section is taken linear.

5.3.10.3 If superstructure extends over practically the whole length of the ship hull, its sides coincide with sides of the ship and they are weakened by a large number of openings, normal stresses in hull σ_h and awning (top) of superstructure σ_s as well as normal σ_{ws} and tangential τ_{ws} stresses in the window soliving in the wall may be calculated by formulae:

$$\sigma_h = M_{des}y/I - T(1/F + ly/I); \qquad (5.3.10.3\text{-}1)$$

$$\sigma_s = T/f; \qquad (5.3.10.3\text{-}2)$$

$$\sigma_{ws} = \pm abcT'/4i_0;\ \tau_{ws} = cT'/bt, \qquad (5.3.10.3\text{-}3)$$

where M_{des} is the design bending moment (at sagging and hogging) of the section in question, in kN·m;
y is the distance between the member in question and neutral axis of hull section, in m;
I is the moment of inertia of the transverse hull section, in m^4;
F is the area of the transverse hull section, in m^2;
f is the area of the transverse superstructure section, in m^2;
l is the distance between the centres of gravity lines of hull sections from the centres of gravity lines of superstructure awning section, in m (Fig. 5.3.10.3);
a is the window height, in m (Fig.5.3.10.3);

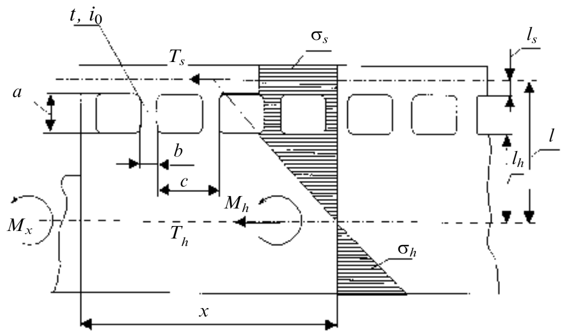


Fig. 5.3.10.3

b is the width of window soliving, in m;
c is the spacing between window openings, in m;
t is the thickness of window soliving, in m;
i_0 is the moment of inertia of the transverse section of window soliving, in m^4;
T is the axial force acting along lines of centre of gravity of hull sections T_h of the superstructure awning T_s, kN, equal to:

$$T_h = -T_N = T = T_0[\frac{\lambda sh\lambda(l-x)}{sh\lambda l}\int_0^l \frac{M_x}{M_0} sh\lambda\xi d\xi + \frac{\lambda sh\lambda x}{sh\lambda l}\int_0^l \frac{M_h}{M_0} sh\lambda(l-\xi)d\xi]; \qquad (5.3.10.3\text{-}4)$$

T_0 is the force acting in the section in question if the superstructure awning shalltally involved in hull bending, in kN:

$$T_0 = \frac{M_0 lf}{(F+f)I/F + fl^2}\,; \qquad (5.3.10.3\text{-}5)$$

$M_x = M_h + Tl$ — design bending moment which is varied along hull length, in kN·m;

M_h is the bending moment acting in the transverse hull section, in kN·m;

$$\lambda^2 = \frac{K}{E}\left(\frac{F+f}{Ff} + l^2/I\right); \qquad (5.3.10.3\text{-}6)$$

E is the normal elasticity modulus, in kPa;

$$T' = K\delta; \qquad (5.3.10.3\text{-}7)$$

δ is the shift of the centre of gravity of hull sections in respect of the centre of gravity of the superstructure awning along axis x, in m;

$$\delta' = T/EF + T/Ef - M_h l/EI; \qquad (5.3.10.3\text{-}8)$$

l is the length of superstructure, in m;

K is the coefficient of hull and superstructure members rigidity, in kN/m^2;

$$K = \frac{1}{1/K_0 + 1/K_h + 1/K_s}; \qquad (5.3.10.3\text{-}9)$$

K_0 is the stiffness coefficient of superstructure side members which are weakened by regular openings located at equal interval from each other, in kN/m^2;

$$K_0 = \frac{E}{ac(a^2/12i_0 + 2{,}6/bt)}; \qquad (5.3.10.3\text{-}10)$$

K_h and K_s are stiffness coefficients taking into account yielding of structure at the level of window openings as well as yielding to shift of the side of superstructure awning and side of hull:

$$K_h = \frac{Et_h}{2{,}6l_h(1 - t_h l_h/2F)}; \qquad (5.3.10.3\text{-}11)$$

$$K_s = \frac{Et_s}{2{,}6l_s(1 - t_s l_s/2F)}; \qquad (5.3.10.3\text{-}12)$$

t_h and t_s are mean thicknesses of plating adjoining window openings, hull and superstructure awning respectively, in m;

l_h is the distance between the line of centre of gravity of hull sections and the lower edge of window openings, in m;

l_s is the distance between the line of centre of gravity of hull sections and the upper edge of window openings, in m.

5.3.10.4 Design values of tangential stresses at sagging and hogging of hull shall comply with the following conditions:

$$\tau = \frac{Q_{des}S_x}{I_x\delta} \leqslant \tau_{per} = 0{,}3R_{p02}, \qquad (5.3.10.4)$$

where Q_{des} is the design value of cutting force calculated in accordance with 5.3.3.3 — 5.3.3.9;

S_x is the moment of area of design transverse section relative to zero line, in m^3;

δ is the total thickness of side and longitudinal bulkheads at the level where tangential stresses are determined, in m.

Total design thickness of side and longitudinal bulkheads in absence of sufficient bulkhead plates resistance to shear forces shall be calculated keeping due note of reduction coefficient which is equal to ratio of Euler stress tangents to design ones.

Side plating shall ensure safety margin of at least 1,5 if exposed to tangential stresses.

Note: if critical tangential stresses are determined with due note of change of material modulus of elasticity, it is allowed to take $\tau \leqslant \tau_{cr}$.

If resistance to tangential stresses is tested, only two hull sections may be verified in the area of maximum cutting forces.

5.3.10.5 Verification of strength ultimate moment shall show that during both sagging and hogging of hull ratio of ultimate moment to the maximum design bending moment in the section under consideration shall comply with the following condition:

$$M_{ult}/M_{des} \geqslant 0{,}8/n_s, \qquad (5.3.10.5\text{-}1)$$

where $M_{ult} = \sigma_0 W_0$; (5.3.10.5-2)

W_0 is the minimum modulus hull section under consideration, in m^3 which is calculated keeping due note of reduction of area of members losing stiffness assuming that in the far ends, the most distant from the zero line of hull members stresses equal to dangerous are acting;

n_s is the safety margin taken in accordance with Fig. 5.2.8.

5.3.11 Calculation of hovercraft and high speed catamarans hull strength at their longitudinal bending.

5.3.11.1 General hull strength during longitudinal bending shall be verified for the cases of sagging and hogging of hull:

permissible normal and tangential stresses if design bending moments and cutting forces determined for accepted design modes of motion are acting in accordance with 5.3.4 — 5.3.7 and 5.3.9;

ultimate moments.

5.3.11.2 Determination of normal and tangential stresses acting in hull members during longitudinal bending as well as determination of ultimate moment is carried out in accordance with 5.3.8. During verification of general strength ultimate moment (see 5.2.9) the safety factor n_s is taken equal to 2,0.

5.3.12 Calculation of hovercraft and high speed catamarans hull strength at their transverse bending.

5.3.12.1 Determination of stresses during verification of the transverse hull strength is carried out by means of the finite element method or by means of the approximate method given below based on the beam models of transverse bulkheads. This method may be used if $B/D \geqslant 2$ provided transverse bulkheads are located across the whole width of hull. Transverse bulkhead is calculated as a girder experiencing exposure of bending moment and cutting forces. General transverse bending moment and cutting force in the longitudinal section of hull are distributed among separate bulkheads pro rata of their bending/shear rigidity.

If the ship is landing on the bottom bearers retroaction is taken up by those members which are located immediately above bearers.

Bending/shear rigidity of some bulkheads is determined by the formula:

$$I_{bs} = \frac{1}{l_b^2/KEI_b + 1/h_b\delta_b G} \qquad (5.3.12.1)$$

where
I_b is the moment of inertia of the vertical section of bulkhead with deck and bottom strakes, in m^4;
l_b is the length of bulkhead span, in m;
h_b is the average bulkhead height, in m;
δ_b is the average thickness of the bulkhead, in m;
K is the coefficient taken from Table 5.3.12.1 in relation to the bulkhead fixing on sides.

Table 5.3.12.1

Conditions of transverse members ends fixing		K
Simple support	Δ——————Δ	24
Fixed embedment	⫲——————⫲	96

For the purposes of determination of the bulkhead moment of inertia adjoining face plates of bottom, platforms, decks shall be considered which width is taken as the lesser value of those equal to 1/8 length of the span or the distance between neighbouring bulkheads.

5.3.12.2 In absence of transverse bulkheads in the middle (by width) part of hull, the calculation of the transverse strength is carried out in relation to the level of the bearing capacity of members supporting hull in transverse direction. If a twofold stability factor is ensured for transverse members (ratio of the critical compressing load of girder to the force equal to the maximum transverse bending moment is greater or equal to two) then an assumption of the combined action of transverse members of superstructure deck and pontoon beams (beams and floors) making a single hull girder shall be made for strength calculations.

If pontoon members (floors) safety factors comply with conditions of 5.3.12.4-3, it is permissible to reduce stability factor of transverse members of the superstructure deck (upper deck) to 1,2. In this case strength calculations shall be based on the assumption that beams and floors bend separately (not forming a single hull girder).

If an assumption of the combined action of beams and floors during transverse bending of hull is accepted, calculation of the hull girder is carried out in a usual manner.

Compression stresses of beams and extension stresses of floors found at an assumption of the combined action of transverse members forming an ideal girder during its transverse sagging shall be added to the additional normal stresses conditioned by bending of transverse members among longitudinal bulkheads which was caused by shear forces acting in hull.

Additional bending moments in some beams and floors are distributed in proportion to their bending/shear rigidity evaluated by the parameter:

$$\lambda_{ts} = \frac{1}{l_{ts}^2\ /(2EI_{ts}) + 1/(GF_{ts})}\ , \qquad (5.3.12.2\text{-}1)$$

where λ_{ts} is the distance among longitudinal bulkheads;
F_{ts} and I_{ts} is the web cross-sectional area of transverse member and moment of inertia of its transverse section.

Total bending moment distributed among separate beams is determined by the formula:

$$M_E = 0{,}33Q_{el}^{trans}\ l_{ts}\ , \qquad (5.3.12.2\text{-}2)$$

where Q_{el}^{trans} is the maximum cutting force in longitudinal hull sections determined in accordance with 5.3.4.4, 5.3.4.6, 5.3.4.8, 5.3.6.3, 5.3.6.5, 5.3.7.3 and 5.3.9.

Determination of the normal and tangential stresses in the transverse member components is carried out by the formulae:

$$\sigma = M_{des}y/I; \qquad (5.3.12.2\text{-}3)$$

$$t = Qs/I\delta, \qquad (5.3.12.2\text{-}4)$$

where M_{des} is the design bending moment in the section under consideration;
I is the moment of inertia of the section area calculated with due account of reduction of members;
y is the distance between the member under consideration from the neutral axis of section;
Q is the design cutting force acting in section;
s is the static moment relative to neutral axis of the part of section area lying above axis under consideration;
δ is the total thickness of section sides at the horizontal level under consideration.

If transverse member represents symmetrical flat girder frame, normal stresses in its strakes are determined by the formula:

$$\sigma = M_{des}/a_hF_{gf}\ , \qquad (5.3.12.2\text{-}5)$$

where F_{gf} is the girder flange area;
a_h is the distance between strakes (height of girder).

Cutting forces are balanced in girder joint by forces in diagonal members and posts which are determined by methods of girder calculation. Normal stresses in diagonal members are calculated as a ratio of the determined axis force to the area of transverse section of respective component.

5.3.12.3 If there are transverse bulkheads amidships critical strength of hull shall be checked against the following conditions:

$$M_{hs}^{trans} / M_{el}^{trans} \geqslant 2;$$
$$Q_{ult}^{trans} / Q_{el}^{trans} \geqslant 1{,}5, \qquad (5.3.12.3)$$

where M_{hs}^{trans} and Q_{el}^{trans} is the maximum value of total bending moment and cutting force in longitudinal section of girder-bulkhead for the mode of operation under consideration;
$M_{hs}^{trans} = \sigma_0 W_k^{trans}$ is the ultimate bending moment of the girder-bulkhead;
$Q_{ult}^{trans} = 0{,}5\Omega_b \sigma_{0,2}$ is the ultimate cutting force for the transverse bulkhead under consideration;
W_k^{trans} is the modulus of section of the girder-bulkhead calculated on the assumption that stresses acting in the end fibres are equal to dangerous σ_0 calculated in accordance with 5.2.3;
Ω_b is the area of the transverse bulkhead (by vertical plane).

5.3.12.4 In absence of transverse bulkheads amidships and use of an assumption of the isolated action of beams and floors at the calculation of transverse strength (see 5.3.12.2), the strength of the latter shall be tested by the value of the ultimate moment and ultimate cutting force determined by the formulae:

$$M_{hs}^F = \sigma_o W_e^F ; \qquad (5.3.12.4\text{-}1)$$

$$Q_{hs}^F = 0{,}5\Omega_F R_{p02}, \qquad (5.3.12.4\text{-}2)$$

where W_e^F is the modulus of the floor section calculated on the assumption that stresses acting in the end fibres are equal to dangerous ones (assigned in accordance with 5.2).
Ω_F is the area of the floor web section.

In this case the following conditions shall be fulfilled:

$$M_{hs}^F / M_F \geqslant 2 ; \quad Q_{hs}^F / Q_F \geqslant 1{,}5, \qquad (5.3.12.4\text{-}3)$$

where M_F and Q_F is the maximum total bending moment and cutting force in the transverse floor sections determined with due account of the moments evolving during general transverse hull bending, local loads (see 5.4.6.5) conditioned by cargo (transported equipment, fuel, water, etc.) and additional bending moments determined in accordance with 5.3.10.2.

In absence of transverse bulkheads amidships and use of an assumption of the combined action of beams and floors (see 5.3.12.2), the hull strength shall be verified for the ultimate moment in compliance with condition (5.3.12.3) and verification of the floor critical strength by condition (5.3.12.4-3). For these purposes only the component conditioned by cargo (equipment, fuel, water, etc.) and additional bending moment determined in accordance with 5.3.12.2 are included into the design value of the total bending moment.

5.3.12.5 During calculation of structure of the high speed catamarans in case of absence of transverse bulkheads in the middle (by width) part of hull bounded from below and from above by connecting structures, it is necessary to assess stresses caused by both symmetrical and skew-symmetrical bending of hull.

General transverse bending moment at skew-symmetrical bending (see 5.3.9.2.5) is distributed among separate transverse girders (floors and beams) of connecting structures in proportion to their bending and shear rigidity.

Stresses arising at the skew-symmetrical bending of the transverse girder components shall be added to the stresses conditioned by symmetrical bending. For these purposes evaluation of symmetrical bending stresses is carried out following the usual scheme, hull girder consisting of the components of connecting structures. Values of symmetrical bending moment and cutting forces are determined by totalling of stresses equal to 70 per cent of values calculated in accordance with 5.3.9.2.3 and 5.3.9.2.4.

5.3.13 Calculation of the hovercraft and high speed catamaran hull torsional strength.

5.3.13.1 If there are transverse bulkheads in hull which extend across the whole width of hull, transverse section is considered rigid in its plane during torsion. General torsion torque acting in the section is distributed among single member contours (the contour means a component of transverse section of hull bound by longitudinal bulkheads or by longitudinal bulkheads and sides, deck, bottom) which comprise transverse section in proportion to the torsional rigidity determined by the formula:

$$C_i = \omega_c^2 / \sum_{c=1}^{n} (l_c/\delta_c), \qquad (5.3.13.1\text{-}1)$$

where l_c is the length of the contour wall, in m;
δ_c is the thickness of the contour wall, in m;
ω_c is the double area bound by c contour, in m^2, (Fig. 5.3.13.1);
n is the number of contour walls.

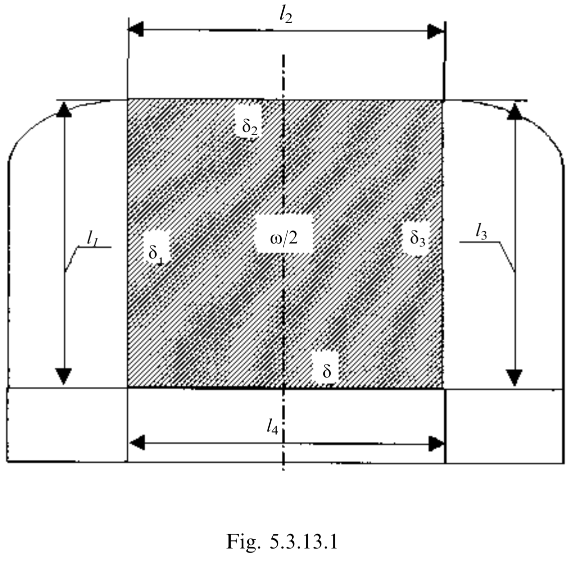


Fig. 5.3.13.1

Tangential stresses caused by torsion in the walls of each contour section are determined by the formula:

$$\tau_i = M_i/\omega_i\delta_i, \qquad (5.3.13.1\text{-}2)$$

where M_i is the share of the torsion torque applied to the i-th contour, in kN·m.

Total of tangential stresses in the common wall of the two neighbouring contours are calculated as the difference of stresses in this wall caused by each contour.

5.3.13.2 Additional normal and tangential stresses in transverse members shall be determined for the ships with the middle cargo compartment where transverse bulkheads are absent over the whole or part of its length.

Additional tangential stresses on the cargo deck and bottom are calculated by the formula:

$$\tau_{db} = \pm G h_d \{\alpha[\frac{3}{2}\frac{1}{l/2} - \frac{3}{2}\frac{y^2}{(l/2)^3}] + \beta\frac{1}{l/2}\}, \qquad (5.3.13.2\text{-}1)$$

where h_d is the height of cargo deck above the main deck, in m;
l is the width of cargo compartment (Fig. 5.3.13.2), in m.
Mark (+) refers to bottom,
Mark (−) refers to cargo deck.

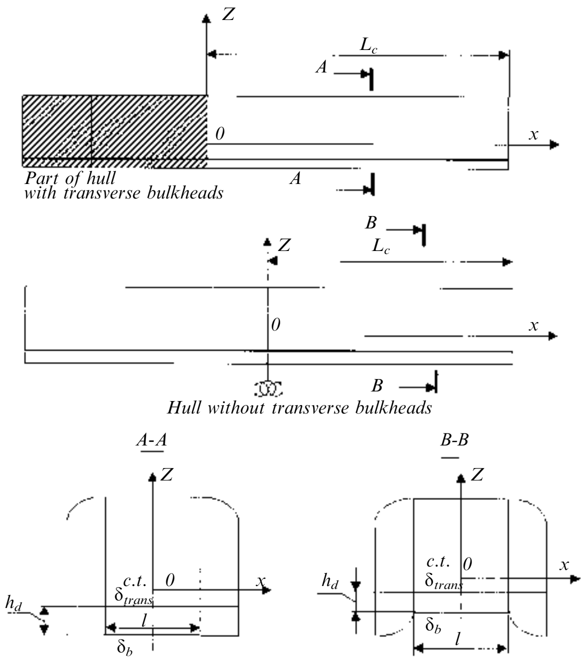


Fig. 5.3.13.2

Parametres α and β are determined by the formulas:

$$\alpha = \frac{F(B-D)}{B^2 - AD};$$

$$\beta = \frac{F(B-A)}{B^2 - AD};$$

$$A = C_g L_c + \frac{E}{G} D_g \frac{L_c^3}{3};$$

$$B = C_\eta L_c + \frac{E}{G} D_{g\eta} \frac{L_c^3}{3};$$

$$D = C_\eta L_c + \frac{E}{G} D_\eta \frac{L_c^3}{3};$$

$$F = \Omega/GL_c;$$

Ω is the torsion torque diagram on the section of L_c, in kN·m^2;
L_c is the length of cargo compartment determined in accordance with Fig 5.3.13.2, in m;
C_g, C_η, D_g, D_η, $D_{g\eta}$ are rigidity parametres determined by the formulae:

$$C_g = 4{,}8\frac{h_d^2}{l}(\delta_d - \delta_b);$$

$$C_\eta = 4\frac{h_d^2}{l}(\delta_d + \delta_b);$$

$$D_g = (I_F/b_F + I_\delta/b_\delta)\frac{6}{(l/2)^3};$$

$$D_\eta = \frac{I_\delta}{b_\delta}\frac{6}{(l/2)^3} + \frac{G}{E}\frac{4t_F h_d}{lb_F};$$

$$D_{g\eta} = \frac{I_\delta}{b_F}\frac{6}{(l/2)^3};$$

I_F and I_δ are floor and beam moments of inertia, in m^4;
b_F and b_δ is the spacing between floors and beams, in m;
t_F is the thickness of floor wall, in m;
δ_d and δ_b is the average thickness of cargo deck and bottom, in m.

Normal stresses in floors and beams caused by general torsion of hull are calculated by the formulas:

$$\sigma_F = -E\alpha x\frac{12}{l^2}z_F; \qquad (5.3.13.2\text{-}2)$$

$$\sigma_\delta = -E(a+b)x\frac{12}{l^2}z_\delta,$$

where z_F and z_δ are distances of the floor or beam point under consideration from the neutral axis of the design member, in m;
x is the section abscissa (Fig. 5.3.13.2), in m.

Tangential stresses in the floor plate are calculated by the formula:

$$\tau_F = G\beta x\frac{1}{l/2}. \qquad (5.3.13.2\text{-}3)$$

Maximum stresses σ_F, σ_δ, τ_F are reached in sections at $x = L_c$.

5.3.13.3 During calculation of high speed catamarans in absence of transverse bulkheads in the middle (by width) part of hull stresses evolving at the skew-symmetrical bending of hull transversely shall be added to stresses caused by twisting and local bending of transverse beams (floors) of the connecting bridge. The value of the skew-symmetrical bending moment and cutting force is determined in accordance with 5.3.9.2.5, while the value of the torsion torque is taken equal to 80 per cent of design value calculated according to 5.3.9.2.6.

Pressure on transverse girders is taken equal to 60 per cent of the value calculated according to 5.4.5.

Permissible stresses during verification of hull strength for the combined action of the skew-symmetrical bending and torsion are taken in accordance with 5.2.

5.4 Calculation of local strength.

5.4.1 General.

5.4.1.1 The following conditions shall be considered during calculation of grillage, plate frame, framing:

.1 spans between girders constituting plate frame are taken for the distance between intersections of the neutral axis of respective girders;

.2 it is allowed not to consider variability of the girder sections formed by brackets if brackets do not exceed 0,1 of the girder span; presence of spans shall be considered in this case for determination of moment of girder resistance on bearers; if brackets exceed 0,1 girder span, it is allowed to consider influence of variability of the moment of inertia on bending moments;

.3 curvilinear girders with sagging of less than 10 per cent of span are considered straight.

5.4.1.2 Geometrical components of girder section shall be determined with due consideration of effective flange whose width depends on various factors.

5.4.1.2.1 During bending calculation the width of effective flange is taken equal to the distance between same girders.

5.4.1.2.2 During rigidity calculation the width of effective flange is taken:

at determination of the girder section area — equal to distance between same girders;

at determination of the moment of inertia of the transverse girder section equal to:

$$C = \frac{a}{2}(1 + \varphi), \qquad (5.4.1.2.2)$$

where C is the width of effective flange, in m;

a is the distance between same girders, in m;

$$\varphi = \sigma_e / \sigma_s .$$

Note: if $\sigma_e > \sigma_s$ take $\varphi = 1$.

5.4.1.2.3 For bending calculation — for the transverse girders lying above longitudinal stiffeners (floating framing system), width of effective flange is taken equal to:

if connecting plates are mounted at every second stiffener — 80 per cent of the normal flange accepted in 5.4.1.2.2;

if connecting plates are mounted at every third stiffener — 60 per cent of the normal flange accepted in 5.4.1.2.2;

if there are connecting plates mounted only in supporting section — 1/32 of the girder span.

Stresses on the effective flange shall be determined by the formula:

$$\sigma_{E.F.} = \sigma^*_{E.F.} \times l/24C, \qquad (5.4.1.2.3)$$

where $\sigma_{E.F.}$ are stresses in effective flange, in kPa;

$\sigma^*_{E.F.}$ are stresses in effective flange, calculated on the assumption that plating of 1/32 is included into the girder section, in kPa;

l is the girder span, in m;

C is the width of the normal effective flange of the girder under consideration taken in accordance with 5.4.1.2.2, in m.

If details connecting transverse girders with plating are absent or plating has lost rigidity between connecting details effective flange is not taken into account.

5.4.1.2.4 In all cases the width of effective flange shall not exceed 1/6 design span — for stiffeners and 1/12 girder length (grillage) for reinforced girders.

5.4.1.2.5 Longitudinal stiffeners located on the strake width form a part of effective flange of stringers and carlings.

5.4.1.3 Calculation of shell plates and deck plating side walls as well as bulkhead and superstructure plating shall be carried out on the assumption of their rigid fixing in the supporting contour. If the ratio of the supporting contour sides is greater than 2,5 it is allowed to treat the plate as the one bending by cylindrical surface.

Issue of consideration of membrane stress in the plate shall be resolved in each particular case. If ratio of the smaller side of plate to its thickness is equal to or less than 60, plates shall be usually treated as absolutely rigid.

5.4.1.4 Strength and rigidity (with safety factor of at least 1,5) of supporting structures (decks, platforms, bulkheads etc.) against maximum loads which are transmitted to them from the said grillage shall be tested during strength verification of girders of bottom and side grillage.

5.4.1.5 Local rigidity of framing girders to normal and tangential stresses with safety factor of at least 1,5 shall be verified during calculation of grillage strength.

5.4.1.6 Calculation of transverse bulkheads framing girders to the emergency flooding is permitted for performance following method of ultimate load with the safety factor of at least 1,5.

5.4.2 Loads determining strength of the hydrofoil bottom structures.

5.4.2.1 Strength of bottom structures shall be tested for the impact of external forces arising during ship motion on foils and during entrance to the foil mode in conditions of the design (stated in the performance specification) seaway and speeds corresponding to those regimes as well as exposure to emergency flooding.

5.4.2.2 Strength of bottom components: plates, stiffeners and frame parts between stringers shall be tested for the impact of equally distributed load P_1, in kPa, which is equal to:

$$P_1 = KP_{max}\ , \qquad (5.4.2.2\text{-}1)$$

where $K = P/P_{max}$ is the distribution of the relative value of hydrodynamic pressures over the hull length determined in accordance with Fig. 5.4.2.2-1;

$$P_{max} = \frac{A\ \rho(V + aV_w)^2}{2}\ , \qquad (5.4.2.2\text{-}2)$$

where P_{max} is the maximum value of hydrodynamic pressures, in kPa;

A is the coefficient determined in accordance with Fig. 5.4.2.2-2;

V_w = $1{,}95(h_{3\%} + 1)$;

a = $(54{,}7 - 3{,}4\ h_{3\%})10^{-2}$ at $h_{3\%} \geqslant 1$ m;

a = $51{,}3 \times 10^{-2}\ h_{3\%}$ at $h_{3\%} \leqslant 1$ m.

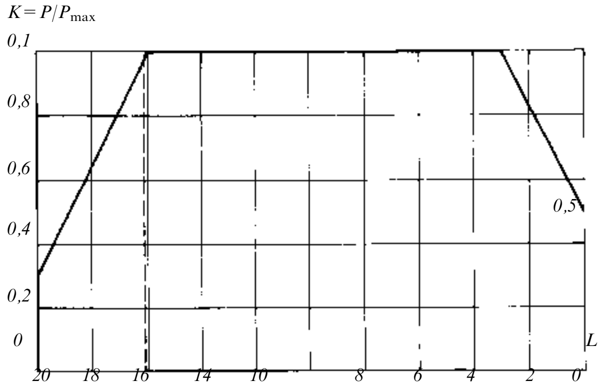


Fig. 5.4.2.2-1

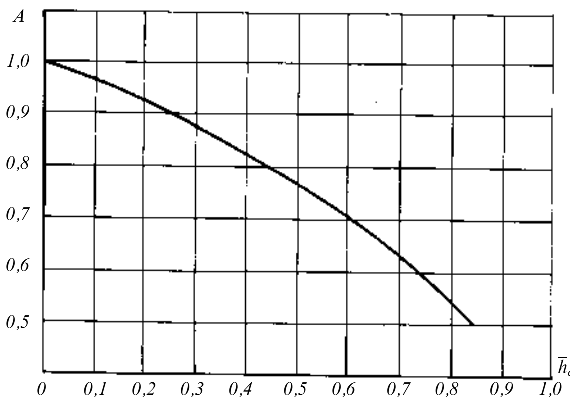


Fig. 5.4.2.2-2

Parts of frame between rigid longitudinals (between keelson — longitudinal bulkhead — side) shall be checked for resistance to equally distributed pressure equal to $\frac{2}{3}p_1$.

5.4.2.3 If there are planing steps, pressure at the first step is taken equal to P_{max}. Pressures at further steps are taken equal to 0,85 of the pressure at previous step.

Immediately after these steps pressures are taken for 0,6 from the design one for the respective step but not less than $0{,}3P_{max}$. Pressure between steps changes along the bottom length according to the linear law.

5.4.2.4 Strength of bottom grillage bound by transverse bulkheads and sides shall be tested for the impact of the hydrodynamic pressures equal to:

$$P_2 = P_{max}K/3, \qquad (5.4.2.4)$$

where $K = P/P_{max}$ is taken from Fig. 5.4.2.2-1.

5.4.3 Loads determining strength of the hovercraft bottom structures.

5.4.3.1 Strength of bottom structures is tested by external forces arising in the conditions of design seaway (stated in the technical specification) for the following design modes:

amphibious hovercraft:

.1 hydrodynamic pressures caused by flat bottom slamming during sailing mode at a speed permissible for the given intensity of seaways;

.2 hydrodynamic pressures caused by flat bottom slamming in the hovering mode;

.3 exposure to emergency flooding;

.4 emergency water landing in case of air cushion loss;

side-wall hovercraft:

.1 hydrodynamic pressures caused by flat slamming of pontoon bottom during sailing mode;

.2 hydrodynamic pressures caused by flat slamming of pontoon bottom during air-cushion sailing mode;

.3 exposure to emergency flooding.

5.4.3.2 Blow spot area and its length at flat blow of wave are determined by the formulae:

$$F_y = 0{,}7\sqrt{h_{3\%}}\ ; \qquad (5.4.3.2\text{-}1)$$

$$L_y = \sqrt{F_y}\ , \qquad (5.4.3.2\text{-}2)$$

where F_y is the area of blow spot, in m^2;

L_y is the length of blow spot, in m.

5.4.3.3 Pressure at flat blow of bottom structures of connecting bridge of side-wall hovercraft and pontoon of amphibious hovercraft is determined by the formula:

$$q = \frac{133\Delta n_g k_0 k_x}{B_x L},\ \text{kN/m}^2\ , \qquad (5.4.3.3)$$

where B_x is the width of structures (width of connecting bridge of side-wall hovercraft or pontoon of amphibious hovercraft);

n_g is the parameter determined by the formulae (5.3.6.2) and (5.3.7.1) (for side-wall hovercraft) and by the formulae (5.3.4.3-10) and (5.3.5.1-5) (for amphibious hovercraft);

k_x is the coefficient characterising pressure distribution along the ship and this coefficient is taken from Fig. 5.4.5.2-1;

k_0 is the coefficient making allowance for relative dimensions of the connecting bridge component under consideration (plates, stiffeners, stringers or floors) which is determined in the following way:

k_0= 1, if $10S_0/BL \leqslant 0{,}00015$;

$k_0 = \exp[-1,9(10S_o/BL - 0,00015)^{0,2}]$,

if $10S_0/BL > 0,00015$,

but not less than 0,3,

where S_0 is the area supported by a component; for plates the supported area is taken equal to product of distance between stiffeners (spacing) by the value equal to the length of the largest plate or triple spacing (whichever is less).

5.4.3.4 Strength of bottom plating shall be tested by pressure determined by the Formula (5.4.3.3) for the sailing on air cushion and for sailing in water-displacing mode keeping due note of 5.4.3.2.

5.4.3.5 Strength of longitudinal stiffeners shall be tested by the load of bq intensity where q is determined in accordance with 5.4.3.2 by the Formula (5.4.3.3).

5.4.3.6 Strength of bottom grillage shall be tested by pressure determined from 5.4.3.3, which acts on the spot (area F) which is located by the most adverse manner for the strength of grillage while:

$F = P/q$ is the area of application of pressure to the grillage, in m^2;

$P = \Delta n_g(1 + m_z)$ is the grillage impact force, in t;

m_z is the parameter determined by the formulae (5.3.4.3-8) (for amphibious hovercraft) or (5.3.6.2-9) (for side-wall hovercraft);

n_g is the hull overload in the gravity centre at wave impact in the grillage under consideration, determined upon testing of models or similar ships. In absence of such data at early design stages it might be determined on the basis of approximated dependencies 5.3.4.3-10 (hovercraft — sailing), 5.3.5.1-5 (hovercraft — during hovering), 5.3.6.2-12 (hovercraft — sailing) and 5.3.7.1 (hovercraft — on air cushion).

5.4.3.7 Loads arising as a result of the emergency flooding are determined by the formula:

$$P_1 = 10(h_1 + H), \qquad (5.4.3.7)$$

where P_1 is the pressure of emergency flooding on bottom, in kPa;

h_1 is the value of emergency flooding taken from Table 5.4.3.7;

H is the spacing between pontoon deck plating and bottom plating, in m.

Table 5.4.3.7

Section №	Meters of lift (m)
0	1,50
3	1,00
6 — 10	0,50

5.4.3.8 In case of emergency water landing (if an air cushion has been deteriorated) strength of bottom grillage — plates, stiffeners and parts of webs between stringers — shall be tested for the impact of equally distributed load, in kPa, which value is taken equal to:

$$P_{max} = \rho V^2/2\ . \qquad (5.4.3.8\text{-}1)$$

Strength of bottom grillage bound by transverse bulkheads and sides shall be tested for the impact of hydrodynamic pressures, in kPa, equal to:

$$P_{gr} = P_{max}/3. \qquad (5.4.3.8\text{-}2)$$

Note: in this case it is necessary to ensure strength and stability of web framing (stringers, frames). The value of permissible stresses $\sigma_{per} = \sigma_0$.

5.4.4 Loads determining strength of bottom structures of the glider.

5.4.4.1 Hydrodynamic pressures on bottom grillage and their components are determined by the following formula:

$$p = K_p \frac{M_{sag}}{B_3 L^2} \varphi_1\varphi_2\varphi_3\ ,\ \text{kN/m}^2, \qquad (5.4.4.1)$$

where B_3 is the width of hull in the area of bilge in the section of the 3rd frame;

K_p is the parameter which is taken equal to 280 for the cavity vault of the ship with an air cavity in the bottom and equal to 370 for other bottom structures of gliders;

$\varphi_1 =$ $0,4 + 1,2x/L$ with $x/L < 0,5$

1,0 with $0,5 \leqslant x/L \leqslant 0,85$

$3,55 - 3x/L$ with $x/L > 0,85$;

$\varphi_2 = (70 - \beta_a)/(70 - \beta_{\otimes})$;

$\varphi_3 = 0,46 - 0,35(U^{0,75} - 1,7)/(U^{0,75} + 1,7)$, but not less than

0,48 — for plates and stiffeners;

0,35 — for floors and stringers;

$U = 200s/(B_{tr}L)$,

where s is the area of load application.

Area s represents the area of grillage; for the floors and stringers — product of distance between girders by their length; for the plates and stiffeners s is taken equal to product distance between stiffeners (spacing) by the value equal to the length of the largest plate side or triple spacing (whichever is less).

5.4.5 Loads determining local strength of high speed catamarans.

5.4.5.1 Local strength of structures is tested by external forces arising in the conditions of design seaway for the following design cases:

impact (slamming) pressures acting in adverse operational conditions (with an exception of the outer side structures);

wave (static) pressures acting in adverse operational conditions (with an exception of connecting bridge);

impact of emergency flooding determined in accordance with 5.4.6.

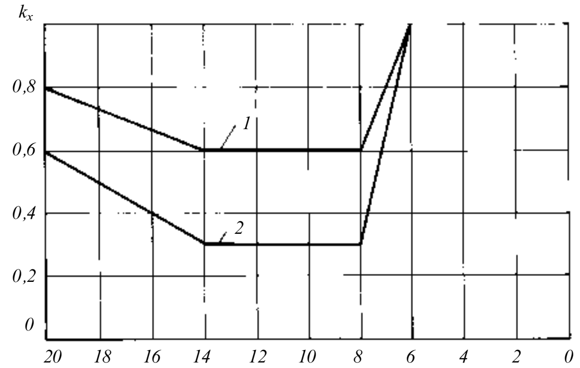
5.4.5.2 Impact pressures on structures of the connecting bridge are determined by the formula:

$$P_{cs} = \frac{133\Delta n k_0 k_x}{B_{cs} L},\ \text{kN/m}^2\ , \qquad (5.4.5.2)$$

where B_{cs} is the width of the connecting bridge (distance between hulls at the level of the connecting bridge);

n is the parameter determined by formula 5.3.9.1;

k_x is the coefficient characterising distribution of pressure along ship length and determined in accordance with Fig.5.4.5.2;



1 — connecting bridge
2 — hull bottom

Fig. 5.4.5.2

k_0 is the coefficient taking into account relative dimensions of the connecting bridge component under consideration (plates, stiffeners, stringers or floors) which is determined in the following manner:

$k_0 =$ 1, if $10S_o/BL \leqslant 0{,}00015$;

$k_0 = \exp[-1{,}9(10S_0/BL - 0{,}00015)^{0,2}]$,
if $10S_0/BL > 0{,}00015$,
but not less than 0,3.

Note: Here S_0 is the area supported by the component; for the plates the supported area is taken equal to the product of distance between stiffeners (spacing) and the value of the largest plate side or triple spacing (whichever is less).

5.4.5.3 Impact pressures on the hull bottom structures are determined by the formula:

$$P_i = \frac{(56Fr_L^2 + 28Fr_L + 70)\bar{h}}{B_h L} k_x k_o^b k_{sh}\text{, kN/m}^2, \quad (5.4.5.3)$$

where B_h is the hull width amidships measured on the waterline corresponding to immersion of hull to the bilge;
$\bar{h}$ is the parameter calculated in accordance with 5.3.9.1;
k_{sh} is the coefficient considering bottom shape;
$k_{sh} =$ 1 — for components of side structures;
$k_{sh} = 0{,}158/\mathrm{tg}\beta$ — for components of side structures;
β is the parameter which is taken equal to the angle of rise of bottom — not less than 10° but not greater than 30°;
k_0^b is the reduction coefficient taken equal to:
$k_0^b = 0{,}46 - 0{,}35(U^{0,75} - 1{,}7)/(U^{0,75} + 1{,}7)$;
$U = 286 S_o T/\Delta$;
S_0 is the the area supported by the component;
T is the ship draught on still water but not less than:
0,48 — for plates and stiffeners;
0,35 — for floors and stringers;
k_x is the coefficient characterising distribution of pressure along ship which is taken from Fig. 5.4.5.2.

5.4.5.4 Impact pressures on the inner side structures (Fig. 5.4.5.4) are taken distributed in accordance with the linear law from the upper point in which pressure is determined in accordance with 5.4.5.2, to the lower bilge point in which pressure is in accordance with 5.4.5.8.

5.4.5.5 The maximum wave pressures are deemed distributed over the hull surface in accordance with Fig. 5.4.5.4.

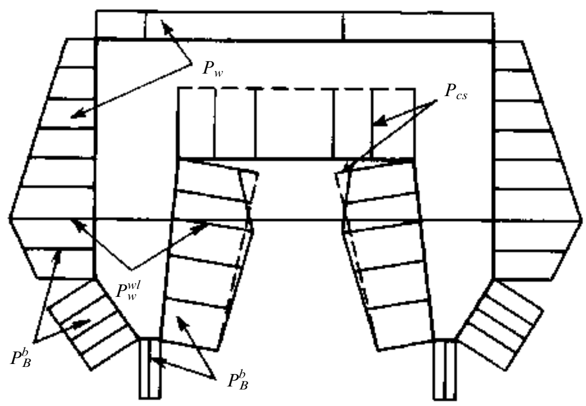


Fig. 5.4.5.4
Distribution of design pressures
by the contour of the transverse section:
– – – – – – Wave pressures
— — — — Blow pressures

5.4.5.6 The maximum wave pressures on the level of design water line is determined by the formula:

$$P_w^{wl} = 0{,}81 f L \rho g\{\alpha(x) + 0{,}25\exp[-(0{,}22\sqrt{L}/h_{3\%}^{0,4} - 1{,}97)^2]\}\text{, kN/m}^2, \quad (5.4.5.6\text{-}1)$$

where $\alpha(x) = \{a\exp[-8\bar{x}^2 + 10\bar{x} + 3{,}29)] - 1{,}05\}\exp(-2{,}9Fr_L) + a\exp[-(1{,}96 - 4{,}9\bar{x})\exp(-2{,}9Fr_L)] + 1{,}05$,
but not less than 0,62;
$\bar{x} = x/L$ is the relative abscissa of the point counted from midship section:

$a = (3{,}1 - 0{,}39Fr_\Delta - 0{,}12L/B_{hor} + 0{,}02Fr_\Delta L/B_{hor}) \times (1{,}1 - 0{,}63\bar{\rho}_y)(1{,}0 - 2{,}5B_{hull}/B)$;

$Fr_\Delta = V/\sqrt{g\nabla^{1/3}}$;

B_{hor} is the distance between hulls amidships measured along the design waterline;
$\bar{\rho}_y$ is the dimensionless central radius of the inertia of ship mass determined in accordance with 5.3.9.1.

The maximum wave pressures above the level of design waterline:

$$P_w = k_w(P_w^{wl} - rgz_i)\text{, kN/m}^2, \quad (5.4.5.6\text{-}2)$$

where z_i is the distance between the point under consideration and the level of design waterline;
$k_w =$ 1 — for freeboard (inner and outer sides);
0,96 — determination of design pressures acting on the structural components of open decks (plates, stiffeners);
0,67 — determination of design pressure acting on beams, stringers and grillage of open decks.

5.4.5.7 The maximum wave pressure acting on bottom structures of hulls are determined by the formula:

$$P_B^b = \rho g[0{,}81 f L\alpha(x)k_\mu(x) + z_b]\text{, kN/m}^2, \quad (5.4.5.7)$$

where z_b is the distance between point on bottom and level of design waterline;

$$k_{\mu}(x) = [1{,}0-3b(x)/L]\{1-[2{,}5-(1{,}2B_{hor}/T(x)+0{,}63)\times$$
$$\times\exp(-21(Fr_L-0{,}28\sqrt{L/B_{hor}})^2)]\frac{b(x)}{L}(1+2{,}5Fr_L)^2\};$$

B_{hor} is the distance between hulls amidships measured along the design waterline;
$b(x)$ is the hull width in the transverse section under consideration with an abscissa x;
$T(x)$ is the hull draught in the section under consideration.

5.4.6 Determination of loads during verification of the local strength of components of other structures.

5.4.6.1 Strength of deck and sides shall be tested for resistance to the emergency flooding, in kPa, determined by the formula:

$$P = 10(h_1 + D - Z), \quad (5.4.6.1)$$

where h_1 is the value of the hydrostatic pressure determined in accordance with Fig. 5.4.6.1, meters of lift;
D is the side height in the section under consideration, in m;
Z is the distance between the structure under consideration and the main plane, in m.

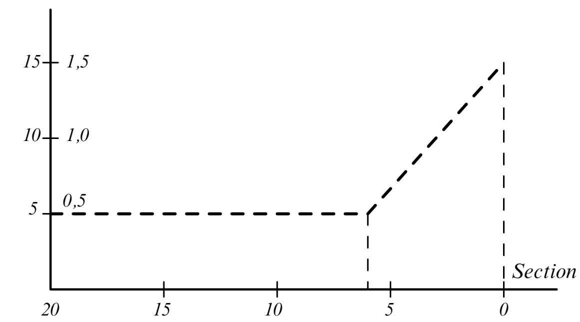


Fig. 5.4.6.1

For the areas of deck where collection of passengers or crew is possible — 0,5 meter of lift (5 kPa).

For the areas of deck where chairs for passengers are located — 0,4 meter of lift (4 kPa).

5.4.6.2 Strength of superstructure components of the I tier and wheelhouses shall be tested for the impact of the following loads:

plating and windows of superstructure front wall (wheelhouses) — uniform pressure corresponding to 2 meters of lift (20 kPa);

for plates and deck longitudinals, roof, side and back walls of superstructures (wheelhouses) and windows — pressure is determined in accordance with 5.4.6.1 but not less than 0,3 meter of lift (3 kPa);

superstructure deck beams 0,15 meters of lift (1,5 kPa).

Strength of the II tier and above superstructures shall be tested for the impact of load which are 50 per cent less than loads applied to relevant sides and windows of the I tier.

If front and side windows of superstructure (wheelhouse) are sealed by rubber profiles their strength shall be generally tested during bench tests.

5.4.6.3 Watertight bulkheads are tested by the emergency flooding determined in accordance with 5.4.1.4 and 5.4.6.1.

5.4.6.4 Forepeak bulkhead shall be tested by emergency flooding (see 5.4.6.1) plus 0,5 meter of lift which is caused by the head due to motion of ship or during its towing at a speed of $V \leqslant 3$ knots. If it is necessary to tow a ship at a greater speed, the head equal to $0{,}5(V_{tow}/3)^2$ is added to the emergency flooding (where V_{tow} shallwing speed in knots).

5.4.6.5 Strength of structures guarding tanks with fuel, fresh water etc. shall be tested:

by hydrostatic head, in kPa, up to the top of the gooseneck distributed in accordance with the linear law which maximum value is equal to:

$$P = 10h_1, \quad (5.4.6.5\text{-}1)$$

where h_1 is the height from the tank bottom to the top of the gooseneck, in m;

by hydrostatic head, in kPa, of liquid cargo if tank is full to the top keeping due note of inertial forces in accordance with the formula:

$$P_2 = 10h_2(1 + n), \quad (5.4.6.5\text{-}2)$$

where h_2 is the height from the member in question to the tank top, in m;
n is the excessive acceleration as a share of acceleration of gravity force in the area of tank location arising due to blows and ship roll in heavy seas.

5.4.6.6 Strength of embarkation station, crinoline of life-saving appliances guards, fenders etc. shall be tested by the following loads:

equally distributed pressure of 0,5 meter of lift (5 kPa); compressed knees of crinoline (or other structures) shall be tested for stability in accordance with 5.1.8;

hydrodynamic pressure applied to crinoline (or other structure) from below which arise during ship motion at all modes of operation and determined in accordance with 5.4.2.2 with due consideration of relative clearance of crinoline (or other structures);

inertia forces acting on the crinoline structures which emerge due to masses on it, such as life-saving appliance (liferafts), because of ship roll or impact of waves against stern or crinoline structures. Resulting overloads shall be taken in accordance with 5.3.

5.4.6.7 Structures bounding hovercraft receiver shall be tested by equally distributed pressure of the following intensity:

$$q_{rec} = q_{ac}(1 + n_g), \quad (5.4.6.7)$$

where q_{ac} is the normal pressure in the air cushion, in kPa.

5.4.6.8 Strength of plates, stiffeners, parts of frames limited by stringers for hovercraft side-walls as well as strength of sidewall grillage shall be tested by hydrodynamic pressures which are determined by the formula:

$$P_{sw} = 4\frac{f(\upsilon, h_{3\%})}{\mathrm{tg}^2\beta_{sw}}\text{, kPa,} \qquad (5.4.6.8)$$

where $f(\upsilon, h_{3\%})$ is the value which is determined in accordance with Fig. 5.4.6.8;

β is the average rise angle of sidewall, in degrees.

5.4.7 Determination of stresses during local strength verification.

5.4.7.1 A stress acting in the plate which is dealt with as a strip girder shall be calculated by the formula:

$$\sigma = \frac{P}{2}(a/\delta)^2\text{, kPa,} \qquad (5.4.7.1)$$

where δ is the strip thickness, in m;

a is the length of the shorter side of strip — distance between ribs, in m;

P is the design pressure acting on the plate, in mPa.

Note: consideration of membrane stress in plates and norming of their strength is carried out in accordance with 5.4.1.3 and 5.4.8.2.

5.4.7.2 Longitudinal stiffeners of bottom and sides shall be calculated as girders rigidly fixed in frames and stresses acting in them shall be calculated by the formula:

$$\sigma = Pal^3/12W\text{, kPa,} \qquad (5.4.7.2)$$

where P is the design pressure acting on the stiffeners, in kPa;

W is the transverse modulus of section with adjoining strake of plating, in m³;

l is the length of stiffener (frame), in m.

5.4.7.3 Deck longitudinal stiffeners shall be calculated as girders rigidly fixed on beams. Pressures are taken in accordance with 5.4.6.1 and stresses are calculated by the Formula (5.4.7.2).

5.4.7.4 Carlings, stringers and vertical keel shall be calculated as girders rigidly fixed in bulkheads.

Hydrofoil bottom frames depending on their structure shall be calculated as girders rigidly fixed in the vertical keel and bilge or as girders rigidly fixed in the keel but simply supported at the bilge. Side frames shall be calculated as girders resiliently built in deck and bottom.

5.4.7.5 Conditions of the hovercraft fixing of bottom and side frames as well as deck beams shall be determined in each particular case in relation to their structure and that of supporting members.

5.4.7.6 Beams shall be calculated as whole beams simply supported by carlings and resiliently fixed in sides. In the area of side openings half-beams are treated as simply supported by coamings.

5.4.7.7 Conditions of fixing of transverse bulkhead vertical stiffener shall be determined in relation to their structural design.

5.4.7.8 When stressed condition of side receiver is calculated it is necessary to consider side and

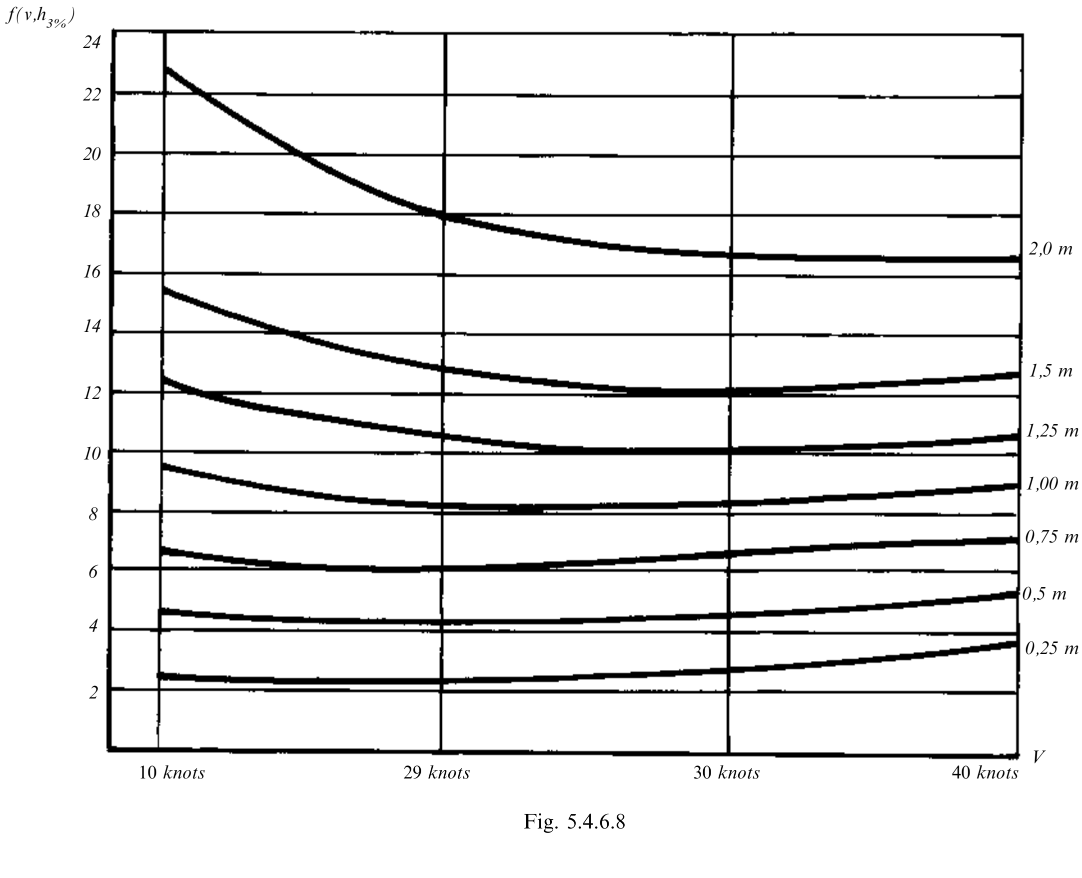


Fig. 5.4.6.8

horizontal areas assuming that they are rigidly fixed on their junction line.

Calculation of each area is carried out in accordance with calculation methods for flat grillage. Distance between sections with girders is taken for the length of grillage and on these edges grillages shall be treated as rigidly supported. One of the longitudinal edges (on the bound of area junction) is also treated as rigidly fixed. Boundary conditions on the other longitudinal edge are taken in relation to the structural design.

5.4.7.9 Calculation of girders of receiver is made by calculation methods for girders exposed to concentrated loads transmitted by flexible skirt. The value of this load is calculated as a product of a load distributed along the length from the flexible skirt which is determined in accordance with 5.7 and distance between girders.

5.4.7.10 In absence of transverse bulkheads in the middle (by width) part of two-hull ships (high speed catamarans) it is necessary to add stresses caused by bending of transverse girders (floors) of the connecting bridge to stresses from general skew-symmetrical transverse hull bending and twisting. While doing summation the values of the skew-symmetrical component of bending and torsion torque shall be taken for 60 per cent of values calculated in accordance with 5.3.9.2.5 and 5.3.9.2.6.

5.4.8 Verification of local strength of high speed craft structures.

5.4.8.1 Verification of the local strength of structural components is carried out on the basis of permissible stresses:

$$\sigma > \sigma_{per}; \quad \tau \leqslant \tau_{per} = 0{,}57\sigma_{per} , \qquad (5.4.8.1)$$

where σ and τ are design normal and tangential stresses in the structural components.

5.4.8.2 During verification of the outer plating strength (normal stresses in the supporting section of plates) permissible stresses shall be taken for:

$$\sigma_{per} = \sigma_0. \qquad (5.4.8.2)$$

5.4.8.3 Stresses permissible during verification of strength of longitudinal stiffeners, frames, stringers and vertical keel are taken for:

$$\sigma_{per} = 0{,}8\sigma_0 . \qquad (5.4.8.3)$$

5.4.8.4 Stresses permissible during verification of strength of structures in accordance with 5.4.6 for webs (except for webs calculated in accordance with 5.4.1.4) and for plates in the middle of a span are taken for:

$$\sigma_{per} = 0{,}8\sigma_0; \quad \tau_{per} = 0{,}40R_{p0,2} . \qquad (5.4.8.4)$$

Design stresses in a span shall not exceed $\sigma_{per} = 0{,}8\sigma_0$ for the calculation of emergency flooding acting on the plates of grillage. Stresses in supporting sections are not regulated.

Safety factor for the ultimate state of members of grillage exposed to emergency flooding shall be 1,5.

N o t e: tanks containing fuel, fresh water, etc. shall be additionally verified for strength in the supporting sections. Permissible stresses in this case are equal to: $\sigma_{per} = 0{,}8\sigma_0$ and $\tau_{per} = 0{,}40R_{p0,2}$.

5.5 Hydrofoil installation strength calculation.

5.5.1 General.

5.5.1.1 Strength of hydrofoil installation shall be tested for resistance to the maximum loads applied to the ship under consideration at motion on foils on still water and seaways at speed stated in technical specification.

5.5.1.2 Verification of the hydrofoil installation for resistance to external load is carried out in span points and for sections between span points of each component during deformation of the foil in general.

5.5.1.3 Calculation of hydrofoil installation strains and deformations caused by external loads shall consider spatial dimensions of structure. Methods of calculation and verification of the hydrofoil installation strength shall be justified and approved by the Register.

N o t e: if the sweep angle of the supporting plane is less than 200 and the hydrofoil struts are installed at a distance of more than 2/3 chord, etc. it is allowed to apply beam model calculation.

5.5.1.4 Hydrofoil installation calculation shall comprise yielding of bottom framing (grillage, except sides, longitudinal and transverse bulkheads) which supports the hydrofoil installation struts.

5.5.1.5 Hydrofoil installation calculation based on the beam model calculation (for calculation of bending moments) for the components which have a variable rigidity it is allowed to take its average value along the length of the component under consideration.

For determination of stresses it is necessary to take rigidity characteristics corresponding to the section under consideration.

5.5.1.6 Hydrofoil struts exposed to axial compression shall be tested for rigidity to compressing forces determined on the basis of calculation in accordance with 5.5.1.4 — 5.5.1.6. Stability factor of 2 at least shall be ensured.

5.5.1.7 Horizontal (cross-arm) shift of the supporting plane shall be determined for the aft hydrofoil installation equipped with transmissions, driving gears, etc. Struts shall be treated as cantilever beams of rigidity varying along their length which are exposed to side loads and forces and moments in the place of fixing strut to the main supporting plane.

5.5.1.8 Hydrofoil installation plating and framing shall be tested for rigidity at bending of their components if 1,5 times safety is ensured. Compression average stresses calculated for the plate thickness are taken for design stresses keeping due note of their change in respect of the profile neutral axis.

5.5.1.9 If at any component of the hydrofoil installation the flap is hitched by three or more hinges to the back edge of the wing it is necessary to verity strength of hinges against forces arising at a combined bending of the hydrofoil installation component and a flap deflected to the maximum angle.

5.5.1.10 Stresses arising in the hydrofoil installation plating during local strength verification are determined on condition of rigid binding of edges.

5.5.2 Determination of design forces.

5.5.2.1 The value of design forces acting on the supporting plane of the hydrofoil installation during ship motion at seaways are determined in accordance with 5.3.3.5 and 5.3.3.8.

5.5.2.2 At distribution of design forces along the supporting plane the following cases shall be considered:

.1 at waterline corresponding to the immersion of the hydrofoil installation at still water;

.2 at waterline corresponding to fully immersed supporting plane;

.3 at waterline which is by ($h_{3\%}/$ 4) lower of the waterline at still water;

.4 unsymmetrical loading of the hydrofoil installation where the waterline is taken in accordance with Fig. 5.5.2.2. For this case permissible stresses may be increased by 10 per cent.

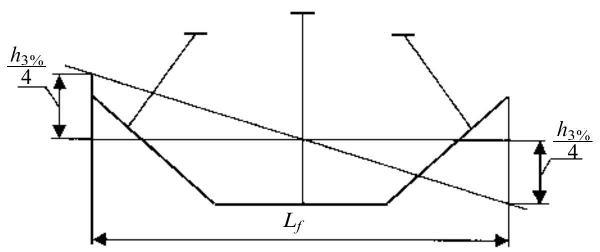


Fig. 5.5.2.2

5.5.2.3 Distribution of design forces along the span of the supporting plane for each design case shall be carried out with due consideration of the free plane, irregularity of load distribution and variability of effective angle of attack along the span supporting plane:

$$q = P_{des}\frac{bf(\bar{h})f(\lambda)}{F_f}\alpha_{ef}\ , \qquad (5.5.2.3\text{-}1)$$

where P_{des} is the design force acting upon the hydrofoil installation (see 5.5.2.1), in kN;

f is the function considering free plane effect which is equal to:

$$f(\bar{h}) = \frac{1+(2\bar{h})^2}{2+(2\bar{h})^2}\ , \qquad (5.5.2.3\text{-}2)$$

where $\bar{h} = h/b$ is the relative immersion of the foil section;

h is the current value of the foil section immersion, in m;

b is the current value of the foil chord, in m;

$f(\lambda)$ is the function considering irregularity of distribution of forces along the span of the supporting plane which is determined in accordance with 5.5.2.3;

λ is the relative narrowing of foil (Fig. 5.5.2.3);

$\alpha_{ef} = \alpha_0 + \alpha_{mt} + \alpha_{adj}$ is the effective angle of the foil attack;

α_0 is the angle of zero hydrodynamic lift;

α_{mt} is the angle of attack conditioned by the motion trim on still water;

α_{adj} is the current value of the adjusting angle of attack;

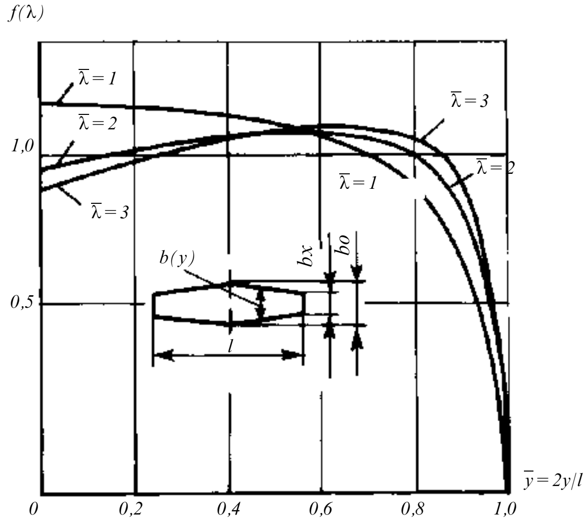


Fig. 5.5.2.3

$$F_f = \int_{-l/2}^{l/2} bf(\bar{h})f(\lambda)\alpha_{ef}\,dl, \qquad (5.5.2.3\text{-}3)$$

where l is the span of the immersed part of supporting plane, in m.

5.5.2.4 For inclined components of the hydrofoil installation the horizontal (traverse) component of forces shall be considered which is equal to:

$$q' = qtq\beta, \qquad (5.5.2.4)$$

where β is the deadrise angle of inclined component.

5.5.2.5 Additionally, the hydrofoil installation strength shall be tested for the impact of the following forces (inclined course, circulation):

forces $P_{i.st.w.}$ determined in accordance with 5.3.3.5;

side loads acting upon struts and inclined components, in kN:

$$P_\delta = 0{,}15\,\frac{\rho V^2}{2}\,S_{st}\ , \qquad (5.5.2.5\text{-}1)$$

where S_{st} is the projection of immersed parts of a strut and inclined components on the longitudinal centre plane, in m^2.

For the aft hydrofoil installations side forces acting on struts caused by the declination of rudders shall be considered. Forces in rudder are taken equal to:

$$P_r = 0{,}054 V^2 F_r \qquad (5.5.2.5\text{-}2)$$

where F_r is the area of the immersed part of the rudder body considering immersion by $0{,}7h_{3\%}$ for seaways as opposed to still water, in m^2.

Distribution of forces P_δ among struts and inclined components of the hydrofoil installation is carried out in proportion to the projection of the wetted surface area on the longitudinal centre plane during immersion of the hydrofoil installation as specified in 5.5.2.2.

$$P_{sti} = \frac{P_\delta}{S_{st}} S_{sti} \,, \qquad (5.5.2.5\text{-}3)$$

where P_{sti} is the design force applied to the i-th strut or inclined component, in kN;
S_{sti} is the projection on the longitudinal centre plane of the immersed part of the i-th strut or inclined component, in m^2.

Distribution of the P_{sti} load along height of strut or along the span of the inclined component of the supporting plane is carried out in proportion to the chords:

$$q_{st} = \frac{P_{sti}}{h_{st}} \frac{b_{st}}{b_{st.av.}} \,, \qquad (5.5.2.5\text{-}4)$$

where h_{st}, b_{st} and $b_{st.av.}$ are immersion, current value of the chord and the average chord of the strut under consideration respectively, in m.

5.5.2.6 For the automatically controlled hydrofoils distribution of loads among components of the supporting plane is as follows: loads applied to components, equipping by flaps increases in proportion to the K coefficient (Fig. 5.5.2.6). The following symbols are used on this figure:

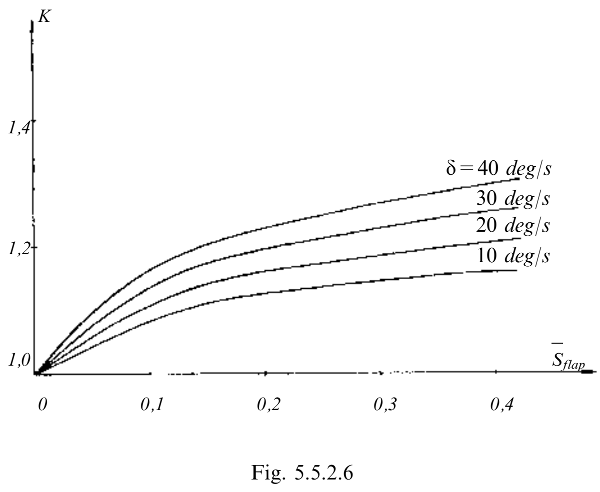


Fig. 5.5.2.6

δ[deg/s] is the speed of the putting of the flap;

$$\overline{S}_{flap} = S_{flap} / S_{comp.flap} \,, \qquad (5.5.2.6)$$

where $\overline{S}_{flap}$ is the relative area of the flap;
S_{flap} is the area of the flap, in m^2;
$S_{comp.flap}$ is the area of the component fitted with the flap, in m^2.

Loads applied to other components reduce on the basis of condition of preservation of the full force applied to the supporting plane.

5.5.2.7 Distribution of loads along the chord of the component under consideration is found by wind tunnel tests or by calculation. In absence of such data loads are distributed across triangle which maximum ordinate starts at the front edge of the profile in accordance with Fig. 5.5.2.7.

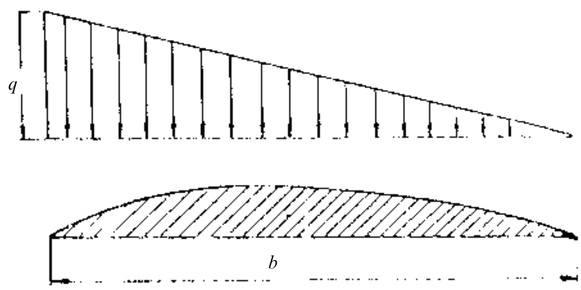


Fig. 5.5.2.7

5.5.2.8 For the components of the hydrofoil installation equipped with flaps the distribution of loads along the main foil chord shall be taken in accordance with Fig. 5.5.2.8-1a.

Ordinates of the load intensity q_1 and q_2 are calculated by the formulae:

$$q_1 = 2 \frac{P_{comp} - P_{flap}}{S_{comp.flap}} \;; \qquad (5.5.2.8\text{-}1)$$

$$q_2 = \overline{b}_{flap} \, q_1, \qquad (5.5.2.8\text{-}2)$$

where P_{flap} is the force transmitted by the flap to the respective foil component, in kN;

$$P_{flap} = C_y^\delta \frac{\rho V^2}{2} S_{comp.flap} \delta_{\max} \,, \qquad (5.5.2.8\text{-}3)$$

where C_y^δ is the coefficient of the hydrodynamic lift of the flap which is determined in accordance with Fig. 5.5.2.8-2;
$\lambda_{flap} = l_{flap}^2 / S_{flap}$ is the relative elongation of the flap;
l_{flap} is the the span of the flap, in m;
$\overline{b}_{flap} = b_{flap}/b$ is the relative chord of the flap (Fig.5.5.2.8-1);
$\delta_{\max}$ is the maximum angle of the flap declination, in degrees.

Force $P_{\max}$ shall be equally distributed among hinges which attach the flap to the main foil.

5.5.2.9 Calculation of the flap strength shall consider force determined by the Formula (5.5.2.8-3). It is assumed that loads distributed along the chord of the flap are distributed across the triangle (Fig. 5.5.2.8-1b) with an ordinate equal to:

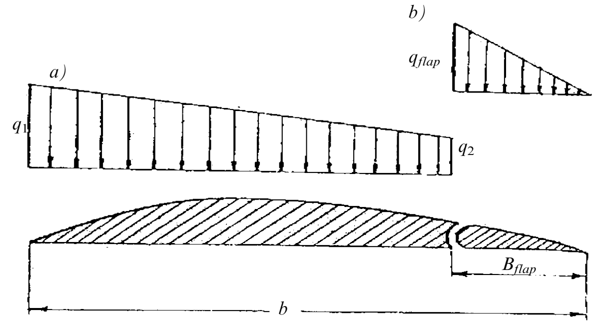


Fig. 5.5.2.8-1

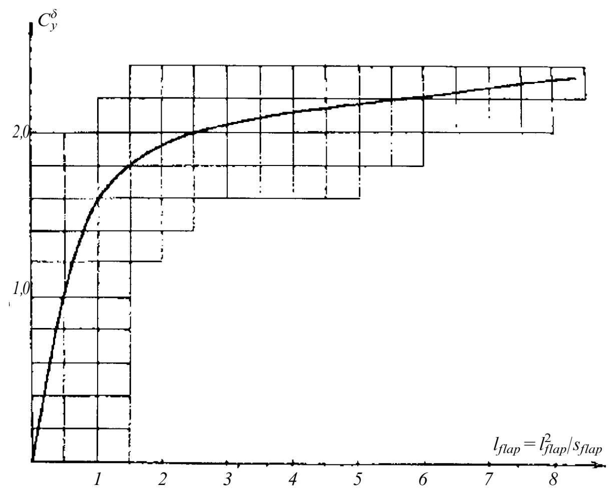


Fig. 5.5.2.8-2

$$q_{flap} = 2P_{flap}/S_{flap} \, . \qquad (5.5.2.9)$$

Distribution of load along the span of the flap is taken in proportion to the chords of the flap.

5.5.2.10 The strength of the additional foil of the hydrofoil installation which enables rise of the ship on foils shall be tested for the resistance to the load, in kN, calculated by the formula:

$$P_{af} = C_{af}^{\max} \frac{\rho V_{lift}^2}{2} S_{af} \, , \qquad (5.5.2.10)$$

where $C_{af}^{\max}$ is the maximum coefficient of the hydrodynamic force of the additional foil profile which is determined upon results of the wind tunnel tests of the profile;
S_{af} is the area of the additional foil, in m^2.

Distribution of the external load among components of the supporting plane and components of the additional foil is carried out in accordance with 5.5.2.2, 5.5.2.4 and 5.5.2.5.

5.5.2.11 The strength of fully immersed turning foils of the steerable hydrofoils installation shall be tested by exposure to loads, in kN, determined by the formula:

$$P_{t.f.} = C_{t.f.}^{\max} \frac{\rho V_{des}^2}{2} S_{t.f.} \, , \qquad (5.5.2.11)$$

where $S_{t.f.}$ is the area of the turning foil, in m^2.

5.5.2.12 The hydrofoil installation plates shall be tested for resistance to hydrodynamic pressures at operating speed for the hydrodynamic lift corresponding to $C_y^{\max}$. Diagram of pressure distribution over the profile surface is determined upon results of wind tunnel test of specific foil profile. In absence of wind tunnel test distribution of loads along the foil chord is taken in accordance with 5.5.2.7 and 5.5.2.8; 60 per cent of total load will act upon the upper surface and 40 per cent on the lower surface.

N o t e . In absence of drain holes the hydrofoil installation plates shall be additionally tested by internal pressures.

5.5.3 Verification of strength of the hydrofoil installation.

5.5.3.1 Strength of the hydrofoil installation shall be tested for permissible stresses:

$$\sigma \leqslant \sigma_{per} \, ; \qquad (5.5.3.1\text{-}1)$$

$$\tau \leqslant \tau_{per} = 0{,}57\sigma_{per} \, , \qquad (5.5.3.1\text{-}2)$$

where σ and τ are design normal and tangential stresses in the hydrofoil installation components.

5.5.3.2 Stresses permissible during verification of the hydrofoil installation components resistance to design loads shall be determined in accordance with 5.5.2 and they are taken equal to:

$$\sigma_{per} = n\sigma_0 \, , \qquad (5.5.3.2)$$

where n is the safety factor taken equal in accordance with Fig. 5.2.13.

N o t e : Stresses permissible during verification of the hydrofoil installation plates resistance to loads determined in accordance with 5.5.2.12 are taken equal to $\sigma_{per} = 0{,}5\sigma_0$.

5.6 Verification of strength of glued-welded joint and spot welds.

5.6.1 During strength calculation of the glued-welded joint and spot welds of framing to plating the spot weld shall be replaced by continuous weld with an adjusted calibre of K_{ad} (presence of glue is not taken into consideration):

$$K_{ad} = Zf/t, \qquad (5.6.1\text{-}1)$$

where Z is the number of rows of spot welds in connection of the members to plating;
$f = \pi d^2/4$ is the area of the spot weld;
d is the diameter of the spot weld taken at normal;
t is the pitch of a spot weld.

Value of shear forces T_{shear} and Q_{det} applied during detachment of spot welds shall be determined by the formulae:

$$T_{shear} = \tau K_{ad} t/Z \, ; \qquad (5.6.1\text{-}2)$$

$$Q_{det} = \sigma_{det} K_{ad} t/Z, \qquad (5.6.1\text{-}3)$$

where τ and σ are tangential stresses of shear and normal stresses of detachment of continuous weld determined upon results of the monolithic (continuous weld) structure calculation.

5.6.2 Strength of the glued-welded (spot welded) joints shall be tested for the permissible shear T_{per} and breakout Q_{per} forces for spot welds:

$$T_{shear} \leqslant T_{per} = nT_0 ; \qquad (5.6.2\text{-}1)$$

$$Q_{det} \leqslant Q_{per} = nQ_0 , \qquad (5.6.2\text{-}2)$$

where n is the safety factor taken in accordance with 5.2.5;
T_0 and Q_0 are dangerous shear and breakout forces for spot welds determined in accordance with Table 5.2.5.

5.7 Flexible skirt strength calculation.

5.7.1 General.

5.7.1.1 General strength of the main components of the flexible skirt structure shall be verified for compliance with methods accepted for pliant skin for exposure to forces arising in the main design cases.

5.7.1.2 Geometrical characteristics of the flexible skirt component under consideration in each characteristic section shall be determined by finding its equilibrium shape.

5.7.1.3 Excessive normal pressure in flexible skirt bag and air cushion corresponding to the main design cases is taken for the external load. Action of the hydrodynamic loads is considered by the safety factors assigned in accordance with 5.2.16, 5.2.17.

5.7.2 Verification of the flexible skirt general strength.

5.7.2.1 The following design cases shall be considered during verification of the flexible skirt general strength:

.1 ship hovering above surface without motion;

.2 ship motion on the air cushion in conditions of design seaways;

.3 ship motion in conditions severer than design seaways (loss of air cushion due to fall from wave crest to wave hollow).

The case in which forces acting in the material will be the greatest shall be taken for the design case.

5.7.2.2 Strains in the inner and outer side of flexible skirt in hovering mode without motion shall be determined by the formulae:

$$T_0 = n_{des} P_r r_0 ; \qquad (5.7.2.2\text{-}1)$$

$$T_i = (P_r - P_c) r_i , \qquad (5.7.2.2\text{-}2)$$

where T_0 and T_i are design strains in the material of the outer and inner side of flexible skirt, in kH/m;
P_r and P_c are excessive normal pressures in the skirt bag and air cushion, in kPa;
r_0 and r_i are radii of curvature in the material of the outer and inner side of flexible skirt, in m.

5.7.2.3 Maximum strains in the shell of cylindrical parts of the flexible skirt during ship motion in seaways are determined by the formulae:

$$T_0 = n_{des} P_r r_0 ; \qquad (5.7.2.3\text{-}1)$$

$$T_i = n_{des}(P_r - P_i) r_i , \qquad (5.7.2.3\text{-}2)$$

where n_{des} is the pressure increment factor determined for each design case upon testing results of the similar prototype; in absence of prototype the value of the n_{des} factor shall be determined in accordance with Table 5.7.2.3.

Table 5.7.2.3

Design case	Pressure overload n_{des}		Note
	Amphibious hovercraft	Side-wall hovercraft	
Motion in design seaway	2,0	3,5	
Motion in seaway higher than design	4,0	5,0	Loss of pressure in air cushion during ship motion in heavy seaway

5.7.2.4 Maximum strains of material of torus-like parts of the hovercraft flexible skirt (bow, angle) shall be determined as for the round torus by the formula:

$$T = \gamma T_i\ , \qquad (5.7.2.4)$$

where $\gamma = \dfrac{1-0{,}5\alpha\sin\theta}{1-\alpha\sin\theta}$;

T_i is the strain of the material inner side of flexible skirt in the design section determined as for the cylindrical part of shell, in kN/m;

θ is the central angle corresponding to the inner side of flexible skirt in design section, in deg;

$\alpha = r_i/R$;

R is the radius of the part of shell along the centre line to the flexible skirt inner surface, in m.

Main symbols given in the present section are shown in Fig. 5.7.2.4.

5.7.3 Verification of the general strength of removable components.

5.7.3.1 Strains in the material of removable component of open type shall be determined by the formula:

$$T = n_{des}\ P_r\ r, \qquad (5.7.3.1)$$

where r is the radius of curvature of the outer wall of removable component, in m.

5.7.3.2 For removable components of closed type strains in outer and inner sides of flexible skirt are determined by the formulae (5.7.2.2-1) and (5.7.2.2-2).

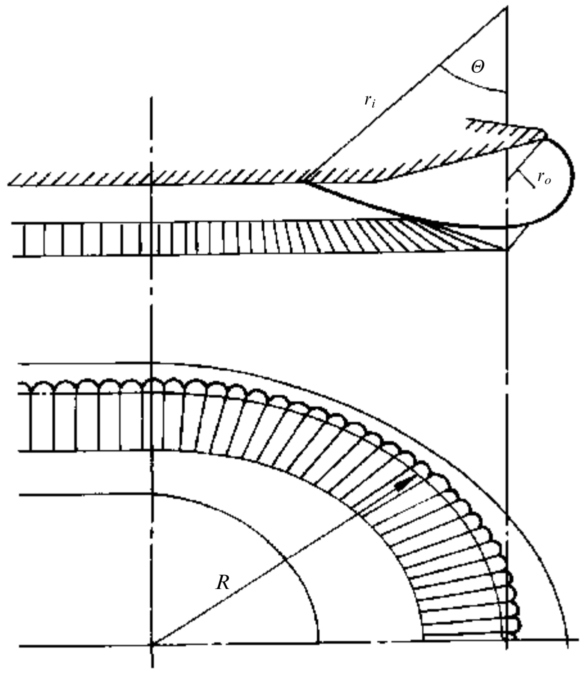


Fig. 5.7.2.4

PART III. ARRANGEMENTS, EQUIPMENT AND OUTFIT

1 GENERAL

1.1 Definitions and explanations relating to general terminology are given in "General" of the present Rules and in Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

1.2 For the purpose of this Part the following definition has been adopted.

W e a t h e r t i g h t means that water will not penetrate into the ship in any wind and wave conditions up to those which are meant by critical design conditions.

2 RUDDER AND STEERING GEAR

2.1 Every high-speed craft shall have a reliable device capable to ensure its steering and course-keeping qualities in all operational modes.

2.2 Air or water rudders, foils, flaps, tilting propellers or nozzles, openings which control keeping a steady course or side thrusters may be used as such devices. Course control may be effected by changing the propeller thrust or the geometrical form of the craft or by combination of both.

2.3 In case of interaction between course control systems and stabilization systems or where dual function elements are provided on craft, the requirements of Part XV "Automation" shall be met.

2.4 The dimensions of the steering gear main elements shall be determined by calculation or shall be based on model tests. Calculations or materials for model tests shall be submitted to the Register together with documentation on the steering gear. Calculations shall be made for the maximum speeds in two modes of operation — displacement and operational modes.

2.5 At least hydrodynamic loads (force, torque) acting on the rudder shall be taken into account in the calculations with an accuracy acceptable for the Register. Maximum values of hydrodynamic forces and torque which are likely to occur within the range of accepted angles of putting the rudder over from one side to the other shall be used as design loads. Materials proving that the accepted values are actually the maximum values shall be submitted to the Register.

2.6 Where only hydrodynamic loads are taken into consideration as external loads in strength calculations, the reduced stresses in the design sections of the steering gear components shall not exceed 0,5 times the upper yield stress. The specific pressure on supports shall not be more than that given in Table 2.6.

Table 2.6

Material of the pair in friction	Specific pressure p, MPa	
	in backwash	outside backwash
Stainless steel — bronze	—	7,0
Stainless steel — rubber	6,0	8,0
Stainless steel — kaprolon	—	6,0

2.7 The dimensions of the steering gear main components of HSC in the displacement mode shall meet the requirements of Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

2.8 Methods for determination of the required propulsive performance of steering gear are not regulated by the Register, and appropriate calculations are not subject to approval by the Register. The above performance is verified by the Register for compliance with the requirements of 2.9 to 2.12 only during sea trials of the craft.

2.9 Steering gear, their controls and actuating systems shall comply with the requirements of Part IX "Materials", Part XI "Electrical Equipment" and Part XV "Automation".

2.10 There shall be provided the main steering gear and auxiliary steering gear. The auxiliary steering gear is not required in case a craft is fitted with several rudders and the steering gear allows to shift each rudder independently of other rudders.

2.11 The main steering gear shall be capable of putting the rudder over from 10° on one side to 10° on the other side in not more than 15 s, with the craft running in the operational mode at the maximum speed.

2.12 The auxiliary steering gear shall be capable of putting the rudder over from 15° on one side to 15° on the other side in not more than 60 s, with the craft running in the displacement mode at a speed of 7 knots.

2.13 The rudder arrangement shall be provided with a system of rudder stops permitting the rudder to be put over on either side only to an angle $\beta°$:

$$(\alpha° + 1°) \leqslant \beta° \leqslant (\alpha° + 1{,}5°),$$

where $\alpha°$ = the maximum angle of putting the rudder over, for which the steering gear control system is adjusted but not more than 15° in the operational mode and not more than 35° in the displacement mode. The greater angle of putting the rudder over in both modes is subject to special consideration by the Register in each case.

Transition (switching over) from one system of rudder stops to the other shall be automatic depending on the rotation speed of the engines which corresponds to the operational or displacement mode.

2.14 All directional control systems shall be operated from the craft's operating station. If directional control systems can also be operated from other positions, then two-way communication shall be arranged between the operating station and these other positions.

2.15 Adequate indications shall be provided at the operating station and these other positions to provide the person controlling the craft with verification of the correct response of the directional control device to this demand, and also to indicate any abnormal responses or malfunction. The indications of steering response or rudder angle indicator shall be independent of the system for directional control.

3 ANCHOR ARRANGEMENT

3.1 Each HSC shall be provided with anchor arrangement consisting of at least one anchor, anchor wire rope (chain cable), machinery for dropping and hoisting the anchor, and holding the craft at anchor, as well as a stopper for securing the anchor in the hawse pipe.

Where the weight of the anchor is less than 25 kg, anchor machinery may be omitted. In such case, the craft shall be provided with a device for securing the anchor wire rope (chain cable) for riding the craft at anchor.

3.2 The mass of each bower anchor, in kg, shall be not less than that determined by the following formula:

$$Q = 1{,}75 N_e, \quad (3.2)$$

where N_e = equipment number according to 3.2, Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

If a high holding power anchor is used as the bower anchor, the mass of the anchor may amount to 75 per cent of the anchor mass determined using the Formula (3.2).

3.3 The length of the anchor wire rope (chain cable) for the bower anchor , in m, shall not be less than that determined by the following formula:

$$l = 7{,}5\sqrt{Q} + 20, \quad (3.3)$$

where Q = anchor mass, in kg.

3.4 The breaking strength F_{st}, in kN, of the anchor wire rope (chain cable) shall not be less than:

$$F_{st} = 0{,}06kQ, \tag{3.4}$$

where k = holding power factor of the used anchor equal to:
3,0 for normal holding power anchors;
6,0 for high holding power anchors;
Q = anchor mass, in kg.

3.5 Ends of a wire rope shall be spliced into sockets, clamps or thimbles. The wire rope shall be connected with the anchor shackle by the joining shackle.

3.6 The craft not fitted with anchor machinery may be provided with synthetic fibre ropes instead of wire ropes (chain cables). The breaking strength F_{syn}, in kN, of the synthetic fibre rope shall be not less than:

$$F_{syn} = 0{,}124\delta_{av}F_{st}^{8/9}, \tag{3.6}$$

where δ_{av} = average relative elongation in breaking a synthetic fibre rope, in %, but not less than 30 %;
F_{st} = breaking strength of the wire rope as a whole determined by the Formula (3.4), in kN.

3.7 The end of the synthetic fibre rope shall be spliced into a thimble and secured to the anchor, if possible, by a wire rope (chain cable) section at least 10 m long which complies with the requirements of 3.4 and 3.5.

The length of the wire rope (chain cable) section may be included in the required length of the rope determined by the Formula (3.3).

3.8 Laying of an anchor wire rope (chain cable) shall provide its free run when dropping or hoisting the anchor.

The design of the spaces containing anchor-recovery equipment shall provide safety of persons using the equipment.

Special attention shall be paid to the means of access to such spaces, the walkways, the illumination and protection against the cable and recovery machinery.

3.9 Adequate arrangements shall be provided for two-way telephone communication between the operating compartment and persons engaged in dropping, hoisting or releasing the anchor.

3.10 The craft shall be protected so as to minimize the possibility of damaging the structure by the anchor and chain cable under all operational conditions.

4 MOORING AND TOWING ARRANGEMENTS

4.1 Each HSC shall be supplied with mooring arrangement for warping to a coastal or floating berth.

4.2 The number of mooring lines on HSC shall be not less than that determined by the following formula:

$$n = 1{,}5 + 0{,}004N_e\ , \tag{4.2}$$

where n = number of mooring lines;
N_e = equipment number according to 3.2, Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

The results of calculations using the Formula (4.2) shall be rounded off to both sides to the nearest figure. In all cases, the number of mooring lines shall not be less than two.

4.3 The length of each mooring line l, in m, shall not be less than 1,5 times the length of the craft with rounding off to the nearest 5 m. With $N_e \geqslant 500$ the length of a mooring line may be taken equal to $1{,}2L$ (where L is the length of HSC, in m).

4.4 The breaking strength, in kN, of wire ropes as a whole shall not be less than that obtained from the following formula:

$$F = 4{,}9\sqrt{N_e}\ . \tag{4.4}$$

4.5 Mooring lines may be of steel wire, natural fibre or synthetic fibre material. The breaking strength of synthetic fibre ropes shall not be less than that obtained from the following formula:

$$F_{syn} = 0{,}074\delta_{av}F^{8/9}, \tag{4.5}$$

where δ_{av} = average relative elongation in breaking a synthetic fibre rope, in %, but not less than 30 %;
F = breaking strength of the wire rope as a whole determined by the Formula (4.4), in kN.

Irrespective of the breaking strength regulated by formulae (4.4) and (4.5), mooring lines made of natural fibre or synthetic fibre material less than 20 mm in diameter shall not be used. On agreement with the Register the use of ropes of smaller diameter for a craft with equipment number $N_e \leqslant 50$ is allowed.

Adequate storage place for mooring lines shall be provided such that they are readily available and reliably secured.

4.6 The number and position of mooring and towing bollards, fairleads and other mooring equipment depend on their constructional features, purpose and a need to provide safe berthing.

4.7 Towing arrangements shall be provided to enable HSC to be safely towed in the worst intended conditions. Other arrangements on the craft may be used for towing purposes. The safe speed at which the craft may be towed shall be determined during delivery trials of the first craft of a series.

4.8 Mooring and towing arrangements shall be designed and secured so that watertight integrity of the craft is not impaired in case of their damage.

Provision shall be made to prevent the towing cable being damaged when under load.

4.9 The maximum permissible speed at which the craft may be towed shall be included in the operational manual.

5 SIGNAL MASTS

5.1 The requirements of this Section apply only to masts intended for carrying navigation lights, daytime signalling lamps and other signal means as well as for installation of radio communication and direction-finder aerials.

5.2 Arrangement, height and equipment installed on signal masts shall comply with the requirements of Part XIX "Signal Means".

5.3 If collapsible signal masts are used on HSC and their mass is 40 kg and more, special machinery shall be installed for their operation or provision shall be made for their connection with other deck machinery. The machinery drive may be hand-operated provided the machinery is of a self-braking type, and the load on the handle is not more than 160 N at any moment of jack-knifing or hoisting the mast.

5.4 Masts on HSC may be of any profile with one or several supports; if necessary they may have arrangements for temporary hoisting signal means. The calculation of such masts shall be based on the assumption that each part of the mast is affected by horizontal force F_i, in N:

$$F_i = \frac{1{,}5G_i(Z_i + 1)}{T^2} + 0{,}4G_i + PA_i\,, \qquad (5.4)$$

where G_i = mass of the part, in kg;

Z_i = elevation of the centre of gravity of each part above that of the craft, in m;

T = period of craft natural oscillations, in s;

A_i = lateral area of the mast part, in m^2;

P = wind specific pressure, in Pa, obtained from the formula:

$$P = 0{,}31(V_s + 22)^2,$$

where V_s = maximum speed in the operational mode, in m/s.

5.5 Under the loads specified in 5.4 stresses in the parts of masts shall not exceed 0,8 times the yield point of their material where they are made of metal, and 12 MPa where they are made of wood (wood shall be of the first grade).

6 ARRANGEMENT AND CLOSURE OF OPENINGS IN HULL, SUPERSTRUCTURES AND DECKHOUSES

6.1 By the term "watertight deck" is meant a deck or a structure bounding the volumes included in the reserve of buoyancy in compliance with 2.2, Part V "Reserve of Buoyancy and Subdivision".

6.2 Closures of openings in the watertight deck shall be watertight in case the spaces located on this deck are flooded with water up to the lower edge of windows or side scuttles.

6.3 If in case of flooding the spaces referred to in 6.2, stability and buoyancy of the craft will be considered unsatisfactory by the Register, the closures in such spaces shall be weathertight. Strength of the closures is subject to special consideration by the Register in each case.

6.4 Side scuttles located below the watertight deck shall be of normal non-opening type with rigid glazing head and fitted with efficient deadlights.

Their arrangement on craft, structure and securing shall comply with 7.2, Part III "Arrangements, Equipment and Outfit" of the Rules for the Classification and Construction of Sea-Going Ships.

6.5 Portable shields (one shield for every two or three windows or side scuttles) shall be provided for each type and size of windows or side scuttles located in spaces referred to in 6.2.

Where closures of windows or side scuttles are not covered by the requirement of 6.3, the strength of portable shields shall be calculated for the loads referred to in 5.4.6.2, Part II "Hull Structure and Strength" of the present Rules. The stresses in the shield members shall not exceed the yield point and its construction shall not lose stability.

6.6 Windows and side scuttles in passenger and crew accommodation spaces shall be made of a material which will not break into dangerous fragments if fractured.

6.7 When secured, covers of tank manholes shall be tight under the effect of the inner pressure up to the top of the air pipe both for water and liquid cargoes or stores for which they are intended.

6.8 The first craft of each series shall undergo full-scale trials under the worst intended conditions.

6.9 The front and, where necessary, side windows of the wheelhouse or operating compartment shall be provided with means or devices for maintaining satisfactory vision during operation in conditions of glass misting, spray or splashes, icing. The means shall be arranged so that failure of one of them cannot interfere with the ability of the operating crew to watch navigation situation and to steer the craft.

6.10 Outer openings of baggage rooms and special-purpose spaces shall be provided with weathertight closures.

7 ARRANGEMENTS AND EQUIPMENT OF CRAFT SPACES. MEANS OF ESCAPE

7.1 General.

7.1.1 Public spaces and crew accommodation shall be designed and arranged so as to protect the occupants from unfavourable environmental conditions and to minimize the risk of injury to occupants in normal and emergency conditions.

7.1.2 Spaces accessible to passengers shall not contain controls, electrical equipment, high-temperature parts and pipelines, rotating assemblies or other items, from which injury to passengers could result, unless such items are adequately shielded, isolated, or otherwise protected.

7.1.3 Public spaces shall not contain operating controls unless the operating controls are protected and located so that their operation by a crew member shall not be impeded by passengers in normal and emergency conditions.

7.1.4 The public spaces, crew accommodation and the equipment therein shall be designed so that each person making proper use of these facilities will not suffer injury during craft's normal and emergency start, stop and manoeuvring in normal cruise and in failure or maloperation conditions.

7.2 Public address and information system.

7.2.1 A general emergency alarm system shall be provided. The alarm shall be audible throughout all the public spaces, corridors and stairways, crew accommodation and normal crew working spaces and open decks. The sound pressure level shall be at least 10 dB(A) above ambient noise levels under way in normal cruise operation. The alarm shall continue to function after it has been triggered until it is normally turned off or is temporarily interrupted by a message on the public address system.

7.2.2 A public address system shall cover all areas where passengers and crew have access, escape routes, and places of embarkation into survival craft. The system shall be such that flooding or fire in any compartment does not render other parts of the system inoperable. The public address system and its performance standards shall be approved by the Register.

7.2.3 All passenger craft shall be equipped with illuminated or luminous notices or video information system(s) visible to all sitting passengers, in order to notify them of safety measures.

7.2.4 The master of the craft shall, by means of the public address system and the visual information system, be able to request passengers "please be seated" when found to be appropriate to safeguard passengers.

7.3 Design acceleration levels.

7.3.1 Special precautions shall be taken with respect to passenger safety provided superimposed vertical accelerations at longitudinal centre of gravity of the craft are above 1,0*g*.

7.3.2 Passenger craft shall be designed for collision design acceleration g_{coll} with respect to the safety in, and escape from, the public, crew accommodation spaces and escape routes, including life-saving appliances and emergency source of power. The size and type of craft together with speed, displacement and building material shall be taken into consideration when collision load is determined. The collision design condition shall be based on head-on impact at a defined collision speed.

7.3.3 Mounting of large masses such as main engines, auxiliary engines, lift fans, transmissions and electrical equipment shall be proved by calculation to withstand, without fracturing, the design acceleration given in Table 7.3.3.

Table 7.3.3

Design acceleration as multiples of *g*

Direction	Types of craft	
	All HSC except amphibious ACVs	Amphibious ACVs
Forward direction	g_{coll}	6
After direction	2 or g_{coll} if less	3
Transverse direction	2 or g_{coll} if less	3
Vertical direction	2 or g_{coll} if less	3
g_{coll} = the collision design acceleration expressed as a multiple of the acceleration due to gravity (9,806 m/s^2).		

7.3.4 Collision design acceleration g_{coll} (for craft other than amphibious ACVs where $g_{coll} = 6$) shall be calculated as follows:

$$g_{coll} = 1{,}2(P/g\Delta) \leqslant 12. \quad (7.3.4\text{-}1)$$

The load P shall be taken as the lesser of P_1 and P_2:

$$P_1 = 460(MC_L)^{2/3}(EC_H)^{1/3}; \quad (7.3.4\text{-}2)$$

$$P_2 = 9000\ MC_L(C_H D)^{1/2}, \quad (7.3.4\text{-}3)$$

where M is the hull material factor taken as:
M = 1,3 for high-tensile steel;
M = 1,00 for aluminium alloy;
M = 0,95 for mild steel;
M = 0,8 for fibre-reinforced plastics;
C_L = the length factor determined from the formula:

$$C_L = \frac{(165+L)}{245}\left\{\frac{L}{80}\right\}^{0,4} \quad (7.3.4\text{-}4)$$

C_H = the height factor determined from the formula:
C_H = (80 – L)/45 but not greater than 0,75 or less than 0,3;
E = the kinetic energy of the craft at speed V_{imp} equal to:

$$E = 0{,}5V_{imp}^2\ ,$$

where L, D, Δ, V_{imp} and g are the main particulars of the craft:
L = craft length, in m;
D = depth of the craft from the underside of keel to the top of the effective hull girder, in m;
Δ = craft displacement, being the mean of the lightweight and maximum operational weight, in t;
V_{imp} = estimated impact speed, in m/s, equal to two-thirds operational speed;
g = acceleration due to gravity equal to 9,806 m/s^2.

For hydrofoils, the collision design acceleration, g_{coll}, shall be taken as the greater of either the g_{coll} as calculated above or:

$$g_{coll} = F/(g\Delta), \quad (7.3.4\text{-}5)$$

where F = failure load of bow foil assembly applied at the operational waterline, in kN.

7.3.5 As an alternative to the requirements of 7.3.3, the collision design acceleration g_{coll} may be determined by carrying out collision load analysis of the craft on a vertical rock having a maximum height of 2 m above the waterline and using the same assumption for displacement Δ and impact speed V_{imp} as described in 7.3.4. This evaluation may be carried out as part of the safety analysis. If the collision design accelerations are determined by both the formula given in 7.3.4 and the collision load analysis, the lower resulting value may be used as the collision design acceleration.

7.3.6 Limiting sea states for operation of the craft shall be given in normal operation condition and in the worst intended conditions, at operational speed and at reduced speed as necessary.

7.4 Accommodation design.

7.4.1 The public spaces, control stations and crew accommodation of the high-speed craft shall be located and designed to protect passengers and crew in the design collision condition. In this respect, these spaces shall not be located forward of a transverse plane (see Fig. 7.4.1) such that:

$$A_{bow} = 0{,}0035AmfV, \text{ but never less than } 0{,}04A,$$

where A_{bow} = the plan projected area of the craft energy absorbing structure forward of the transverse plane, in m^2;
A = total plan projected area of the craft, in m^2;
m = material factor = 0,95/M;
M = appropriate hull material factor as given in 7.3.4. Where materials are mixed, the material factor m shall be taken as a weighted mean weighted according to the mass of material in the area defined by A_{bow}.
f = framing factor as follows:
f = 0,8 – longitudinal deck and shell stiffening;
f = 0,9 – mixed longitudinal and transverse framing;
f = 1,0 – transverse deck and shell stiffening;
V = operational speed, in m/s.

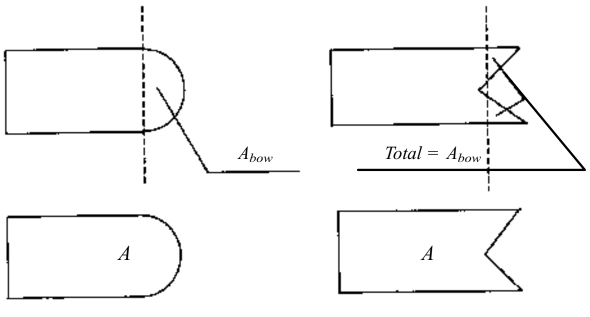


Fig. 7.4.1 Plan view of two different craft styles

7.4.2 The public spaces and crew accommodation shall be designed based on the guidelines given in Table 7.4.2 or by other methods approved by the Register, which have been proven to give equal protective qualities.

Table 7.4.2

Guidelines on general design characteristics[1]

Design level 1: g_{coll} less than 3	
1	Seat/seat belts
1.1	Low or high seatback
1.2	No restrictions on seating direction
1.3	Sofas allowed
1.4	No seat belts requirements
2	Tables in general allowed
3	Padding of projecting objects
4	Kiosks, bars, etc — no special restrictions
5	Baggage — no special requirements
6	Large masses — restrainment and location in certain position
Design level 2: g_{coll} = 3 to 12	
1	Seat/seat belts
1.1	High seatback with protective form and padding
1.2	Forward or backward seating direction
1.3	No sofas allowed as seat
1.4	Lap belt in seats when no protective structure in front
2	Tables with protective features allowed. Dynamic testing
3	Padding of projecting objects
4	Kiosks, bars, etc — on aft side of bulkheads, or other specially approved arrangements
5	Baggage placed with protection in front
6	Large masses — restrainment and location in certain position

[1]Other means may be used which ensure equal safety level.

7.4.3 Equipment and baggage in public spaces and in the operator's compartment shall be positioned and secured so that they remain in the stowed position when exposed to collision design acceleration according to 7.3.4 and 7.3.5 and Table 7.3.3.

7.4.4 Seats, life-saving appliances and items of substantial mass and their supporting structure shall not deform or dislodge under any loads up to those specified 7.3.4 and 7.3.5 and Table 7.3.3 in any manner that would impede subsequent rapid evacuation of passengers.

7.4.5 There shall be adequate handholds on both sides of any passage to enable passengers to steady themselves while moving around.

7.5 Seats construction.

7.5.1 A seat shall be provided for each passenger and crew member.

7.5.2 Seats fitted in addition to those required in 7.5.1 and which are not permitted to be used in hazardous navigational situations and potentially dangerous weather or sea conditions need not comply with 7.5 or 7.6. Such seats shall be secured according to 7.4.4 and it shall be clearly identified that they are not permitted for use in hazardous situations.

7.5.3 The installation of seats shall be such as to allow adequate access to any part of the accommodation space. They shall not obstruct access to any essential emergency equipment or means of escape.

7.5.4 Seats and their attachments, and the structure in proximity of the seats, shall have a form, design and construction such as to minimize the possibility of injury and to avoid trapping of passengers after the assumed damage in the collision design conditions according to 7.4.1. Dangerous projections and hard edges shall be eliminated or padded.

7.5.5 Seats and adjacent parts such as tables shall be designed for the collision design acceleration as specified in 7.3.4.

7.5.6 All seats, their supports and their deck attachments shall have good energy-absorbing characteristics and shall meet the requirements of Appendix to this Part.

7.6 Safety belts.

7.6.1 One-hand-release belts of three-point type or belts with shaller harness shall be provided for all seats from which the craft may be operated for all craft with collision design acceleration g_{coll} exceeding $3g$ (see 7.3.4).

7.6.2 Safety belts shall be provided for passenger seats and, if necessary, for crew members seats to ensure safety as specified in Appendix to this Part.

7.7 Exits and means of escape.

7.7.1 Easy, safe and quick access from the operating compartment to passenger accommodation spaces shall be provided. In order to ensure immediate assistance of the crew in an emergency situation, the crew accommodation spaces, including cabins, shall be located with due regard to easy, safe and quick access to public spaces.

7.7.2 The craft design shall be such that all occupants may safely evacuate the craft into survival craft under all emergency conditions, by day and by night. The positions of all exits, which may be used in an emergency, and of all life-saving appliances, the practicability of the evacuation procedure, and the evacuation time to evacuate all passengers and crew shall be demonstrated.

7.7.3 Public spaces, means of escape, exits, lifejackets stowage places, survival craft stowage places, and the embarkation stations shall be clearly and permanently marked and illuminated as required in Part XI "Electrical Equipment".

7.7.4 Each enclosed public space and similar permanently enclosed space allocated to passengers or crew shall be provided with at least two exits as widely separated as practical. All exits shall clearly indicate the directions to the evacuation station and safe areas. On category A craft and cargo craft, at least one exit shall give access to the evacuation station serving the persons in the enclosed space considered, and all other exits shall give access to a position on the open deck from which access to an evacuation station is provided. On category B craft, exits shall provide access to the alternative safe area required by 2.5.4, Part VI "Fire Protection"; external routes may be accepted providing that the requirement of 7.7.3 and 7.7.11 are complied with.

7.7.5 Subdivision of public spaces to provide refuge in case of fire may be required in compliance with the requirements 2.3.1 and 2.5.4, Part VI "Fire Protection".

7.7.6 Exit doors shall be capable of being readily operated from inside and outside the craft in daylight and in darkness. The means of operation shall be obvious, rapid and of adequate strength. Doors along escape flow shall, wherever appropriate, open in the direction of escape flow from the space served.

7.7.7 The closing, latching and locking arrangements for exits shall be such that it is readily apparent to the appropriate crew member when the doors are closed and in a safe operational condition, either in direct view or by an indicator. The design of external doors shall be such as to minimize the possibility of jamming by ice or debris.

7.7.8 The craft shall have a sufficient number of exits, which are suitable to facilitate the quick, and unimpeded escape of persons wearing approved lifejackets in emergency conditions, such as collision damage or fire.

7.7.9 Sufficient space for a crew member shall be provided adjacent to exits for ensuring the rapid evacuation of passengers.

7.7.10 All exits, together with their means of opening, shall be adequately marked for the guidance of passengers. Adequate marking shall also be provided for the guidance of rescue personnel outside the craft.

7.7.11 Footholds, ladders, etc., provided to give access from the inside to exits shall be of rigid construction and permanently fixed in position. Permanent handholds shall be provided whenever necessary to assist persons using exits, and shall be suitable for conditions when the craft has developed any possible angles of list and trim.

7.7.12 At least two unobstructed evacuation paths shall be available for the use of each person. Evacuation paths shall be disposed such that adequate evacuation facilities will be available in the event of any likely damage or emergency conditions. Evacuation paths shall have adequate lighting supplied from the main and emergency sources of power.

7.7.13 The width of corridors, doorways and stairways which form part of the evacuation paths shall be not less than 900 mm for passenger craft and 700 mm for cargo craft. This width may be reduced to 600 mm for corridors, doorways and stairways serving spaces where persons are not normally employed. There shall be no protrusions in evacuation paths, which could cause injury, ensnare clothing, damage lifejackets or restrict evacuation of disabled persons.

7.7.14 Adequate notices shall be provided to direct passengers to exits.

7.7.15 Provision shall be made on board for embarkation stations to be properly equipped for evacuation of passengers into life-saving appliances. Such provision shall include handholds, anti-skid treatment of the embarkation deck, and adequate space, which is clear of cleats, bollards and similar fittings.

7.7.16 Main propulsion machinery spaces and ro-ro spaces shall be provided with two means of escape leading to a position outside the spaces from which a safe route to the evacuation stations is available. One means of escape from the main propulsion machinery spaces shall avoid direct access to any ro-ro space. Main propulsion machinery spaces having a length of less than 5 m and not being routinely entered or continuously manned, may be provided with a single means of escape.

7.8 Baggage rooms, stores and cargo compartments.

7.8.1 Provision shall be made to prevent shifting of baggage, stores and cargo compartment contents, having due regard to occupied compartments and acceleration likely to arise. If safeguarding by positioning is not practicable, adequate means of restraint for baggage, stores and cargo shall be provided. Shelves and overhead shelves for storage of carry-on baggage in public spaces shall be provided with adequate means to prevent luggage from falling out in any conditions that may occur.

7.8.2 Controls, electrical equipment, high-temperature parts, pipelines or other items, the damage or failure of which could affect the safe operation of the craft or which may require access by crew members during a voyage, shall not be located in baggage, store and cargo compartments unless such items are adequately protected so that they cannot be damaged or operated inadvertently by loading, by unloading or by movement of the contents of the compartment.

7.8.3 Loading limits, if necessary, shall be durably marked in those compartments.

7.8.4 Having regard to the purpose of the craft, the closures of the exterior openings of the baggage and cargo compartment as well as special category spaces shall be appropriately weathertight.

8 GUARD RAILS, BULWARKS

8.1 Guard rails or bulwarks shall be fitted on all exposed parts of decks to which crew or passengers have access. Alternative arrangements such as safety harnesses and jack-stays may be accepted if they provide an equivalent level of safety. The height of the bulwarks or guard rails shall be at least 1 m from the deck. Where this height would interfere with the normal operation of the craft, a lesser height may be approved on agreement with the Register.

8.2 The opening below the lowest course of the guard rails shall not exceed 230 mm. The other courses shall be not more than 380 mm apart. In case of craft with rounded gunwales the guard rail supports shall be placed on the flat of the deck.

8.3 Satisfactory means (in the form of guard rails, life lines, gangways or underdeck passages, etc.) shall be provided for the protection of the crew in getting to and from their quarters, the machinery space and all other parts used in the necessary work of the craft.

8.4 Deck cargo carried on any craft shall be so stowed that any opening which is in way of the cargo and which gives access to any space used in the work of the craft can be properly closed and secured against the admission of water. Effective protection for the crew in the form of guard rails or life lines shall be provided above the deck cargo if there is no convenient passage on or below the deck of the craft.

9 EMERGENCY OUTFIT

9.1 The provision of emergency outfit shall be governed by a structural type of HSC and conditions of its operation and is subject to special consideration by the Register in each case. In all cases, emergency outfit shall include a lightened soft collision mat and wooden bars.

9.2 Emergency outfit shall be stored at least in two emergency stations, one of which shall be in the machinery space. Emergency stations may be special places, boxes or places allocated on deck or in spaces. In the emergency station of the machinery space the outfit necessary for carrying out the emergency operations inside the space shall be stored; the rest of emergency outfit shall be stored in the emergency stations located above the bulkhead decks. On ships of less than 45 m in length it is allowed to locate the emergency station below the bulkhead deck on condition that free access to the station is provided. On ships 31 m in length and below it is allowed to store emergency outfit only in one emergency station.

9.3 A free passage shall be provided in front of the emergency station; the width of the passage shall be selected depending on the overall dimensions of the outfit stored in the station but not less than 0,8 m. On ships 31 m in length and less, the width of the passage may be reduced to 0,6 m.

Passages to emergency stations shall be straight and short as far as practicable.

9.4 Items of emergency outfit (other than collision mats) or cases for their storage shall be painted blue either entirely or in stripes. Cases for emergency equipment shall have a distinct inscription showing the name of the material, weight and warranted storage period.

9.5 Emergency stations shall be provided with distinct inscriptions "Emergency station". In addition, notices showing location of the emergency station shall be posted in passages and on decks.

APPENDIX

CRITERIA FOR TESTING AND EVALUATION OF REVENUE AND CREW SEATS

1. PURPOSE AND SCOPE

1.1 This Appendix shall provide requirements for revenue and crew seats, seat anchorage and seat accessories and their installation to minimize occupant injury and/or obstacles for evacuation of people if the craft suffers a collision.

2. STATIC SEAT TESTS

2.1 The requirements of this Section are applicable to all crew and revenue seats.

2.2 All seats to which this Section applies, along with their supports and deck attachments, shall be designed to withstand at least the following static forces applied in the direction of the craft:

.1 forward direction — a force of 2,25 kN;

.2 after direction — a force of 1,5 kN;

.3 transverse direction — a force of 1,5 kN;

.4 vertically downward — a force of 2,25 kN;

.5 vertically upward — a force of 1,5 kN.

A seat shall comprise a frame, bottom and back. Forces applied in the fore or aft direction of the seat shall be applied horizontally to the seat back 350 mm above the seat bottom. Forces applied in the transverse seat direction shall be applied horizontally to the seat bottom. Vertical upward forces shall be evenly distributed to the corners of the seat bottom frame. Vertical downward forces shall be uniformly distributed over the seat bottom. If a seating unit consists of more than one seating position, these forces shall be applied at each seating position concurrently during the tests.

2.3 When the forces are applied to a seat, consideration shall be given to the direction in which the seat shall face in each craft. For example, if the seat faces sideways, the transverse craft force is applied fore and aft to the seat and the forward craft force is applied transversely to the seat.

2.4 Each seating unit to be tested shall be attached to the support structure similar to the manner in which it will be attached to the deck structure in the craft. Although a rigid support structure can be used for these tests, a support structure, having the same strength and stiffness as the support structure in the craft, is preferred.

2.5 The forces described in 2.2.1 to 2.2.3 shall be applied to a seat through a cylindrical surface having a radius of 80 mm and a width at least equal to the width of the seat. The surface shall be equipped with at least one force transducer able to measure the forces applied.

2.6 The seat shall be considered acceptable if:

.1 under the influence of the forces referred to in 2.2.1 to 2.2.3, the permanent displacement measured at the point of application of the force is not more than 400 mm;

.2 no part of the seat, the seat mountings or the accessories become completely detached during the tests;

.3 the seat remains firmly held, even if one or more of the anchorages is partly detached;

.4 all of the locking systems remain locked during the entire test but the adjustment and locking systems need not be operational after the tests; and

.5 rigid parts of the seat with which the occupant may come into contact shall present a curved surface with a radius of at least 5 mm.

2.7 The requirements of Section 3 may be used in lieu of the requirements of this section provided that the accelerations used for the tests are at least 3*g*.

3. DYNAMIC SEAT TESTS

3.1 The requirements of this Section are applicable in addition to those in 2.1 for crew and revenue seats in craft having a design collision load of 3*g* or greater.

3.2 All seats for which this Section applies, the seat supporting structure, the attachment to the deck structure, the lap belt, if installed, and shaller harness, if installed, shall be designed to withstand the maximum acceleration force that can be imposed upon them during a design collision. Consideration shall be given to the orientation of the seat relative to the acceleration force (i. e. whether the seat is forward-, aft-, or side-facing).

3.3 The acceleration pulse to which the seat is subjected shall be representative of the collision time-history of the craft. If the collision time-history is not known, or cannot be simulated, the acceleration time-history envelope shown in the figure can be used.

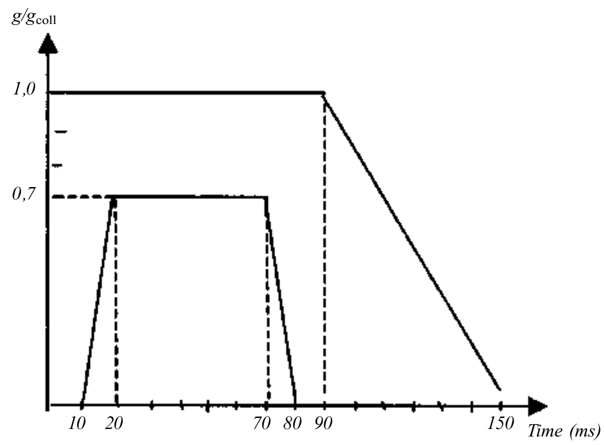


Fig. 3.3 Acceleration time-history envelope

3.4 In the test frame, each seat unit and its accessories (e. g., lap belts and shaller harnesses) shall be attached to the support structure similar to the manner in which it will be attached in the craft. The support structure can be a rigid surface; however, a support structure having the same strength and stiffness as the support structure in the craft is preferred. Other seats and/or tables with which the occupant may come in contact during a collision shall be included in the test frame in orientation and with a method of attachment typical of that in the craft.

3.5 During the dynamic seat test, a fiftieth percentile anthropomorphic test dummy, suitable for the test being conducted, shall be placed in the seat in an upright seating position. If a typical seating unit is composed of more than one occupant seat, a test dummy shall be placed in each occupant seat in the unit. The dummy, or dummies, shall be secured in the seat unit in accordance with procedures recognized by the Register and be secured using only the lap belt and shaller harness if they are installed. The tray tables and other such devices shall be placed in the position that would cause the greatest potential for an occupant to become injured.

3.6 The test dummy shall be instrumented and calibrated in accordance with the requirements of a recognized national standard, so as to permit, as a minimum, calculation of the head injury criterion, calculation of the thoracic trauma index, measurement of force in the femur, and measurement, if possible, of extension and flexion of the neck.

3.7 If more than one dummy is used in the tests, the dummy located in the seat having the highest potential for an occupant to be injured shall be the one instrumented. The other dummy or dummies need not be instrumented.

3.8 The tests shall be conducted and the instrumentation shall be sampled at a rate sufficient to reliably show response of the dummy in accordance with the requirements of standard ISO 6487.

3.9 The seat unit tested in accordance with the requirements of this Section shall be considered acceptable if:

.1 the seat unit and tables installed in the seat unit do not become dislodged from the supporting deck structure and do not deform in a manner that would cause the occupant to become trapped or injured;

.2 the lap belt, if installed, remains attached and on the test dummy's pelvis during the impact. The shaller harness, if installed, remains attached and in the immediate vicinity of the test dummy's shaller during the impact. After the impact, the release mechanisms of any installed lap belt and shaller harness shall be operative;

.3 the following acceptability criteria are met:

.3.1 the head injury criterion (HIC), calculated in accordance with the formula, does not exceed 500:

$$HIC = (t_2 - t_1)\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} a(t)dt\right]^{2,5},$$

where t_1 and t_2 are the beginning and ending time (in seconds) of the interval in which the HIC is a maximum. The term $a(t)$ is the resultant measured acceleration in the head of the dummy, in g;

.3.2 the thoracic trauma index (TTI), calculated in accordance with the formula, does not exceed $30g$ except for periods totalling less than 3 ms:

$$TTI = \frac{g_r - g_{ls}}{2}$$ or acceleration at the center of gravity

where g_r is the acceleration, in g, of either upper or lower rib;
g_{ls} is the acceleration, in g, of lower spine;

.3.3 the force in the femur does not exceed 10 kN except that it cannot exceed 8 kN for periods totalling more than 20 ms;

.4 loads on the upper torso harness straps do not exceed 7,8 kN or a total of 8,9 kN if dual strap are used.

PART IV. STABILITY

1 SCOPE OF APPLICATION

1.1 This Part applies to the enclosed (decked) type craft.

1.2 The requirements of this Part do not apply to the light-craft loading condition.

2 DEFINITIONS AND EXPLANATIONS

2.1 Definitions and explanations relating to general terminology are given in "General" of the present Rules and in Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships.

2.2 For the purpose of this Part, the following additional definitions are given.

Air-cushion skirt is a downwardly extending, flexible structure used to contain or divide an air cushion.

Multihull craft is a craft which, in any normally achievable operating trim or heel angle, has a rigid hull structure which penetrates the surface of the sea over more than one discrete area.

Monohull craft means any craft, which is not a multihull craft.

Fully submerged foil is a foil having no lift components piercing the surface of the water in the foil-borne mode.

Downflooding point means any opening, irrespective of size, that would permit passage of water through a water/weathertight structure (e.g. opening windows), but excludes any opening kept closed in compliance with the requirements of Chapter 6, Part III "Arrangements, Equipment and Outfit" at all times other than when required for access or for operation of portable submersible bilge pumps in an emergency (e.g. non-opening windows of similar strength and weathertight integrity to the structure in which they are installed).

Hull slope angle is an angle lying in the vertical plane perpendicular to the craft side or bow or stern and measured along the shortest arc between the base line and the lowest knuckle of the craft side or bow or stern (Fig. 2.2).

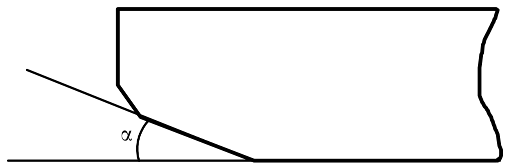


Fig. 2.2

3 GENERAL TECHNICAL REQUIREMENTS

3.1 All crafts shall be provided with stability characteristics and stabilization systems adequate for safety:

when the craft is operated in the displacement, operational (non-displacement) modes and during the transitional mode;

in transfer of the craft from any mode to the displacement mode in case of any system malfunction.

3.1.1 Stability may be verified by calculation and/or experimental methods.

Other means of demonstrating compliance with the requirements of this Part may be accepted, provided that the method chosen can be shown to provide an equivalent level of safety. Such methods may include:

mathematical simulation of dynamic behaviour;

scale model testing;

full-scale trials.

The adequacy of mathematical simulations shall be demonstrated by correlation with full-scale or model tests for the appropriate type of craft. It may be appropriate to use mathematical simulations to help to identify the more critical scenarios for subsequent physical testing.

Model or full-scale trials and/or calculations (as appropriate) shall also include consideration of the following known stability hazards to which high-speed craft are known to be liable, according to craft type:

.1 directional instability, which is often coupled to roll and pitch instabilities;

.2 broaching and bow diving in following seas at speeds near to wave speed, applicable to most types;

.3 bow diving of planing monohulls and catamarans due to dynamic loss of longitudinal stability in relatively calm seas;

.4 reduction in transverse stability with increasing speed of monohulls;

.5 porpoising of planing monohulls, being coupled pitch and heave oscillations, which can become violent;

.6 chine tripping, being a phenomenon of planing monohulls occurring when the immersion of a chine generates a strong capsizing moment;

.7 plough of air-cushion vehicles, either longitudinal or transverse, as a result of bow or side skirt tuck-under or sudden collapse of skirt geometry, which, in extreme cases, can result in capsize;

.8 pitch instability of SWATH (small waterplane area twin hull) craft due to the hydrodynamic moment developed as a result of the water flow over the submerged lower hulls;

.9 reduction in effective metacentric height (roll stiffness) of surface effect ship (SES) in high speed turns compared to that of straight course, which can result in sudden increase in heel angle and/or coupled roll and pitch oscillations; and

.10 resonant rolling of SES in beam seas, which, in extreme cases, can result in capsize.

Verification procedures and calculation programmes shall be approved by the Register.

3.1.2 Stability characteristics of the designed HSC in the displacement mode may be determined using calculation methods; in the operational and transitional modes, by calculations or experimentally by testing a model of the designed craft or on the basis of the results of full-scale trials of the craft prototype.

For craft having a distinguishing mark **AUTstab** in the class notation, data proving sufficient stability of the craft in case of possible failures in the stabilization controls and their drives shall be presented.

3.1.3 Stability characteristics of the craft shall be finally corrected in the displacement mode in accordance with the inclining test results (4.1), in the operational and transitional modes according to the experimental data.

An ability of the craft to keep the operational and transitional modes under the worst intended conditions shall be proved experimentally during delivery seaworthiness trials of the craft.

Suitable calculations shall be carried out and/or tests conducted to demonstrate that, when operating within approved operational limitations, the craft will, after a disturbance causing roll, pitch, heave or heel due to turning or any combination thereof, return to the original attitude.

Where calculations are employed, it shall first be shown that they correctly represent dynamic behaviour within the operational limitations of the craft.

3.2 HSC stability shall be verified for the loading conditions referred to in 13.1.1, 13.1.2, 13.2.1 of the present Rules.

3.3 If in the process of normal service of a craft the worse loading variants with regard to stability are intended in comparison with those mentioned in 3.2, the stability for those loading variants shall be verified also.

3.4 The requirements of 1.4.1, 1.4.2.1 to 1.4.2.3, 1.4.2.5 to 1.4.7, 1.4.9 and 1.4.10, Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships apply to HSC in the displacement mode. Calculations of HSC stability levers shall be carried out with respect to accompanying trim.

3.5 Unless provided otherwise, the requirement of 12.2 shall be met in the transitional mode under conditions referred to in 3.2; the maximum angles of heel shall not exceed 15°.

3.6 On completion of loading of the craft and prior to its departure on a voyage, the master shall determine the trim and stability of the craft and also to ascertain and record in the ship's log that the craft is in compliance with stability criteria of the relevant requirements. The Register may accept the use of an electronic loading and stability computer or equivalent means for this purpose.

4 INCLINING AND STABILITY INFORMATION

4.1 Every craft, on completion of build, shall be inclined and the elements of its stability determined. When an accurate inclining is not practical, the lightweight displacement and centre of gravity shall be determined by a lightweight survey and accurate calculation.

4.2 Where an accurate inclining experiment is impractical owing to the height of the centre of gravity (KG) being less than one third of the initial transverse metacentric height (GM_T), the Register may accept estimation of KG by detailed calculation in place of an inclining test. In such a case, the lightweight check shall be undertaken to confirm the calculated light-ship characteristics, including the longitudinal center of gravity of the craft. The calculation results may be accepted as true if the data resulting from the light-weight check differ from the measured ones for not more than 2 per cent by the light-ship displacement and for not more than 1 per cent of the ship's length between perpendiculars by the light-ship longitudinal centre of gravity.

4.3 The master shall be supplied by the owner with reliable information relating to the stability of the craft in accordance with the provisions of this Section. The Information on Stability shall, before being issued to the master, be submitted to the Register for approval, together with a copy thereof for their retention.

The Information on Stability of a HSC shall incorporate the information on provision of stability of the craft in different modes of operation, as well as all the restrictions specified for the craft, such as distances allowed to proceed from a place of refuge and navigation seasons, sea state and wave height, angles to safely put the rudder over from one side to the other, etc. In compiling the Information on Stability, one shall be guided by Appendix 1, Part IV

"Stability" of the Rules for the Classification and Construction of Sea-Going Ships, having regard to specific features of HSC and the requirements of the present Rules.

4.4 Where any alterations are made to a craft so as significantly to affect the Information on Stability supplied to the master, amended Information on Stability shall be provided. If necessary the craft shall be re-inclined.

4.5 A report on each inclining or lightweight survey (weighting) carried out in accordance with the present Rules and of the calculation therefrom of the lightweight condition particulars shall be submitted to the Register for approval, together with a copy for their retention. The approved report shall be placed on board the craft by the owner in the custody of the master and shall incorporate such additions and amendments as the Register may in particular case require.

4.6 Following any inclining or lightweight survey, the master shall be supplied with amended Information on Stability if the Register so requires. The Information on Stability shall be submitted to the Register for approval, together with a copy thereof for their retention, and shall incorporate such additions and amendments as the Register may in each particular case require.

4.7 Information on Stability demonstrating compliance with this Part shall be furnished in the form of a Information on Stability book which shall be kept on board the craft at all times in the custody of the master. The Information shall include particulars appropriate to the craft and shall reflect the craft loading conditions and mode of operation. Any enclosed superstructures or deckhouses included in the cross curves of stability and the critical downflooding points and angles shall be identified.

At the operating station there shall be plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with their means of closure and position of any controls thereof.

4.8 Every craft shall have scales of draughts marked clearly at the bow and stern. In the case where the draught marks are not located where they are easily readable, or operational constraints for a particular trade make it difficult to read the draught marks, then the craft shall be also fitted with a readable draught-indicating system by which the bow and stern draughts can be determined.

For amphibious air-cushion vehicles this may be achieved by the use of draught gauges in conjunction with deck datum plates.

4.9 The owner or builder, as appropriate, shall ensure that the positions of the draught marks are accurately determined and that the marks are located on the hull in a permanent manner. Accuracy of the draught marks shall be demonstrated to the Register prior to inclining experiment.

4.10 The requirements of 1.5, Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships, apply to HSC.

4.11 Other methods of determining the displacement and centre of mass coordinates of the lightweight craft may be used upon agreement with the Register.

5 DEPARTURES FROM THE RULES

5.1 The requirements of 1.3.4, "General Regulations for the Classification and Other Activity" of the Rules for the Classification and Construction of Sea-Going Ships apply to HSC.

5.2 The Register may apply additional requirements for craft stability in the operational and transitional modes of HSC fitted with automatic stabilization systems the components of which may affect the value of heel.

6 CONDITIONS OF SUFFICIENT STABILITY

6.1 In the worst loading condition in respect of stability out of those referred to in 3.2, stability of the craft shall meet the following requirements:

.1 a craft without capsizing in the displacement mode and without losing the mode in the operational mode shall withstand simultaneous action of a dynamically applied wind pressure and rolling the parameters of which shall be determined in accordance with the requirements given below;

.2 numerical values of parameters of static stability curve in the displacement mode and the value of the corrected initial metacentric height in all modes shall not be lower than those indicated in this Part;

.3 icing effect shall be taken into account in compliance with Section 11 of this Part;

.4 stability in service shall comply with the requirements of Section 12 of this Part;

.5 craft stability shall meet the additional requirements contained in Section 13 of this Part.

6.2 Where the characteristics of multihull craft are inappropriate for application of the requirements of Section 13 or the characteristics of monohull craft are inappropriate for application of the requirements of Sections 8 and 9, the Register may accept alternative criteria equivalent to those stipulated, as appropriate to the type of the craft and area of operation. The requirements of Sections 8, 9, 10 and 13 may be applied as indicated in Table 6.2.

Table 6.2

Application of the requirements for stability of monohull and multihull craft

GM_T	Angle of maximum righting lever GZ	
	⩽25°	> 25°
⩽3 m	Sections 8, 9, 10 and 13	Sections 8, 9, 10
> 3 m	Sections 13	Sections 8, 9 and 13
GM_T = initial transverse metacentric height, in m, under the load corresponding to the design waterline corrected for free surface effects of liquids.		

7 PASSAGE OF CRAFT FROM ONE PORT TO ANOTHER

7.1 The requirements of Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships apply to HSC.

8 GENERAL REQUIREMENTS FOR STABILITY

8.1 Weather criterion.

8.1.1 Operation of HSC is restricted by weather conditions. The conditions are assigned depending on the intended routes and are specified more exactly based on the results of trials during delivery seaworthiness trials of the first and any craft of series as required by the Register.

8.1.2 In the displacement mode stability of HSC other than hydrofoils and multihull craft is considered sufficient as regards weather criterion if the craft can withstand the combined effects of steady wind and rolling with reference to the following:

.1 the craft is subjected to a steady wind pressure acting perpendicular to the craft centreline which results in a steady wind heeling lever HL_1 (see Fig. 8.1.2.1);

.2 from the resultant angle of heel θ_h, the craft is assumed to roll owing to wave action to an amplitude of rolling θ_r to windward;

.3 the craft is then subjected to a gust wind pressure which results in a gust wind heeling lever HL_2;

.4 the areas *a* and *b* are compared (shaded areas in Fig. 8.1.2.1). The area *b* is bounded by the righting lever curve, a straight line corresponding to lever HL_2 and an angle of heel:

50° or angle of heel θ_c which corresponds to the second intercept between wind heeling lever HL_2 and the righting lever curve; or

angle of heel θ_d corresponding to the angle of downflooding, whichever is less.

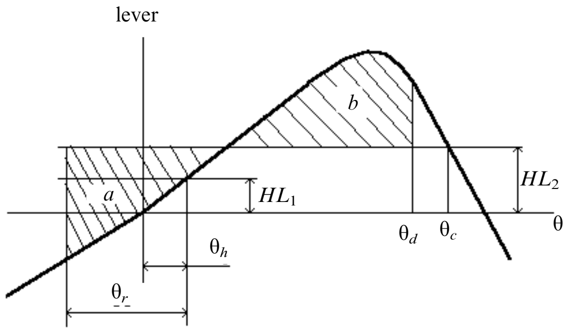


Fig. 8.1.2.1
θ_h = angle of heel under action of steady wind;
θ_r = angle of rolling;
θ_d = angle of downflooding;
θ_c = angle of second intercept between a straight line HL_2 and *GZ* curve;
HL_1 = steady wind heeling lever;
HL_2 = gust wind heeling lever

The area *a* is bounded by the righting lever curve, a straight line HL_2 and an angle of heel corresponding to amplitude of rolling θ_r.

Craft stability is considered sufficient as regards weather criterion if area *b* is equal to or greater than area *a*;

.5 the permissible angle of heel θ_0 due to steady wind shall not exceed 16° or the angle equal to 0,8 times the angle of deck edge immersion, whichever is less. In this case, where the angle of heel exceeds 10°, efficient non-slip deck surfaces and suitable holding points shall be provided as specified in 4.4.1.1, Part V "Reserve of Buoyancy and Subdivision";

.6 the wind heeling lever HL_1, in m, is assumed to be a constant value at all angles of inclination and shall be calculated as follows:

$$HL_1 = \frac{PAZ}{1000g\Delta}, \qquad (8.1.2.6)$$

where: $P = 500\left(\frac{V_w}{26}\right)^2$ — steady wind pressure, in N/m²;

V_w = wind speed corresponding to the worst intended conditions, in m/s;
Z = windage area lever; it is assumed equal to the vertical distance from the centre of windage to the centre of the waterline lateral area or approximately to a point at one half of the draught, in m;
A = windage area, in m²;
Δ = displacement of the craft, in t;
g = 9,81 m/s².

The heeling lever HL_2 is equal to 1,5 HL_1.

In assessing the roll angle θ_r account shall be taken of the roll damping characteristics of individual craft, which may alternatively be derived from model or full-scale tests using the procedure for determining the angle θ_r given in 13.3.1.2.1.5.3. Hulls with features, which greatly increase damping, such as immersed sidehulls, substantial arrays of foils, or flexible skirts, are likely to experience significantly smaller magnitudes of roll angle. For such craft, therefore, the roll angle shall be derived from model or full-scale tests or, in the absence such data, shall be taken as 15°.

8.1.3 Amplitudes of rolling are determined in the following manner:

.1 amplitudes of rolling for the displacement and operational modes shall be calculated using the procedures agreed with the Register or obtained from the data of experimental studies;

.2 if calculations or the data of experimental studies are lacking, the amplitude of rolling is assumed to be equal to $\theta_r = 15°$;

.3 in determining the amplitude of rolling by means of experiments, it shall be determined as an amplitude of irregular rolling with 2 per cent of exceeding level and craft beam to the waves the intensity of which corresponds to:

in the operational mode — the worst intended conditions;

in the displacement mode — critical design conditions;

.4 the amplitude of rolling of an air-cushion vehicle in the operational mode is assumed equal to that in the cushion-borne mode; for all types of HSC in the displacement mode it shall be determined for the craft without motion.

8.1.4 The assumed design moment of losing the operational mode M'_c shall be determined by a method approved by the Register. The recommended procedure for determination of M'_c is given in Appendix 1 to this Part.

9 STATIC STABILITY CURVE

9.1 The area under the righting lever curve (*GZ* curve) shall not be less than 0,07 m·rad up to $\theta = 15°$ when the maximum righting lever (*GZ*) occurs at $\theta = 15°$ and 0,055 m·rad up to $\theta = 30°$ when the maximum righting lever (*GZ*) occurs at $\theta = 30°$ or over. Where the maximum righting lever occurs at angles of heel between $\theta = 15°$ and $\theta = 30°$, the corresponding area under the righting moments curve shall be not less than:

$$A = 0{,}055 + 0{,}001\ (30° - \theta_{max}),\ \text{m·rad}, \qquad (9.1)$$

where θ_{max} = the angle of heel, in deg., at which the righting lever reaches its maximum.

9.1.1 The area under the righting lever curve between $\theta = 30°$ and $\theta = 40°$ or between $\theta = 30°$ and the angle of flooding θ_f, if this angle is less than 40°, shall not be less than 0,03 m·rad.

9.1.2 The righting lever *GZ* shall be at least 0,20 m at an angle of heel equal to or greater than 30°.

9.1.3 The maximum righting lever shall occur at an angle of heel not less than 15°.

9.2 Characteristics of static stability curves of air-cushion vehicles in the cushion-borne mode shall be determined according to the methods approved by the Register.

10 METACENTRIC HEIGHT

10.1 The corrected initial metacentric height under all loading conditions and in all modes shall be not less than 0,15 m.

11 ALLOWANCE FOR ICING

11.1 The possibility of HSC operation under conditions of likely icing and design rate of icing are subject to special consideration by the Register in each particular case.

The recommended method of taking allowance for icing is given in Appendix 2.

12 STABILITY IN SERVICE

12.1 The stability of the craft in the displacement mode shall be such that, when in still water conditions, the inclination of the craft from the horizontal in any direction would not exceed 10° under all permitted cases of loading and uncontrolled passenger movements as may occur.

Hydrofoil craft fitted with surface-piercing and/ or fully submerged foils shall have sufficient stability under all permitted cases of loading to comply with the relevant provisions of 13.3 and maintain a heel angle of less than 10° when subjected to the greater of the heeling moments referred to in 13.3.1.2.

12.2 Under weather conditions up to the worst intended conditions, the time to pass from the displacement mode to the operational mode and vice versa shall not exceed 2 min unless it is proved to the Register that no substantial reduction of stability occurs during this transition.

12.3 It shall be proved by calculations or by tests that in the operational and transitional modes within the approved operational limitations, the craft will, after a disturbance causing heel, pitch, heave, roll or any combination thereof, return to the original attitude without occurrence of natural oscillations.

12.4 It shall be proved that no forces will arise in the operational mode on surface-piercing structures or appendages subsequent to collision with floating or submerged objects which might result in dangerous heel, trim or loss of stability.

12.5 It shall be proved that in case of any fault of the craft that can adversely affect stability in the transitional and operational modes provision is made for the safe transition of the craft into the displacement mode.

12.6 An inward angle of heel due to turning shall be provided in still water in the operational mode. Otherwise, it shall be proved to the Register that turning of the craft at the speeds and angles of putting-over of the steering controls where the inward angle of heel is not provided will be safe. In all cases, the heel due to turning shall not exceed 8°.

12.7 Stability of the craft in the following sea in the operational mode shall be proved by testing a full-scale craft. In the following and quartering seas under the worst permissible conditions and the worst loading condition as regards stability as well as in case of turning under such conditions from the following sea to the head sea, the maximum angle of heel shall not exceed the angle of flooding or 0,6 of the angle corresponding to the lever HL_2 according to 8.1.2 or 12°, whichever is the less.

For the verification of characteristics of stability under the worst permissible conditions model tests shall be used. The method of model tests shall be approved by the Register.

12.8 The verification methods under 12.1 to 12.7 and the restrictions set up shall be agreed with the Register.

13 ADDITIONAL REQUIREMENTS FOR STABILITY

13.1 Requirements for passenger craft.

13.1.1 Stability of HSC shall be verified for the following loading conditions:

the craft with full muster of passengers and cargo, and with full stores;

the craft with full muster of passengers and cargo and 10 per cent of stores;

the craft without passengers and cargo, and with 10 per cent of stores.

The distribution of passengers, their mass and the position of their centre of gravity shall be assumed in compliance with the guidelines given below:

.1 the distribution of passengers is 4 persons per square metre;

.2 each passenger has a mass of 75 kg;

.3 vertical centre of gravity of seated passengers is 0,3 m above the seat;

.4 vertical centre of gravity of standing passengers is 1,0 m above the deck;

.5 passengers and luggage are considered to be in the space normally at their disposal;

.6 passengers shall be distributed on available deck areas towards one side of the craft on the decks where assembly stations are located and in such a way that they produce the most adverse heeling moment;

.7 passengers assumed to be occupying seats shall be taken as having a vertical centre of gravity corresponding to being seated, with all others standing;

.8 on the decks where assembly stations are located, the number of passengers on each deck shall be that which generates the maximum heeling moment. Any remaining passengers shall be assumed to occupy decks adjacent to those on which the assembly stations are located, and positioned such that the combination of number on each deck and the total heeling moment generate the maximum static heel angle;

.9 passengers shall not be assumed to gain access to the weather deck nor be assumed to crowd abnormally towards either end of the craft unless this is a necessary part of the planned evacuation procedure;

.10 where there are seats in areas occupied by passengers, one passenger per seat shall be assumed, passengers being assigned to the remaining free areas of the deck (including stairways, if appropriate) at the rate of four per square metre.

13.1.2 Stability of passenger HSC in all modes shall be additionally verified in still water for the loading condition with full muster of passengers and cargo, and with 10 per cent of stores but with 50 per cent of passengers seated on one side from the centreline of the craft. The other 50 per cent of passengers are accommodated in fore-and-aft passages between the seats according to 3.1.6 to 3.1.8, Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships.

13.1.3 The experimental checking of the lateral stability of a full-scale HSC shall be made in the following manner:

a force equal to at least twice the double heeling moment is applied to the craft by moving solid ballast; the corresponding angles of heel and trim in the displacement, transitional and operational modes are measured.

The maximum heeling moment shall be not less than the moment which corresponds to the loading condition according to 13.1.2.

The conditions for the experimental checking of the longitudinal stability of HSC are subject to special agreement with the Register in each case.

13.1.4 The requirement of 12.1 shall be met for each passenger craft.

13.1.5 Stability of a craft in the non-displacement mode:

.1 the total angle of heel in still water due to the effect of passengers movements or due to beam wind pressure as per 13.3.1.2.1.4 shall not exceed 10°;

.2 under all loading conditions, the outward angle of heel due to turning shall not exceed 8°, and the total angle of heel due to beam wind pressure as per 13.3.1.2.1.4 and due to turning shall not exceed 12° outward.

13.1.6 Verification of the effects produced by the passenger heeling moment calculated as given in 13.1.1.1 to 13.1.1.10, or by a defined beam wind pressure when at speed, shall be carried out by comparing results of a trial or model test with an equivalent heeling moment applied by test weights. Passenger movement may only be neglected on craft where the safety announcement expressly requires passengers to remain seated throughout the voyage.

13.1.7 Inclining tests and Information on Stability.

13.1.7.1 At periodical intervals not exceeding 5 years, a light-weight check shall be carried out on all passenger crafts to verify any changes in light-weight displacement and longitudinal centre of gravity. The passenger crafts shall be re-inclined whenever, in comparison with the approved Information on Stability, a deviation from the lightweight displacement exceeding 2 per cent, or a deviation of the longitudinal centre of gravity exceeding 1 per cent of L is found or anticipated.

13.1.7.2 A report on each inclining test or lightweight check carried out in accordance with 4.1 and of the calculation therefrom of the lightweight condition particulars shall be submitted to the Register for approval, together with a copy for their retention. The approved report shall be placed on board the craft by the owner in the custody of the master and shall incorporate such additions and amendments as the Register may in particular case require.

13.1.7.3 Following any inclining test or light-weight check, the master shall be supplied with amended Information on Stability if the Register so requires. The Information on Stability shall be submitted to the Register for approval, together with a copy thereof for their retention, and shall incorporate such additions and amendments as the Register may in each particular case require.

13.2 Requirements for cargo crafts.

13.2.1 Stability of cargo crafts shall be verified for the following loading conditions:

.1 the craft with full cargo and full stores;

.2 the craft with full cargo and 10 per cent of stores;

.3 the craft without cargo and with 10 per cent of stores.

13.2.2 Inclining tests.

Where it is satisfied by light-weight check or other demonstration that the lightweight displacement of a craft is closely similar to that of another craft of the series, which has been inclined, the Register may waive the requirement for the craft to be inclined, provided the craft lies within the parameters of 13.1.5.1, when compared with a craft of the series which has been inclined.

13.3 Special requirements for stability of hydrofoils, air-cushion vehicles and multihull crafts.

13.3.1 Hydrofoils.

13.3.1.1 The stability of these crafts shall be considered in the hull-borne, transitional and foil-borne modes under all permissible loading conditions. The stability investigation shall also take into account the effects of external forces.

The requirements of this Section shall be applied on the assumption that any stabilisation systems fitted are fully operational.

The roll and pitch stability on the first and/or any other craft of a series shall be qualitatively assessed during operational safety trials. The results of such trials may indicate the need to impose operational limitations.

13.3.1.2 Hydrofoils fitted with surface-piercing foils.

13.3.1.2.1 Displacement mode:

.1 hydrofoils fitted with surface-piercing foils shall have sufficient stability under all permitted loading conditions to comply with the relevant provisions of this paragraph and specifically to maintain an angle of heel of less than 10° when subjected to the greater of the heeling moments referred to in 13.3.1.2.1.2 and 13.3.1.2.1.4;

.2 the heeling moment developed during manoeuvring.

The heeling moment developed during manoeuvring of the craft may be derived from the following formula:

$$M_R = 0{,}196(V_0^2/L)\Delta KG, \qquad (13.3.1.2.1.2)$$

where M_R = heeling moment, in kN·m;
V_0 = speed of the craft in the turn, in m/s;
Δ = displacement, in t;
L = length of the craft on the waterline, in m;
KG = height of the centre of gravity above keel, in m.

This formula is applicable when the ratio of the radius of the turning circle to the length of the craft is 2 to 4;

.3 weather criterion.

The stability of a hydrofoil in the displacement mode shall be verified for compliance with the weather criterion k according to the formula:

$K = M_c/M_v \geqslant 1$, (13.3.1.2.1.3)

where M_c = minimum capsizing moment as determined when account is taken of rolling;
M_v = dynamically applied heeling moment due to the wind pressure;

.4 heeling moment due to wind pressure.

Heeling moment due to wind pressure M_v, in kN/m, is determined by the formula:

$M_v = 0{,}001 p_v A_v Z$, (13.3.1.2.1.4)

where P_v = wind pressure, in N/m^2, = 750 $(V_w/26)^2$;
A_v = windage area, in m^2, including the projections of the lateral surfaces of the hull, superstructure and various structures above the waterline;
Z = windage area lever, in m, = the vertical distance to the geometrical centre of windage area from the waterline;
V_w = wind speed corresponding to the worst intended conditions, in m/s.

The value of the heeling moment is taken as constant during the whole period of heeling;

.5 evaluation of the minimum capsizing moment M_c in the displacement mode.

The minimum capsizing moment is determined from the static or dynamic stability curves taking rolling into account;

.5.1 when the static stability curve is used, M_c is determined by equating the area under the curves of capsizing and righting moments (or levers) taking rolling into account as indicated by Fig. 13.3.1.2.1.5-1, where θ_r is the amplitude of rolling and MK is a line drawn parallel to the abscissa axis such that the shaded areas S_1 and S_2 are equal.

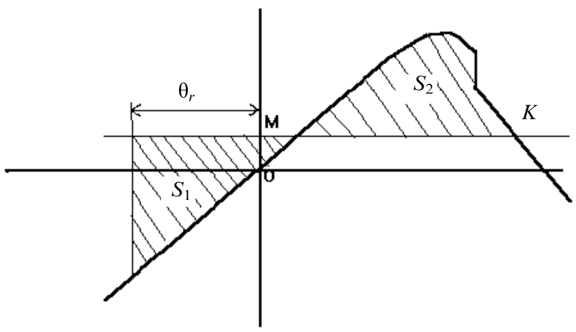


Fig. 13.3.1.2.1.5-1

M_c = OM, if the scale of ordinates represents moments;

M_c = OM × displacement, if the scale of ordinates represents levers;

.5.2 when the dynamic stability curve is used, first an auxiliary point A shall be determined. For this purpose the amplitude of rolling is plotted to the right along the abscissa axis and point A′ is found (see Fig. 13.3.1.2.5-2). A line AA′ is drawn parallel to the abscissa axis equal to the double amplitude of heeling (AA′ = 2θ_r) and the required auxiliary point A is found. A tangent AC to the dynamic stability curve is drawn. From the point A the line AB is drawn parallel to the abscissa axis and equal to 1 radian (57,3°). From the point B a perpendicular is drawn to intersect the tangent in the point E. The distance BE is equal to the capsizing moment if measured along the ordinate axis of the dynamic stability curve. If, however, the dynamic stability levers are plotted along this axis, BE is then the capsizing lever, and in this case the capsizing moment M_c is determined by multiplication of ordinate BE, in metres, by the corresponding displacement in tonnes:

$M_c = 9{,}81\Delta \mathrm{BE}$, kN·m; (13.3.1.2.1.5.2)

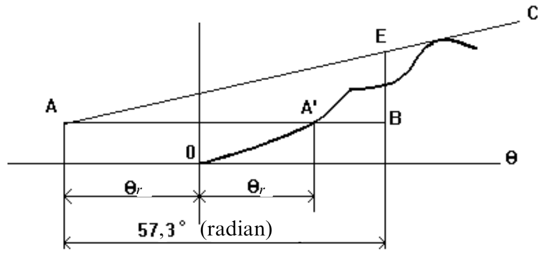


Fig. 13.3.1.2.5-2

.5.3 the amplitude of rolling Θ_r shall be determined by means of model and full-scale tests in irregular seas as a maximum amplitude of 50 oscillations of a craft travelling at 90° to the wave direction in sea state for the worst design condition.

If such data are lacking the amplitude of rolling is assumed to be equal to 15°;

.5.4 the effectiveness of stability curves shall be limited to the angle of flooding.

13.3.1.2.2 Transitional and foil-borne modes:

.1 the stability in the transient and foil-borne modes shall be verified for all cases of loading for the intended service of the craft. Under all weather conditions up to the worst intended conditions, the time to pass from the displacement mode to the foil-borne mode and vice versa shall be minimized unless it is demonstrated that no substantial reduction of stability occurs during the transition;

.2 stability in the transitional and foil-borne modes may be determined either by calculation or on the basis of data obtained from model experiments and shall be verified by full-scale tests by imposition of a series of known heeling moments by off-centre ballast weights, and recording the angles of heel produced by these moments. When taken in the displacement, take-off and steady foil-borne and settling to the displacement mode, these results will provide an indication of the values of the stability in the various situations of the craft during the transitional condition. Procedures for determination of static stability curve characteristics shall be submitted to the Register for approval;

.3 the angle of heel in the foil-borne mode caused by the concentration of passengers at one side is not to exceed 8. During the transient mode the angle of heel due to the concentration of passengers on one side is not to exceed 12. The concentration of passengers shall be taken in accordance with the provisions of 1.3.1.1;

.4 one of the possible methods of assessing foil-borne metacentric height (GM) in the design stage for a particular foil configuration as given in Fig. 13.3.1.2.2.4 is as follows:

$$GM = n_B(L_B/2\tan l_B - S) + n_H(L_H/2\tan l_H - S), \quad (13.3.1.2.2.4)$$

where n_B = percentage of hydrofoil load borne by front foil;
n_H = percentage of hydrofoil load borne by aft foil;
L_b = clearance width of front foil;
L_H = clearance width of aft foil;
a = clearance between bottom of keel and water;
g = height of centre of gravity above bottom of keel;
l_B = angle at which front foil is inclined to the horizontal;
l_H = angle at which aft foil is inclined to the horizontal;
S = height of centre of gravity above water.

13.3.1.3 Fully submerged hydrofoils.

13.3.1.3.1 Displacement mode.

Requirements 13.3.1.2.1.1 to 13.3.1.2.1.5 shall be applied to this type of craft in the displacement mode.

13.3.1.3.2 Transitional mode.

The stability shall be examined by numerical simulation with the use of the Register-approved computer program which allows to evaluate the craft's behaviour under the normal and limited conditions of operation, as well as its response under the influence of any malfunctions.

Stability conditions resulting from any potential failures in systems or operational procedures during the transitional stage which could be hazardous to the craft watertight integrity and stability shall be examined.

13.3.1.3.3 Foil-borne mode.

Craft stability in the foil-borne mode shall be in compliance with provisions of Section 12 and 13.3.1.3.2.

Requirements of 13.3.1.2.2.1 to 13.3.1.2.2.4, 13.3.1.3.2 and 13.3.1.3.3 shall be applied to this type of craft as appropriate and any computer simulations or design calculations shall be verified by full-scale tests.

13.3.2 Multihull craft.

13.3.2.1 A multihull craft, in the intact condition, shall have sufficient stability when rolling in a seaway to withstand successfully the effect of either passenger crowding or high-speed turning as described in 13.3.2.2.

13.3.2.2 The following stability criteria shall be met:

.1 The area under the GZ curve.

The area (A_1) under the GZ curve up to angle θ shall be at least:

$$A_1 = 0{,}055 \times 30^\circ/\theta, \text{ m·rad}, \quad (13.3.2.2.1)$$

where θ is the least of the possible angles:
the downflooding angle;
the angle at which the maximum GZ occurs;
30°;

.2 the maximum value of righting lever GZ.

Section at front foil *Section at aft foil*

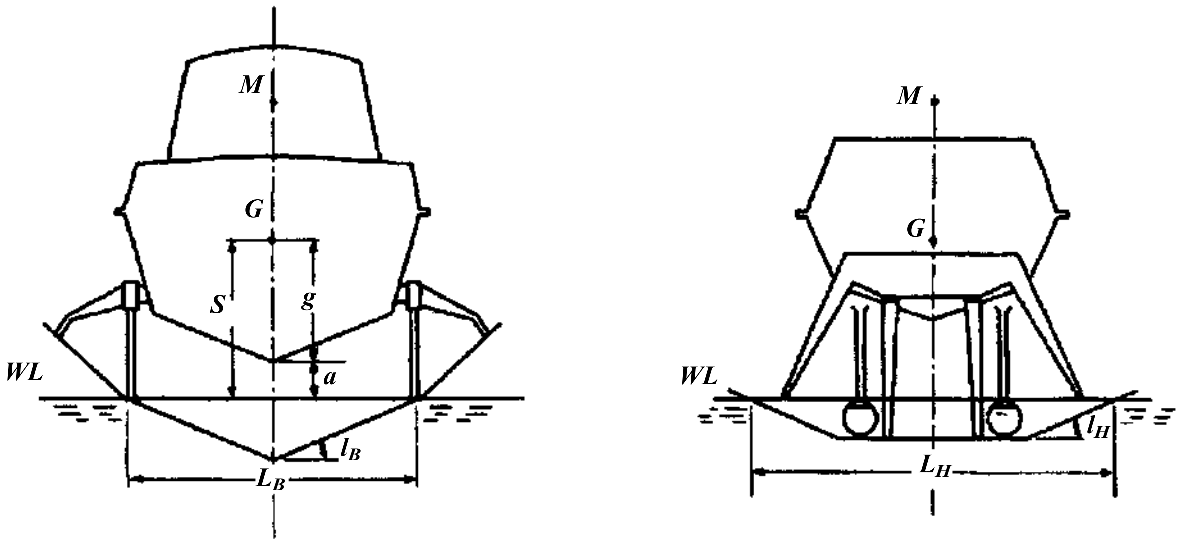


Fig. 13.3.1.2.2.4

The maximum GZ value shall occur at an angle of at least 10°;

.3 heeling due to wind.

The wind heeling lever shall be assumed constant at all angles of inclination and shall be calculated as follows:

$$HL_1 = \frac{P_i A Z}{9800\Delta}, \text{ in m,} \qquad (13.3.2.3.3)$$

$HL_2 = 1{,}5 HL_1$, in m, (see Fig. 13.3.2.2),

where P_i = wind pressure, in N/m^2, to be obtained from the formula:
P_i = 500 $(V_w/26)^2$;
V_w = wind speed corresponding to the worst intended conditions, in m/s;
A = projected lateral area of the portion of the craft above the lightest service waterline, in m^2;
Z = vertical distance from the centre of A to a point one half the lightest service draught, in m;
Δ = displacement, in t;

.4 heeling due to passenger crowding or high-speed turning.

Heeling lever due to the crowding of passengers on one side of the craft or to high-speed turning, whichever is the greater, shall be considered in combination with the heeling lever HL_2 due to wind (regarding the gust);

.4.1 heeling due to passenger crowding.

When calculating the heel a heeling lever due to passenger crowding shall be determined. The calculation shall be made with regard to provisions of 13.1.1 and 3.1.6 to 3.1.9, Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships;

.4.2 heeling due to high-speed turning.

When calculating the heel a heeling lever due to high-speed turning shall be determined using the following formula:

$$TL = \frac{1}{g}\,\frac{V_0^2}{R}\,(KG - d/2), \qquad (13.3.2.2.4.2)$$

where TL = turning lever, in m;
V_0 = speed of the craft in the turn, in m/s;
R = turning radius, in m;
KG = height of vertical centre of gravity above keel, in m;
d = mean draught, in m;
g = acceleration due to gravity.

Alternatively, another method of assessment may be employed as provided for 3.1.1;

.5 rolling in waves (see Fig. 13.3.2.2).

The effect of rolling in a seaway upon the craft stability shall be demonstrated mathematically. In doing so, the residual area (A_2) under the GZ curve, i. e. beyond the angle of heel θ_h , shall be at least equal to 0,028 m·rad up to the angle of rolling θ_r. In the absence of model tests results or other data θ_r shall be taken as 15° or as an angle of $(\theta_d - \theta_h)$, whichever is less.

The determination of θ_r from the model test or other data shall be carried out using the procedure for determining θ_r given in 13.3.1.2.1.5.3;

.6 for the purpose of intact stability calculations and application of Fig. 13.3.2.2, the following heeling levers shall be used:

.6.1 wind heeling lever (including gusting effect) – HL_2;

.6.2 total heeling lever equal to the sum of heeling lever due to wind (+ gusting) and heeling lever due

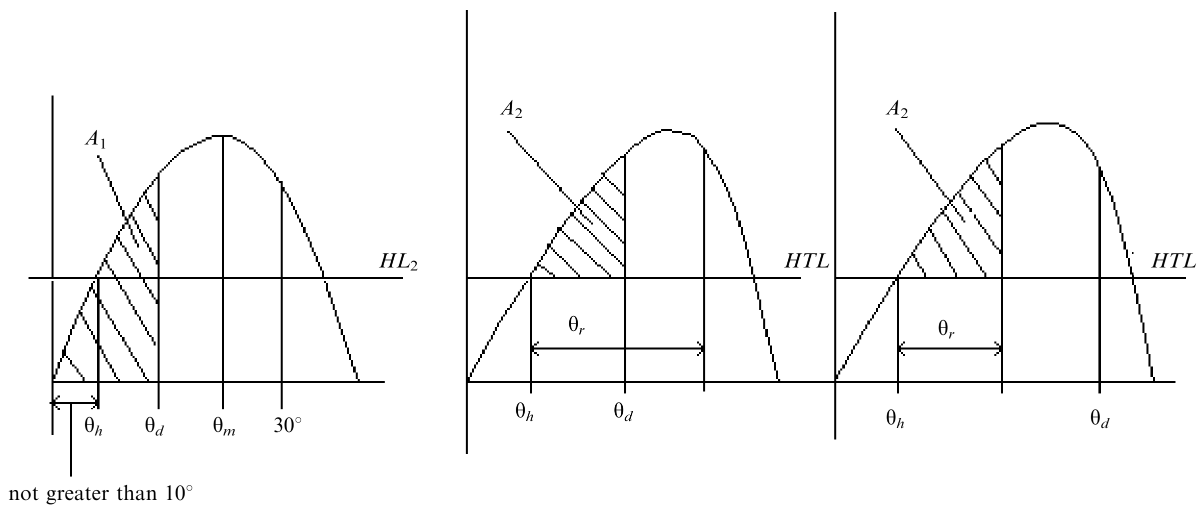


Fig. 13.3.2.2

HL_2 = heeling lever due to wind + gusting;
HTL = heeling lever due to wind + gusting + (passenger crowding or turning), whichever is the greater;
θ_h = angle of heel due to heeling moment with lever HL_2 or HTL;
θ_r = angle of roll;
θ_d = angle of downflooding;
θ_m = angle of maximum GZ.

to either passenger crowding or turning, whichever is the greater.

The angle of heel due to the wind heeling lever (HL_2) shall not exceed 10°.

13.3.3 Air-cushion vehicles.

13.3.3.1 These requirements apply to air-cushion vehicles of all types.

13.3.3.2 Air-cushion vehicles in the displacement mode are covered by the requirements of 13.3.1.2.1.2. The angle of heel due to the combined effect of turning and passenger crowding shall be determined experimentally.

13.3.3.3 Stability of air-cushion vehicles in the transitional mode shall be such that the inclination of the craft from the horizontal in any direction will not exceed 8° under all possible loading conditions and passenger movements as may occur.

13.3.3.4 Stability of air-cushion vehicles in the operational and transitional modes shall meet the requirements of 13.3.1.2.2. The total angle of heel due to passenger crowding and wind pressure or due to passenger crowding and turning shall be determined on the basis of model tests of the designed craft or prototype craft.

The total angle of heel due to passenger crowding and turning shall be determined experimentally in a more accurate way during delivery trials of the full-scale craft.

13.3.3.5 Where an air-cushion vehicle shall go to a shore which is not protected against waves, it shall be demonstrated to the Register that the craft stability is sufficient when it passes the tidal area under the worst permissible conditions or other conditions indicated in the Classification Certificate. These proofs shall be confirmed during delivery trials of the first or any other craft of the series as indicated by the Register.

13.3.3.6 The following structural requirements shall be met to ensure stability of an air-cushion vehicle:

.1 the shape of the rigid hull in the forward end shall provide the hydrodynamic righting moment in water landing with a bow trim in still water and in a seaway. The hull slope angle shall be not less than 12°;

.2 for air-cushion vehicles fitted with flexible skirts it shall be demonstrated that flexible skirts will not lose stability in the modes allowed by the operational manual and in all possible loading conditions. The height of flexible skirts and hull structure shall be such that in the cushion-borne mode the contact of the main hull with the supporting surface (water, land) can occur at a heel angle not less than 9° and trim 3°. The opening angle of flexible skirt shall be not less than 30°;

.3 in designs where periodic use of cushion deformation is employed as a means of assisting craft control, or periodic use of cushion air exhausting to atmosphere for purposes of craft manoeuvring, the effects upon cushion-borne stability shall be determined, and the limitations on the use by virtue of weather conditions, mode and loading condition of the craft shall be established. These limitations shall be indicated in Information on Stability.

APPENDIX 1

DETERMINATION OF ASSUMED DESIGN MOMENT AT WHICH HIGH-SPEED CRAFT LOSES OPERATIONAL MODE

The assumed design moment M_c taking rolling into account when HSC loses the operational mode and is transferred into the displacement mode may be determined from the dynamic and static stability curves.

For air-cushion vehicles the curves cut short at an angle of heel which corresponds to the point of intersection of the static stability curve in the displacement mode (curve 1) and that in the cushion-borne mode (curve 2) determined in still water without motion (see Fig. 1 to this Appendix).

For hydrofoil craft the curves cut short at the angle of heel corresponding to the limiting angle of heel for which hydrodynamic characteristics of the foil system are calculated at the specified speed.

Moment M_c shall be determined (as in the case when the curve cuts short at the flooding angle) by one of the methods described in Appendix to Part IV "Stability" of the Rules for the Classification and Construction of Sea-Going Ships.

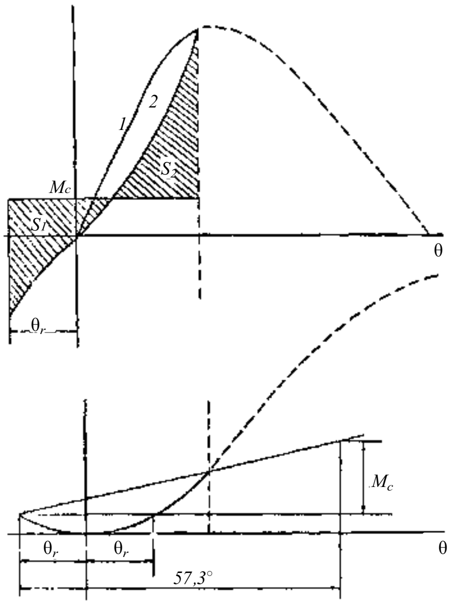


Fig. 1

APPENDIX 2

ICING AS APPLIED TO ALL TYPES OF CRAFT

1 ICING ALLOWANCES

1.1 For crafts operating in areas where icing is likely to occur, stability calculations shall be made concidering the following:

.1 icing allowances:

30 kg/m^2 on exposed weather decks and gangways;

7,5 kg/m^2 of projected lateral area of each side of the craft above the water;

.2 the projected lateral area of discontinuous surfaces of rail, sundry booms, spars (except masts) and rigging and the projected lateral area of other small objects shall be computed by increasing the total projected area of continuous surfaces by 5 per cent and the static moments of this area by 10 per cent;

.3 reduction of stability due to asymmetric ice accumulations in cross-structure.

1.2 For crafts operating in areas where icing may be expected:

.1 within the areas defined in 2.1, 2.3, 2.4 and 2.5 and known to have ice conditions significantly different from those specified in 1.1, ice accretion requirements of one half to twice the required allowance may be applied;

.2 within the area defined in 2.2, where icing twice exceeding the allowance required by 2.2 may be expected, more severe requirements than those given in 1.1 may be applied.

1.3 Information shall be provided in respect of assumptions made in calculating the condition of the craft in each of cases set out in this Appendix for the following:

.1 duration of the voyage in terms of the period spent in reaching the destination and returning to port;

.2 consumption rates during the voyage for fuel, water, stores and other consumables.

2 AREAS OF ICING CONDITIONS

2.1 In the application of 1, the following icing areas shall be considered:

.1 the area north of latitude 65°30′N, between longitude 28°W and the west coast of Iceland; north of the north coast of Iceland; north of the rhumb line running from latitude 66°N, longitude 15°W to latitude 73°30′N, longitude 15°E, north of latitude 73°30′N, between longitude 15°E and 35°E, and east of longitude 35°E, as well as north of latitude 56°N in the Baltic Sea;

.2 the area north of latitude 43°N bounded in the west by the North American coast and the east by the rhumb line running from latitude 43°N, longitude 48°W to latitude 63°N, longitude 28°W and thence along longitude 28°W;

.3 all sea areas north of the North American continent, west of the areas defined in 2.1 and 2.2 of this paragraph;

.4 the Bering and Okhotsk Seas and the Tatary Straight in winter;

.5 south of latitude 60°S.

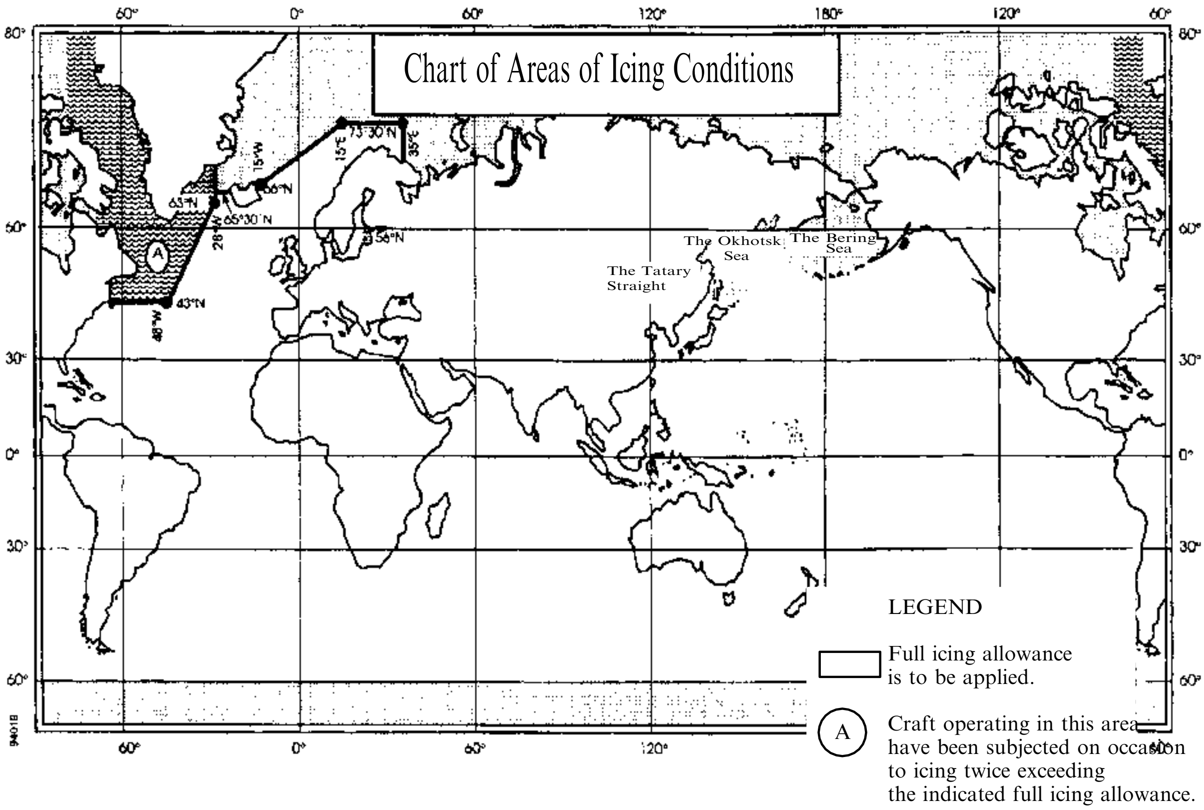
The chart to illustrate the areas is attached.

3 GENERAL REQUIREMENTS

3.1 Craft intended for operation in areas where icing is likely to occur shall be:

.1 designed to minimize the accretion of ice;

.2 equipped with means for ice removing.



PART V. RESERVE OF BUOYANCY AND SUBDIVISION

1 GENERAL

1.1 Scope of application.

The requirements of Sections 1, 2, 3 of this Part are mandatory for high-speed crafts of all types referred to in Part I "Classification" of the present Rules.

The requirements of Section 4 of this Part apply to crafts referred to in 1.1.1 and 1.1.2, "General" of the present Rules.

1.2 Definitions and explanations.

Definitions and explanations relating to general terminology are given in Part I "Classification" of the present Rules and in Part V "Subdivision" of Rules for the Classification and Construction of Sea-Going Ships.

1.3 Scope of technical supervision.

For every craft meeting the requirements of this Part, the Register carries out:

.1 verification of structural arrangements taken to ensure subdivision of the craft with the requirements of 2.2 of Rules for Safety of Dynamically Supported Craft (1990 edition), Part III "Equipment, Arrangements and Outfit" and Part VIII "Systems and Piping" of the present Rules;

.2 consideration and approval of Information on Damaged Trim and Stability;

.3 verification of correct assignment and marking of the design waterline.

1.4 General technical requirements.

General technical requirements given in 1.4.4 to 1.4.8 and 1.4.10, Part V "Subdivision" of the Rules for the Classification and Construction of Sea-Going Ships apply to HSC of all types.

2 INTACT BUOYANCY

2.1 All crafts shall have a sufficient reserve of buoyancy at the design waterline to meet the intact and damage stability requirements of this chapter. A craft in the displacement mode at a draught to the design waterline shall have at least 100 per cent reserve of buoyancy. The Register may require a larger reserve of buoyancy to permit the craft to operate in any of its intended modes.

2.2 The reserve of buoyancy shall be calculated by including only those compartments which are:

.1 watertight and situated below the watertight deck (or an equivalent structure);

.2 watertight or weathertight and situated above the watertight deck (or an equivalent structure);

.3 accepted as having scantlings and arrangements adequate to maintain their watertight integrity.

In considering the stability after damage, flooding shall be assumed to occur until limited by watertight boundaries in the equilibrium condition, and weathertight boundaries in intermediate stages of flooding and within the range of positive righting lever required to satisfy the residual stability requirements.

2.3 Arrangements for checking the watertight or weatherhight integrity of compartments referred to in 2.2 shall be provided in accordance with Part II "Hull" of the Rules for the Classification and Construction of Sea-Going Ships.

2.4 Where entry of water into structures above the watertight deck defined in 2.2.1 will significantly influence the craft stability and buoyancy, such structures shall be:

.1 of adequate strength to maintain the weathertight integrity and fitted with weathertight closing appliances; or

.2 provided with adequate drainage arrangements; or

.3 an equivalent combination of both.

2.5 The means of closing of openings in structures bounding weathertight compartmentsare shall be such as to maintain weathertight integrity of the compartments in all operational conditions.

2.6 Opening in watertight divisions.

2.6.1 The number of doors in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the craft, and all such doors shall be closed prior to departure of the craft from the berth.

2.6.2 Doors in watertight bulkheads may be hinged or sliding. They shall be shown by suitable testing to be capable of maintaining the watertight integrity of the bulkhead. Such testing shall be carried out for both sides of the door and shall apply a pressure head 10 per cent greater than that determined from the minimum permissible height of the downflooding opening. Testing may be carried out either before or after the door is fitted into the craft but where shore testing is adopted, satisfactory installation on the craft shall be verified by inspection and hose testing.

2.6.3 Type approval may be accepted in lieu of testing individual doors, provided the approval process includes pressure testing to a head equal to, or greater than, the required head (refer to 2.6.2).

2.6.4 All watertight doors shall be capable of being operated when the craft is inclined up to 15°, and shall be fitted with means of indication in the operating compartment showing whether they are open or closed. All such doors shall be capable of being opened and closed locally from each side of the bulkhead.

2.6.5 Watertight doors shall remain closed when the craft is at sea, except that they may be opened for access. A notice shall be attached to each door to the effect that it shall not be left open.

2.6.6 Watertight doors shall be capable of being closed by remote control from the operating compartment in not less than 20 s and not more than 40 s, and shall be provided with an audible alarm, distinct from other alarms in the area, which shall sound for at least 5 s but no more than 10 s before the doors begin to move whenever the door is closed remotely by power, and continue sounding until the door is completely closed. The power, control and indicators shall be operable in the event of main power failure. In passenger areas and in areas where the ambient noise exceeds 85 dB(A) the audible alarm shall be supplemented by an intermittent visual signal at the door. If the Register is satisfied that hinged doors are essential for safe work of the craft, such watertight doors having only local control may be permitted for areas to which crew only have access, provided they are fitted with remote indicators as required in 2.6.4.

2.6.7 Where pipes, scuppers, electric cables, etc. are carried through watertight divisions, the arrangements for creating a watertight penetration shall be of a type, which has been prototype tested under hydrostatic pressure equal to or greater than that required to be withstood for the actual location in the craft in which they shall be installed. The test pressure shall be maintained for at least 30 min and there shall be no leakage through the penetration arrangement during this period. The test pressure head shall be 10 per cent greater than that determined from the minimum permissible height of a downflooding opening. Watertight bulkhead penetrations which are effected by continuous welding do not require prototype testing. Valves on scuppers from weathertight compartments, included in the stability calculations, shall have arrangements for remote closing from the operating station.

2.6.8 Where a ventilation trunk forms part of a watertight boundary, the trunk shall be capable of withstanding the water pressure that may be present taking into account the maximum inclination angle of the damaged craft allowable during all stages of flooding.

2.7 Inner bow doors.

2.7.1 Where ro-ro craft are fitted with bow loading doors, an inner bow door shall be fitted abaft such openings, to restrict the extent of flooding in the event of failure of the outer closure. This inner bow door, where fitted, shall be:

.1 weathertight to the deck above, which deck shall itself be weathertight forward to the bow loading opening;

.2 so arranged as to preclude the possibility of a bow loading door causing damage to it in the case of damage to, or detachment of, the bow loading door;

.3 forward of all positions on the vehicle deck in which vehicles are intended to be carried; and

.4 part of a boundary designed to prevent flooding into the remainder of the craft.

2.7.2 A craft shall be exempted from the requirement 2.7.1 for such inner bow door where one of the following applies.

2.7.2.1 The vehicle loading deck at the inner bow door position is above the design waterline by a height more than the significant wave height corresponding to the worst intended conditions.

2.7.2.2 It can be demonstrated using model tests or mathematical simulations that when the craft is proceeding at a range of speeds up to the maximum attainable speed in the loaded condition at all headings in long crested seas of the greatest significant wave height corresponding to the worst intended conditions, either:

.1 the bow loading door is not reached by waves; or

.2 having been tested with the bow loading door open to determine the maximum steady state volume of water which accumulates, it can be shown by static analysis that, with the same volume of water on the vehicle deck(s) the residual stability requirements are satisfied. If the model tests or mathematical simulations are unable to show that the volume of water accumulated reaches a steady state, the craft shall be considered not to have satisfied the conditions of this exemption.

Where mathematical simulations are employed they shall already have been verified against full-scale or model testing.

2.7.2.3 Bow loading openings lead to open ro-ro spaces provided with guard-rails or having freeing ports complying with 2.7.2.4.

2.7.2.4 The deck of the lowest ro-ro space above the design waterline is fitted on each side of the deck with freeing ports evenly distributed along the sides of the compartment. These shall either proven to be acceptable using tests according to 2.7.2.2 above or comply with the following:

.1 $A \geqslant 0{,}3l$, (2.7.2.4.1)

where A = the total area of freeing ports on each side of the deck, in m^2;

l = the length of the compartment, in m;

.2 the craft shall maintain a residual freeboard to the deck of the ro-ro space of at least 1 m in the worst condition;

.3 such freeing ports shall be located within the height of 0,6 m above the deck of the ro-ro space, and the lower edge of the ports shall be within 0,02 m above the deck of the ro-ro space; and

.4 such freeing ports shall be fitted with closing devices or flaps to prevent water entering the deck of the ro-ro space whilst allowing water which may accumulate on the deck of the ro-ro space to drain.

2.8 Other provisions for ro-ro craft.

2.8.1 All accesses to the ro-ro space that lead to spaces below the deck shall have a lowest point which is not less than the height required from the tests conducted according to 2.7.2.2 or 3 m above the design waterline.

2.8.2 Where vehicle ramps are installed to give access to spaces below the deck of the ro-ro space, their openings shall be capable of being closed weathertight to prevent ingress of water below.

2.8.3 Accesses in the ro-ro space that lead to spaces below the ro-ro deck and having a lowest point which is less than the height required from the tests conducted according to 2.7.2.2 or 3 m above the design waterline may be permitted provided they are watertight and are closed before the craft leaves the berth on any voyage and remain closed until the craft is at its next berth.

2.8.4 Accesses referred to in 2.8.2 and 2.8.3 above shall be fitted with alarm indicators in the operating compartment.

2.8.5 Special category spaces and ro-ro spaces shall be patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the craft is underway.

2.9 Indicators and surveillance.

2.9.1 Indicators.

Indicators shall be provided in the operating compartment for all shell doors, loading doors and other closing appliances, which, if left open or not properly secured, could lead to major flooding in the intact or damaged conditions. The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked, and by audible alarms if such door or closing appliance becomes open or the securing arrangements become unsecured. The indicator panel in the operating compartment shall be equipped with a mode selection function "harbour/ sea voyage" so arranged that an audible alarm is given in the operating compartment if the craft leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator systems shall be independent of the power supply for operating and securing the doors.

2.9.2 Television surveillance.

Television surveillance and a water leakage detection system shall be arranged to provide an indication to the operating compartment and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors, which could lead to major flooding.

2.10 Integrity of superstructure.

2.10.1 Where entry of water into structures above the bulkhead deck would significantly influence the stability and buoyancy of the craft, such structures shall be:

.1 of adequate strength to maintain the weathertight integrity and fitted with weathertight closing appliances; or

.2 provided with adequate damage arrangements; or

.3 an equivalent combination of both measures.

2.10.2 Weathertight superstructures and deckhouses located above the bulkhead deck shall have in the outside boundaries means of closing openings with sufficient strength such as to maintain weathertight integrity in all damage conditions where the space in question is not damaged. Furthermore, the means of closing shall be such as to maintain weathertight integrity in all operational conditions.

2.11 Doors, windows, etc. in boundaries of weathertight spaces.[1]

2.11.1 Strength of doors, windows, etc., and any associated frames and mullion in weathertight superstructures and deckhouses shall be equivalent to the strength of the structure in which they are fitted, i. e. they shall be weathertight and shall not leak or fail at a uniformly applied pressure to which the structure where they are fitted is designed.

2.11.2 For doors in weathertight superstructures, hose tests shall be carried out with a water pressure 200 kN/m^2 from the outside.

2.11.3 The height above the deck of sills to doorways leading to exposed decks shall be as high above the deck as is reasonable and practicable, particularly those located in exposed positions. Such sill heights shall not be less than 100 mm for doors to weathertight spaces on decks above the bulkhead deck, and 250 mm elsewhere. For craft of 30 m in length and under, sill heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.11.4 Windows shall not be permitted in the boundaries of:

special category spaces; or

ro-ro spaces; or

below the bulkhead deck.

If required by restrictions in the Permit to Operate, forward facing windows, or windows which

[1] For the purpose of this paragraph the word "elsewhere" is applied to all the weathertight and watertight closures located on or below the datum.

may be submerged at any stage of flooding shall be fitted with hinged or sliding storm shutters ready for immediate use.

2.11.5 Side scuttles to spaces below the bulkhead deck shall be fitted with efficient hinged deadlights arranged inside so that they can be effectively closed and secured watertight.

2.11.6 No side scuttle shall be fitted in a position so that its sill is below a line drawn parallel to and one metre above the design waterline.

2.12 Hatchways and other openings.[1]

2.12.1 Hatchways closed by weathertight covers.

The construction and the means for securing the weathertightness of cargo and other hatchways shall comply with the following:

.1 coaming heights shall be not less than 100 mm for hatches to weathertight spaces on decks above the bulkhead deck, and 250 mm elsewhere. For the craft of 30 m in length and under, coaming heights may be reduced to the maximum which is consistent with the safe working of the craft;

.2 the height of these coamings may be reduced, or the coamings omitted entirely, on condition that the Register is satisfied that the safety of the ship is not thereby impaired in any sea conditions up to the worst intended conditions. Where coamings are provided, they shall be of substantial construction; and

.3 the arrangements for securing and maintaining weathertightness shall ensure that the tightness can be maintained in any sea conditions up to the worst intended conditions.

2.12.2 Machinery space openings.

2.12.2.1 Machinery space openings shall be properly framed and efficiently enclosed by casings of ample strength. Where the casings are not protected by other structures, their strength shall be specially considered by the Register. Access openings in such casings shall be fitted with weathertight doors.

2.12.2.2 Height of sills and coamings shall be not less than 100 mm for openings to weathertight spaces on decks above the bulkhead deck, and not less than 380 mm elsewhere. For the craft of 30 m in length and under, these heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.12.2.3 Machinery space ventilator openings shall comply with the requirements of 2.12.4.2.

2.12.3 Openings in exposed decks.

2.12.3.1 Manholes and flush scuttles on the bulkhead deck or within superstructures other than enclosed superstructures shall be closed by substantial covers capable of being made watertight. Unless secured by closely spaces bolts, the covers shall be permanently attached.

2.12.3.2 Service hatches to machinery, etc. may be arranged as flush hatches provided that the covers are secured by closely spaced bolts, are kept closed at sea, and are equipped with arrangements for portable guardrails.

2.12.3.3 Openings in exposed decks leading to spaces below the bulkhead deck or enclosed superstructures other than hatchways, machinery space openings, manholes and flush scuttles shall be protected by an enclosed superstructure, or by a deckhouse or companionway of equivalent strength and weathertightness.

2.12.3.4 The height above the deck of sills to the doorways in companionways shall not be less than 100 mm for doors to weathertight spaces on decks above the bulkhead deck, and 250 mm elsewhere. For the craft of 30 m in length and under, sill heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.12.4 Ventilators.

2.12.4.1 Ventilators to spaces below the bulkhead deck or decks of enclosed superstructures shall have substantially constructed coamings efficiently connected to the deck. Coaming heights shall be not less than 100 mm for ventilators to weathertight spaces on decks above the bulkhead deck, and not less than 380 mm elsewhere. For the craft of 30 m in length and under, coaming heights may be reduced to the maximum which is consistent with the safe working of the craft.

2.12.4.2 Ventilators the coamings of which extend to more than one metre above the deck or which are fitted to decks above the bulkhead deck need not be fitted with closing arrangements unless they face forward or are specifically required by the Register, based on the construction and purpose of the craft.

2.12.4.3 Except as provided in 2.12.4.2, ventilator openings shall be provided with efficient weathertight closing appliances.

2.12.4.4 Ventilator openings shall face aft or athwartships wherever practicable.

2.13 Scuppers, inlets and discharges.

2.13.1 Discharges led through the shell either from spaces below the bulkhead deck or from within superstructures and deckhouses fitted above the bulkhead deck shall be fitted with efficient and accessible means for preventing water from passing inboard. Normally each separate discharge shall have one automatic non-return valve with a positive means of closing it from a position above the bulkhead deck. Where, however, the vertical distance from the design waterline to the inboard end of the discharge pipe exceeds $0{,}01L$, the discharge may have two automatic non-return valves without positive means of closing,

[1] For the purpose of this paragraph the word "elsewhere" is applied to all the weathertight and watertight closures located on or below the datum.

provided that the inboard valve is always accessible for examination under service conditions. Where that vertical distance exceeds $0,02L$, a single automatic non-return valve without positive means of closing may be accepted. The means for operating the positive action valve shall be readily accessible and provided with an indicator showing whether the valve is open or closed.

2.13.2 Valves on scuppers from weathertight compartments included in the stability calculations shall be operable from the operating compartment.

2.13.3 In manned machinery spaces, main and auxiliary sea inlets and discharges in connection with the operation of machinery may be controlled locally. Such controls shall be readily accessible and shall be provided with indicators showing whether the valves are open or closed. In unmanned machinery spaces, main and auxiliary sea inlet and discharge controls in connection with the operation of machinery shall be:

.1 located at least 50 per cent of the significant wave height corresponding to the worst operational conditions and measured above the deepest damage waterline with damages defined in accordance with 4.3 of the present Part; or

.2 operable from the operating compartment.

2.13.4 Scuppers leading from superstructures and deckhouses not fitted with weathertight doors shall be led overboard.

2.13.5 All shell fittings and the valves required by the present Rules shall be of a suitable ductile material. Valves of ordinary cast iron or similar material shall not be acceptable.

2.14 Air pipes.

2.14.1 Main storage tanks containing flammable liquids or tanks which can be pumped or filled from the sea shall have air pipes which do not terminate in enclosed spaces.

2.14.2 All air pipes extending to exposed decks shall have a height from the deck to the point where water may have access below of at least 300 mm where the deck is less than $0,05L$ above the design waterline, and 150 mm on all other decks.

2.14.3 Air pipes may discharge through the side of the superstructure provided that this is at a height of at least $0,02L$ above any waterline when the intact craft is heeled to an angle of 15°, or of at least $0,02L$ above the highest waterline at all stages of flooding as determined by the damaged stability calculations, whichever is higher.

2.14.4 All air pipes shall be equipped with weathertight closing devices that close automatically.

2.15 Freeing ports.

2.15.1 Where bulwarks on weather decks form wells, provision shall be made for rapidly freeing the decks of water and for draining them. The minimum freeing port area A, in m^2, on each side of the craft for each well on the weather deck of the main hull(s) shall be:

.1 where the length of bulwark l in the well is 20 m or less:

$$A = 0{,}7 + 0{,}035l; \qquad (2.15.1.1)$$

.2 where l exceeds 20 m:

$$A = 0{,}07l, \qquad (2.15.1.2)$$

and, in no case, l need be taken as greater than $0{,}7L$.

If the bulwark is more than 1,2 m in average height, the required area shall be increased by 0,004 square metres per metre of length of well for each 0,1 metre difference in height. If the bulwark is less than 0,9 m in average height, the required area shall be decreased by 0,004 square metres per metre of length of well for each 0,1 metre difference in height.

2.15.2 Freeing ports shall be located within the height of 0,6 m above the deck and the lower edge shall be within 0,02 m above the deck.

2.15.3 All such openings in the bulwarks shall be protected by rails or bars spaced approximately 230 mm apart. If shutters are fitted to freeing ports, ample clearance shall be provided to prevent jamming. Hinges shall have pins or bearings of non-corrodible material. If shutters are fitted with securing appliances, these appliances shall be of approved construction.

2.15.4 A craft, having superstructures which are open in front or both ends, shall comply with the provisions of 4.2.11.1.

2.15.5 In a craft, having superstructures which are open at the aft end, the minimum freeing port area, in m^2, shall be:

$$A = 0{,}3b, \qquad (2.15.5)$$

where b = the breadth of the craft at the exposed deck, in m.

2.15.6 Ro-ro craft fitted with bow loading openings leading to open vehicle spaces shall comply with the provisions of 2.7.

3 FREEBOARD

3.1 The freeboard for a craft in the displacement mode shall be assigned so that the requirements regarding reserve of buoyancy and intact stability of the craft are met for the appropriate design waterline.

3.2 Based on the reserve of power necessary for craft's motion in the operational mode, a greater freeboard than indicated in 3.1 may be assigned.

3.3 The design waterline shall be clearly and permanently marked on the craft's outer sides at the level of the load line mark described below. This and the reference line described in 3.4.2 shall be recorded in the High-Speed Craft Safety Certificate. For craft where this is not practicable, e. g. amphibious air-cushion vehicles fitted with peripheral skirts, defined deck reference points shall be provided, from which the freeboard can be measured, and hence the draughts obtained.

3.4 Load line mark.

3.4.1 The load line mark shall consist of a ring with an outside diameter of 300 mm and width of 25 mm which is intersected by a horizontal line of length 450 mm and having a breadth of 25 mm, the upper edge of which passes through the centre of the ring. The centre of the ring shall be placed at the longitudinal center of floatation in the displacement mode and a height corresponding to the design waterline.

3.4.2 To assist in verifying the position of the load line mark, a reference line shall be marked on the hull at the longitudinal centre of floatation by a horizontal bar having a length of 300 mm and a breadth of 25 mm and having the upper edge corresponding to the reference line.

3.4.3 Where practicable, the reference line shall be related to the uppermost deck at side. Where this is not possible, the position of the reference line shall be defined from the underside of the keel at the longitudinal centre of floatation.

3.4.4 The mark of the authority by whom the load lines are assigned may be indicated alongside the load line ring above the horizontal line which passes through the centre of the ring, or above and below it. This mark shall consist of not more than four initials to identify the authority's name, each measuring approximately 115 mm in height, and 75 mm in width.

3.4.5 The ring, lines and letters shall be painted in white or yellow on a dark ground or in black on a light ground, and permanently marked. The marks shall be plainly visible.

3.5 Verification.

The High-Speed Craft Safety Certificate shall not be delivered until the Register has verified that the marks are correctly and permanently indicated on the sides of the craft.

For air-cushion vehicles with flexible skirts and similar craft marking of the load line mark and load lines are subject to special consideration by the Register.

4 SUBDIVISION

4.1 General.

4.1.1 Stability and reserve of buoyancy under all service conditions (taking no account of icing) shall be sufficient for meeting the requirements for damage trim and stability.

4.1.2 Requirements for subdivision are considered satisfied if with damages referred to in 4.3, compartments flooded in the worst possible position of the hole and permeabilities determined in accordance with 4.2, trim and stability of the craft meet the requirements of 4.4.

4.1.3 Calculations confirming compliance with the requirements of 4.4 shall be made for such number of the worst service loading conditions as regards trim and stability, such location and extent of damage defined in 4.3 that it can be predicted with confidence that in all other cases the damaged craft will be in a better condition as regards trim and stability.

In doing so, account shall be taken of the actual configuration of damaged compartments, their permeabilities, type of closing appliances, intermediate decks, platforms, transverse and longitudinal bulkheads and enclosures, watertightness of which is such that these constructions restrict totally or temporarily water flow inside the craft.

Any damage of a lesser extent than that postulated in 4.3.1 to 4.3.4, as applicable, which would result in a more severe condition shall be also investigated. The shape of the damage shall be assumed to be a parallelepiped.

4.1.4 Calculations of damage trim and stability shall be made for the craft in the displacement mode.

4.1.5 Where the equalization time of the damaged craft is not specified, the requirement of 3.4.1.7, Part V "Subdivision" of Rules for the Classification and Construction of Sea-Going Ships shall be applied.

4.1.6 Arrangements for equalization of the damaged craft shall be self-acting and be approved by the Register.

4.2 Permeabilities.

4.2.1 For the purpose of making damage stability calculations the volume and surface permeabilities shall be in general as follows:

Table 4.2.1

Spaces	Permeability
Intended for cargo or stores	60
Accommodation	95
Machinery	85
Intended for liquids	0 or 95[1]
Intended for cargo vehicles	90
Void spaces	95

[1]Whichever results in the more severe requirements.

4.2.2 Notwithstanding 4.2.1, permeability determined by direct calculation shall be used where a more onerous condition results, and may be used where a less onerous condition results from that provided according to 4.2.1.

4.2.3 Use of low-density foam or other media to provide buoyancy in void spaces may be permitted, provided that satisfactory evidence is provided to the Register that any such suggested medium is the most suitable alternative and:

.1 is of close-cell form if foam, or otherwise impervious to water absorption;

.2 is structurally stable under service conditions;

.3 is chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact (see 2.1.10, Part VI "Fire Protection");

.4 properly secured in place and easily removable for inspection of void spaces.

4.2.4 The Register may permit void bottom spaces to be fitted within the watertight envelope of the hull without the provision of a bilge system or air pipes provided that:

.1 the structure is capable of withstanding the pressure head after any of the damages required by this section;

.2 when carrying out a damage stability calculation in accordance with the requirements of this section, any void space adjacent to the damaged zone shall be included in the calculation and the criteria of damage trim and stability shall be complied with;

.3 the means by which water has leaked into the void space shall be removed shall be included in the craft operating manual; and

.4 adequate ventilation is provided for inspection of the space under consideration.

.5 the space filled with a low-density foam or modular buoyancy elements, as well as any space not fitted with a venting system are considered as a void space for the purpose of this paragraph provided such foam or modular buoyancy elements fully comply with 4.2.3.

4.3 Extent of damages.

All possible damages shall be assumed in damage trim and stability calculations anywhere on the periphery of the craft.

4.3.1 Extent of side damage.

The following side damages shall be assumed anywhere on the periphery of the craft:

.1 the longitudinal extent of damage shall be $0{,}75\nabla^{1/3}$ or $(3\text{ m} + 0{,}225\nabla^{1/3})$, or 11 m, whichever is the least;

.2 the transverse extent of penetration into the craft shall be $0{,}2\nabla^{1/3}$. However, where the craft is fitted with inflated skirts or with non-buoyant side structures, the transverse extent of penetration shall be at least $0{,}12\nabla^{1/3}$ into the main buoyancy hull or tank structure; and

.3 the vertical extent of damage shall be taken for the full vertical extent of the craft,

where:

∇ = volume of displacement corresponding to the design waterline, in m^3.

The damage is supposed to have the shape of a parallelepiped[1]. The parallelepiped inboard face at its mid-length shall be tangential to the surface corresponding to the specified side damage (transverse extent of penetration) or otherwise touching in at least two places, as shown in Fig. 4.3.1-1.

The side damage shall not transversely penetrate a greater distance than the extent of 0,21/3 at the corresponding design waterline, except where a lesser extent is assumed in accordance with 4.3.1.2 (see Figs. 4.3.1-2 and 4.3.1-3).

If considering a multihull, the periphery of the craft is considered to only be the surface of the shell encompassed by the outboard surface of the outermost hull at any given section.

4.3.2 Extent of bow and stern damage.

4.3.2.1 The following extents of damage shall be applied to bow and stern (see Fig. 4.3.2):

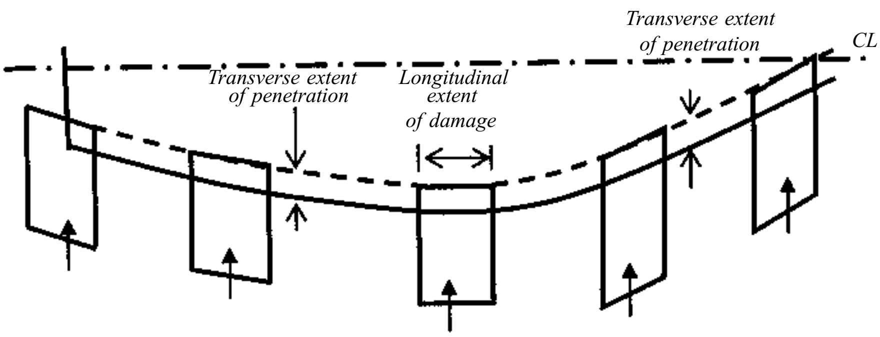


Fig. 4.3.1-1

[1] A parallelepiped is defined as "a solid contained by parallelograms" and a parallelogram is defined as "a four-sided rectilinear figure whose opposite sides are parallel".

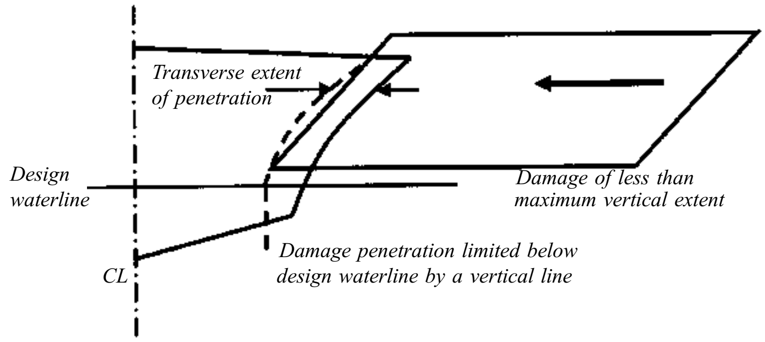


Fig. 4.3.1-2

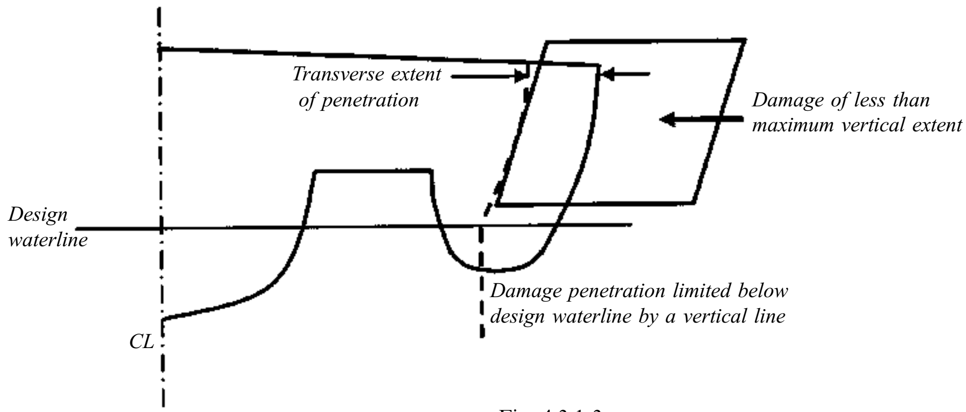


Fig. 4.3.1-3

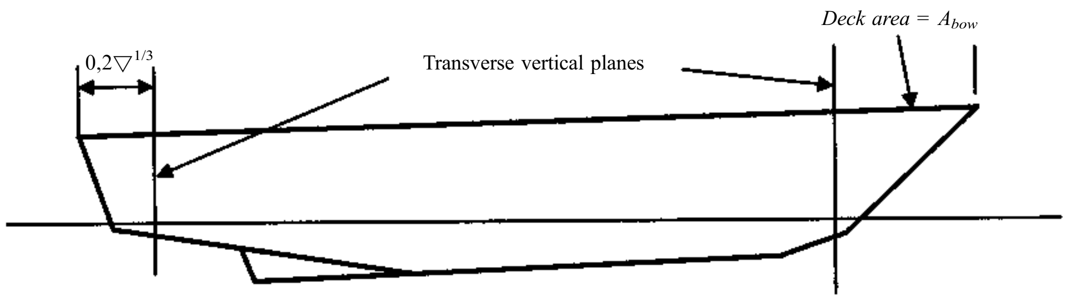


Fig. 4.3.2

.1 at the fore end, damage to the area defined as A_{bow} in compliance with 7.4.1, Part III, "Arrangements, Equipment and Outfit", the aft limit of which being a transverse vertical plane, provided that this area need not extend further aft from the forward extremity of the craft's watertight envelope than the distance defined in 4.3.1.1;

.2 at the aft end, damage to the area aft of a transverse vertical plane at a distance 0,21/3 forward of the aft extremity of the watertight envelope of the hull.

4.3.2.2 Where the damage of a lesser extent than defined in 4.3.2.1 may lead to grave consequences, the damage trim and stability calculations shall be performed for such damage.

4.3.3 Extent of bottom damage in areas vulnerable to raking damage.

4.3.3.1 Application.

.1 Any part of the surface of the hull(s) is considered to be vulnerable to raking damage if it is in contact with the water at 90 per cent of maximum speed in still water, and it also lies below two planes which are perpendicular to the craft centreline plane and at heights as shown in Fig. 4.3.3.1.

For multihulls, individual hulls shall be considered separately.

.2 Raking damage shall be assumed to occur along any fore-and-aft line on the surface of the hull(s) between the keel and the upper limit defined in the Fig. 4.3.3.1.

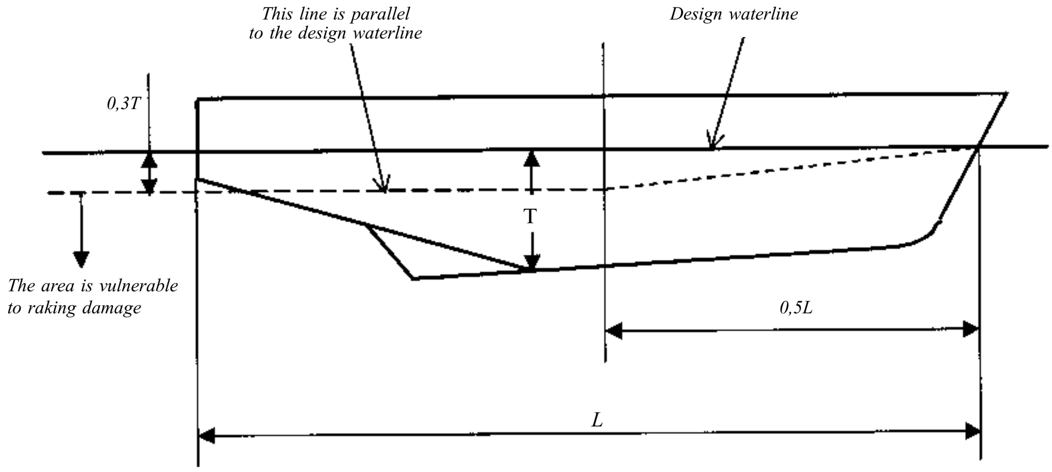


Fig. 4.3.3.1
T = maximum draught of the hull (each hull considered individually in case of multihulls) to the design waterline, excluding any non-buoyant structure such as single plate skegs or solid metal appendages.

.3 Damage shall not be applied at the same time as that defined in 4.3.1 or 4.3.4.

4.3.3.2 Extents of damage.

4.3.3.2.1 Two different longitudinal extents shall be considered separately:

.1 55 per cent of the length L, measured from the most forward point of the underwater buoyant volume of each hull; and

.2 a percentage of the length L, applied anywhere in the length of the craft, equal to 35 per cent for a craft where $L = 50$ m and over and equal to $(L/2 + 10)$ per cent for a craft where L is less than 50 m.

4.3.3.2.2 Except as provided below, the penetration normal to the shell shall be $0{,}04\nabla^{1/3}$ or 0,5 m, whichever is the lesser, in association with a girth along the shell equal to $0{,}1\nabla^{1/3}$, where ∇ is the volume of displacement corresponding to the design waterline, in m^3. However this penetration or girth is under no circumstances to extend above the vertical extent of the vulnerable area as specified in 4.3.3.1.1.

4.3.3.2.3 The shape of damage shall be assumed to be rectangular in the transverse plane as shown in Fig. 4.3.3.2.3. The damage shall be assumed at a series of sections within the defined longitudinal extent in accordance with Fig. 4.3.3.2.3, the mid-point of the damaged girth being maintained at a constant distance from the centreline throughout that longitudinal extent.

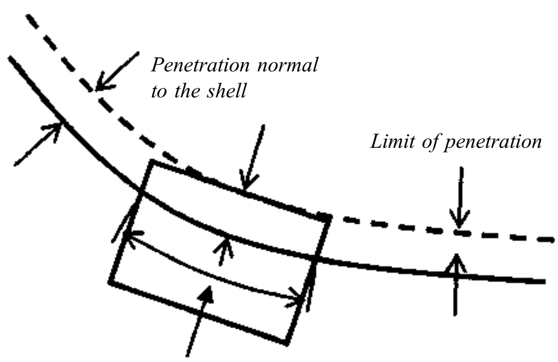


Fig. 4.3.3.2.3

4.3.4 Extent of bottom damage in areas not vulnerable to raking damage.

4.3.4.1 Application.

The requirements apply to all parts of the hull(s) below the design waterline which are not defined as vulnerable to raking damage in 4.3.3.1. Damage shall not be applied at the same time as that defined in 4.3.1 or 4.3.3.

4.3.4.2 Extent.

The following extent of damage shall be assumed:

.1 the length of damage in the fore-and-aft direction shall be $0{,}75\nabla^{1/3}$ or $(3\text{ m} + 0{,}225\nabla^{1/3})$, or 11 m, whichever is the least;

.2 the athwartships girth of damage shall be $0{,}2\nabla^{1/3}$;

.3 the depth of penetration normal to the shell shall be $0{,}02\nabla^{1/3}$

where:

∇ = volume of displacement corresponding to the design waterline, in m^3.

.4 the shape of damage shall be assumed to be rectangular in the plane of the shell of the craft, and rectangular in the transverse plane as shown in Fig. 4.3.3.2.1.

4.3.5 In applying 4.3.3 and 4.3.4 to multihull craft, an obstruction at or below the design waterline of up to 7 m in width shall be considered in determining the number of hulls damaged of any one time. The requirement of 4.1.3 shall be applied.

4.3.6 Following any of the postulated damages detailed in 4.1.3 to 4.3.5, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that:

.1 for all craft other than amphibious air-cushion vehicles, after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 50 per cent of the significant wave height corresponding to the worst intended conditions;

.2 for amphibious air-cushion vehicles, after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 25 per cent of the significant wave height corresponding to the worst intended conditions;

.3 there is a positive freeboard from the damage waterline to survival craft embarkation positions;

.4 essential emergency equipment, emergency radiostations, power supplies and public address systems needed for organizing the evacuation remain accessible and operational;

.5 the residual stability of craft meets the appropriate criteria as laid out in 4.6 and 4.7 according to Table 6.2.1, Part IV "Stability". Within the range of positive stability governed by the criteria of 4.6 and 4.7, no unprotected opening shall be submerged.

4.3.7 Downflooding openings referred to in 4.3.6 shall include doors and hatches which are used for damage control or evacuation procedures, but may exclude those which are closed by means of weathertight doors and hatch covers and not used for damage control or evacuation procedures.

4.4 Requirements for passenger crafts.

4.4.1 Following any of the postulated damages detailed in 4.3.1 to 4.3.5, in addition to satisfying the requirements of 4.3.6 and 4.3.7, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that:

.1 the angle of inclination of the craft from the horizontal does not normally exceed 10° in any direction. However, where this is clearly impracticable, angles of inclination up to 15° immediately after damage but reducing to 10° within 15 min shall be permitted provided that efficient non-slip deck surfaces and suitable holding points, e. g., holes, bars, etc., are provided; and

.2 any flooding of passenger compartments or escape routes which might occur will not significantly impede the evacuation of passengers.

4.4.2 In addition to the requirements in 4.4.1, category B craft shall also satisfy the following criteria after sustaining raking damage of 100 per cent of length *L*, having the girth and penetration given in 4.3.3.2.2, to any part of the surface of the hull(s) defined in 4.3.3.2.1:

.1 the angle of inclination of the craft from the horizontal shall not exceed 20° in the equilibrium condition;

.2 the range of positive righting lever shall be at least 15° in the equilibrium condition;

.3 the positive area under the righting lever curve shall be at least 0,015 m·rad in the equilibrium condition;

.4 the requirements of 4.3.6.3 and 4.4.1.2 are satisfied;

.5 in intermediate stages of flooding, the maximum righting lever shall be at least 0,05 m and the range of positive righting lever shall be at least 7°.

In complying with the above, the righting lever curve shall be terminated at the angle of downflooding, and only one free surface need be assumed.

4.5 Requirements for cargo crafts.

Following any of the postulated damages detailed in 4.1.3, 4.3.1 to 4.3.5, in addition to satisfying the requirements of 4.3.6 and 4.3.7, the craft in still water shall have sufficient buoyancy and positive stability to simultaneously ensure that the angle of inclination of the craft from the horizontal does not normally exceed 15° in any direction. However, where this is clearly impracticable, angles of inclination up to 20° immediately after damage but reducing to 15° within 15 min may be permitted provided that efficient non-slip deck surfaces and suitable holding points, e .g., holes, bars, etc., are provided.

4.6 Requirements for monohull crafts.

The stability required in the final condition after damage, and after equalization where provided, shall be determined as specified in 4.6.1 to 4.6.4.

4.6.1 The positive residual righting lever curve shall have a minimum range of 15° beyond the angle of equilibrium. This range may be reduced to a minimum of 10°, in the case where the area under the righting lever curve is that specified in 4.6.2, increased by the ratio:

$$\frac{15}{range}, \qquad (4.6.1)$$

where the range is expressed in degrees.

4.6.2 The area under righting lever curve shall be at least 0,015 m·rad, measured from the angle of equilibrium to the lesser of:

.1 angle at which progressive flooding occurs;

.2 27° measured from the upright.

4.6.3 A residual righting lever *GZ*, in m, shall be obtained within the range of positive stability, taking into account the greatest of the following heeling moments:

.1 the crowding of all passengers towards one side;

.2 the launching of all fully loaded davit-launched survival craft on one side;

.3 due to wind pressure,

as calculated by the formula:

$$GZ = \frac{heeling\ moment}{displacement} + 0{,}04. \qquad (4.6.3.3)$$

However, in no case, this righting lever shall be less than 0,1 m.

4.6.4 For the purpose of calculating the heeling moments referred to in 4.6.3, the following assumptions shall be made.

4.6.4.1 Moments due to crowding of passengers shall be calculated in accordance with 13.1.1, Part IV "Stability".

4.6.4.2 Moments due to launching of all fully loaded davit-launched survival craft on one side:

.1 all lifeboats and rescue boats fitted on the side to which the ship has heeled after having sustained damage shall be assumed to be swung out fully loaded and ready for lowering;

.2 for lifeboats which are arranged to be fully loaded from the stowed position, the maximum heeling moment during launching shall be taken;

.3 a fully loaded davit-launched liferaft attached to each davit on the side to which the craft has heeled after having sustained damage shall be assumed to be swung out and ready for lowering;

.4 persons not in life-saving appliances which are swung out shall not provide either additional heeling or righting moment; and

.5 life-saving appliances on the side of the ship opposite to the side to which the ship has heeled shall be assumed to be in a stowed position.

4.6.4.3 Moments due to wind pressure:

.1 the wind pressure P_d, in N/m^2, shall be taken as

$$P_d = 120(V_w/26)^2, \qquad (4.6.4.3.1)$$

where V_w = wind speed, in m/s, corresponding to the worst intended conditions;

.2 the area applicable shall be the projected lateral area of the ship above the waterline corresponding to the intact condition; and

.3 the moment arm shall be the vertical distance from a point at one half of the mean draught corresponding to the intact condition to the centre of gravity of the lateral area.

4.6.5 In intermediate stages of flooding, the maximum righting lever shall be at least 0,05 m and the range of positive righting levers shall be at least 7°. In all cases, only one breach in the hull and only one free surface need be assumed.

4.7 Requirements for multihull crafts.

4.7.1 Calculation of criteria for the residual stability curve (see Fig. 4.7.1) is similar to that for intact stability except that the craft in the final condition after damage shall be considered to have an adequate standard of residual stability provided:

.1 the required area A_2 shall be not less than 0,028 m·rad (see Fig. 4.7.1);

.2 there is no requirement regarding the angle of inclination at which the maximum GZ value shall occur.

4.7.2 The wind heeling lever for application on the residual stability curve shall be assumed constant at all angles of inclination and shall be calculated as follows:

$$HL_3 = \frac{P_d A Z}{9800\Delta}, \qquad (4.7.2)$$

where $P_d = 120\,(V_W/26)^2$, in N/m^2;

V_w = wind speed corresponding to the worst intended conditions, in m/s;

A = projected lateral area of the portion of the ship above the lightest service waterline, in m^2;

Z = vertical distance from the center of A to a point one half of the lightest service draught, in m;

Δ = displacement, in t.

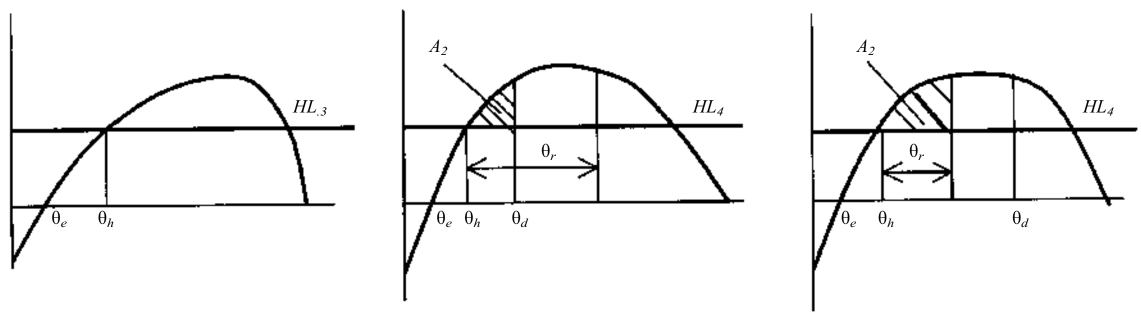


Fig. 4.7.1 Damage stability

Abbreviations used:

HL_3 = heeling lever due to wind;

HL_4 = heeling lever due to wind plus passenger crowding;

θ_d = angle of downflooding;

θ_r = angle of roll;

θ_e = angle of equilibrium, assuming no wind and passenger crowding;

θ_h = angle of heel due to heeling lever HL_3 or HL_4

4.7.3 The same values of roll angle shall be used as for the intact stability.

4.7.4 The residual stability curve shall terminate at the downflooding point. The area A_2 shall therefore be truncated at the downflooding angle.

4.7.5 The stability of the craft in the final condition after damage shall be examined and shown to satisfy the criteria, when damaged as stipulated in 4.3.

4.7.6 In the intermediate stages of flooding, the maximum righting lever shall be at least 0,05 m and the range of positive righting lever shall be at least 7°. In all cases, only one breach in the hull and only one free surface need to be assumed.

4.7.7 In applying the heeling levers to the damaged curves, the following shall be considered:

heeling lever due to steady wind, HL_3; and

heeling lever due to steady wind plus heeling lever due to passenger crowding HL_4.

4.7.8 The angle of heel due to steady wind shall not exceed 15° for a passenger craft and 20° for a cargo craft.

PART VI. FIRE PROTECTION

1 GENERAL

1.1 The requirements of Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships (including references to the International Code for Application of Fire Test Procedures, IMO Resolution MSC.61(67)) as far as reasonable and practicable, having regard to the requirements given below, apply to HSC.

1.2 Definitions and explanations relating to general terminology are given in "General" of the present Rules and Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

1.3 For the purpose of the present Rules the following definitions have been additionally accepted.

S m o k e - t i g h t o r c a p a b l e o f p r e v e n t i n g t h e p a s s a g e o f s m o k e means that a division made of non-combustible or fire-restricting materials is capable of preventing the passage of smoke at an ambient temperature.

A r e a s o f m a j o r f i r e h a z a r d referred to in Tables 2.5.2 and 2.6.2 by "A" include:

machinery spaces defined in 1.3, Part VII "Machinery Installations" of the Rules;

ro-ro cargo spaces;

spaces containing dangerous goods;

special-category spaces;

storerooms containing flammable liquids;

galleys;

shops of 50 m^2 and more in area in which flammable liquids are sold;

main ducts directly connected with the above-mentioned spaces.

A r e a s o f m o d e r a t e f i r e h a z a r d referred to in Tables 2.5.2 and 2.6.2 by "B" include:

auxiliary machinery spaces defined in 1.4, Part VII "Machinery Installations" of the Rules;

stores containing packaged beverages with alcohol content not exceeding 24 per cent by volume;

crew accommodation spaces with berths;

service spaces;

shops of less than 50 m^2 in area, containing limited quantity of flammable liquids for sale and having no separate storage area;

shops of more than 50 m^2 in area which do not sell flammable liquids;

main ducts directly connected with the above-mentioned spaces.

A r e a s o f m i n o r f i r e h a z a r d referred to in Tables 2.5.2 and 2.6.2 by "C" include:

auxiliary machinery spaces defined in 1.5, Part VII "Machinery Installations" of the present Rules;

cargo spaces;

oil fuel tanks compartments;

public spaces;

tanks, void spaces and areas of minor or no fire hazard;

snack-bars;

shops other than those arranged in the above-mentioned areas;

corridors in passenger accommodation spaces and stairway enclosures;

crew accomodation spaces without berths;

main ducts directly connected with the above-mentioned spaces.

I M D G C o d e means the International Maritime Dangerous Goods (IMDG) Code in accordance with Resolution MSC.205(81).

E v a c u a t i o n s t a t i o n s a n d e x t e r n a l e s c a p e r o u t e s r e f e r r e d t o i n T a b l e s 2.5.2 a n d 2.6.2 b y " E ", including the following areas:

external stairs and open decks used for escape routes;

muster stations, internal and external;

open deck spaces and enclosed promenades forming lifeboat and liferaft embarkation and lowering stations;

craft side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas.

In relation to the classification of spaces in 1.3, the following additional criteria shall be applied:

.1 if a space is divided by partial bulkheads into two (or more) smaller areas such that they form enclosed spaces, then the enclosed spaces shall be surrounded by bulkheads and decks in accordance with Tables 2.5.2 and 2.6.2, as applicable. However, if the separating bulkheads of such spaces are at least 30 per cent open, then the spaces may be considered as the same space;

.2 cabinets having a deck area of less than 2 m^2 may be accepted as part of the space they serve, provided they have open ventilation to the space and do not contain any material or equipment that could be a fire risk;

.3 where a space has the special characteristics of two or more space groupings, the structural fire protection time of the divisions shall be the highest for the space groupings concerned. For example, the structural fire protection time of the divisions of emergency generator rooms shall be of the highest value for the space when the space is considered as being a control station (D) and a machinery space (A).

F i r e - r e s t r i c t i n g m a t e r i a l s are materials which have the following characteristics defined in accordance with IMO Fire Test Procedures Code:

meet low flame spread characteristics;

limit heat flux, due regard being paid to the risk of furniture ignition in the compartment;

have the limited rate of heat release, due regard being paid to the risk of fire spread to an adjacent compartment;

do not emit gas and smoke in quantities that could be dangerous to the occupants of the craft.

F i r e - r e s i s t i n g d i v i s i o n s are divisions formed by bulkheads and decks and constructed of non-combustible or fire-restricting materials which by insulation or inherent fire-resisting properties satisfy the following requirements:

they shall be suitably stiffened;

they shall be constructed so as to be capable of preventing the passage of smoke and flame up to the end of the appropriate standard fire test time;

where required, they shall maintain load-carrying capabilities during the appropriate standard fire test time;

they shall have thermal properties such that the average temperature on the unexposed side will not rise more than 139 °C above the original temperature, nor will the temperature at any point, including any joint, rise more than 180 °C above the original temperature during the appropriate standard fire test time;

specimens of the relevant bulkheads or decks shall be tested in accordance with IMO Fire Test Procedures Code to ensure that they meet the above-mentioned requirements.

O p e n s p a c e s r e f e r r e d t o i n T a b l e s 2.5.2 a n d 2.6.2 b y "F" are spaces including open spaces which are not control stations of evacuation stations and external escape routes.

1.4 Enclosed spaces with low illumination level (cinemas, discotheques, and similar spaces) are not permitted. Pantries which do not contain cooking facilities with exposed heating surfaces may be permitted. Galleys, if fitted, shall be in full compliance with the requirements of 2.1.9, Part VI "Fire Protection"of the Rules for the Classification and Construction of Sea-Going Ships.

1.5 The structural fire protection items shall be considered regarding the spread of heat and provision of heat barriers.

1.6 On each craft fire control plans meeting the requirements of 1.4, Part VI “Fire Protection” of the Rules for the Classification and Construction of Sea-Going Ships shall be provided.

2 STRUCTURAL FIRE PROTECTION

2.1 Requirements for materials.

2.1.1 The requirements given below apply to all craft, irrespective of construction materials of the hull.

2.1.2 The hull, superstructure, structural bulkheads, decks, deckhouses and pillars shall be constructed of approved non-combustible materials having the adequate structural characteristics. The use of other fire-restricting materials may be permitted provided the requirements of this Section are met and the materials comply with the requirements of IMO Fire Test Procedures Code.

Paragraph 2.1.2 does not apply to appendages such as propellers, air ducts to propellers, transmission shafts, rudders and other control surfaces, struts, spars, flexible skirts, etc., which do not comprise part of the main structure of the craft.

2.1.3 All separating divisions, ceilings or linings if they are not fire-resisting, shall be of non-combustible or fire-restricting materials. Draught stops shall be of non-combustible or fire-restricting materials.

2.1.4 Where insulation is installed in areas where it could come into contact with any flammable fluids or their vapours, its surface shall be impermeable to such flammable fluids or vapours.

The fire insulation in such spaces may be covered by metal sheets (not perforated) or by vapour proof glass cloth sealed at joints.

2.1.5 Furniture in crew accommodation spaces shall comply with the following requirements:

all case furniture, e.g. desks, wardrobes, dressing tables, bureaux and dressers shall be constructed entirely of approved non-combustible or fire-restricting materials, except that a combustible veneer with a calorific value not exceeding 15 MJ/m^2 may be used on the exposed surface of such articles;

all furniture, such as chairs, sofas and tables, shall be constructed with frames of non-combustible or fire-restricting materials;

all upholstered furniture shall be resistant to ignition and flame spreading, as defined by IMO Fire Test Procedures Code.

2.1.6 All draperies, curtains and other suspended textile materials, bedding components and deck finish materials shall be of a type approved by the Register based on the positive results of standard tests in accordance with IMO Fire Test Procedures Code.

2.1.7 Subject to 2.1.8 the following surfaces shall, as a minimum, be constructed of materials having low flame-spread characteristics:

.1 exposed surfaces of corridors, stairway enclosures, bulkheads (including windows), wall and ceiling linings in all public, crew accommodation and service spaces, control stations, internal muster and evacuation stations;

.2 surfaces in concealed and inaccessible areas in corridors and stairway enclosures, public, service and crew accommodation spaces, control stations and internal muster and evacuation stations.

Paragraph 2.1.7 does not apply to partitions, windows and side scuttles made of glass which are deemed to be non-combustible and to comply with the requirements for low-flame spread surfaces or to items and materials referred to in 2.1.5[1].

2.1.8 Any thermal or acoustic insulation material shall be of non-combustible material, except when the use of fire-restricting materials is permitted in compliance with the present Rules.

2.1.9 Surfaces referred to in 2.1.7.1 shall be of materials which, when exposed to fire, do not emit smoke or toxic gases in excessive quantities as defined by IMO Fire Test Procedures Code.

2.1.10 Void compartments, where low-density combustible materials are used to provide buoyancy shall be protected from adjacent fire hazardous areas by fire-resisting divisions in accordance with Tables 2.5.2 and 2.6.2. Besides, spaces and closures to them shall be gastight but ventilated to atmosphere.

2.1.11 In compartments where smoking is allowed, suitable non-combustible ash containers shall be provided. In compartments where smoking is not allowed, adequate notices shall be displayed.

2.2 Closures of doorways and other openings.

2.2.1 Except for hatches between cargo, special category, store, and baggage spaces, and between such spaces and weather decks, all openings shall be provided with permanently attached means of closing which shall be at least as effective for resisting fires as the divisions in which they are fitted.

2.2.2 It shall be possible for each door to be opened and closed from each side of the bulkhead by one person only.

2.2.3 Fire doors in bounding bulkheads of areas of major fire hazard and stairway enclosures shall satisfy the following requirements:

2.2.3.1 Doors shall be self-closing and be capable of closing with an angle of inclination up to 3,5° opposing closure, the time of closure for hinged doors shall be no more than 40 s but no less than 10 s from the beginning of their movement with the craft in the upright position. Sliding doors shall move with the uniform rate of no more than 0,2 m/s but no less than 0,1 m/s with the craft in the upright position.

2.2.3.2 Remote-controlled doors or power-operated doors shall be equipped with an alarm that sounds at least 5 s but no more than 10 s before the door begins to move and continues sounding until the door is completely closed. A door shall be designed so that to re-open when contacting an object in its path; it shall re-open sufficiently to allow a clear passage of no more than 1 m from the point of contact.

2.2.3.3 All doors shall be capable of remote and automatic release from a continuously manned control station, either simultaneously or in groups, and also individually from a position at both sides of the door. Indication shall be provided in the continuously manned central control station panel whether each of the remote-controlled doors is closed. The release mechanism shall be designed so that the door will automatically close in the event of disruption of control system or central power supply. Release switches shall have an on-off function to prevent automatic resetting of the system. Hold-back hooks not subject to central control station release are prohibited.

2.2.3.4 Local power accumulators for power-operated doors shall be provided in the immediate vicinity of the doors to enable the doors to be operated at least 10 times (fully opened and closed).

2.2.3.5 Double-leaf doors equipped with a latch necessary to their fire integrity shall have a latch that

[1] Refer to paragraph 7.9.3.4 and the IMO Fire Test Procedures Code, Annex 2, paragraphs 1 and 5.1.

is automatically activated by the operation of doors when the operating system is released.

2.2.3.6 Doors giving direct access to special-category spaces which are power-operated and automatically closed need not be equipped with alarms and remote-release mechanisms required in 2.2.3.2 and 2.2.3.3.

2.2.3.7 Doors closed remotely from a continuously manned control station shall be capable of being re-opened at both sides of the door by local control. After such local opening, the door shall close again automatically.

2.2.3.8 Disruption of the control system or the main source of electrical power of one door shall not impair safe functioning of other doors.

2.2.3.9 Access shall be provided to local controls for adjustment and maintenance.

2.2.3.10 Power-operated doors shall be provided with a control system of the approved type which shall ensure functioning of doors in case of fire as defined by IMO Fire Test Procedures Code. This system shall comply with the following requirements:

.1 the control system shall be able to operate the door at the temperature of at least 200 °C for at least 60 min, served by power supply;

.2 power supply for doors not subject to fire shall not be impaired;

.3 at temperatures exceeding 200 °C the control system shall be automatically isolated from the power supply and shall be capable of keeping the door closed up to at least 945 °C.

2.2.3.11 Doors in smoke-tight divisions shall be self-closing. Doors which are normally in open position shall be closed automatically or remotely from a continuously manned control station.

2.2.4 The requirements for fire integrity of outer boundaries facing open decks do not apply to glass partitions, windows and sidescuttles and to exterior doors of superstructures and deckhouses.

2.2.5 In public, crew accommodation and service spaces, control stations, corridors and stairways air spaces enclosed behind ceilings, panels and linings shall be suitably divided by close-fitting draught stops spaced not more than 14 m apart. Draught stops are not required in public spaces of category A craft having only one public space and on other craft in spaces with open ceilings (perforated ceilings) where the opening is 40 per cent or more and the ceiling is arranged in such a way that a fire behind the ceiling can be easily seen and extinguished.

2.2.6 Indicators shall be provided on the navigating bridge, which shall indicate when any door leading to or from the special category space or ro-ro space is closed.

2.2.7 Fire doors in boundaries of special category spaces leading to spaces below the vehicle deck shall be arranged with coamings of a height of at least 100 mm.

2.3 Arrangement of stairways.

2.3.1 For internal stairways connecting two decks, enclosures with self-closing doors may be provided on one deck only. In such cases, the fire protection time for these enclosures shall comply with the requirements of Tables 2.5.2 and 2.6.2 for divisions separating spaces served by the stairway involved.

2.3.2 Lift trunks shall be fitted so as to prevent the passage of smoke and flame from one deck to another and shall be provided with means of closing so as to permit the control of draught and smoke.

2.3.3 Open stairways may be fitted in public spaces consisting of only two decks, provided the stairways lie wholly within such public spaces and the following conditions are met:

.1 all levels are used for the same purpose;

.2 the area of the opening between the lower and upper parts of the space is at least 10 per cent of the deck area between the upper and lower parts of the space;

.3 the design is such that persons within the space should be generally aware, or could easily be made aware of, a developing fire or other hazardous situation located within that space;

.4 sufficient means of escape are provided from both levels of the space directly leading to an adjacent safe area or compartment;

.5 the whole space is served by one section of the sprinkler system.

2.4 Fire-resisting divisions.

2.4.1 Areas of major and moderate fire hazard shall be enclosed by fire-resisting divisions, except where the omission of any such division would not affect the safety of the craft. The requirements need not be applied to parts of the structure in contact with water at least 300 mm below the craft's waterline in the lightweight condition in displacement mode, but due regard shall be given to the effect of temperature of hull in contact with water and heat transfer from any uninsulated structure in contact with water to insulated structure above water.

2.4.2 Fire-resisting bulkheads and decks shall be constructed to resist exposure to the standard fire test for a period of 30 min for areas of moderate fire hazard and 60 min for areas of major fire hazard except as provided in 2.5.2 and 2.6.2.

For open ro-ro cargo spaces (category F spaces) which are not essential elements of main load-bearing structure, and are not accessible for passengers and crew members in emergency situations, the structural fire protection time may be reduced to 0 min.

2.4.3 Main load-bearing structures within areas of major fire hazard and areas of moderate fire hazard and structures supporting control stations shall be arranged to distribute load so that there will be no collapse of the construction of the hull and superstructure when it is exposed to fire for the appropriate fire protection time. The load-carrying structure shall also comply with the requirements of 2.4.4 and 2.4.5 below.

2.4.4 If the structures specified in 2.4.3 are made of aluminium alloy their insulation shall be such that the temperature of the core does not exceed the ambient temperature more than 200 °C in accordance with the periods of time specified in 2.4.2 with regard to provisions of 2.5.2 and 2.6.2.

2.4.5 If the structures specified in 2.4.3 are made of combustible material, their insulation shall be such that their temperatures will not rise to a level where deterioration of the construction will occur during the exposure to the composite standard fire test (see Resolution MSC.45(65)) to such an extent that the load-carrying capability, in accordance with 2.4.3, 2.5.2 and 2.6.2, will be impaired.

2.4.6 Construction of all doors and door frames in fire-resisting divisions with means of securing them when closed, shall provide fire resistance as well as resistance to passage of smoke and flame equivalent to that of the bulkheads in which they are situated. Watertight doors of steel need not be insulated. Where a fire-resisting division has openings for pipes, ducts, controls, electrical cables or for other purposes, arrangements and necessary testing in compliance with IMO Fire Test Procedures Code shall be made to ensure that fire-resisting integrity of the division is not impaired.

Where machinery shafts penetrate fire-resisting watertight divisions, arrangements shall be made to ensure that the required fire-resisting integrity of the division is not impaired.

2.4.7 In approving structural fire protection details, the risk of heat transmission at intersections and terminal points of required thermal barriers shall be regarded.

.1 to prevent heat transmission at intersections and terminal points, the insulation of the deck or bulkhead shall be carried past the intersection or terminal point for a distance of at least 450 mm in the case of steel or aluminium structures (see Figs. 2.4.7, *a* and 2.4.7, *b*);

.2 if the space is divided by a deck or bulkhead and the fire insulation required for each space is different, the insulation with the higher structural fire protection time shall continue on the deck or bulkhead with the insulation of the lesser structural fire protection time for a distance of at least 450 mm beyond the boundary between the spaces;

.3 where the lower part of the fire insulation has to be cut for drainage, the construction shall be in accordance with the structural details shown in Fig. 2.4.7, *c*.

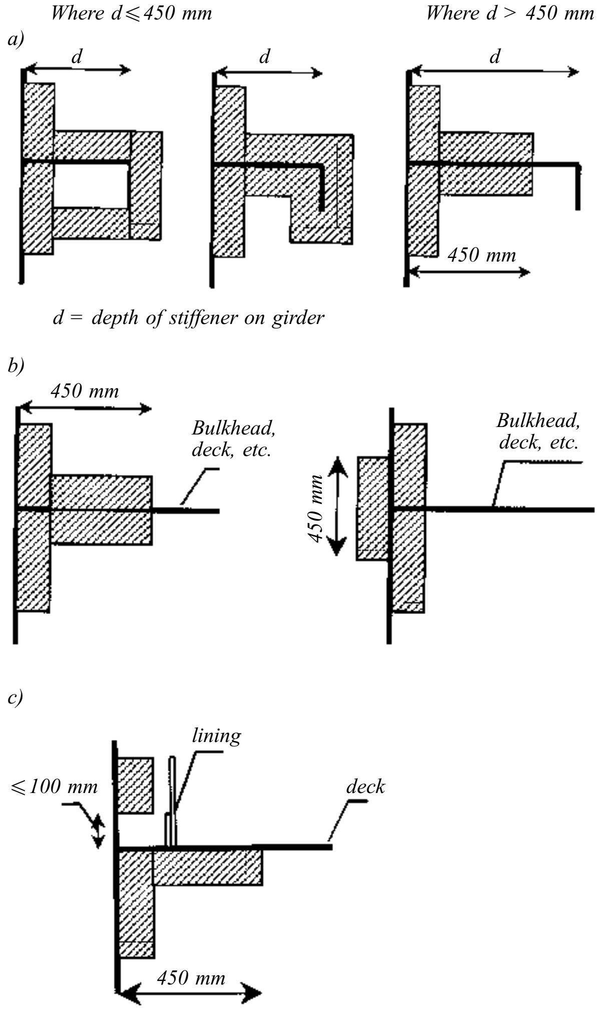


Fig. 2.4.7

2.4.8 Ventilation openings may be accepted in entrance doors to public toilets, provided they are positioned in the lower portion of the door and fitted with closable grilles made of non-combustible or fire-restricting material and operable from outside the space.

2.4.9 Boundaries of special category spaces shall be insulated in accordance with Tables 2.5.2 and 2.6.2. The vehicle deck of the special category space or a ro-ro space, including an open ro-ro space, need only be insulated on the underside if required. Vehicle decks located totally within ro-ro spaces may be accepted without structural fire protection, provided these decks are not part of, or do not provide support to, the craft's main load-carrying structure and provided satisfactory measures are taken to ensure that the safety of the craft, including fire-fighting abilities, integrity of fire resisting divisions and means of evacuation, is not affected by a partial or total collapse of these internal decks.

2.5 Passenger craft.

2.5.1 The requirements of this Chapter are supplementary to those of 2.1 to 2.4.

2.5.2 The structural fire protection time for separating bulkheads and decks shall be in accordance with Table 2.5.2 (the structural fire protection periods of time are all based on providing protection for a period of 60 min as referred to in 12.1, Part XVI "Life-Saving Appliances"). If any other lesser structural fire protection time is specified for category A craft in 12.1, Part XVI "Life-Saving Appliances", the periods of time given in 2.4.2 and 2.4.3 may be amended pro rata. In no case shall the structural fire protection time be less than 30 min.

2.5.3 In using Table 2.5.2, it shall be noted that the title of each category is intended to be typical rather than restricted. If while determining the appropriate fire integrity standards to be applied to boundaries between adjacent spaces, there is doubt as to their classification for the purpose of this section, they shall be treated as spaces within the relevant category having the most stringent boundary requirement.

2.5.4 For category B craft, public spaces shall be divided into zones according to the following.

2.5.4.1 The craft shall be divided into at least two zones. The mean length of each zone shall not exceed 40 m.

2.5.4.2 For the occupants of each zone there shall be an alternative safe area to which it is possible to escape in case of fire. The alternative safe area shall be separated from other passenger zones by smoke-tight divisions of non-combustible or fire-restricting materials extending from deck to deck. The alternative safe area can be another passenger zone provided the additional number of passengers may be accommodated in case of emergency.

The alternative safe area shall be sized according to the number of occupants plus 0,35 m^2 of net area per occupant.

2.5.4.3 The alternative safe area shall, as far as practicable, be located adjacent to the passenger zone it is intended to serve. There shall be at least two exits from each passenger zone, located as far away from each other as possible, leading to the alternative safe area. Escape routes shall be provided to enable all passengers and crew to be safely evacuated from the alternative safe area within the structural fire protection time for areas of major fire hazard.

2.5.5 Category A craft need not be divided into zones.

2.5.6 Control stations, stowage positions of life-saving appliances, escape routes and places of embarkation into survival craft shall not, as far as practicable, be located adjacent to any areas of major or moderate fire hazard.

Table 2.5.2

Structural fire protection time for separating bulkheads and decks of passenger craft

Zones \ Categories	A	B	C	D	E	F
A Areas of major fire hazard	60 60 1,2 1,2	30 60 1	60 3 1,8	3 60 4 1	60 3 1	60 1,7,9
B Areas of moderate fire hazard		30 30 2 2	30 3 8	3 60 4	30 3	3
C Areas of minor fire hazard			3 3	3 30 4 8,10	3 3	3
D Control stations				3 3 4 4	3 4	3
E Evacuation stations and escape routes					3 3	3
F Open spaces						—

N o t e s:

Figures on both sides of the diagonal line represent the required structural fire protection time for the protection system on the relevant side of the division.

When a steel division separates spaces of different zones, the structural fire protection time shall be set with regard to the area of the highest fire hazard.

1. The upper side of decks within spaces protected by fixed fire-extinguishing systems need not be insulated.

2. Where adjacent spaces are in the same alphabetical category and a note 2 appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Register. For example, a bulkhead need not be required between two store-rooms.

A bulkhead is, however, required between a machinery space and a special-category space even if both spaces are in the same category.

3. No fire resistance requirements; however, smoke-tight bulkhead made of non-combustible or fire-restricting material is required.

4. Control stations which are also auxiliary machinery spaces shall be provided with 30 min structural fire protection.

5. There are no special requirements for materials or integrity of boundaries where only a dash appears in the tables.

6. Fire protection time is 0 min and the time for prevention of passage of smoke and flame is 30 min as determined by the first 30 min of the standard fire test.

7. Fire-restricting divisions may not comply with the requirements for fire-resisting divisions (see 1.3) as regards their insulation properties governed by the temperatures during standard fire test.

8. When steel construction is used, fire resisting divisions adjacent to void spaces need not comply with the requirement for a temperature rise according to the standard fire test (see 1.3 of Section 1).

9. The fire protection time may be reduced to 0 min for those parts of open ro-ro spaces which are not essential parts of the craft's main load bearing structure, where passengers have no access to them and the crew need not have access to them during any emergency.

.10 On category A craft, the fire protection time may be reduced to 0 min where the craft is provided with only a single public space (excluding lavatories) protected by a sprinkler system and adjacent to the operating compartment.

2.6 Cargo craft.

2.6.1 The requirements of this Chapter are supplementary to those of 2.1 to 2.4.

2.6.2 Fire integrity of separating bulkheads and decks shall be in accordance with Table 2.6.2 to which notes given in Table 2.5.2 and provisions of 2.5.3 apply. If any other lesser structural fire protection time is specified for cargo craft in 12.1, Part XVI "Life-Saving Appliances" the period of time given above in 2.4.2 and 2.4.3 may be amended pro rata. In no case shall the structural fire protection time be less than 30 min.

Table 2.6.2

Structural fire protection time for separating bulkheads and decks of cargo craft

Zones \ Categories	A	B	C	D	E	F
A Areas of major fire hazard	60 60 1,2 1,2	30 60 1	60 3 1,8	3 60 4 1	60 3 1	60 — 1,7
B Areas of moderate fire hazard		6 6 2 2	3 6	3 60 4	3 6	— 3 —
C Areas of minor fire hazard			3 3	3,4 30 8	3 3	— 3
D Control stations				3 3 4 4	3 4	3 —
E Evacuation stations and escape routes					3 3	— 3
F Open spaces						— —

2.6.3 Control stations, stowage positions of life-saving appliances, escape routes and places of embarkation into survival craft shall be located adjacent to crew accommodation spaces.

3 FIRE FIGHTING EQUIPMENT AND SYSTEMS

3.1 Areas of major fire hazard shall be protected by an approved fixed fire-extinguishing system which corresponds to a potential fire hazard and is operated from the operating compartment and, where provided, from a control station. Provision shall be made for remote and manual control of the system from continuously manned control stations.

This system shall comply with the requirements of 3.2 and 3.3 or with the provisions of MSC/Circ.668, MSC/Circ.728, MSC/Circ.848.

3.1.1 Additional fixed fire-extinguishing systems not required by IMO Fire Test Procedures Code, but fitted to the craft shall meet the design requirements of this Code, except for the second discharge required for fixed gas fire-extinguishing systems.

3.2 In all craft where gas is used as the fire-extinguishing medium, the quantity of gas shall be sufficient to provide two independent discharges. The second discharge into the space shall only be activated (released) manually from a position outside the space being protected. Where a local fire-extinguishing system complying with the requirements of MSC/Circ.913 and intended to give diesel oil, lubricating and hydraulic oil a fire-retarding treatment, arranged in the vicinity of exhaust headers, turbochargers or similar heated surfaces of main and auxiliary engines, is installed in the space, the second discharge is not required.

3.3 Fixed fire-extinguishing systems (having regard to the provisions of 1.1 of this Part) shall comply with the following requirements.

3.3.1 The use of a fire-extinguishing medium which either by itself or under expected conditions of use will adversely affect the earth ozone layer and/or gives off toxic gases in such quantities as to endanger persons is not permitted.

3.3.2 Means shall be provided to close all openings which may admit air to, or allow gas to escape from, a protected space.

Openings that may admit air to, or allow gas to escape from, a protected space shall be capable of being closed from outside the protected space.

3.3.3 Means shall be provided for automatically giving audible warning of fire-extinguishing medium release into any space in which personnel work or which personnel can be expected to enter (e.g. ro-ro spaces) and where their access is facilitated by doors or hatches. The alarm shall automatically operate (e.g. by opening of the release cabinet door) for a suitable period before the medium is released and last not less than 20 s. In addition to audible alarm, visual alarm shall be provided.

3.3.4 Automatic release of fire-extinguishing medium shall not be permitted.

3.3.5 Pressure containers required for the storage of fire-extinguishing medium shall be located outside protected spaces.

Pressure containers may be located inside protected spaces, unless in case of an accidental gas blow-by a threat is produced to human life.

3.3.6 Means shall be provided for the crew to check safely the quantity of medium in the containers without moving the containers completely from their fixing position.

3.3.7 Containers for the storage of fire-extinguishing medium and associated pressure components shall be designed having regard to their locations and maximum ambient air temperatures expected in service.

3.3.8 When the fire-extinguishing medium is stored outside a protected space, it shall be stored in a room which shall be situated in a safe and readily accessible location. For the purpose of the application of Tables 2.5.2 and 2.6.2, such storage rooms shall be treated as control stations. For the storage rooms for fire-extinguishing media of fixed gas fire-extinguishing systems, the following apply:

.1 the storage room shall not be used for any other purposes;

.2 if the storage space is located below deck, it shall be located no more than one deck below the open deck and shall be directly accessible by a stairway or ladder from the open deck;

.3 spaces shall be effectively ventilated. Spaces which are located below deck or spaces where access from the open deck is not provided, shall be fitted with a mechanical ventilation system designed to take exhaust air from the bottom of the space and to provide at least 6 air changes per hour; and

.4 access doors shall open outwards, and bulkheads and decks including doors and other means of closing any opening therein, which form the boundaries between such rooms and adjacent enclosed spaces shall be gastight.

3.3.9 Spare parts for the system shall be stored on board or at a base port.

3.3.10 Pipelines may pass through accommodation spaces, provided they are of substantial thickness and their tightness is verified with a pressure test, after their installation, at a pressure head not less than 5 N/mm^2. In addition, pipelines passing through accommodation area shall only be joined by welding and shall not be fitted with drains or other openings within such spaces. Pipelines shall not pass through refrigerated spaces.

3.3.11 Where the volume of free air contained in air receivers in any space is such that, if released in such space in the event of fire, such release of air within that space would seriously affect the efficiency of the fixed fire-extinguishing system, it is necessary to require the provision of an additional quantity of fire-extinguishing medium corresponding to the gross volume of the machinery space being increased by the volume of air receivers converted to free air volume. Alternatively, a discharge pipe connected to a safety valve may be fitted to each air receiver, provided it leads directly to the open air.

3.3.12 Where the extinguishing medium is required to protect more than one space, the quantity of medium available need not be more than the largest quantity required for any one space so protected. Spaces are considered as separated where divisions comply with Tables 2.5.2 and 2.6.2, as appropriate, or the divisions are gastight and of steel or equivalent materials.

3.4 The carbon dioxide system shall comply with the requirements of 3.8, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

3.5 The water fire main system shall comply with the relevant requirements of 3.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships, having regard to the following:

3.5.1 At least two pumps powered by independent sources of power shall be arranged. Each pump shall have at least two-thirds of the capacity of a bilge pump (see 2.6 and 2.7, Part VIII "Systems and Piping" of the present Rules) but not less than 25 m^3/h. Each pump shall be capable to deliver sufficient quantity and pressure of water to simultaneously operate two hydrants.

3.5.2 The arrangement of pumps shall be such that, in the event of fire, in any one compartment, all fire pumps will not be put out of action.

3.5.3 Fire hoses, together with all the necessary fittings and tools, shall be kept ready for use in conspicuous positions near hydrants. All fire hoses in interior locations shall be always connected to hydrants. One fire hose shall be provided for each hydrant.

Each fire hose shall be of non-perishable material. Fire hoses shall have a length of:

.1 at least 10 m;

.2 not more than 15 m in machinery spaces; and

.3 not more than 20 m for other spaces and open decks.

3.5.4 The fire main shall be capable of being drained and shall be fitted with valves arranged so that fire main branches can be isolated when the main is used for purposes other than fire-fighting.

3.5.5 Hydrants shall be arranged so that any location on the craft can be reached by the water jets from two fire hoses from two different hydrants, one of the jets being from a single length of hose. Ro-ro space hydrants shall be located so that any location within the space can be reached by two water jets from two different hydrants, each jet being supplied from a single length of hose.

One hydrant shall be located in the vicinity of and outside each entrance to a machinery space.

3.6 Each special-category space and ro-ro spaces shall be fitted with an approved fixed pressure water-spraying system for manual operation which shall protect all parts of any deck and vehicle platform in such space.

3.6.1 The pumps of the system shall be capable of maintaining:

.1 half the total required application rate with any one pump unit out of function, for category A craft; and

.2 the total required application rate with any one pump unit out of function, for category B craft.

3.6.2 Fixed fire-extinguishing systems shall meet the following requirements:

.1 the valve manifold shall be provided with a pressure gauge, and each of the valves shall be marked to identify the protected areas;

.2 instructions for maintenance and operation of the installation shall be set up in the room where the valves are located; and

.3 the piping system shall be provided with a sufficient number of drainage valves.

However, the Register may permit the use of any other fixed fire-extinguishing system, provided it has been shown by full-scale test in conditions simulating a flowing petrol fire in a special-category space that it is not less effective in controlling fires likely to occur in such a space.

3.7 Each space in which independent tanks are located shall be fitted by a fire-extinguishing system referred to in 3.1.

3.8 On cargo craft cargo spaces, except open deck areas or refrigerated holds shall be protected with an approved fixed quick-acting fire-extinguishing system complying with 3.3 operable from the control station.

3.9 Public spaces, service spaces, crew accommodation spaces with berths (in case of cargo craft, only these spaces of more than 50 m^2 in area including corridors leading thereto), storage rooms other than those containing flammable liquids, and similar spaces shall be protected by a sprinkler system complying with IMO Resolution MSC.44(65) as amended by MSC/Circ.912. A stairway open at one deck shall be considered part of the space to which it is open and consequently shall be protected by any sprinkler system provided for that space. Manually operated sprinkler systems shall be divided into sections of appropriate size, and valves for each section, start of sprinkler pump(s) and alarms shall be operable from two spaces separated as widely as possible, one of which shall be a continuously manned control station. In category B craft, no section of the system shall serve more than one of the zones required in 2.5.4.

Plans of the system shall be displayed at each control station. Suitable measures shall be taken for the drainage of water discharged when the system is activated.

3.10 In category A craft requirements of 3.9 may not be fulfilled provided that:

.1 smoking is forbidden;

.2 the maximum number of passengers onboard does not exceed 200 persons;

.3 sales shops, galleys, service spaces, ro-ro spaces and cargo spaces are not fitted;

.4 duration of voyage at 90 per cent of maximum speed from the port of departure to the port of destination does not exceed 2 hours.

3.11 Where deep fat cooking equipment is used, this equipment shall meet the requirements of 2.1.9.9, Part VI “Fire Protection” of the Rules for the Classification and Construction of Sea-Going Ships.

4 FIRE DETECTION AND ALARM SYSTEMS

4.1 Fire detection and alarm systems shall comply with the requirements of Section 4, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

It shall be taken into consideration that the term "machinery spaces of major fire hazard" (see 1.3) shall be used instead of the term "machinery spaces of category A".

4.2 Areas of major and moderate fire hazard and other enclosed spaces within crew accommodation spaces and public spaces not regularly occupied (such as toilets, stairway enclosures, corridors and means of escape) shall be provided with an approved automatic smoke-detection system and manually operated call points complying with the requirements of 7.4, Part XI "Electrical Equipment" of Rules for the Classification and Construction of Sea-Going Ships, to indicate at the control station the location of fire outbreak in all normal operating conditions of installations.

Control stations not normally occupied (e.g. emergency generator rooms) need not be provided with manually operated call points.

Galleys may be provided with heat detectors instead of smoke detectors. Main propulsion machinery rooms shall, in addition to smoke detectors, have detectors sensing factors other than smoke and be supervised by TV cameras monitored from the operating compartment.

One manually operated call point shall be located in each public space, crew space, corridor and stairway enclosure, service space and, where required, control station.

4.3 Fire detection system shall be provided in spaces where independent oil fuel tanks are arranged.

4.4 In cargo craft, cargo spaces, except open deck areas or refrigerated holds, shall be provided with a smoke-detection system to indicate at the control station the location of a fire outbreak in all normal operating conditions of installations.

4.5 Special-category spaces and ro-ro spaces:

where no continuous fire patrol is maintained a fixed fire-detection and fire-alarm system and a television monitoring system shall be provided.

The fixed fire-detection system shall be capable of rapidly detecting a fire outbreak. The spacing and location of detectors shall be tested taking into account the effects of ventilation and other factors;

manually operated call points shall be provided, one close to each exit from such spaces.

The maximum distance between call points shall not exceed 20 m.

4.6 The fire detection system in vehicle deck spaces, excluding manual call points, may be switched off with a timer during loading/unloading of vehicles.

5 FIRE OUTFIT AND SPARE PARTS

5.1 Control stations, public spaces, crew accommodation spaces, corridors and service spaces shall be provided with portable fire extinguishers of the approved type and design. At least five portable fire extinguishers shall be provided and positioned so as to be accessible and available for immediate use. In addition, at least one fire extinguisher suitable for machinery space fires shall be positioned outside each machinery space entrance.

5.2 All craft other than category A passenger craft shall carry at least two fireman outfits complying with the requirements of 5.1.15, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

5.3 In addition, in category B passenger craft for every 80 m, or part thereof, of the aggregate length of all passenger spaces and service spaces on the deck which carries such spaces or, if there is more than one such deck, on the deck which has the largest aggregate length of such spaces, there shall be provided two fireman outfits and two sets of personal equipment, each set comprising the items stipulated in 5.1.15.1.1 to 5.1.15.1.3, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

5.4 In category B passenger craft for each pair of breathing apparatuses there shall be provided one water fog applicator meeting the requirements of 5.7.1, which shall be stored adjacent to such apparatus.

5.5 The Register may require additional sets of personal equipment and breathing apparatus, with due regard to the size and type of the craft.

5.6 Fireman outfits and sets of personal equipment shall be stored in permanently and clearly marked locations arranged so as to be easily accessible and ready for use and, where more than one set of personal equipment is carried, they shall be stored in widely separated positions. In passenger craft, at least two fireman outfits and one set of personal equipment shall be available at one of control stations (5.1.15, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships).

5.7 In each special-category space there shall be provided:

.1 at least three water fog applicators, which shall consist of a metal L-shaped pipe, the long limb being approximately 2 m in length and capable of being fitted to a fire hose, and the short limb being approximately 250 mm in length and fitted with a fixed water fog nozzle or capable of being fitted with a water spray nozzle;

.2 one portable foam applicator unit consisting of an air-foam nozzle of an inductor type capable of being connected to the fire main by a fire hose together with a portable tank containing 20 litres of foam-making liquid and one spare tank. The nozzle shall be capable of producing effective foam suitable for extinguishing an oil fire at the rate of at least 1,5 m^3/min. At least two portable foam applicator units shall be available on the craft for use in such spaces;

.3 portable fire extinguishers shall be located so that no point in the space is more than approximately 15 m from an extinguisher, provided that at least one portable fire extinguisher is located at each access to such space.

Each portable fire extinguisher shall:

.3.1 not exceed 23 kg in total mass;

.3.2 have a capacity of at least 5 kg if of powder or carbon dioxide type;

.3.3 have a capacity of at least 9 l if of foam type;

.3.4 be examined annually;

.3.5 be provided with a sign indicating the date when was last examined;

.3.6 be hydraulic-pressure tested (cylinders and propellant bottles) every 10 years;

.3.7 not be placed in accommodation spaces if of carbon dioxide type;

.3.8 if located in control stations and other spaces containing electrical or electronic equipment or appliances necessary for the safety of the craft, be provided with extinguishing media which are neither electrically conductive nor harmful to the equipment and appliances;

.3.9 be ready for use and located in easily visible places such than it can be reached quickly and easily at any time in the event of a fire;

.3.10 be located such that its serviceability is not impaired by the weather, vibration or other external factors; and

.3.11 be provided with a device to identify whether it has been used.

In addition to complying with 5.1, fire extinguishers shall be suitable for A and B class[1] fires and have a capacity of 12 kg dry powder or equivalent.

5.8 Spare parts and tools shall meet the requirements stipulated in 5.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships (see also 3.3.9 of this Part).

6 OPEN RO-RO SPACES

6.1 Open ro-ro spaces shall comply with the requirements set out in 2.5.2, 2.6.2, 3.6, 4.5, 5.7 of this Part and those stipulated in 2.17 and 2.18, Part VIII "Systems and Piping".

6.2 For those parts of a ro-ro space, which are completely open from above, the requirements set out in 3.6 and 4.5 of this Part and those stipulated in 2.17 and 2.18, Part VIII "Systems and Piping", need not be complied with. However, a continuous fire patrol or a television surveillance system shall be maintained.

7 CRAFT AND CARGO SPACES INTENDED FOR THE CARRIAGE OF DANGEROUS GOODS

7.1 Craft and cargo spaces intended for the carriage of dangerous goods shall comply with special requirements for structures, equipment and outfit set out in 7.1 and 7.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

7.2 The requirements regarding water supply may be fulfilled by a water spray system approved by the Register and developed with due regard for the requirements of MSC/Circ.6081/Rev.1[2], provided that the amount of water required for fire-fighting purposes in the largest cargo space allows simultaneous use of the water spray system plus four jets of water from hose nozzles in accordance with 7.2.5.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships.

7.3 Craft carrying dangerous cargoes shall be provided with three fire hoses and dual-purpose type nozzles (i.e. producing a compact and a spayed jet) in addition to those required by 3.5.3 of this Part.

7.4 Solid dangerous cargoes carried in bulk include cargoes of group B of the Code of Safe Practice for Solid Bulk Cargoes, 2004, except for cargoes denoted Materials Hazardous in Bulk.

[1] Refer to publication IEC 60529 — Degrees of protection provided by enclosures (IP Code), in particular, refer to the standards for an ingress protection of at least IP 55 or refer to the publication IEC 60079 series — Electrical apparatus for explosive gas atmospheres, in particular, refer to the standards for protection by an apparatus for use in zone 2 areas.

[2] Refer to 9.2, 9.3 and 9.4, Interim guidelines for open-top containerships (MSC/Circ.6081/Rev.1).

PART VII. MACHINERY INSTALLATIONS

1 GENERAL

1.1 This Part of the Rules applies to the machinery installations, equipment of machinery spaces, lift and propulsion devices and spare parts. In addition, the requirements of 2.1.6, 2.1.10, 2.3 to 2.5, 3.3 and Section 4, Part VII "Machinery Installations" of the Rules for the Classification and Construction of Sea-Going Ships, as well as the requirements for controls of lift and propulsion devices, their elements, including shafting and propellers set out in Part IX "Machinery" of the present Rules shall be complied with.

1.2 For the purpose of this Part, the definitions given in "General" of the present Rules and the definitions given in 1.2, Part VII "Machinery Installations" of the Rules for the Classification and Construction of Sea-Going Ships, as appropriate, are used.

1.3 The requirements of the present Rules are based on a condition that a flash point of the oil fuel used in HSC shall be not below +43 °C.

The use of oil fuel with a flash point below +43 °C but not lower than +35 °C is subject to special consideration by the Register. In this case, special structural arrangements shall be made to prevent a risk of fire or explosion.

1.4 Spaces where oil fuel tanks are arranged shall be provided with mechanical ventilation using exhaust fans capable of providing at least six air-changes per hour.

1.5 Vibration levels of machinery and equipment after installation on board shall not exceed those given in Section 9, Part VII "Machinery Installations" of the Rules for the Classification and Construction of Sea-Going Ships.

1.6 The machinery installation of a high-speed craft shall generally be of a design and construction, suitable for operation as in unmanned machinery space, including automatic fire detection system, bilge alarm system, remote machinery instrumentation and alarm system. Special consideration shall be given to the reliability of single essential propulsion components. A separate source of propulsion power sufficient to give the craft a navigable speed, especially in the case of unconventional arrangements, may be required.

1.7 Requirements for machinery installations of passenger crafts.

1.7.1 Category B crafts shall be provided with at least two independent means of propulsion so that the failure of one engine or its support systems would not cause the failure of the other engine or engine systems. Provision shall be made for additional machinery controls in or close to the machinery space.

1.7.2 Category B crafts shall be capable of maintaining the propulsion machinery, essential machinery and controls so that, in the case of fire or other casualties in any one compartment on board, the craft can return to a port of refuge under its own power.

1.8 Requirements for machinery installations of cargo crafts.

1.8.1 Cargo crafts shall be provided with additional machinery controls in or close to the machinery space.

1.8.2 Cargo crafts shall be capable of maintaining the propulsion machinery, essential machinery and controls so that, in the case of fire or other casualties in any one compartment on board, the craft can return to a port of refuge under its own power.

2 POWER OUTPUT OF MAIN MACHINERY

2.1 The power output of the main propulsion machinery in a high-speed craft (driving engines of propulsion units) shall be such that no overload of the engines exceeding that specified in the documentation could occur when the craft achieves its operational mode in the worst intended conditions.

2.2 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative. Having regard to overall safety considerations, a partial reduction in propulsion capability from normal operation may be accepted.

2.3 Machinery installation shall be capable to provide motion of the craft astern for its better manoeuvrability in the displacement mode under all operating conditions.

The power output of the craft when going astern shall be sufficient for braking the craft within a reasonable period of time depending on the purpose of the craft and operating conditions.

3 CONTROL STATIONS

3.1 The requirements of 3.1 and 3.2, Part VII "Machinery Installations" of the Rules for the

Classification and Construction of Sea-Going Ships shall be met, having regard to 1.7.1 and 1.8.1 of this Part.

3.2 All operations on engine and machinery control shall be performed from the craft control station.

3.3 Where provision is made for machinery control from a special station, in addition to the craft control station, control from one station to the other shall be transferred from the craft control station.

4 SPARE PARTS

4.1 The requirements of 10.1, Part VII "Machinery Installations" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

4.2 Crafts shall be provided with spare parts in compliance with the standards given in Table 4.2 where the quantity of spare parts is shown irrespective of the number of similar items of machinery installed on board.

Table 4.2

Nos	Spare parts	Quantity
1	**Internal-combustion engines**	
1.1	Starting valve in assembly	1 pc.
1.2	Fuel-valve in assembly (each type and size)	1/4 of a set (for one engine)
1.3	H.P. oil fuel pipes (each type and size)	1 pc.
2	**Auxiliary and deck machinery and craft arrangements**	
2.1	Pump shaft sealing items (each type and size)	1 pc.
2.2	Special packing for stuffing boxes (each type and size)	1 pc.
2.3	Safety valve springs or valves in assembly (each type and size)	1 pc.
3	**Boilers, pressure vessels and heat exchangers**	
3.1	Safety valve springs or valves in assembly (each type and size)	1 pc.
3.2	Sight glasses or flat glasses of medium level gauges	1 pc.
3.3	Pressure gauges (each type and size)	1 pc.
4	**Main and auxiliary gas-turbine installations**	
4.1	Main burners	1 set per each combustion chamber
4.2	Starting burners	Ditto
4.3	Ignition arrangement	Ditto
4.4	Ignition plugs	Ditto

PART VIII. SYSTEMS AND PIPING

1 GENERAL

1.1 The requirements of 1.2 to 1.6, Sections 2, 3, 4, 5, 20, 21, Part VIII "Systems and Piping"of the Rules for the Classification and Construction of Sea-Going Ships shall be met as far as they are applicable.

1.2 Fluid systems shall be constructed and arranged so as to ensure a safe and adequate flow of fluid at a prescribed flow rate and pressure under all conditions of craft operation. The probability of a failure in any one fluid system, causing damage to the electrical system, a fire or an explosion shall be extremely remote.

1.3 The maximum allowable working pressure in any part of the fluid system shall not be greater than the design pressure, having regard to the allowable stresses in the materials. Where the maximum allowable working pressure of a system component, such as a valve or a fitting, is less than that calculated for the pipe or tubing, the system pressure shall be limited to the lowest of the component maximum allowable working pressures. Every system component that can be exposed to pressures higher than the system's maximum allowable working pressure shall be safeguarded by appropriate relief devices.

1.4 Pipes shall be capable to withstand prolonged exposure to vibration.

1.5 Pipes shall be provided with arrangements for drainage and purging of the conveyed liquid.

1.6 Tanks and piping shall be pressure-tested to a pressure that will assure a safety margin in excess of the working pressure of the item. The test on any storage tank shall take into account any possible static head in the overflow condition and the dynamic forces arising from craft motions.

Securing devices and foundations of the tanks and reservoirs shall be designed for the same loads.

1.7 Tanks containing oil fuel and other flammable fluids shall be separated from passenger, crew and baggage compartments by vapour-proof enclosures or cofferdams which are suitably ventilated and drained.

Tanks for fluids with a flashpoint not less than 60 °C may be located within such areas provided the tanks are made of steel or other equivalent material (see 1.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships).

1.8 Pipes and valves and couplings of the systems conveying oil fuel and other flammable fluids under pressure shall be arranged as far from hot surfaces, electrical appliances and other potential sources of ignition as is practicable. They shall be located, shielded or protected with suitable enclosures so that the likelihood of fluid leakage coming into contact with such sources of ignition is kept to a minimum. The number of joints in such piping systems shall be kept to a minimum. Flexible pipes carrying flammable fluids shall be of an approved type.

This requirement is also applicable to air intakes of engine installations.

1.9 Pipes conveying flammable fluids, including oil fuel, lubricating oils, hydraulic and thermal oils located in machinery spaces and spaces containing sources of ignition shall be made of steel or other material meeting the Register requirements in respect of strength and fire integrity, having regard to the working pressure and the spaces in which they are installed. Wherever practicable, the use of flexible pipes shall be avoided.

1.10 Fuel oil, lubricating oils and other flammable oils shall not be carried forward of public spaces and crew accommodation.

1.11 Cooling systems shall be adequate to maintain all lubricating and hydraulic fluid temperatures within the limits recommended by manufacturers under all intended conditions of craft operation.

1.12 Materials used in piping systems shall be compatible with the conveyed medium and shall be fire resisting where necessary.

1.13 Use of pipes made of aluminium alloys may be permitted in systems with non-combustible fluids and temperatures of not greater than 150 °C.

1.14 Piplines made of plastics shall meet the requirements of Section 3, Part VIII «Systems and Piping» of the Rules for the Classification and Construction of Sea-Going Ships.

2 BILGE SYSTEM

2.1 The requirements of 7.1.3, 7.1.5, 7.2.2, 7.2.4, 7.3.6 to 7.3.8, 7.4.3, 7.4.5, 7.4.8, 7.6, 7.8 to 7.12, 7.14, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

2.2 Arrangements shall be made for draining any watertight compartment other than compartments intended for permanent storage of liquid.

Drainage arrangements for some compartments may be omitted provided it will be demonstrated that the safety of the craft will not be impaired with the particular compartment flooded.

Bilge wells shall be of sufficient capacity and arranged in each watertight compartment near side plating.

2.3 The system shall be capable to provide drainage under all possible values of list and trim after the craft has sustained the damage postulated in 4.3, Part V "Reserve of Buoyancy and Subdivision".

2.4 The bilge system shall be designed so as to prevent water flowing from one compartment to another.

2.5 The necessary valves for controlling the bilge suctions shall be capable of being operated from the positions above the datum. All distribution boxes and manually operated valves shall be located in positions, which are accessible under ordinary circumstances.

The spindles of the sea inlet valves shall extend well above the machinery space floor plates.

2.6 All bilge suction piping up to the connection to the pumps shall be independent of other piping.

2.7 For category B passenger crafts at least three and for category A crafts at least two power-operated bilge pumps connected to the bilge main shall be provided. One of them may be driven by the propulsion machinery.

Alternatively, the use of submersible pumps meeting the requirements of 2.12 is allowed.

At least one of the required bilge pumps shall be available for use under all conditions of flooding which the craft is required to withstand. For this purpose:

.1 at least one of the pumps shall be of a submersible type driven from an emergency source of power;

.2 the bilge pumps and their sources of power shall be so distributed throughout the length of the craft that at least one undamaged pump and source of power in an undamaged compartment will be available.

On multihull crafts, each hull shall be provided with at least two bilge pumps.

2.8 On cargo crafts at least two power pumps shall be provided, one of which may be driven by the main engine.

Alternatively, the arrangements in accordance with the requirements of 2.12 are allowed.

On multihull crafts, each hull shall be provided with at least two power pumps, unless a bilge pump in one hull is capable of pumping bilge in the other hull. At least one pump in each hull shall be an independent power pump.

2.9 Distribution boxes, cocks and valves in connection with the bilge system shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative in any compartment. In addition, damage to a pump or its pipe connecting to the bilge main shall not put the bilge system out of action. When, in addition to the main bilge pumping system, an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating in any compartment under flooding conditions as specified in 2.3. In that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the bulkhead deck.

2.10 All cocks and valves referred to in 2.5, which can be operated from above the bulkhead deck, shall have their controls at their place of operation clearly marked and shall be provided with means to indicate whether they are open or closed.

2.11 For crafts provided with a bilge main with individual pumps, the total capacity of bilge pumps for each pump shall not be less than 2,4 times the capacity of the pump based on the necessity to pump out the water through the required bilge main at a rate at least 2 m/s.

The diameter (d) of the bilge main shall be calculated according to the following formula, except that the actual internal diameter of the bilge main may be rounded off to the nearest size of a recognized standard:

$$d = 25 + 1{,}68\sqrt{L(B+D)}, \qquad (2.11)$$

where d = the internal diameter of the bilge main, in mm;
L = the length of the craft, in m;
B = for monohull craft, the breadth of the hull, in m; for multihull craft, the breadth of a hull at or below the design waterline, in m;
D = the moulded depth of the craft measured to the top of the upper deck, in m.

Dimentions of suction branches shall comply with the requirements of 7.2.1 and 7.2.2, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships but are not to be less than 25 mm. Suction branches shall be provided with effective strainers.

2.12 For crafts where a bilge main is not provided at least one fixed submersible pump shall be provided for each space. In addition, at least one portable pump shall be provided supplied from the emergency supply source, for use in individual spaces. The capacity of each submersible pump Q_n, m^3/h, shall be not less than:

$$Q_n = Q/(N - 1), \qquad (2.12)$$

where N = number of submersible pumps;
Q = total capacity.

The minimum capacity shall be at least 8 m^3/h.

2.13 The power operated self-priming bilge pumps may be used for other duties such as fire fighting or general service but not for pumping fuel or other flammable liquids.

2.14 An emergency bilge suction shall be provided for each machinery space containing a propulsion prime mover. This suction shall be led to the largest power water pump available in the machinery space.

2.15 Spaces located above the upper deck shall be drained if penetration of water through windows, doors and other openings substantially affect stability and buoyancy of the craft. The spaces may be drained directly overboard through scuppers fitted with non-return valves.

2.16 Any space including buoyancy compartments for which bilge pumping arrangements are required shall be provided with a bilge alarm.

2.17 In view of the serious loss of stability, which might arise due to accumulation of large quantities of water accumulating on the deck or decks consequent to the operation of the fixed water main fire-extinguishing system, additional means of drainage shall be provided in the spaces served by this system. The capacity of the bilge or drainage arrangements available shall provide removal of not less than 125 per cent of the amount of water, which may result from operation of the water fire extinguishing systems.

2.18 Where watertightness or weathertightness shall be maintained, scuppers shall be arranged so that they can be operated from outside the protected space.

2.19 Non-return valves shall be fitted in the following bilge pumping components:

.1 bilge valve distribution manifolds;

.2 bilge suction hose connections where fitted directly to the pump or to the main bilge suction pipe;

.3 direct bilge suction pipes and bilge pump connections to main bilge suction pipe.

3 BALLAST SYSTEM

3.1 The requirements of 8.1.1, 8.1.2, 8.1.5, 8.2, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

3.2 Water ballast shall not in general be carried in tanks intended for oil fuel. In craft in which it is not practicable to avoid putting water in oil fuel tanks, the requirements of 4.1.1, 5.1.1 and 5.4 or 6.2.2, Part II "Requirements for Ship's Construction and Equipment for the Prevention of Pollution by Oil" of the Rules for the Prevention of Pollution from Ships, shall be met.

3.3 Where a fuel-transfer system is used for ballast purposes, the system shall be isolated from ballast system and meet the requirements for oil fuel systems.

4 VENTILATION SYSTEMS

4.1 The requirements of 12.1 to 12.3, 12.5.1, 12.6 to 12.10, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

4.2 The main inlets and outlets of all ventilation systems shall be capable of being closed from outside the spaces being ventilated. In addition, such openings to areas of major fire hazard shall be capable of being closed from a continuously manned control station.

4.3 All ventilation fans shall be capable of being stopped from outside the spaces which they serve, and from outside the spaces in which they are installed. Ventilation fans serving the areas of major fire hazard shall be capable of being operated from a continuously manned control station.

Means provided for stopping the mechanical ventilation to the machinery space shall be separated from the means provided for stopping ventilation of other spaces.

4.4 Areas of major fire hazard and spaces serving as assembly stations shall have independent ventilation systems and ventilation ducts. Ventilation ducts for areas of major fire hazard shall not pass through other spaces, unless they are contained within a trunk or in an extended machinery space or casing insulated in accordance with Tables 2.5.2 and 2.6.2, Part VI "Fire Protection" of the Rules for the Classification and Construction of Sea-Going Ships; ventilation ducts of other spaces shall not pass through areas of major fire hazard.

Ventilation outlets from areas of major fire hazard shall not terminate within a distance of 1 m from any control station, evacuation station or external escape route. In addition, exhaust ducts from galley ranges shall be fitted with:

.1 a grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted;

.2 a fire damper located in the lower end of the duct, which is automatically and remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct;

.3 a fixed means for extinguishing a fire within the duct;

.4 remote control arrangements for shutting off the exhaust and supply fans, for operating the fire dampers mentioned in 4.4.2 and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley. Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system; and

.5 suitably located hatches for inspection and cleaning.

4.5 Where a ventilation duct passes through a fire-resisting division, a fail-safe automatic closing fire damper of a type approved by the Register shall be fitted adjacent to the division.

The duct between the division and the damper shall be of steel or other equivalent material and insulated to the same standard as required for the fire-resisting division.

The fire damper may be omitted where ducts pass through spaces surrounded by fire-resisting division without serving those spaces, provided that the duct has the same structural fire protection time as the divisions it penetrates. Where a ventilation duct passes through a smoke-tight division, a smoke damper shall be fitted at the penetration unless the duct, which passes through the space, does not serve that space.

4.6 Where ventilation systems penetrate decks, arrangements shall be such that the effectiveness of the deck in resisting fire is not thereby impaired. Precautions shall be taken to reduce the likelihood of smoke and hot gases passing from one between-deck space to another through the ventilation system.

4.7 All dampers fitted on fire-resisting or smoke-tight divisions shall also be capable of being manually closed from each accessible side of the division in which they are fitted, except for those dampers fitted on the ducts serving spaces not normally manned such as stores and toilets that may be manually operated only from outside the served spaces. All dampers shall also be capable of being remotely closed from the continuously manned control station.

4.8 There shall be provided an effective mechanical ventilation system for special-category spaces sufficient to give at least 10 air changes per hour when navigating and 20 air changes per hour at the quayside during vehicle loading and unloading operations. Ventilation system for such spaces shall be entirely separated from other ventilation systems and shall operate at all times when vehicles are in such spaces. Ventilation ducts serving special-category spaces and ro-ro spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

Ventilation shall be such as to prevent air stratification and the formation of air pockets.

Means shall be provided to indicate in the operating compartment any loss or reduction of the required ventilating capacity.

Arrangements shall be provided to permit a rapid shutdown and effective closure of the ventilation system in case of fire.

Ventilation ducts, including dampers, shall be made of steel or other equivalent material.

4.9 The ducts shall be made of non-combustible or fire-restricting material. Short ducts, however, may be of combustible materials subject to the following conditions:

.1 their cross-section does not exceed 0,02 m^2;

.2 their length does not exceed 2 m;

.3 they may only be used at the terminal end of the ventilation system;

.4 they shall not be situated less than 600 mm from an opening in a fire-resisting or fire-restricting divisions;

.5 their surfaces have low flame-spread characteristics.

4.10 The design of exhaust-gas operated heaters for ventilation air shall prevent exhaust gas from penetration into the ventilation air.

4.11 The ventilation arrangements shall be adequate to ensure uniform air exchange and to prevent the formation of air pockets.

4.12 Machinery spaces shall be adequately ventilated so as to ensure that when machinery therein is operating at full power in all weather conditions, including heavy weather, an adequate supply of air is maintained to the spaces for the safety and comfort of personnel and the operation of the machinery. Auxiliary machinery spaces shall be adequately ventilated appropriate for the purpose of those spaces. The ventilation arrangements shall be adequate to ensure that the safe operation of the craft is not put at risk.

4.13 The ventilation of machinery spaces shall be sufficient under all normal conditions to prevent accumulation of oil vapour.

4.14 The main passenger spaces shall be served by a ventilation system independent of the ventilation system of any other spaces. The ventilation fans of each zone in the public spaces shall be also capable of being independently controlled from a continuously manned control station.

4.15 Engine air intake systems shall provide sufficient air to the engine under all envisaged operating conditions and give adequate protection against ingress of foreign matter. Where appropriate, arrangements shall ensure that enclosed engine compartments are forcibly ventilated to the atmosphere before the engine can be started.

5 OIL FUEL SYSTEM

5.1 The requirements of 13.1.3, 13.1.4, 13.2.3, 13.2.4, 13.3 to 13.7, 13.8.2, 13.8.4, 13.9.2, 13.9.3, 13.9.7, 13.9.8, 13.10, Part VIII "Systems and Piping", and 4.3, Part VII "Machinery Installations" of Rules for the Classification and Construction of Sea-Going Ships shall be met. The equipment of the oil fuel system shall provide supply of oil fuel properly pretreated and purified to the extent required for the engine involved.

5.2 Location of fuel tanks shall be in accordance with 1.7. Each oil fuel tank which, if damaged, would allow oil to escape from a storage, settling, or daily service tank shall be fitted with a cock or valve installed directly on the tank capable of being closed from a safe position outside the space concerned in the event of a fire occurring in the space in which such tanks are situated.

5.3 Oil fuel pipes shall be made of steel or other equivalent material meeting the requirements of the Register in respect of their strength and fire integrity.

5.4 The use of flexible pipes shall be avoided but, if used, they shall meet the requirements of 2.1.8, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships.

5.5 Arrangements shall be made to minimize the quantity of oil fuel which remains in pipes, filters, etc. located in machinery spaces when not in use.

5.6 All parts of oil fuel pipes containing heated oil fuel under pressure exceeding 0,18 MPa shall be located in open, adequately illuminated spaces.

5.7 Means of ascertaining the amount of oil fuel contained in any oil fuel tank shall meet the requirements of 11.4 and 11.5.

5.8 In each craft where oil fuel with a flash point below 43 °C is used, the following additional arrangements shall be made:

.1 tanks for the storage of such oil fuel shall be located outside any machinery space and at a distance not less than 760 mm inboard from the shell side and bottom plating and from decks and bulkheads;

.2 air pipe ends shall be fitted with flame arresters;

.3 spaces in which oil fuel tanks are located shall be mechanically ventilated, using exhaust fans providing not less than six air changes per hour. Fans shall be such as to avoid the possibility of ignition of flammable gas-air mixtures. Suitable flame arresters shall be fitted over inlet and outlet ventilation openings. The outlets for such exhausts shall be discharged to a safe position. "No Smoking" signs shall be posted at the entrances to such spaces;

.4 electrical equipment used shall meet the requirements of Part XI "Electrical Equipment";

.5 means of ascertaining the amount of oil fuel shall comply with the requirements of 11.4 and 11.5;

.6 a fixed vapour-detection system shall be installed in each space through which fuel lines pass, with alarms provided at the continuously manned control station;

.7 every fuel tank shall be provided with "savealls" or gutters which would catch any fuel which may leak from such tank;

.8 vessel-to-shore fuel connections shall be of a closed type and suitably grounded during bunkering operations.

5.9 Provision shall be made to prevent over-pressure in any fuel tank or in any part of the oil fuel system, including the filling pipes. Any relief valves and air or overflow pipes shall discharge to a safe position and, for oil fuel with a flashpoint less than 43 °C, shall terminate with flame arresters.

5.10 The equipment used in the oil fuel system shall meet the following additional requirements:

.1 where daily service oil fuel tanks are filled automatically or by remote control, means shall be provided to prevent overflow spillages;

.2 other equipment, which treats oil fuel automatically, such as oil fuel purifiers, whenever practicable, shall be installed in a special place that shall have arrangements to prevent overflow spillages;

.3 where daily service oil fuel tanks or settling tanks are fitted with heating arrangements, a high-temperature alarm shall be provided if the flashpoint of the oil can be reached due to failure of the thermostatic control.

6 LUBRICATING OIL SYSTEM

6.1 The requirements of 14.1, 14.2, 14.5.1, 14.5.2, 14.5.4 to 14.5.6, 14.6, 14.7, Part VIII "Systems and Piping" of Rules for the Classification and Construction of Sea-Going Ships shall be met and also of 1.7 to 1.10 and 5.10 of the present Part.

6.2 The arrangements for the storage, distribution and utilisation of oil used in pressure lubrication systems shall be such as to ensure the safety of craft and persons on board. The arrangements made in machinery spaces and, whichever practicable, in auxiliary machinery spaces shall at least comply with the requirements of 5.1 to 5.7 and 5.9 exept that:

.1 this does not preclude the use of sight-flow glasses in lubricating systems provided they are shown by test to have a suitable degree of fire resistance;

.2 sounding pipes may be permitted in machinery spaces if fitted with appropriate means of closure;

.3 lubricating oil storage tanks with a capacity of less than 500 l may be permitted without remote operated valves.

7 COMPRESSED AIR SYSTEM

7.1 The requirements of 16.1.3 to 16.1.6, 16.2.2, 16.3, Part VIII "Systems and Piping" of Rules for the Classification and Construction of Sea-Going Ships shall be met.

8 EXHAUST GAS SYSTEM

8.1 The requirements of Section 11, Part VIII "Systems and Piping" of Rules for the Classification and Construction of Sea-Going Ships shall be met.

8.2 Exhaust gas systems shall be arranged so that any possibility of exhaust gas penetration into the spaces where people may be present, as also into the air-conditioning system and air intakes of engines is kept to a minimum. Exhaust systems, as a rule, shall not be discharged into air-cushion intakes.

8.3 Exhaust gas pipes shall be arranged so that any possibility of fire is precluded. For that purpose, all structures located in vicinity of the exhaust gas system as well as those which are likely to be exposed to exhaust gases under all service conditions shall be made of non-combustible materials or properly insulated.

8.4 Gas-turbine engine exhausts shall be arranged that hot exhaust gases are directed away from the areas to which personnel have access, either on board the craft or in the vicinity of the craft when berthed.

8.5 Silencers and spark arresters which can be split for inspections and cleaning may be made without inspection holes.

8.6 Adequate arrangements shall be made to prevent water from flooding the space or entering the engine exhaust manifold.

Pipes through which exhaust gases are discharged through the hull in the vicinity of the waterline shall be fitted with erosion-/corrosion-resistant shut-off flaps or other devices on the shell or pipe end.

9 COOLING WATER SYSTEM

9.1 In case of one main engine, fresh and sea water cooling systems shall be provided with stand-up pumps with a capacity not less than that of the main pumps. One stand-by pump for fresh and sea water with an independent drive may be used. In this case, arrangements shall be made to prevent mixing of fresh and sea water.

For engines which may be cooled with sea water the stand-by fresh water pump may be omitted.

For two and more engines stand-by pumps are not required.

9.2 Sea water cooling suction pipes shall be provided with filters which can be cleaned when the craft is running in the displacement mode.

9.3 Arrangements shall be provided to ensure that, in the event of failure in the cooling system, it is rapidly detected and alarmed (visual and audible) and means installed to minimise the effects of such failures on machinery serviced by the system.

10 HYDRAULIC SYSTEM

10.1 The requirements of Section 7, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

10.2 A working medium of hydraulic systems shall meet the requirements of 2.3.11, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships.

10.3 Hydraulic system shall be capable to stand up to additional pressures arising due to likely hydraulic impacts.

10.4 Provision shall be made for cleaning filters without interruption of the system operation.

10.5 Redundant pumps shall be provided in hydraulic systems of the craft with automatic stabilisation systems, having a distinguishing mark **AUTstab** in the class notation. Redundancy rate is subject to special consideration by the Register in each case.

10.6 Arrangements for storage, distribution and use of flammable hydraulic oils shall ensure safety of the craft and occupants on board. In places where there are sources of ignition, such arrangements shall at least comply with the provisions of 1.7, 5.2 and 11.3, and in respect of strength and construction with those of 5.3 and 11.2.

11 AIR, OVERFLOW AND SOUNDING PIPING

11.1 Each tank intended for the storage of liquid, each filled cofferdam, as well as ice and sea inlet boxes shall have air pipes vented to the atmosphere or other arrangements shall be made to prevent excessive pressure or vacuum in tanks and their associated pipelines.

11.2 Any safety valves, air or overflow pipes of oil fuel tanks shall direct fuel and vapour-air mixture to a safe position. Where the flash point of fuel is less than 43 °C the outlets of pipes shall be protected by flame-arresting fittings approved by the Register.

11.3 Each tank intended for the storage of liquid, cofferdams and void spaces with bilge connections, as well as bilges and bilge wells in spaces which are not accessible at all times shall be provided with sounding pipes or other sounding arrangements approved by the Register.

11.4 Upper ends of sounding pipes of fuel and lubricating oil tanks shall not be led to spaces which may present risk of ignition of leakage from sounding pipes. Leading of sounding pipes of fuel tanks to accommodation and service spaces is prohibited. Upper ends of sounding pipes shall be provided with appropriate shut-off devices. Arrangements shall be made to prevent spillage during the loading of fuel.

11.5 Other sounding arrangements for liquid oil fuel shall be permitted, if such arrangements do not require penetration below the top of the tank and their failure or overfilling of tanks will not permit release of fuel.

11.6 The use of cylindrical gauge glasses is prohibited.

Level indicators fitted with transparent inserts may be used in oil fuel and lubricating oil tanks in cargo craft. The transparent inserts shall be made of flat glass or shockproof plastics, which do not lose transparency under the action of oil fuel, and protected against damage. Self-closing cocks shall be fitted between level indicators and tanks.

For lubricating oil tanks with a capacity under 500 l installation of self-closing cocks is not compulsory.

12 THERMAL LIQUID SYSTEMS

12.1 Arrangements for storage, distribution and use of flammable heat transfer agents used under pressure shall ensure safety of the craft and occupants on board. In places where sources of ignition are present, such arrangements shall comply with the requirements of 1.7, 5.2 and 11.3, and as regards strength and construction with those of 5.3 and 11.2.

12.2 Thermal liquid systems shall meet the applicable requirement of Section 20, Part VIII "Systems and Piping" of the Rules for the Classification and Construction of Sea-Going Ships.

PART IX. MACHINERY

1 GENERAL

1.1 General requirements.

1.1.1 The requirements of Section 1, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships shall apply to machinery of HSC.

1.1.2 The machinery, associated piping systems and fittings relating to main machinery and auxiliary power units shall be of a design and construction adequate for the service for which they are intended and shall be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards. The design shall have regard to materials used in construction, the purpose for which the equipment is intended, and the working conditions to which it will be subjected and environmental conditions on board. Machinery shall be designed and constructed so as to provide access for inspection, cleaning and maintenance.

1.1.3 The reliability of machinery installed in the craft shall be adequate for its intended purpose.

Special consideration shall be given to the reliability of a generating set, which serves as a main source of electrical power; pumps of the fuel oil supply systems for engines; the sources of lubricating oil pressure; the sources of water pressure; an air compressor and receiver for starting or control purposes; the hydraulic, pneumatic or electrical means for control in main propulsion machinery, including propellers.

Technical documentation submitted to the Register for consideration and approval shall include a failure mode and effect analysis for main machinery and essential auxiliary power units and their associated controls.

The manufacturers shall make available the information necessary for correct installation of the machinery on board regarding operating conditions and limitations.

1.1.4 The Register may accept machinery, which does not show detailed compliance with the requirements of these Rules where it has been used satisfactorily in a similar application and evidence is submitted to the Register that construction, manufacture, testing and maintenance prescribed allow to use it in marine environment (having regard to the requirement of 1.8, Part VII "Machinery Installations" of the present Rules), the equivalent level of safety being ensured.

2 ENGINES

2.1 General requirements.

2.1.1 Engines shall withstand excessive thermal and dynamic loads during operation time of protective devices in respect of rotation speed, temperature and power for which these devices are set.

2.1.2 Main engines (driving engines of propulsion devices) shall be protected against overload during speeding-up period to take off the craft from the displacement mode or under other service conditions. Safety devices shall not cause complete engine shutdown without prior warning, except in cases where it interferes with safety of navigation and safety of life at sea.

2.1.3 Provision shall be made to drain all excess oil fuel and oil to a specially equipped place.

2.1.4 Failures of machinery driven by the engine shall not unduly affect the integrity of the engine itself.

2.1.5 The design of the engine shall be such as to minimize the risk of fire or explosion and to enable compliance with the requirements set out in Part VI “Fire Protection” of the present Rules.

2.1.6 At least two independent means o stopping the engines quickly from the operating compartment under any operating conditions shall be available. Duplication of the actuator fitted to the engine is not required.

2.2 Internal combustion engines.

2.2.1 The requirements of Section 2, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships apply to engines, having regard to their construction and purpose.

2.3 Gas turbines.

2.3.1 The requirements of 8.1 (except 8.1.8), 8.2 to 8.9, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships apply to gas turbines.

2.3.2 Where two or more gas turbines are installed on board, provision shall be made for starting a gas turbine from another running engine.

2.3.3 Gas turbine exhausts shall be located so as to prevent exhaust gas from penetrating into air intakes of other engines as well as harmful effect on people.

2.3.4 Gas turbines shall be so designed and installed that any reasonably probable shedding of compressor or turbine blades will not endanger the craft, other machinery, occupants of the craft or any other person. Where necessary, guards may be fitted to achieve compliance with these requirements.

2.3.5 The requirements of 2.1.3 shall apply to gas turbines in respect of fuel which might reach the interior of the jet pipe or exhaust system after a false start or after stopping.

3 SHAFTING, GEARS, DISENGAGING AND ELASTIC COUPLINGS

3.1 The applicable requirements of Section 5 "Shafting", Section 8 "Torsional Vibration", Part VII "Machinery Installations" and Section 4 "Gears, Disengaging and Elastic Couplings", Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships shall be applied to HSC shafting, transmissions and couplings. Calculations of torsional vibration in transmissions to air propellers and lift fans are subject to special consideration by the Register.

3.2 All propulsion components which transmit the torque from the engine to the propeller shall be of adequate strength and stiffness to enable them to withstand the most adverse combination of the loads expected in service without exceeding acceptable stress levels for the material concerned. Minimum diameters of shafts with no account for an allowance for future turning-down in the process of operation are subject to special consideration by the Register, having regard to the operational experience of the prototype craft shafts.

3.3 The design of transmissions to air propellers and lift fans is subject to special consideration by the Register.

3.4 The design of shafting, bearings and mounts shall be such that hazardous whirling and excessive vibration could not occur at any speed up to 105 per cent of the shaft speed attained at the designed overspeed trip setting of the prime mover.

3.5 In craft whose hull is made of light alloys, shafting shall be electrically isolated from the hull.

3.6 Normal or inadvertent engagement of the clutch shall not cause excessive stresses in the transmission or driven items.

3.7 A failure in any part of the transmission shall not cause damage which might endanger the craft or its occupants.

4 PROPULSION AND LIFT DEVICES

4.1 For the purpose of this Part, the following definitions have been adopted:

Propulsion devices are a combination of machinery, arrangements and structures, the primary function of which shall contribute to the propulsive thrust. They include machinery items, propellers and any associated ducts, vanes, scoops and nozzles. Propulsion devices may be air, or water propellers or water jets.

Lift devices are those items of machinery which directly raise the pressure of the air and move it to provide lifting force for an air-cushion vehicle.

Propulsion arrangements and lift arrangements may be provided by separate devices, or be integrated into a single propulsion and lift device.

4.2 The design of propulsion and lift devices shall ensure adequate strength and stiffness of the items for those conditions that may occur in service, which shall be proved by calculations and tests. Drives and reduction gear shall comply with the requirements of Section 4, Part IX "Machinery", and the propellers to those of Section 6, Part VII "Machinery Installations" of the Rules for the Classification and Construction of Sea-Going Ships.

4.3 The design of air propellers, subcavitating and partially submerged propellers as well as water-jet propellers is subject to special consideration by the Register.

4.4 The design of propulsion and lift device shall pay due regard to the effects of corrosion (including electrochemical corrosion), erosion and cavitation, as well as the effects of spray, salt, sand, icing, debris floating in the water.

4.5 The design of propulsion and lift device shall pay due regard to any pressure which could be developed as a result of a duct blockage, to steady and cyclic loadings, to loadings that arise in manoeuvring and reversing. Inertial loadings in transmissions under any operating conditions shall not result in emergency situations.

4.6 Impellers of axial lift fans shall be balanced statically, and those of radial lift fans dynamically.

4.7 All parts and items shall have faceplates at the inlet edges or special coatings to protect them against erosion.

4.8 Appropriate arrangements shall be met to ensure that the probability of ingestion of debris or foreign matter is minimized, possibility of injury to personnel from rotating parts is minimized; and inspection and removal of debris can be carried out safely in service.

5 MECHANICAL AND HYDRAULIC DRIVES

5.1 Hydraulic drives.

Hydraulic drives shall meet the requirements of Section 7, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships.

5.2 Anchor machinery.

5.2.1 Anchor machinery shall meet the requirements of 6.3.1.3, 6.3.2.1, 6.3.5, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships.

5.2.2 The drive engine power of anchor machinery shall provide heaving-in of any anchor chain cable at a speed 10 m/min with a pull on the drum not less than that determined by the formula:

$$F = 49Q \text{ , N,} \tag{5.2.2}$$

where Q = anchor mass, in kg.

The starting torque of the anchor machinery drive shall build up a pull not less than $2F$ ($98Q$) on the drum.

5.2.3 The drive shall provide heaving-in of an anchor cable at the speed and with the pull specified in 5.2.2 above without any interruption during the time which shall be agreed with the Register.

5.2.4 Anchor machinery shall have automatic stopper devices to avoid spontaneous running-out of an anchor cable in case of disconnection, stoppage or failure of the drive engine or taking-off the load from the manual drive handle.

5.2.5 The cable drum shall have a brake with a braking torque sufficient to stop and hold the dropping anchor at any depth within the length of the anchor cable. The force applied to the brake drive handle shall not exceed 120 N. The automatic brake shall ensure a braking torque corresponding to a force in the chain cable not less than $1{,}3F$.

5.2.6 The cable drum of the anchor engine drive shall have a stopper or a brake for the craft anchorage capable to provide a brake torque corresponding to a pull on the drum not less than $1{,}5F$ obtained in accordance with 5.2.2. The force applied to the brake drive handle shall not exceed 120 N.

5.2.7 The cable drum shall have an arrangement for reliable securing of the bitter end of the cable which does not interfere with proper stowage of the cable on the drum. The securing arrangement shall provide quick, efficient and safe release of the cable from the drum, including when it is tightened.

5.2.8 The cable drum shall allow stowage of the cable not more than in six rows.

5.2.9 The cable drum shall have an automatic cable layer which provide proper laying of the cable even if it is not under load.

5.2.10 Anchor machinery having both automatic and hand drives shall be fitted with an interlocking device to prevent them from simultaneous operation.

5.3 Mooring machinery.

5.3.1 Mooring machinery installed on board shall meet the requirements of 6.4.1 — 6.4.5, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships.

5.3.2 The strength shall be verified in accordance with 6.4.4, Part IX "Machinery" of the Rules for the Classification and Construction of Sea-Going Ships.

5.4 Towing winches.

Towing winches installed on board shall meet the requirements of 6.5, Part IX "Machinery" of the above-mentioned Rules.

5.5 Craft auxiliary machinery.

Craft auxiliary machinery shall meet the requirements of Section 5, Part IX "Machinery" of the above-mentioned Rules.

5.6 Steering gear.

5.6.1 Steering gear shall meet the requirements of 6.2.1.1, 6.2.1.3, 6.2.1.7, 6.2.3.1, 6.2.4.2, 6.2.5 to 6.2.9, Part IX "Machinery" of the above-mentioned Rules.

5.6.2 The main steering gear shall be capable of putting the rudder over from one side to another side in accordance with 2.11, Part III "Equipment, Arrangements and Outfit" of the present Rules.

5.6.3 Provision shall be made for inspection and repair of the rudder control system.

5.6.4 The auxiliary steering gear shall be capable of putting the rudder over from one side to another side in accordance with 2.12, Part III "Equipment, Arrangements and Outfit" of the present Rules.

5.6.5 The design and characteristics of tilt mechanism of air rudders, tilt pylons, tilt flaps and foils and other stabilization and steering controls are subject to special consideration by the Register.

PART X. BOILERS, HEAT EXCHANGERS AND PRESSURE VESSELS

1 GENERAL

1.1 The requirements of Part X, "Boilers, Heat Exchangers and Pressure Vessels" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

1.2 Strength calculations shall be made for boilers, heat exchangers and pressure vessels as well as their attachments to the craft foundations as regards stresses which may arise in any service conditions, including grounding, abrupt transfer to the displacement mode, etc. The reduced stresses shall not exceed 0,95 R_{eH} of the material used.

PART XI. ELECTRICAL EQUIPMENT

1 GENERAL

1.1 Scope of application.

1.1.1 This Part of the Rules applies to electrical installations of high-speed craft and individual items of electrical equipment in compliance with 1.3.

1.1.2 All applicable requirements of Part XI "Electrical Equipment" of the Rules, for the Classification and Construction of Sea-Going Ships unless provided otherwise in this Part, apply to electrical installations and individual items of electrical equipment of high-speed craft.

1.2 Definitions and explanations.

Definitions and explanations relating to the general terminology are given in "General" of the present Rules and in Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

1.3 Scope of technical supervision.

1.3.1 The following equipment, systems and arrangements are subject to technical supervision:

.1 electric propulsion plant;

.2 main and emergency sources of electrical power;

.3 power and lighting transformers and converters used in the equipment, systems and arrangements referred to in 1.3.1;

.4 distribution devices, control and monitoring panels;

.5 electric drives of machinery serving main machinery; steering gear (hydraulic and aerodynamic rudders, tilt struts of foils, pylons, etc); machinery and arrangements of stabilization systems; anchor and mooring arrangements; machinery of lift fans and air propellers; foil lifting and lowering machinery; machinery of lifeboat and liferaft lowering devices; staring air compressors and air compressors for sound signal means; bilge and fire pumps, ventilation fans of machinery spaces and passenger accommodation spaces;

.6 main lighting for spaces and locations of essential machinery and equipment, escape routes and emergency lighting;

.7 navigation and flashing lights;

.8 service telephone communications, electric engine-room telegraph;

.9 general alarm system;

.10 fire detection and warning systems indicating the release of fire smothering medium;

.11 signalling systems of watertight and fire doors;

.12 charging facilities for accumulator batteries.

1.3.2 All items of electrical equipment listed in 1.3.3, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships, as well as other electrical equipment used in propulsion and steering of HSC are subject to technical supervision during manufacture.

1.4 Technical documentation.

1.4.1 The requirements for technical documentation of the craft to be submitted to the Register for consideration and approval are given in "General" and Part I "Classification" of the present Rules.

1.4.2 Before fabrication of individual items of electrical equipment to be installed on HSC, the documents listed in 1.4.2, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships, shall be submitted for consideration and approval.

2 GENERAL REQUIREMENTS

2.1 Operational conditions.

2.1.1 The design, installation and arrangement of electrical equipment shall ensure its proper operation at the worst angles of list and trim likely to arise under the worst intended conditions, including emergency situations.

2.1.2 Electrical equipment shall reliably operate under conditions listed in 2.1, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

2.2 Constructional requirements and protection of electrical equipment.

2.2.1 The electrical installation shall be designed and installed so that the probability of the whole craft being at risk in case of failure of any item of machinery or control system is extremely remote.

2.2.2 Depending on the place of installation electrical equipment with an appropriate safety enclosure shall be used or other precautions shall be taken to protect the equipment from adverse effects of the environment and to ensure protection of passengers, crew and craft from electrical hazards.

2.2.3 Minimum protection of electrical equipment to be installed in spaces and areas of the craft shall be chosen in accordance with Table 2.4.4.2, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

2.3 Protective earthing.

Protective earthing of electrical equipment shall comply with 2.5, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

2.4 Arrangement of electrical equipment.

2.4.1 In arrangement of electrical equipment the requirements of 2.7, except 2.7.2, and 2.9, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships shall be met.

2.4.2 Electrical equipment shall be reliably secured in regular places. Means shall be provided to prevent electrical equipment securing devices from loosening and electrical equipment from shifting. Materials used for securing devices of electrical equipment and cables shall not cause electrolitic corrosion of hull structures and the material of securing devices itself.

2.4.3 Lighting fittings shall be arranged and installed so as to prevent heating of surrounding cables, pipes, finishing and other materials above the temperature allowable for their safe operation and to prevent a risk of ignition.

3 MAIN SOURCE OF ELECTRICAL POWER

3.1 Itemization and capacity of the main source of electrical power.

3.1.1 Each craft shall be provided with the main source of electrical power of sufficient capacity to supply all the necessary electrical equipment to maintain normal operational conditions of the craft and comfortable conditions of habitability. The main source of electrical power shall consist of at least two independent generating sets.

3.1.2 The number and capacity of generating sets and electrical converters in the main source of electrical power shall be such that, in the event of failing any one of them, the remaining set will be capable of supplying:

.1 all electrical equipment necessary to provide the normal operational conditions of propulsion and safety of the craft along with the minimum comfortable conditions of habitability for people on board;

.2 those services which are necessary to start the main propulsion plant from the dead craft condition. The emergency source of electrical power may be used for the purpose of starting from the dead craft condition if its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time those services required to be provided in 5.3.2.1 to 5.3.2.4.1 or 5.4.2.1 to 5.4.2.3 or 5.4.3.1 to 5.4.3.4, as appropriate.

3.2 Connection of electrical power source units.

3.2.1 Disconnecting devices shall be installed on the main switchboard for the main busbars to be subdivided into at least two parts which shall be connected by a circuit-breaker or some other approved means. So far as it is practicable, the connection of generating sets or any other duplicated equipment shall be equally divided between the parts.

For category B crafts each part of the main busbars with their associated generators shall be arranged in separate compartments.

3.2.2 In passenger crafts each system shall be able to supply all equipment necessary to maintain control of propulsion, stabilization, navigation, lighting and ventilation, and allow starting of the largest essential electrical engine.

4 DISTRIBUTION OF ELECTRICAL POWER

4.1 Distribution systems and allowable stresses.

4.1.1 For electrical power distribution, two-wire or three-wire or four-wire insulated systems shall be used. Four-wire systems with neutral solidly earthed but without hull return may also be used.

4.1.2 The electrical distribution voltages throughout the craft may be either direct current or alternating current and shall not exceed:

.1 500 V for power, cooking, heating and other permanently connected equipment;

.2 250 V for lighting, internal communications and receptacle outlets.

4.1.3 The use of higher voltages for electric propulsion plants is subject to special consideration by the Register.

4.2 Supply of essential services.

4.2.1 All essential services other than those for which additional requirements shall be met or other means of power supply are allowed as described below, shall be supplied from the main switchboard by separate independent feeders.

4.2.2 Electric drives and control systems of steering gear and stabilization devices shall be supplied by two independent feeders, one of which shall be fed either from the emergency source of electrical power or from other independent power source.

4.2.3 Where drives and control systems of steering gear and stabilization devices are not essentially dependent on the continuous availability of electric power but at least one alternative system, not dependent on the electric supply, is installed, then the steering gear and stabilization devices electrically powered or controlled may be fed by a single circuit protected in accordance with the requirements of 8.4.2, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

4.2.4 Navigation light switchboard shall be supplied by two independent feeders.

4.2.5 Anchor and mooring arrangements may be supplied from the nearest section switchboard provided it is supplied directly from the main switchboard.

4.2.6 Electric drives of the machinery serving the main propulsion plant, electric drives of passenger and service spaces ventilation, electric drives of survival craft lowering devices and electrical drives of foil lifting and lowering machinery may be supplied by separate feeders from section switchboards.

4.2.7 Electrical devices of internal communications including loud-speaking announcing system and main and emergency lighting fittings may be fed by separate feeders from section switchboards intended to supply such services. Such switchboards shall be fed from the main and emergency switchboards.

5 EMERGENCY ELECTRICAL INSTALLATIONS

5.1 General.

5.1.1 Each craft shall be provided with an independent emergency source of electrical power.

5.1.2 Main and emergency distribution systems shall be arranged so that feeders from main and emergency sources of power are separated both vertically and horizontally as widely as practicable.

5.1.3 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following requirements.

5.1.3.1 Where the emergency source of electrical power is a generator, it shall be:

.1 driven by a suitable prime mover with an independent supply of oil fuel having a flash point not lower than 43 °C;

.2 started automatically upon failure of the electrical supply from the main source of electrical power and shall be automatically connected to the emergency switchboard. The automatic starting system and the characteristic of the prime mover shall be such as to permit the emergency generator to carry its full rated load, subject to a maximum of 45 s. Starting devices shall meet the requirements of Section 9.5, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships;

.3 provided with a transitional emergency source of electrical power according to 5.3.4 or 5.4.4;

5.1.3.2 Where an emergency source of electrical power is an accumulator battery, it shall be capable of:

.1 carrying of the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage;

.2 connecting automatically to the emergency switchboard in the event of failure of the main source of electrical power;

.3 immediately supplying at least the services specified in 5.3.4 or 5.4.4.

5.1.4 The emergency generator and its prime mover and any emergency accumulator battery shall be designed and arranged so as to ensure that they will function at full rated power when the craft is upright and when the craft has a list or trim which may arise under the worst intended conditions, including emergency situations.

5.1.5 Capacity of emergency source of power shall be sufficient to supply simultaneously all those services that are essential for the safety of navigation in an emergency. In ships where electrical power is necessary for propulsion, the capacity of the emergency source of electrical power shall be sufficient to restore propulsion to the ship (in conjunction with other machinery, as appropriate) from a dead ship condition within 30 min after blackout.

5.1.6 Where the emergency diesel-generator is provided for use in exceptional cases and for short periods to supply non-emergency circuits, suitable measures shall be taken for safeguarding independent emergency operation under all circumstances and arrangements shall be made, where necessary, to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power is available to the emergency circuits.

5.2 Spaces for emergency sources of electrical power.

5.2.1 The emergency source of electrical power and associated transforming equipment, if any, the transitional emergency source of electrical power, the emergency switchboard and the emergency electrical lighting switchboard shall be located above the waterline in the final condition of damage, operable in that condition and readily accessible.

5.2.2 As far as practicable, the space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of electrical power and the emergency switchboard shall not be contiguous to the boundaries of main machinery spaces or spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard.

5.3 Emergency sources on cargo craft.

5.3.1 Where the main source of electrical power is located in two or more compartments which are not contiguous, each of which has its own independent systems, including power distribution and control systems, completely independent of each other and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, or to the services required by 5.3.2, the requirements of 5.1.1 and 5.2.1 may be considered satisfied without an additional emergency source of electrical power, provided that:

.1 there is at least one generating set, meeting the requirements of 5.1.4 and of the sufficient capacity to meet the requirements of 5.3.2, in each of at least two non-contiguous spaces;

.2 arrangements required by 5.3.1.1 in each such space are at least equivalent to those required by 5.1.3.1 so that a source of electrical power is available at all times to the services required by 5.3.2;

.3 generator sets referred to in 5.3.1.1 and their independent distribution systems are installed in accordance with 5.2.1, and starting devices shall meet the requirements of Section 9.5, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

5.3.2 The emergency source of electrical power shall be capable of supplying simultaneously at least the following services for the periods specified hereunder:

.1 for a period of 12 h emergency lighting:

.1.1 at the stowage spaces of life-saving appliances;

.1.2 at all escape routes such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc;

.1.3 in public spaces, if any;

.1.4 in machinery spaces and generating sets spaces;

.1.5 in all control stations and main and emergency switchboard spaces;

1.6 at the stowage spaces for emergency outfit, fire-fighting equipment, fireman outfits and manually operated call point positions;

.1.7 at the steering gear;

.2 for a period of 12 h:

.2.1 navigation lights, "Not under command" and other lights required by International Regulations for Preventing Collisions at Sea in force;

.2.2 internal communication equipment for announcements;

.2.3 fire-detection and general alarm systems and manual fire alarm;

.2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h of intermittent operation:

.3.1 the daylight signalling lamp, if it has no independent supply from its own accumulator battery;

.3.2 the craft whistle, if electrically driven;

.4 for a period of 12 h:

.4.1 navigational equipment required by Part XVIII "Navigational Equipment";

.4.2 essential electrically powered instruments and controls for propulsion machinery, if alternative sources are not available for such devices;

.4.3 one of fire pumps required by Part VI "Fire Protection";

.4.4 the sprinkler pump and drencher pump, if fitted;

.4.5 the emergency bilge pump and all the equipment essential for the operation of electrically powered remote-controlled bilge valves as required by Part VIII "Systems and Piping";

.4.6 radio equipment required by Part XVII "Radio Equipment";

.5 for a period of 10 min, power drives for directional control devices, including those required to direct thrust forward and astern, unless there is a manual alternative.

5.3.3 Where the automatic starting of the emergency generator according to 5.1.3.1.2 is not provided during 45 s, provision shall be made for a transitional emergency source of electrical power.

5.3.4 The transitional emergency source of electrical power required by 5.3.3 shall be an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and arranged so as to supply automatically, in case of failure of either the main or emergency source of electrical power, at least the following services, if their operation depends upon a source of electrical power:

.1 for a period of 30 min, consumers specified in 5.3.2.1 to 5.3.2.3;

.2 devices of closing of watertight doors, but not necessarily simultaneously, unless an independent temporary source of stored energy is provided. The power source shall have sufficient capacity to operate each door at least three times, i.e. closed — open — close, against an adverse list of 15°;

.3 for a period of 30 min, control, indication and alarm circuits for watertight doors.

5.4 Emergency sources of electrical power on passenger craft.

5.4.1 Where the main source of electrical power is located in two or more compartments which are not contiguous, each having its own independent systems of electrical power distribution and control, completely independent of each other and such that a fire or other casualty in any one of the spaces will not affect the electrical power distribution from other systems or devices and systems required by 5.4.2 or 5.4.3, the requirements of 5.1.1 and 5.2.1 may be considered satisfied without an additional emergency source of electrical power, provided that:

.1 there is at least one generating set of sufficient capacity to meet the requirements of 5.1.4, 5.4.2 or 5.4.3 in each of at least two non-contiguous spaces;

.2 arrangements required by 5.4.1.1 in each such space are equivalent to those required by 5.1.3.1 so that the main source of electrical power is available at all times to the services required by 5.4.2 or 5.4.3;

.3 generator sets referred to in 5.4.1.1 and their independent distribution systems are installed so that one of them remains operable after damage or flooding of any one compartment.

.4 Starting devices shall meet the requirements of Section 9.5, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

5.4.2 For category A craft, the emergency source of electrical power shall be capable of supplying simultaneously the following services, if they depend upon a source of electrical power for their operation:

.1 for a period of 5 h, emergency lighting:

.1.1 at the stowage places of life-saving appliances;

.1.2 at all escape routes such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc;

.1.3 in public spaces;

.1.4 in machinery spaces and generating set spaces, including their control stations;

.1.5 in control stations;

1.6 at stowage places of emergency outfit, fire-fighting equipment, fireman outfits and manually operated call point positions;

.1.7 at the steering gear;

.2 for a period of 5 h:

.2.1 navigation lights, except for "Not under command" lights;

.2.2 internal communication equipment for announcements;

.2.3 fire-detection and general alarm systems and manual fire alarms;

.2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h of intermittent operation:

.3.1 the daylight signalling lamp, if it has no independent supply from its own accumulator battery;

.3.2 the craft whistle, if electrically driven;

.4 for a period of 5 h:

.4.1 radio equipment as required by Part XVII "Radio Equipment";

.4.2 gyrocompass;

.4.3 essential electrically powered instruments and controls for propulsion machinery, if alternative sources are not available for such devices;

.4.4 navigational equipment required by Part XVIII "Navigational Equipment", provided the emergency source of power is a diesel-generating set;

.5 for a period of 12 h, the "Not under command lights;

.6 for a period of 10 min, power drives for directional control devices, including those required to direct thrust forward and astern, unless there is a manual alternative.

5.4.3 For category B crafts, the emergency source of electrical power shall be capable of supplying simultaneously the following services, if they depend upon a source of electrical power for their operation:

.1 for a period of 12 h, emergency lighting:

.1.1 at stowage places of life-saving appliances;

.1.2 at all escape routes such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc;

.1.3 in passenger compartments;

.1.4 in machinery spaces and generating set spaces, including their control stations;

.1.5 in all control stations and main and emergency switchboards;

1.6 at stowage places for emergency outfit, fire-fighting equipment, fireman outfits and manually operated call point positions;

.1.7 at the steering gear;

.2 for a period of 12 h:

.2.1 navigation lights, "Not under command" and other lights required by International Regulations for Preventing Collisions at Sea in force;

.2.2 internal communication equipment for announcements;

.2.3 fire-detection and general alarm systems and manual fire alarms;

.2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h of intermittent operation:

.3.1 the daylight signalling lamp, if it has no independent supply from its own accumulator battery;

.3.2 the craft whistle, if electrically driven;

.4 for a period of 12 h:

.4.1 navigational equipment as required by Part XVIII "Navigational Equipment";

.4.2 essential electrically powered instruments and controls for propulsion machinery, if alternative sources are not available for such devices;

.4.3 one of the fire pumps required by Part VI "Fire Protection";

.4.4 the sprinkler pump and drencher pump, if fitted;

.4.5 the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves required by Part VIII "Systems and Piping";

.4.6 radio equipment required by Part XVII "Radio Equipment";

.5 for a period of 30 min, any power-operated watertight doors together with their indicators and warning signals;

.6 for a period of 10 min, power drives for directional control devices, including those required to direct thrust forward and astern, unless there is a manual alternative.

5.4.4 The transitional emergency source of electrical power required by 5.1.3.1.3 shall be an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and arranged so as to supply automatically, in case of failure of either the main or emergency source of electrical power, at least the following services, if they depend upon a source of electrical power for their operation:

.1 for a period of 30 min, the consumers specified in 5.4.2.1 to 5.4.2.3, 5.4.3.1 to 5.4.3.3;

.2 with respect to watertight doors: power to operate watertight doors, but not necessarily simultaneously, unless an independent temporary source of stored energy is provided. The power source shall have sufficient capacity to operate each door at least three times, i.e. closed — open — close, against an adverse list of 15°;

.3 for a period of 30 min: power to the control, indication and alarm circuits for watertight doors.

5.4.5 In addition to the emergency lighting required by 5.4.2.1, 5.4.3.1 and 5.4.4.1, on passenger craft with special category spaces all passenger spaces and alleyways shall be provided with supplementary emergency lighting which can operate for at least 3 h under any condition of heel when all other sources of electrical power have failed.

5.4.6 Lighting provided in 5.4.5 shall be such that the approach to the means of escape can be readily seen (or to provide illumination of 0,5 lx). Any failure of a lamp shall be immediately apparent.

5.4.7 The source of electrical power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard and replaced in an interval specified by the manufacturer, having regard to the conditions for which they are intended.

5.4.8 A portable rechargeable battery-operated lamp shall be provided in every crew space alleyway, recreational space and every working space which is normally occupied unless supplementary emergency lighting required by 5.4.5, is provided.

6 ACCUMULATOR BATTERIES

6.1 Any accumulator batteries meeting the requirements of Section 13, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships are allowed for installation on board.

6.2 Accumulator batteries shall not be located in the crew accommodation spaces.

6.3 Charging facilities shall be provided on board every craft where accumulator batteries are used as the main or emergency source of electrical power or as independent sources of electrical power for supplying separate essential consumers.

6.4 Charging facilities shall be designed to permit the supply of essential consumers, regardless of whether a battery is on charge or not. Means shall be provided to minimize the risk of overcharging or overheating of batteries. Means for efficient air ventilation shall be provided.

7 CABLES AND WIRES

7.1 The use shall be made of non-combustible and flame-retarding cables and wires meeting the requirements of Section 16, Part XI "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

7.2 Cables for service communication, fire detection system, warning system on starting a smothering fire-extinguishing system, general alarm system and watertight door signalling system, lighting system as well as feeders supplying lighting fittings and emergency consumers shall not be routed through machinery spaces and their casings, boiler rooms, galleys and other spaces with a major fire hazard, except for the cases where devices and machinery of the above-mentioned systems are arranged in such spaces. On the outside bulkheads of the spaces cables shall be placed at a distance of at least 100 mm.

7.3 Cables and wires shall be installed and secured so as to avoid their chafing or other damage.

7.4 All conductors shall be linked and connected so that the initial electrical and mechanical properties of the cable and also its flame-retarding properties and, where necessary, fire-resisting properties are maintained.

7.5 Cable armour or braid of all cables shall be electrically continuous and earthed.

8 SPARE PARTS

8.1 Every craft shall have a store of spare parts in an amount sufficient for carrying out repairs in case of a failure of essential devices in any situations, including emergency at sea, to ensure propulsion, steering, safety of the craft and occupants on board.

8.2 In determining the required number of spare parts, one shall be guided by the recommendations of manufacturers of the particular equipment.

8.3 Spare parts shall be included in the list of spare parts referred to in 3.2.11.1.25, Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships, approved by the Register, and their number shall at least comply with that list.

PART XII. REFRIGERATING PLANTS

1 GENERAL

1.1 Refrigerating plants are subject to special consideration by the Register in each particular case.

PART XIII. MATERIALS

1 GENERAL

1.1 Materials for manufacture of HSC and machinery to be installed on board and subject to the Register technical supervision shall meet the requirements of Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships.

PART XIV. WELDING

1 GENERAL

1.1 Welding of HSC structures shall meet the requirements of Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships.

PART XV. AUTOMATION

1 GENERAL

1.1 Scope of application.

1.1.1 This Part applies to machinery installations of high-speed crafts and to individual devices of automation systems of installations.

1.1.2 In addition to the requirements of this Part, all the relevant requirements of Sections 1 to 3, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships are applicable to machinery installations of high-speed crafts and to individual devices of the automated equipment.

1.2 Definitions and explanations.

1.2.1 Definitions and explanations relating to general terminology are given in "General" of the present Rules and in Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships.

For the purpose of the present Rules the following additional definitions have been adopted.

Stabilization control system is a system intended to stabilize the main parameters of the craft attitude: heel, trim, course and height and control the craft motions: roll, pitch, yaw and heave.

Automatic stabilization system is a system providing automatic stabilization of the craft according to parameters mentioned above.

Self-stabilization of the craft is stabilization ensured solely by the craft inherent characteristics (hull, foils, etc.).

Forced stabilization is stabilization achieved by an automatic control system or a manually assisted control system.

Combined stabilization is stabilization which is achieved by both automatic and manually assisted control systems.

Remote control systems are systems providing control of machinery installation from the craft control station.

Back-up control systems are systems necessary to maintain control of essential functions required for the craft safe operation when the main control systems have failed or malfunctioned.

1.3 Scope of technical supervision.

1.3.1 The following equipment, systems and devices are subject to technical supervision during manufacture:

.1 automatic stabilization systems;

.2 control, monitoring and protection systems of arrangements, machinery and systems subject to technical supervision by the Register and listed in the relevant parts of the present Rules;

.3 other systems, equipment and devices on the Register requirement.

1.3.2 Automation systems, devices and equipment referred to in other parts of the Rules for the Classification and Construction of Sea-Going Ships are also subject to technical supervision on board.

2 TECHNICAL DOCUMENTATION

2.1 The requirements for technical documentation to be submitted to the Register for consideration and approval are described in "General" of the present Rules.

2.2 Before manufacture of automation and essential devices to be installed on board, the documentation referred to in 1.4.1, Part XV "Automation" of the Rules for the Classification and Construction of Sea-Going Ships shall be submitted to the Register for consideration and approval.

3 STABILIZATION SYSTEM

3.1 The stabilization system shall be designed so that, in case of failure or malfunctioning of any one of stabilization devices or equipment (rudders, flaps, foils, skirts, water-jet arrangements), its power drive or automation equipment of the stabilization system (transducers, logic units) it would be possible either to ensure maintaining of the main parameters of craft motion within the safe limits with the aid of working stabilization devices or to put the craft into the displacement or other safe mode.

3.2 In case of failure of the automatic stabilization system on crafts not fitted with self-stabilization, an automatic safety system shall be provided to put the craft into a displacement or other safe mode. An automatic safety system may not be fitted where the redundancy in the stabilization system provides safety. Where the above-mentioned safety system is fitted, provision shall be made to override it and to cancel an override from the main control station.

Alarms on overriding the automatic safety system, on a failure in its circuit, and on transfer to the stand-by component, system or device shall be provided.

3.3 In case the safe values of the controlled parameters are exceeded, the automatic safety system shall decrease the craft speed and put the craft safely into the displacement or other safe mode. Account shall be taken of the safe values of heel, trim, yaw and combination of trim and draught appropriate to the particular craft and service. Consequences of power failure for propulsion, lift or stabilization devices shall also be taken into consideration.

3.4 The automatic stabilization system shall be supplied from two independent sources of power. The transfer from one source to the other shall not impair stabilization of the craft.

3.5 The designer of the craft shall establish hazardous values of heel, trim and changes in clearance, and a calculation (or the results of model tests) shall be submitted to prove that the selected parameters and degree of stabilization of the craft preclude the hazardous values.

It shall be demonstrated during the trials of the first craft of the series that the stabilization system provides safe operation of the craft in the operational mode under the worst intended conditions and the consequences shall also be demonstrated by simulation of the most dangerous failures.

4 CRAFT CONTROL STATION

4.1 Any failure of craft remote or automatic control systems shall initiate alarms and shall not prevent normal manual control.

4.2 Control stations shall be provided with workstations equipped with controls for the following emergency services:

.1 fixed fire-extinguishing systems;

.2 emergency stopping of fans and dampers in the spaces protected by the fire-extinguishing system;

.3 emergency stopping of oil fuel booster pumps for main and auxiliary machinery;

.4 emergency stopping of all sources of electrical power (a control shall be protected against accidental or inadvertent operation);

.5 emergency stopping of main and auxiliary machinery.

Controls shall be located so as to be within the reach of the officer on watch.

5 AUTOMATION EQUIPMENT OF MACHINERY INSTALLATIONS

5.1 Where remote automated control of machinery installation (reversing and change of rotational speed) is used, all control and manoeuvring functions shall be performed from the craft control station. In case of failure of the remote automated system, reversing and change of rotational speed shall be controlled from the engine control station.

5.2 In addition to the remote control, provision shall be made at the craft control station for an emergency arrangement to quickly transfer the craft into the displacement mode and, where necessary, to eliminate the thrust. Such arrangement shall be totally independent of the remote control.

5.3 Where the engine control station is beyond the operating compartment of the craft, communication shall be provided between the two control stations. Transfer of control from one station to the other shall be possible only from the craft control station.

On category B crafts, the controls for craft's movement or manoeuvring, as well as for arrangements and systems specified in 4.2 shall be provided in one or more control stations beyond the operating compartment of the craft. Such control stations shall have direct communications with the operating compartment of the craft where continuous watch is kept.

5.4 The safety system shall stop automatically the part of the controlled machinery installation, the failures in which may result in the emergency condition of the installation.

Propulsion and lift of the craft shall be ceased only if a danger arises which requires immediate stopping of the craft.

Any failure in the safety system circuit shall not cause a stop of the controlled item of machinery.

Provision shall be made for an arrangement for overriding (and re-activating) the safety system from the craft control station; the arrangement shall be protected against inadvertent operation.

5.5 For passenger and cargo crafts the remote control systems for propulsion machinery and steering gear shall be equipped with back-up control systems. For cargo crafts, the back-up system controllable from machinery space is acceptable.

6 ALARM SYSTEM

6.1 Alarms giving indications of conditions requiring immediate action shall be distinctive and in full view of the crew members at control stations.

6.2 The alarm system at the craft control station shall give the alarms indicated in Table 6.2:

Table 6.2

Nos	Controlled parameter	Colour of visual alarm
1.	Activation of fire alarm and detection system	Red
2.	Loss of power supply from main source of electrical power	Red
3.	Overspeed	Red
4.	Thermal runaway of storage battery	Red
5.	Exceeding the limiting value of any craft machinery or system parameter (other than engine overspeed)	Yellow
6.	Failure of normal power supply to powered directional and trim devices	Yellow
7.	Operation of any automatic bilge pump	Yellow
8.	Failure of compass system	Yellow
9.	Upper and lower level contents in fuel tank and in any fluid reservoir the contents of which are essential for craft normal operation	Yellow
10.	Failure of power supply to side, masthead and stern navigational lights	Yellow
11.	Failure of any connected electrical power source	Yellow
12.	Failure of any ventilation fan installed for ventilating spaces in which inflammable vapours, gases and dust-and-air mixtures may accumulate	Yellow
13.	Failure of main or essential auxiliary diesel engine high-pressure fuel line	Yellow
14.	High level of bilge water in each watertight compartment shall be located below the design load waterline	Yellow

6.3 The alarm on activation of an emergency arrangement for transfer of the craft into the displacement mode as required by 5.2 shall be provided at all control stations from where craft control functions may be effected.

6.4 The following alarms shall be provided at the craft control station:

.1 "Water in the machinery space";

.2 "Fire in the machinery space";

.3 "Failure of the alarm system".

7 SAFETY SYSTEM

7.1 The arrangements for overriding safety system shall be such as to preclude inadvertent operation.

When the arrangements are activated, a visual alarm shall be given.

PART XVI. LIFE-SAVING APPLIANCES

1 GENERAL AND DEFINITIONS

1.1 Life-saving appliances and arrangements shall enable abandonment of the craft in accordance with the requirements of 7.7, Part III "Equipment, Arrangements and Outfit" and Section 13 of this Part.

1.2 Except where otherwise provided in this Part, life-saving appliances and arrangements shall meet the requirements of Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships.

1.3 Definitions relating to general terminology are given in "General" of the present Rules and in Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships.

1.4 For the purpose of this Part, the following definitions have been additionally adopted.

Embarkation station is a place from which a survival craft is boarded. An embarkation station may also serve as a muster station, provided there is sufficient room, and the muster station activities can safely take place there.

Launching appliance or arrangement is a means of transferring a survival craft or rescue boat from its stowed position safely to the water.

Retrieval is the safe recovery of survivors.

2 COMMUNICATIONS AND SIGNAL EQUIPMENT

2.1 Crafts shall be provided with the following radio equipment for life-saving appliances:

.1 at least three two-way VHF radiotelephone apparatuses shall be provided on every passenger high-speed craft and on every cargo high-speed craft of 500 gross tonnage and over;

см.циркуляр **.2** at least one radar transponder shall be provided on each side of every passenger high-speed craft and on every cargo high-speed craft of 500 gross tonnage and over. Radar transponders shall be stowed in such places that they can be rapidly placed in one of the liferafts. Alternatively, one radar transponder shall be stowed in each survival craft;

.3 provision of cargo high-speed crafts under 500 gross tonnage with radio equipment for life-saving appliances is subject to special consideration by the Register.

2.2 Internal communication means and general alarm system shall meet the requirements of Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

3 PERSONAL LIFE-SAVING APPLIANCES

3.1 Where passengers or crew have access to exposed decks under normal operating conditions, at least one lifebuoy on each side of the craft capable of quick release from the control station and from a position at or near where it is stowed, shall be provided with a self-igniting light and self-activating smoke signal. The positioning and securing arrangements of the self-activating smoke signal shall be such that it cannot be released or activated solely by the accelerations produced by collisions or groundings.

3.2 At least one lifebuoy shall be provided adjacent to each normal exit from the craft and on each open deck to which passengers and crew have access, on condition at least two lifebuoys being installed.

3.3 Lifebuoys fitted adjacent to each normal exit from the craft shall be fitted with buoyant lines of at least 30 m in length.

3.4 Not less than half of the total number of lifebuoys shall be fitted with self-igniting lights. However, lifebuoys provided with self-igniting lights shall not be the lifebuoys provided with lifelines in accordance with the requirements of 3.3.

3.5 A lifejacket shall be provided for every person on board and, in addition:

.1 a number of jackets suitable for children equal to at least 10 per cent of the number of passengers on board shall be provided or such greater number as may be required to provide a lifejacket for each child;

.2 every passenger craft shall carry lifejackets for not less than 5 per cent of the total number of persons on board. These lifejackets shall be stowed in conspicuous places on deck or at muster stations;

.3 a sufficient number of lifejackets shall be carried for persons on watch and for use at remotely located survival craft and rescue boat stations;

.4 all lifejackets shall be fitted with a light.

3.6 Lifejackets shall be placed so as to be readily accessible and their positions shall be clearly indicated.

3.7 An immersion suit of any appropriate size shall be provided for every person assigned to crew the rescue boat.

3.8 An immersion suit or anti-exposure suit shall be provided for each member of the crew assigned, in the muster list, to duties in a MES party for embarking passenger into survival craft. These immersion suits or anti-exposure suits need not be required if the craft is constantly engaged on voyages in warm climates where, in the opinion of the Register, such suits are unnecessary.

4 EMERGENCY INSTRUCTIONS AND MANUALS

4.1 Clear instructions to be followed in the event of emergency shall be provided for each person on board.

4.2 Illustrations and instructions in appropriate languages shall be posted in public spaces and be conspicuously displayed at muster stations, at other passenger spaces and near each seat to inform passengers of:

.1 their muster station;

.2 essential actions they must take in emergency;

.3 the method of donning lifejacket.

4.3 Each passenger craft shall have muster stations:

.1 in the vicinity of, and which provide ready access for all the passengers to, the embarkation stations unless in the same location;

.2 which have ample room for the marshalling and instruction of passengers.

4.4 A training manual shall be provided in each crew messroom and recreation room.

5 OPERATING INSTRUCTIONS

5.1 Posters or signs shall be provided on or in the vicinity of survival craft and their launching controls and shall:

.1 illustrate the purpose of controls and the procedures for operating the appliance and give the relevant instructions and warnings;

.2 be easily seen under emergency lighting conditions;

.3 use symbols in accordance with recommendations given in Appendix 2, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships.

6 STOWAGE OF SURVIVAL CRAFT

6.1 Survival craft shall be securely stowed outside and as close as possible to passenger accommodation spaces and embarkation stations. The stowage shall be such that each survival craft can be safely launched in a simple manner and remain secured to the craft during and subsequent to the launching procedure. The length of the securing lines and the arrangements of the bowsing lines shall be such as to maintain the survival craft suitably positioned for embarkation. The Register may permit the use of adjustable securing and/or bowsing lines at exits where more than one survival craft is used. The securing arrangements for all securing and bowsing lines shall be of sufficient strength to hold the survival craft in position during the evacuation process.

6.2 Survival craft shall be stowed so as to permit release from their securing arrangements at or near to their stowage position on the craft and from a position at or near to the control station.

6.3 So far as is practicable, survival craft shall be distributed in such a manner that there is an equal capacity on both sides of the craft.

6.4 The launching procedure for inflatable liferafts shall, where practicable, initiate inflation. Where it is practicable to provide automatic inflation of liferafts (for example, where liferafts are associated with a MES), the arrangements shall be such that people can be evacuated within the time specified in 13.1.

6.5 Survival craft shall be capable of being launched and then boarded from the designated embarkation stations in all operational conditions indicated in Part IV "Stability" and also in all conditions of flooding after receiving damage to the extent prescribed in Part V "Reserve of Buoyancy and Subdivision".

6.6 Survival craft launching stations shall be in such positions as to ensure safe launching, having particular regard to clearance from the propeller or waterjet and steeply overhanging portions of the hull.

6.7 During preparation and launching, the survival craft and the area of water into which it shall be launched shall be adequately illuminated by the lighting supplied from the main and emergency sources of electrical power required by Part XI "Electrical Equipment".

6.8 Means shall be available to prevent any discharge of water on to survival craft when launched.

6.9 Each survival craft shall be stowed:

.1 so that neither the survival craft nor its stowage arrangements will interfere with the operation of any other survival craft or rescue boat at any other launching station;

.2 in a state of continuous readiness;

.3 fully equipped;

.4 as far as practicable, in a secure and sheltered position and protected from damage by fire and explosion.

6.10 Every liferaft shall be stowed with its painter permanently attached to the craft and with a float-free arrangement so that, as far as practicable, the liferaft floats free and, if inflatable, inflates automatically, shall the high-speed craft sink.

6.11 Rescue boats shall be stowed:

.1 in a state of continuous readiness for launching in not more than 5 min;

.2 in a position suitable for launching and recovery;

.3 so that neither the rescue boat nor its stowage arrangements will interfere with the operation of survival craft at any other launching station.

6.12 Rescue boats and survival craft shall be secured and fastened to the deck so that they at least withstand the loads likely to arise due to a defined horizontal collision load for the actual craft and the vertical design load at the stowage position.

7 SURVIVAL CRAFT AND RESCUE BOATS EMBARKATION AND RECOVERY ARRANGEMENTS

7.1 Embarkation stations shall be readily accessible from accommodation and work spaces. If the designated muster stations are other than passenger spaces, muster stations shall be readily accessible from passenger spaces, and embarkation stations shall be readily accessible from muster stations.

7.2 Evacuation routes, exits and embarkation points shall comply with the requirements of 7.7, Part III "Equipment, Arrangements and Outfit".

7.3 Alleyways, stairways and exits giving access to muster and embarkation stations shall be adequately illuminated by lighting supplied from the main and emergency sources of electrical power required by Part XI "Electrical Equipment".

7.4 Where davit-launched survival craft are not fitted, MES or equivalent means of evacuation shall be provided in order to avoid persons entering the water when boarding the survival craft. Such MES or equivalent means of evacuation shall be designed so as to enable persons to board survival craft in all operational conditions indicated in Part IV "Stability" and also in all conditions of flooding after receiving damage to the extent prescribed by Part V "Reserve of Buoyancy and Subdivision".

7.5 The Register may accept a system where persons board liferafts directly. In such case, survival craft and rescue boat embarkation arrangements shall be effective within the environmental conditions in which the craft is permitted to operate and in all undamaged and prescribed damage conditions of trim and heel, where the freeboard between the intended embarkation position and the waterline is not more than 1,5 m.

7.6 Where MES is provided for embarkation into survival craft on a category B craft, an alternative means of evacuating passengers and crew into survival craft on the same side of the craft in conditions up to and including the worst intended conditions shall be provided for use if the MES is lost or rendered unserviceable in the event of damage of the longitudinal extent specified in 4.3.1.1, Part V "Reserve of Buoyancy and Subdivision".

7.7 Rescue boat embarkation arrangements shall be such that the rescue boat can be boarded and launched directly from the stowed position and recovered rapidly when loaded with its full complement of persons and equipment.

7.8 Launching systems for rescue boats on category B craft may be based on power supply from the craft's power supply under the following conditions:

.1 the davit or crane shall be supplied with power from 2 sources in each independent engine room;

.2 the davits or crane shall comply with the required launching, lowering and hoisting speeds when using only one power source; and

.3 the davit or crane is not required to be activated from a position within the rescue boat.

7.9 On multihull crafts with a small HL_1 angle of heel and trim, the design angles required in paragraph 6.20.1.1, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships, may be changed from 20°/10° to the maximum angles calculated in accordance with 13.3.2 of Part IV "Stability" and 4.7 of Part V "Reserve of Buoyancy and Subdivision" of the present Rules, including heeling lever HL_2, HTL, HL_3 or HL_4.

7.10 Rescue boat davits or cranes may be designed for launching and recovering the boat with 3 persons only on the condition that an additional boarding arrangement is available on each side complying with 7.5.

7.11 A safety knife shall be provided at each MES embarkation station.

8 LINE-THROWING APPLIANCE

8.1 A line-throfoil appliance complying with the requirements of 6.21, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships, shall be provided.

9 OPERATIONAL READINESS, MAINTENANCE

9.1 Operational readiness.

Before the craft leaves the port and at all times during the voyage, all life-saving appliances shall be in working order and ready for immediate use.

9.2 Maintenance.

9.2.1 Instructions for on-board maintenance of life-saving appliances shall be provided and maintenance shall be carried out accordingly.

9.2.2 The Register may accept, instead of the instructions required by 9.2.1, a planned programme for on-board maintenance of life-saving appliances.

9.3 Maintenance of falls.

9.3.1 Falls used in launching shall be inspected periodically with special regards for areas passing through sheaves and be renewed when necessary due to deterioration of the falls or at intervals of not more than five years, whichever is the earlier.

9.4 Spare parts and repair equipment.

Spare parts and repair equipment shall be provided for life-saving appliances and their components which are subject to excessive wear or consumption and need to be replaced regularly.

9.5 Marking of stowage locations.

Containers, brackets, racks and other similar stowage locations for life-saving equipment shall be marked with symbols in accordance with the recommendations given in Appendix 2 to Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships, indicating the device stowed in that location for that purpose. If more than one device is stowed in that location, the number of devices shall be indicated.

10 SURVIVAL CRAFT AND RESCUE BOATS

10.1 All crafts shall carry:

.1 survival craft with sufficient capacity as will accommodate not less than 100 per cent of the total number of persons the craft is certified to carry, subject to a minimum of two such survival craft being carried;

.2 in addition, survival craft with sufficient aggregate capacity to accommodate not less than 10 per cent of the total number of persons the craft is certified to carry;

.3 in the event any one survival craft being lost or rendered unserviceable, sufficient survival craft to accommodate the total number of persons the craft is certified to carry;

.4 at least one rescue boat for retrieving persons from the water, but not less than one such boat on each side when the craft is certified to carry more than 450 passengers;

.5 craft of less than 30 m in length may be exempted from carrying a rescue boat, provided the craft meets all of the following requirements:

.5.1 the craft is arranged to allow a helpless person to be recovered from the water;

.5.2 recovery of the helpless person can be observed from the navigating bridge;

.5.3 the craft is sufficiently manoeuvrable to close and recover persons in the worst intended conditions;

.6 notwithstanding the provisions of 10.1.4 and 10.1.5 the craft shall carry sufficient number of rescue boats to ensure that, in providing for abandonment by the total number of persons the craft is certified to carry:

.6.1 not more than nine liferafts provided in accordance with 10.1.1 are marshalled by each rescue boat; or

.6.2 if the Register is satisfied that the rescue boats are capable of tofoil a pair of such liferafts simultaneously, not more than 12 of the liferafts provided in accordance with 10.1.1 are marshalled by each rescue boat;

.6.3 the craft can be evacuated within the time specified in Section 13.

10.2 The Register may permit the use of open reversible inflatable liferafts complying with the requirements of Section 12, on category A craft instead of liferafts complying with requirements 6.9 or 6.10, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships, where the Register considers it appropriate, in view of the sheltered nature of the voyages and the suitable climatic conditions of the intended area of navigation.

11 HELICOPTER PICK-UP AREAS

11.1 Craft operating on voyages having duration of 2 h or more between each port of call shall be provided with a helicopter pick-up area approved by the Register. The arrangement, location and construction of the helicopter pick-up area are subject to special consideration by the Register in each particular case.

12 OPEN REVERSIBLE LIFERAFTS

12.1 General.

All open reversible liferafts shall:

.1 be properly constructed of materials approved by the Register;

.2 not be damaged in stowage at the air temperature range of −18 to +65 °C;

.3 be capable of operating at the air temperature range of −18 to +65 °C and the sea water temperature range of −1 to +30 °C;

.4 be rot-proof, corrosion-resistant and not to be unduly affected by seawater, oil or fungal attack;

.5 be stable and maintain their shape when inflated and fully loaded;

.6 be fitted with retro-reflective material, where it will assist in detection, and in accordance with the requirements of Appendix 1 to Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships.

12.2 Construction.

12.2.1 The open reversible liferaft shall be constructed so that when it is dropped into water in its container from a height of 10 m, the liferaft and its equipment will operate satisfactorily. If the open reversible liferaft shall be stowed at a height of more than 10 m above the waterline in the lightest seagoing condition, it shall be of a type which has been satisfactorily drop-tested from at least that height.

12.2.2 The open reversible floating liferaft shall be capable of withstanding repeated jumps on to it from a height of at least 4,5 m.

12.2.3 The open reversible liferaft and its fittings shall be constructed as to enable it to be towed at a speed of 3 knots in calm water when loaded with its full number of persons and equipment, with the sea-anchor deployed.

12.2.4 The open reversible liferaft when fully inflated shall be capable of being boarded from the water whichever way up it inflates.

12.2.5 The main buoyancy chamber shall be divided into:

.1 not less than two separate compartments, each inflated through a non-return inflation valve on each compartment;

.2 buoyancy chambers shall be arranged so that in the event of one of the compartments being damaged or failing to inflate, the intact compartments shall be able to support, with positive freeboard over the open reversible liferaft's entire periphery, the number of persons which the liferaft is permitted to accommodate, each having a mass of 75 kg and seated in their normal positions.

12.2.6 The floor of the open reversible liferaft shall be waterproof.

12.2.7 The open reversible liferaft shall be inflated with a non-toxic gas by an inflation system complying with the requirements of 6.9, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships. Inflation shall be completed within the period of one minute at an ambient temperature of between +18 and +20 °C and within a period of three minutes at an ambient temperature of −18 °C. After inflation the open reversible liferaft shall maintain its form when loaded with its full number of persons and equipment.

12.2.8 Each inflatable compartment shall be capable of withstanding a pressure equal to at least three times the working pressure and shall be prevented from reaching a pressure exceeding twice the working pressure either by means of relief valves or by a limited gas supply. Means shall be provided for fitting the topping-up pump or bellows.

12.2.9 The surface of buoyancy tubes shall be of a non-slip material. At least 25 per cent of these tubes shall be of a highly visible colour.

12.2.10 The number of persons which an open reversible liferaft is permitted to accommodate shall be equal to the lesser of:

.1 the greatest whole number obtained by dividing by 0,096 the volume, measured in cubic metres, of the main buoyancy tubes (which for this purpose are not to include the thwarts, if fitted) when inflated; or

.2 the greatest whole number obtained by dividing by 0,372 the inner horizontal cross-sectional area of the open reversible liferaft measured in square metres (which for this purpose may include the thwart or thwarts, if fitted) measured to the innermost edge of buoyancy tubes; or

.3 the number of persons having an average mass of 75 kg, all wearing lifejackets, that can be seated inboard of buoyancy tubes without interfering with the operation of any of the liferaft equipment.

12.3 Open reversible liferaft fittings.

12.3.1 Lifelines shall be securely becketed around the inside and outside of the open reversible liferaft.

12.3.2 The open reversible liferaft shall be fitted with an efficient painter of a length suitable for automatic inflation on reaching the water. For open reversible liferafts accommodating more than 30 persons an additional bowsing-in line shall be fitted.

12.3.3 The breaking strength of the painter system, including its means of attachment to the open reversible liferaft, except the weak link required by 6.8.6.2, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships, shall be:

.1 7,5 kN for open reversible liferafts accommodating up to 8 persons;

.2 10,0 kN for open reversible liferafts accommodating 9 to 30 persons;

.3 15,0 kN for open reversible liferafts accommodating more than 30 persons.

12.3.4 The open reversible liferaft shall be fitted with at least the following number of inflated ramps to assist boarding from the sea, whichever way up the raft inflates:

.1 one boarding ramp for open reversible liferafts accommodating up to 30 persons; or

.2 two boarding ramps for open reversible liferafts accommodating more than 30 persons; such boarding ramps shall be 180° apart.

12.3.5 The open reversible liferaft shall be fitted with water pockets complying with the following requirements:

.1 the cross-sectional area of the pockets shall be in the shape of isosceles triangle with the base of the triangle attached to buoyancy tubes of the open reversible liferaft;

.2 the design shall be such that the pockets fill to approximately 60 per cent of capacity within 15 to 25 s of deployment;

.3 the pockets attached to each buoyancy tube shall normally have a total capacity of between 125 and 150 l for inflatable open reversible liferafts accomodating up to and including 10 persons;

.4 pockets to be fitted to each buoyancy tube on liferafts certified to carry more than 10 persons shall have, as far as practicable, a total capacity of 12 N litres, where N is the number of persons carried;

.5 each pocket on a buoyancy tube shall be attached so that when the pocket is in the deployed position it is attached along the full length of its upper edges to, or close to, the lowest part of the lower buoyancy tube;

.6 the pockets shall be distributed symmetrically round the circumference of the liferaft with sufficient separation between each pocket to enable air to escape readily.

12.3.6 At least one manually controlled lamp complying with the requirements of 6.8.3.3, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships, shall be fitted on the upper and lower surfaces of buoyancy tubes.

12.3.7 Suitable automatic drain arrangements shall be provided on each side of the floor of the liferaft in the following manner:

.1 one for open reversible liferafts accommodating up to 30 persons; or

.2 two for open reversible liferafts accommodating more than 30 persons.

12.3.8 The equipment of every open reversible liferaft shall consist of:

.1 one buoyant rescue quoit, attached to of buoyant line not less than 30 m length with a breaking strength of at least 1 kN;

.2 two safety knives of the non-folding type, having a buoyant handle, shall be attached to open reversible liferaft by light lines. They shall be stowed in pockets so that, irrespective of the way in which the open reversible liferaft inflates, one will be readily available on the top surface of the upper buoyancy tube in a suitable position to enable the painter to be readily cut;

.3 one buoyant bailer;

.4 two sponges;

.5 one sea-anchor permanently attached to the open reversible liferaft in such a way as to be readily deployable when the open reversible liferaft inflates. The position of the sea-anchor shall be clearly marked on both buoyancy tubes;

.6 two buoyant paddles;

.7 one first-aid outfit in a waterproof container capable of being closed tightly after use;

.8 one whistle or equivalent sound signal;

.9 two hand flares;

.10 one waterproof electric torch suitable for Morse signalling together with one spare set of batteries and one spare bulb in a waterproof container;

.11 one repair outfit for repairing punctures in buoyancy compartments;

.12 one topping-up pump or bellows.

12.3.9 The equipment specified in 12.3.8 is designated as "HSC Pack".

12.3.10 Where necessary, the equipment shall be stowed in a container which, if it is not an integral part of, or permanently attached to, the open reversible liferaft, shall be stowed and secured to the open reversible liferaft and be capable of floating in water for at least 30 min without damage to its contents. Irrespective of whether the equipment container is an integral part of, or permanently attached to, the open reversible liferaft, the equipment shall be readily accessible irrespective of which way up the open reversible liferaft inflates. The line which secures the equipment container to the open reversible liferaft shall have a breaking strength of 2 kN or a breaking strength of 3:1 based on the mass of the complete equipment pack, whichever is the greater.

12.4 Containers for open reversible inflatable liferafts.

12.4.1 Open reversible liferafts shall be packed in a container that is:

.1 constructed so as to withstand conditions encountered at sea;

.2 of sufficient inherent buoyancy, when packed with the liferaft and its equipment, to pull the painter from within and to operate the inflation mechanism shall the craft sink;

.3 as far as practicable, watertight, except for drain holes in the container bottom.

12.4.2 The container shall be marked with:

.1 manufacturer's name or trademark;

.2 serial number;

.3 the number of persons permitted to be carried;

.4 "non-SOLAS" reversible;

.5 type of emergency pack enclosed;

.6 date when last serviced;

.7 length of painter;

.8 maximum permitted height of stowage above waterline (depending on drop-test height);

.9 launching instructions.

12.5 Marking of open reversible liferafts.

Open reversible liferafts shall be marked with:

.1 manufacturer's name or trademark;

.2 serial number;

.3 date of manufacture (month and year);

.4 name and place of service station where it was last surveyed;

.5 number of persons permitted to be carried on top of each buoyancy tube, in characters not less than 100 mm height and of colour contrasting with the colour of the tube.

12.6 Instructions and information.

Instructions and information required for inclusion in the craft training manual and in instructions for on-board maintenance shall be in a form suitable for inclusion in such training manual and instructions for on-board maintenance. Instructions and information shall be in a clear and concise form and shall include, as appropriate, the following:

.1 general description of the open reversible liferaft and its equipment;

.2 installation arrangements;

.3 operational instructions, including the use of associated survival equipment;

.4 servicing requirements.

12.7 Testing of open reversible inflatable liferafts.

12.7.1 When testing open reversible inflatable liferaft in accordance with the recommendations of Part 1 of Resolution MSC.81(70):

.1 tests prescribed by paragraphs 5.5, 5.12, 5.16, 5.17.2, 5.17.10 to 5.17.12, 5.18 and 5.20 may be omitted;

.2 the part of test 5.8 regarding closing arrangement may be omitted;

.3 the temperature –30 °C in the test 5.17.3 and 5.17.5 may be substituted with –18 °C; and

.4 drop height of 18 m in test prescribed by paragraph 5.1.2 may be substituted with 10 m.

12.7.2 Omissions and substitutions, as described above, shall be reflected in the type approval certificate of the liferaft.

13 EVACUATION TIME

13.1 Provisions for evacuation shall be designed so that the craft can be evacuated under controlled conditions in a time of one third of the structural fire protection time (SFP) provided in Part VI "Fire Protection" for areas of major fire hazard after subtracting a period of 7 min for initial detection and extinguishing action.

$$T = \frac{(SFP) - 7}{3}, \qquad (13.1)$$

where T = evacuation time, in min;
SFP = structural fire protection time, in min.

13.2 Evacuation procedure, including a critical path analysis, shall be developed for the information of the Register in connection with the approval of fire insulation plans and for assisting owners and shipbuilders in planning the evacuation demonstration required in 13.3.

Evacuation procedure shall include:

.1 emergency announcement made by the Master;

.2 contact with the base port;

.3 donning of lifejackets;

.4 manning of survival craft and emergency stations;

.5 shutting down of machinery and oil fuel supply lines;

.6 order to evacuate;

.7 deployment of survival craft and marine escape systems and rescue boats;

.8 bowsing in of survival craft;

.9 supervision of passengers;

.10 orderly evacuation of passengers under supervision;

.11 crew checking that all passengers have left the craft;

.12 evacuation of the craft;

.13 releasing survival craft from the craft;

.14 marshalling of survival craft by the rescue boat, where provided.

13.3 Achievement of the required evacuation time (as ascertained in accordance with 13.1) shall be verified by a practical demonstration conducted under controlled conditions in the presence of the Register representatives, and for passenger craft shall be fully documented and verified by the Register.

13.4 Evacuation demonstrations shall be carried out with due regard to the problems of mass movement or panic acceleration likely to arise in emergency situation when rapid evacuation is necessary. Evacuation demonstrations shall be dry shod with the survival craft initially in their stowed positions and shall be conducted as follows:

.1 evacuation time on category A craft shall be the time elapsed from the moment the first abandon craft announcement is given, with any passengers distributed in a normal voyage configuration, until the last person has embarked in a survival craft, and shall include the time for passengers and crew to don lifejackets;

.2 evacuation time on category B craft and cargo craft shall be the time elapsed from the moment the order to abandon the craft is given, until the last person has embarked in a survival craft. Passengers and crew may be wearing lifejackets and prepared for evacuation, and they may be distributed among muster stations;

.3 for all craft evacuation time shall include the time necessary to launch, inflate and secure the survival craft alongside ready for embarkation.

13.5 Evacuation time shall be verified by an evacuation demonstration which shall be performed using the survival craft and exits on one side, for which the critical path analysis indicates the greatest evacuation time with the passengers and crew allocated to them.

13.6 On crafts where a half trial is impracticable, the Register may consider a partial evacuation trial using a route which the critical path analysis shows to be the most critical.

13.7 Demonstration shall be carried out in controlled conditions in compliance with the evacuation plan in the following manner:

.1 demonstration shall commence with the craft afloat in harbour, in reasonably calm conditions with all machinery and equipment operating in the normal seagoing condition;

.2 all exits and doors inside the craft shall be in the same position as they are under normal seagoing condition;

.3 safety belts, if required, shall be fastened;

.4 evacuation routes for all passengers and crew shall be such that no person need enter the water during the evacuation.

13.8 For passenger craft a number of persons with normal health, height and weight shall be used in the demonstration, and shall consist of different sexes and ages so far as it is practicable and reasonable.

13.9 Persons, other than the crew selected for the demonstration, shall not have been specifically drilled for such a demonstration.

13.10 Emergency evacuation demonstration shall be carried out for all new designs of high-speed crafts and for other crafts where evacuation arrangements differ substantially from those previously tested.

13.11 The specific evacuation procedure during the craft initial demonstration on which certification is based shall be included in the craft operating manual together with the other evacuation procedures specified in 13.2. During the demonstration, video recordings shall be made, both inside and outside the craft, which shall form an integral part of the training manual.

14 NOISE LEVELS

14.1 The noise level in public spaces and accommodation shall be kept as low as possible to enable the public address system to be heard, and shall not in general exceed 75 dB(A).

14.2 The maximum noise level in the operating compartment shall not in general exceed 65 dB(A) to facilitate communication within the compartment and external radiocommunications.

PART XVII. RADIO EQUIPMENT

1 SCOPE OF APPLICATION

1.1 This Part applies to high-speed crafts engaged on international voyages referred to in 1.1 and 1.2, «General» of the present Rules, to high-speed crafts not engaged on international voyages, unless decided otherwise by the Administration of the State whose flag the craft is flying, and to radio equipment intended for installation on board such craft.

1.2 This Part sets forth technical requirements to be met by the radio equipment and specifies its composition and arrangement.

1.3 Radio equipment not dealt with in this Part or dealt with only partially is covered by the requirements of Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships, unless they are contradictory to the requirements of this Part.

2 DEFINITIONS AND EXPLANATIONS

2.1 Definitions relating to general terminology are given in "General" of the present Rules and in Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

3 SCOPE OF TECHNICAL SUPERVISION

3.1 All types of radiocommunication equipment required by this Part, all associated arrangements, independent sources of electrical power, switching devices and cable lines as well as spaces and areas where the equipment is arranged are subject to technical supervision by the Register during the craft construction and service.

3.2 Design and production of all radio equipment intended for installation on HSC are subject to technical supervision by the Register at the manufacturer.

3.3 The procedure of the technical supervision is given in "General Regulations for the Classification and Other Activitiy" and in Part I "Survey Regulations" of Rules for the Equipment of Sea-Going Ships.

4 TECHNICAL DOCUMENTATION

4.1 The requirements for technical documentation on the radio equipment of HSC to be submitted for consideration together with technical or working design are set forth in 3.2.5, Part I "Survey Regulations", and those for design and production, in 1.3.4, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

4.2 In addition to the documentation required by 4.1, documentation on sea areas depending on which radio equipment for HSC is chosen and documentation on maintenance requirements for GMDSS shall be submitted.

5 RADIO INSTALLATIONS OF HIGH-SPEED CRAFT

5.1 General.

Radio installations of HSC in terms of their itematization, technical characteristics, mounting, operation and maintenance requirements shall be capable of:

transmitting ship-to-shore distress alerts by at least two separate and independent means;

receiving shore-to-ship distress alerts;

transmitting and receiving ship-to-ship distress alerts;

transmitting and receiving search and rescue coordinating communications;

transmitting and receiving on-scene communications;

transmitting, using radar transponders in accordance with 2.1.2, Part XVI "Life-Saving Appliances", and receiving, using radar in accordance with item 6, Table 5.1, Part XVIII "Navigational Equipment", signals for locating objects in distress;

transmitting and receiving marine safety information;

transmitting and receiving general radiocommunications;

transmitting and receiving bridge-to-bridge communications.

6 LIST OF RADIO EQUIPMENT

6.1 Each HSC shall be provided with radio equipment in compliance with requirements 2.2.1 and 2.6, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships, as appropriate for sea areas and maintenance procedures which are used to ensure operation of the radio equipment.

7 ARRANGEMENT OF RADIO EQUIPMENT

7.1 All the required radio equipment shall be installed in the space from which the craft is navigated. An operating position to maintain a radio watch shall be provided in the space in accordance with the requirements of Section 3, Part IV “Radio Equipment” of the Rules for the Equipment of Sea-Going Ships.

7.2 The control position for maintaining a radio watch shall be provided with a table (a hinged table may be used) of a sufficient size to keep records and with a seat for the radio operator. Where radio equipment is installed so that it can be operated directly from the operating position of the navigator on watch, the table and seat required by Section 11, Part XVIII “Navigational Equipment” of the present Rules, may be used for these purposes.

7.3 All controls, switches and indicators shall be positioned at the place from where radio watch is maintained so that they can be accessible for the radio operator without leaving his seat and without interference with steering the craft.

7.4 Radio equipment shall be installed so that it is readily accessible for maintenance purposes both in port and at sea.

7.5 Radio equipment may be arranged in a space other than that required in 7.1 provided the requirements of 3.2, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships are met. In this case, distress alerts and safety announcements may be made from the radio room and transmission of distress alerts shall be initiated from the position from which the craft is normally navigated.

7.6 The switchboard for power supply to the radio equipment referred to in 8.3 shall be positioned close to the radio operator’s position. In case the position from where radio watch is maintained is arranged in the compartment from which the craft is normally navigated, the switchgear for power supply circuits of radio transmitters and command broadcast facilities shall be designed so that they can be locked in the "off" position.

The fulfilment of the requirements of this Chapter is mandatory where the compartment from which the craft is normally navigated cannot be locked.

7.7 The emergency accumulator battery for radio equipment required by 8.1 shall be arranged in compliance with the requirements of 3.3, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

8 SOURCES OF POWER

8.1 Supply of electrical power from the main, reserve and emergency sources of electrical power in accordance with the requirements of 2.3.4, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships, sufficient to operate radio installations and to charge a reserve source of energy shall be available at all times, while the craft is at sea.

8.2 The reserve source of energy required by 8.1 shall be capable of simultaneously operating the radio equipment installed on board the craft in accordance with 6.1 for a period of at least 1 h. The requirements for the reserve source of electrical power are set forth in 2.3, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships, except for 2.3.5 of the same Part of the Rules for the Classification and Construction of Sea-Going Ships.

8.3 Power to radio equipment and command broadcast facilities shall be supplied by separate feeders provided with appropriate switching and protection devices from the switchboard intended solely for the particular purpose. Power supply to switchboard busbars shall be provided from the main switchboard and from the emergency switchboard by separate feeders.

9 AERIALS

9.1 Every craft shall be provided with aerials necessary for operation of radio equipment in accordance with 2.4, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

9.2 Leads and feeders of aerials inside the spaces shall fitted in compliance with 4.1 to 4.6, Part IV "Radio Equipment", and 4.2, Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships.

9.3 The aerial of the VHF installation shall be fitted at the maximum possible height above the craft hull. The VHF installation and radar aerials shall not be shadowed from all the directions by metal structures (such as superstructures, pylons, etc.). Besides, the radar aerial shall be positioned so that there is no inadmissible level of emissive power on open decks and spaces not enclosed by metal structures where people can be present.

10 CONSTRUCTIONAL AND OPERATIONAL REQUIREMENTS FOR RADIO EQUIPMENT

10.1 All radio equipment required by this Part of the present Rules shall comply with constructional and performance requirements contained in Sections 5 to 15, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

11 MAINTENANCE

11.1 Serviceability of radio equipment of HSC shall be provided in accordance with 2.6, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

11.2 For craft operating only between ports where adequate facilities for shore-based maintenance and repair of radio installations are available and provided no journey between two such ports exceeds 6 h at least one maintenance method may be used.

12 SPARE PARTS

12.1 Where serviceability of radio equipment is ensured by proper at-sea maintenance and repair, the craft shall be provided with spare parts in accordance with 2.5, Part IV "Radio Equipment" of Rules for the Equipment of Sea-Going Ships.

13 RADIO PERSONNEL

13.1 Every craft shall carry radio operators to the satisfaction of the Administration of the State whose flag the craft is flying, any one of whom shall be designated for distress and safety radio communication purpose. In passenger craft at least one qualified operator shall be designated to have primary responsibility for radio communications during distress incidents.

PART XVIII. NAVIGATIONAL EQUIPMENT

1 SCOPE OF APPLICATION

1.1 This Part of the Rules applies to high-speed crafts engaged on international voyages referred to in 1.1 and 1.2, «General» of the present Rules, to all other high-speed crafts engaged on any voyages, unless decided otherwise by the Administration of the State whose flag the craft is flying, regarding composition of navigational equipment to be installed on such craft categories, and to navigational equipment intended for installation on board the above craft.

1.2 This Part of the Rules sets forth technical requirements to be met by the navigational equipment and specifies its composition and arrangement.

1.3 Navigational equipment not dealt with in this Part or dealt with only partially is covered by the requirements of Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships, unless they are contradictory to the requirements of this Part.

2 DEFINITIONS AND EXPLANATIONS

2.1 Definitions and explanations relating to general terminology are given in "General" of the present Rules and in Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships.

3 SCOPE OF TECHNICAL SUPERVISION

3.1 All types of navigational equipment required by this Part, all associated arrangements, independent sources of electrical power, switchgear and cable lines as well as spaces and areas where the equipment is arranged are subject to technical supervision by the Register during the craft construction and service.

3.2 Design and production of all navigational equipment intended for installation on HSC are subject to technical supervision by the Register at the manufacturer.

3.3 The procedure of the technical supervision is given in "General Regulations for the Classification and Other Activitiy" and in Part I "Survey Regulations" of Rules for the Equipment of Sea-Going Ships.

4 TECHNICAL DOCUMENTATION

4.1 The requirements for technical documentation on navigational equipment of high-speed craft to be submitted for consideration together with technical or working design are set forth in 3.2.6, Part I "Survey Regulations" of Rules for the Equipment of Sea-Going Ships, and those for production, in 1.3.6, Part V "Navigational Equipment" of the same Rules.

5 LIST OF NAVIGATIONAL EQUIPMENT

5.1 Navigational equipment of HSC shall meet the requirements of Table 5.1.

5.2 In order to plan and plot the craft's voyage, each high-speed craft shall be provided with a set of updated paper nautical charts for at least the intended voyage. An electronic chart display and information system (ECDIS) may be accepted as meeting the chart carriage requirements. In such case, back-up arrangements shall be provided to meet the requirements of 5.15.90, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships.

5.3 In addition to the requirements of 5.1, it is recommended that high-speed crafts be equipped with unified timing system and integrated navigation system.

6 ARRANGEMENT OF NAVIGATIONAL EQUIPMENT

6.1 All navigational equipment required by this Part shall be arranged at the stations from where the craft is navigated.

Where some sets of navigational equipment cannot be arranged at such stations, their indicators and controls shall be positioned in all cases in accordance with these requirement.

6.2 Indicators and controls of the navigational equipment shall be readily accessible and arranged so that the craft operating crew can steer the craft and obtain all the necessary information without leaving their seats.

6.3 The compass card or repeater shall be capable of being easily read from the position at which the craft is normally controlled.

Table 5.1

No	Craft's navigational equipment	Quantity			Remarks
		Passenger craft (100 passengers and less)	Passenger craft (450 passengers and less)	Cargo craft of 500 gross tonnage and more or passenger craft (more than 450 passen-gers)	
1.	Magnetic compass	1	1	1	
2.	Remote device to transfer information on magnetic course to other navigational equipment	1	—	—	Not required if gyrocompass is installed
3	Gyrocompass	—	1	1	
4.	Log (dynamic pressure, induction, Doppler, etc.)	1	1	1	Where interface with auto tracking aid (ATA) or automatic radar plotting aid (ARPA) is required, the log shall be capable to measure craft's speed through the water
5.	Echo sounder	1	1	1	Only for non-amphibian craft for sounding depths in the displacement mode
6.	Radar[1]	1	1	2[2, 3]	Radar shall operate at 9 GHz (3 cm range scale)
7.	Radionavigational system receiver[4]	1	1	1	
8.	Rudder angle indicator and/or propeller thrust direction indicator	1	1	1	
9.	Rate-of-turn indicator	1[5]	1[5]	1[5]	Mandatorily required for craft of more than 500 gross tonnage
10.	Night vision equipment	1[6]	1[6]	1[6]	
11.	Craft's heading or track control system	1	1	1	
12.	Sound reception system	1	1	1	Required on craft with enclosed control station
13.	Automatic identification system (AIS)	1	1	1	
14.	Voyage data recorder[7]	1	1	1	
15.	Radar reflector	1[8]	1[8]	1[8]	Radar reflectors shall operate both at 9 GHz and 3 GHz
16.	Marine sextant	1	1	1	
17.	Prismatic binocular	2	1	1	
18.	Aneroid barometer		1	1	
19.	Anemometer	1	1	1	
20.	Inclinometer	1	1	1	
21.	Marine chronometer	1	1	1	
22.	Stopwatch	1	1	1	
23.	Electronic chart display and information system (ECDIS)	1	1	1	Every craft shall be provided with corrected paper nautical charts for route planning and route monitoring throughout the intended voyage. An electronic chart display and information system (ECDIS) may be accepted as meeting the above requirement. In such a case, back-up arrangements shall be provided in accordance with the requirements of 5.15.90, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships. All high-speed crafts being subject to the requirements of this Part of the Rules shall be fitted with the electronic chart display and information system (ECDIS) on the following dates: crafts constructed on or after 1 July 2008 — at craft's construction; crafts constructed before 1 July 2008 — not later than 1 July 2010.

[1] At least one radar shall be equipped with automatic radar plotting or auto tracking aid suitable for craft's speed.
[2] The second radar shall operate at 3 GHz (10 cm range scale).
[3] Where two radars are required, they shall be independent of each other.
[4] The radionavigational system used shall be accessible at all times during the intended voyage.
[5] The rate-of-turn indicator is required for craft of less than 500 gross tonnage if the test according to Annexes 3 and 9, Chapter 19 of the International Code of Safety for High-Speed Craft, 2000, shows that the turn rate can exceed safety level 1.
[6] According to the requirements of 9.1.
[7] Voyage data recorders shall be installed on cargo craft of more than 3000 gross tonnage.
[8] To be installed on any craft of 150 gross tonnage and less.

6.4 The radar display unit shall be installed in a compartment from where the craft is navigated. The display unit shall be positioned so that in case of course orientation mark "course" on the display shall be oriented in relation to the fore-and-aft line of the craft.

6.5 The radar shall be so arranged that the operator could work when seated.

6.6 Each radar shall be mounted so as to be as free as practicable from vibration.

6.7 Controls and monitors for information display of the night vision equipment shall be readily accessible and positioned at the navigating workstation, the distance between the observer's eyes and the information display shall not be greater than the screen diagonal more than 2,3 times.

6.8 The sensor of the night vision equipment shall be arranged so that:

.1 in the required horizontal field of view there are no shadow sectors forward of the bow on either side to 30°;

.2 in the required vertical field of view, sea surface shown on the screen shall not reduce by more than two lengths of the ship following changes of the shadow zone of the ship due to vertical inclinations of the sensor.

7 SOURCES OF POWER

7.1 Navigational equipment required by this Part shall be supplied from the main and emergency sources of electrical power in compliance with the requirements of Part XI "Electrical Equipment" of the present Rules.

7.2 Each navigational instrument indicated in Table 5.1 and requiring electrical power shall be supplied from the navigational equipment switchboard by separate feeders. Power supply to switchboard busbars shall be provided from the main switchboard and from the emergency switchboard by two separate feeders.

7.3 Magnetic compasses shall be illuminated from the main and emergency sources of electrical power.

8 SPARE PARTS

8.1 Spare parts for all navigational instruments shall be provided in accordance with 2.5, Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships.

The number of spare parts may be changed on agreement with the Register depending on navigational conditions and duration of the voyage.

9 NIGHT VISION EQUIPMENT

9.1 For navigation of high-speed craft in dark time, they shall be fitted with night vision equipment.

10 CRAFT CONTROL STATIONS

10.1 All control functions of the craft when under way in any mode shall be exercised from the craft control station at the navigating bridge.

10.2 The craft control station shall be positioned in the upper part of the superstructure or be raised above the upper deck. The operating compartment shall be fitted with windows around the periphery to provide view all round the horizon when at sea and in manoeuvring the craft to a berth. Where all-round view is not provided, two control stations shall be arranged.

At least one exit to the craft's side or stern shall be provided at the craft's operating compartment. Besides, the operating compartment shall communicate with interior spaces. Arrangements shall be made to prevent passengers from entering the operating compartment.

10.3 Blind sectors shall be as few as possible. The total arc of blind sectors from right ahead to 22,5° abaft the beam on either side shall not exceed 20°. Each individual blind sector shall not exceed 5° and the clear sector between two blind sectors shall not be less than 10°. The view of the sea surface from the control station, when the navigators are seated, shall not be obscured by more than one craft length forward of the bow to 90° on either side, irrespective of the craft draught, trim and deck cargo.

10.4 The control station of the craft shall be, as far as possible, such as to ensure visual observation for the navigators and utilization of leading marks astern of the craft.

10.5 The number of workstations for personnel on watch in the craft control station shall be sufficient to normally maintain the watch and steer the craft. The required vision of the surroundings from each workstation sufficient for the operating personnel to perform their duties shall be provided.

10.6 The number of workstations and their arrangement depending on a possibility of all-round view, procedure of maintaining the watch by a navigator, helmsman, craft engineer and radio operator as well as on the extent of craft automation may be different and are subject to special consideration by the Register.

10.7 Where a docking station is provided for docking the craft, the field of vision from the docking workstation shall permit one navigator to safely manoeuvre the craft to a berth.

10.8 If separate workstations for supervision of engine performance and use of the radio equipment are placed in the operating compartment, the location and use of these workstations shall not interfere with primary functions in the operating compartment.

10.9 Each workstation shall be equipped with a seat, control panels with all necessary controls for the officer in charge to perform all the prescribed functions.

10.10 Seats shall be comfortable and so positioned that in the operational mode each operating crew member could be seated facing right ahead. The height of the seat shall be adjustable so that, in addition to the view referred to in 10.3, all indicators, controls and alarms referred to 10.16 could be easily used.

10.11 Seats shall be provided with safety belts and permanently attached in the most convenient position for the personnel in charge which shall not be changed during the craft operation. The operating crew members, with the seats suitably adjusted and safety belts correctly worn, shall be able to perform the operations referred to in 10.10. Subsequent change of seat position to operate any control shall not be acceptable. Exception may be made only in respect of controls which are required on very rare occasions and which are not associated with the need for safety restraint.

10.12 A table suitable for chart work and record keeping in a logbook at the workstation shall be of a size sufficient for keeping nautical charts and publications thereon. The table shall be so placed that the navigator could work with charts and publications not leaving the seat.

10.13 The dimensions of the table at the workstation shall be not less than:

.1 760 mm in width;

.2 660 mm in depth.

10.14 The arrangement of the equipment in the control station is subject to special consideration by the Register.

10.15 Where an automatic steering aid is provided, a chart table may be positioned beyond the workstation but close thereto. In such case the officer in charge may temporarily leave the seat.

10.16 The following devices and instruments shall be located at each workshop in the control station:

.1 levers to control main engines direction and speed of rotation or engine telegraph hand levers;

.2 hand levers, buttons or wheels of directional control systems, i.e. steering engines, foils, flaps, steerable propellers, jets, yaw control ports, side thrusters, differential propulsive thrust, variable geometry of the craft or its lifting-system components, aerial or water rudders, lift fans, etc.;

.3 main engine rotational speed and direction indicators, course indicators, rudder angle indicators, position indicators of foils, flaps, sterable propellers, jets, yaw control ports, side thrusters, differential propulsive thrust, variable geometry of the craft or its lifting-system components, aerial or water rudders, lift fans, etc.;

.4 alarms on failures in engines, control devices and systems referred to in 10.16.1, 10.16.2 and 10.16.5;

.5 craft's automatic stabilization system control station and automatic safety control station;

.6 hand controls of safety device of automatic stabilization system of craft modes;

.7 illuminated indicator panels and sound alarms of the warning and alarm systems of craft automated machinery, systems and arrangements;

.8 illuminated indicator panels and sound alarms of fire detection systems;

.9 a device for remote starting of fire-extinguishing systems;

.10 navigation light boards and associated signalling systems;

.11 navigational equipment required by this Part;

.12 radio equipment required by Part XVII "Radio Equipment";

.13 light and sound signalling devices on failures in ventilation system for special-category spaces;

.14 switches for remote stopping of fans in accommodation, service, machinery spaces and in special-category spaces;

.15 instruments for measuring temperature, pressure, level of liquid, voltage, load and other essential parameters of craft propulsion machinery and arrangements;

.16 remote arrangements for stopping flammable liquid transfer pumps and fire-extinguishing systems control;

.17 alarms on high water level in drained spaces;

.18 any other instruments, arrangements, controls, including those for emergency purposes, which may be required depending on the craft structure.

10.17 The equipment referred to in 10.16 shall be arranged on consoles, bulkheads, desks, etc. It shall have such design and size of light and digital indicator scales, signal lamps, controls, and be so mounted and illuminated that operating personnel can easily view the instruments and operate the controls without leaving their seats in all possible service conditions.

10.18 All alarm, indication and monitoring instruments referred to in 10.16, and controls shall be logically grouped according to their function. The alarm, indication and monitoring instruments shall be clearly marked with any limitation if this information is not otherwise clearly presented to the operating crew. The instrument panels forming the emergency control for the monitoring of the fire-fighting systems and launching of liferafts, etc. shall be grouped and be separate. The instruments shall not be rationalized by sharing functions or by inter-switching.

10.19 The alarm, indication and monitoring instruments shall be so designed as to be plainly visible at any level of lighting. Glare and reflections from the instruments shall not interfere with normal work of the operating personnel at nighttime.

10.20 The surfaces of the alarm, indication and monitoring instruments, and console tops shall have dark, matt, glare-free colours.

10.21 Only the most essential equipment shall be arranged in front of the operating crew members facing right ahead, provided their attention and observation of the surroundings is not prevented.

Where indications of the alarm, indication and monitoring instruments and visual information on the displays of navigational equipment shall be used by more than one person, they shall be located for easy viewing by all users concurrently. If this is not possible, the instrument or display shall be duplicated.

10.22 Where maintaining watch and radio equipment control at workstations are difficult due to arrangement of the radio equipment used, a special workstation for the radio operator, in addition to the workstations referred to in 10.5, shall be provided. The VHF radio installation control desk shall be positioned in all cases at the workstations referred to in 10.5.

10.23 Means to communicate between the operating compartment and spaces containing essential machinery, such as propulsion machinery, emergency steering positions, etc., shall be provided.

10.24 A portable microphone shall be provided in the operating compartment for making public address and safety announcements to all areas to which passengers and crew have access and through which escape paths are routed, and to all survival craft embarkation stations.

10.25 The operating compartment shall be equipped with adequate temperature and ventilation control systems.

10.26 An adequate level of lighting shall be provided in the operating compartment to enable the operating personnel to efficiently perform their tasks both at sea and in port. Red light shall be used to maintain dark adaptation whenever any items of equipment other than the chart table require local illumination in the operational mode.

10.27 Lighting in the operating compartment and noise generated by the instruments installed in the operating compartment shall not produce any interference for navigation.

10.28 Where provision is additionally made to control the craft from control stations other than the craft's operating compartment referred to in 10.2, the alarm, indication and monitoring instruments and controls shall be switched over to operation from other stations only from the craft's operating compartment.

10.29 Sockets supplied from the emergency source of electrical power for connection of a portable lamp which shall be permanently kept in the craft control station shall be provided in the craft.

10.30 Where the craft control station is equipped with a combined craft control panel, one shall be guided by the provisions of this Section, those of 5.12, Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships and 4.5 "Electrical Equipment" of the Rules for the Classification and Construction of Sea-Going Ships.

10.31 Divisions between windows shall be kept to a minimum. No division shall be installed immediately forward of the officer in charge and helmsman workstations.

10.32 The arrangement of the control station windows and the curvature of their surface shall be such that no glare, reflections or distortions are produced which might result in navigation errors. Neither polarized or tinted window glass shall be fitted. The windows shall be angled from the vertical plane top out to not less than 10° but not more than 25° to reduce unwanted reflections. Windows shall be made of a material which will not break into dangerous fragments if fractured.

10.33 Front windows and, depending of configuration of the control station, other window shall be provided with means for wiping, heating and air blowing of the windows. The means shall be so arranged that no reasonably probable single failure can result in a reduction of the cleared field of vision from the operating compartment.

10.34 The design and software of the equipment arranged in the operating compartment shall be such as to prevent their use for purposes other than navigation, communication and other functions essential to the safe operation of the craft.

11 OPERATIONAL REQUIREMENTS FOR NAVIGATIONAL EQUIPMENT

11.1 General requirements.

11.1.1 All navigational instruments and devices that are part of the craft's navigational equipment shall have technical characteristics not lower than those required by this Part of the Rules, and they shall be arranged so that safety of navigation is ensured in the area and under conditions for which the craft is intended.

11.1.2 All navigational equipment required by this Part of the Rules as well as the navigational aids to be installed on high-speed craft in addition to those required shall comply in respect of their technical characteristics with the requirements of Section 5, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships, provided they are not specially defined in this Part, and with special requirements dictated by high speeds of the craft between 30 and 70 knots. Such requirements, if they are not set forth below, are subject to special consideration by the Register.

11.2 Radars.

11.2.1 The radars installed on HSCs on or after 1 July 2008 shall comply with the requirements of Section 5.7, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships. The number of the radars required shall comply with the requirements of Table 5.1 of this Part of the Rules and their performance characteristics, depending on gross tonnage, shall comply with the requirements of Table 5.7.2, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships. In this case, a speed of aerial rotation shall be at least 40 rpm. The radars installed on HSCs before 1 July 2008 shall comply with the performance standards given below.

11.2.2 The radar shall be capable of providing a clear indication of coastlines, surface objects and locating their position giving continuous uninterrupted all round scanning of the horizon under true and relative motion presentation. All radars operating in 3 cm range shall have horizontally polarized radiation.

11.2.3 Where the radar antenna is mounted at a height of 7,5 m above sea level, the radar display unit shall be capable of giving clear indication of surface objects, such as navigation buoys having an effective echoing area of 10 m^2 at 2,5 nautical miles in the absence of clutter. These objects shall be clearly seen at the radar display at a minimum distance of 35 m and up to a distance of one nautical mile without changing of controls position except the range scale switch. The above-mentioned requirements shall be met at rolling and pitching motions up to 10°.

11.2.4 The radar display shall have an effective diameter of at least 250 mm without any outside magnifying instruments. The display shall provide multi-colour presentation and adjustment of its brightness. Provision shall be made for the quick change of colour presentation for better observation both in daytime and at night.

The display unit of the radar shall be provided with the following set of range scales: 0,25; 0,5; 0,75; 1,5; 3; 6; 12 and 24 nautical miles. Additional range scales may be provided. There shall be indicated not less than two fixed electronic range rings on the range scales 0,25, 0,5 and 0,75 nautical miles, and up to six rings on the other scales.

The nominal value of the range scale and distance between fixed electronic range rings shall be clearly indicated on the working part of the display unit.

Besides, variable electronic range ring with a numeric read-out of the range shall be provided.

The fixed and the variable range rings shall ensure the accuracy of measurement of the object range with an error not exceeding 1 per cent of the maximum range of the scale in use, or 30 m, whichever is the greater.

Provision shall be made for off-set of the centre of scanning at least for 50 per cent but not more than for 75 per cent from the range scale used.

It shall be possible that brightness of the fixed and a variable range rings be varied up to their total removal from the display.

11.2.5 The display unit of the radar shall have an electronic direction sighting device intended for determination of the direction to any target which mark appears on the screen. The error of measurement of the direction to a target which is on the edge of the screen shall not exceed $\pm 1°$.

Provision shall be made for at least two lines of the direction sighting device.

After installation on the craft and adjustment the accuracy of measurement of the direction to the target shall be maintained without any adjustments independently of the craft movement in magnetic fields of the Earth.

11.2.6 The craft heading shall be indicated on the screen by means of electronic course mark in the form of a line with a maximum error $\pm 1°$. The width of the course mark at the edge of the display face shall not exceed 0,5°.

The possibility shall be provided for temporary removal of the course mark image using a switch with automatic reset to "on" position.

11.2.7 Provision shall be made for indication on the screen of the display unit, along with radar information, of the planned route in graphical form, i. e. route points and segments of straight lines connecting them. The source of graphical information shall be clearly indicated.

The possibility shall be provided for displaying target motion trajectories in the form of trails created by marks of targets due to the screen artificial afterglow.

Trails shall be relative or true, true trails shall be stabilized relative to the water or ground.

11.2.8 The radar shall have a resolution that, in the absence of clutter, provides:

.1 on 1 mile range scale and less, separate indication of two objects with an effective target area of 10 m^2 located on the same azimuth at the distance equal to 50 — 100 per cent of the range nominal value of the range scale used and distant not more than 35 m from each other;

.2 on 1,5 mile range scale and less, separate indication of two objects with an effective target area of 10 m^2 located at the same distance within 0,5 to 1 mile limits and not more than 2,5° from each other for radar operating in 3 cm range and not more than 4° for radar operating in 10 cm range.

11.2.9 Devices shall be provided to eliminate clutter created by reflections from precipitation, clouds, sand storms and sea surface.

Provision shall be made for smooth manual regulation of such devices and for switching off those signal processing devices which may prevent reflection from the radar beacon responder.

11.2.10 The radar shall be ready for operation within 4 min upon being switched on. The "stand-by" position shall be provided after which the radar may be set in the "switched on" position within 15 s.

11.2.11 Means shall be provided to check and determine a substantial drop in performance relative to the manufacturer calibration standard and to check that the equipment is correctly adjusted in the absence of targets indication on the screen of the display unit.

11.2.12 The radar shall be capable of receiving information signals from gyrocompass, log, receivers of radionavigation systems. Alarms on absence or decreasing of quality of information signals from the above-mentioned equipment shall be duplicated.

11.2.13 The radar shall be capable to provide all-round view over the entire horizon in the relative motion mode. The accuracy of alignment with a course information source shall be within $\pm 0{,}5^\circ$ with a rotation rate of 20°/s.

The radar shall operate properly in the absence of a signal from a course information source.

It is recommended to provide the possibility of radar operation in the true motion mode.

11.2.14 Provision shall be made in the radar for clockwise continuous and automatic scan through 360° of azimuth. The scan rate shall be not less than 40 rpm.

The antenna shall be capable to operate with a relative wind velocity up to 100 knots.

11.2.15 Controls shall be readily accessible and easily recognizable.

In case symbols are used for their indication, they shall correspond to commonly used symbols for identification of navigation marine radar controls. The navigator shall be able to switch on and operate the radar from his workstation, when seated.

11.3 Gyrocompasses.

11.3.1 In craft whose speed is below 30 knots the gyrocompass shall comply with the requirements of 5.3, Part V “Navigational Equipment” of the Rules for the Equipment of Sea-Going Ships; for craft having speeds between 30 and 70 knots the gyrocompass shall meet the requirements given below.

11.3.2 The gyrocompass positioned on a horizontal and stationary base on board the craft operating in latitudes of up to 70° shall comply with the following requirements:

.1 the gyrocompass shall be brought into alignment with meridian within 6 hours;

.2 the steady-state error at any course shall not exceed $\pm 0{,}75^\circ$ x secant latitude, the root mean square value of the difference between individual course indications and the mean value of the course shall be not less than $\pm 0{,}25^\circ$ x secant latitude;

.3 the permissible error from one run-up to another shall be within $\pm 0{,}25^\circ$ x secant latitude.

11.3.3 In latitudes between 70°N and 70°S, when the craft operates within the latitude range 10°, the gyrocompass shall comply with the following requirements:

.1 under rolling and pitching harmonic motions with a period of 6 to 15 s, amplitude of 5° at maximum accelerations of 22 m/s^2 the gyrocompass shall be brought into alignment with meridian within 6 h;

.2 the steady-state error of the master compass readings, from one run-up to another, under service conditions associated with variations of the magnetic field and environmental temperature shall be within $\pm 1^\circ$ x secant latitude;

.3 the residual error at a straight course (after correction for speed and course at a speed of 70 knots shall not exceed $\pm 0{,}25^\circ$ x secant latitude;

.4 the maximum error of readings due to a rapid acceleration of the craft up to a speed of 70 knots shall not exceed 2;

.5 the error of readings due to rapid alteration of course of 180° at a turn angular speed 20°/s and speed of 70 knots shall not exceed $\pm 3^\circ$;

.6 steady and variable errors of the indications caused by harmonic rolling up to 20°, pitching up to 10° and yawing up to 5° with a period from 6 to 15 s and the maximum horizontal acceleration not more than 1 m/s^2 at any course (in particular, 45°, 90° and 315°) shall not exceed $\pm 1^\circ$ x secant latitude;

.7 gyrocompasses shall operate reliably as it is required in 5.1.2, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships; the maximum error shall not exceed $\pm 1^\circ$;

.8 the maximum divergence in readings between the master compass and repeaters shall not exceed $\pm 0{,}5^\circ$ under any operational conditions;

.9 the respond rate of the gyrocompass follow-up system shall be not less than 20°/s.

11.3.4 Gyrocompass shall be provided with a compass card or analogue repeater for indication of course information, visual bearing taking devices as well as a corrector used for correction of compass readings in respect of craft speed and latitude.

The device shall be calibrated in 1° or 1/10° increments. Digital markings shall be indicated in every 10° clockwise from 0 to 360°.

In addition, a digital indicator may be provided. The course shall be presented on the digital indicator in the form of three figures (the fourth figure may indicate tenths of a degree). If a gyrocompass with a digital indicator is used it shall include a turn indicator.

11.3.5 The remote indication system of the gyrocompass shall be designed so as to ensure simultaneous operation of gyrocompass own repeaters, course recorder, as well as repeaters fitted in other navigational equipment.

11.3.6 A course recorder shall be capable of recording craft course in respect of time with an accuracy ± 1 %.

11.3.7 Provision shall be made for a visual and/or audible indication of gyrocompass readiness for operation as well as audible and visual alarms on power supply failure or failures in the compass system.

11.3.8 The compass shall be supplied with electric power from the main and emergency sources of power with automatic switching-over.

11.3.9 Gyrocompass shall be provided with devices for correction of error due to a rapid alteration of craft's speed and influence of the magnetic field in different latitudes.

11.3.10 Appropriate interfaces shall be provided to transfer of the course information to other navigation equipment, such as radars, ARPA, ATA, ETA, AIS, ECDIS, voyage data recorder, craft's heading control system or track control system.

11.4 Craft heading control systems (automatic steering devices).

11.4.1 The heading control system for HSC shall meet the requirements of 5.16, Part V "Navigational Equipment" of the Rules for the Convention Equipment of Sea-Going Ships as well as the requirements given below and governed by specific features of HSC and the following operational conditions:

.1 craft speed -30 to 70 knots;

.2 maximum rate of turn $-20°$/s;

.3 navigation of the craft in latitudes up to 70°.

11.4.2 The heading control system shall enable the craft to keep automatically the preset heading with minimum operation of the craft steering gear.

11.4.3 The heading control system, having regard to the craft's manoeuvring qualities, shall enable the craft to keep automatically the preset heading with an accuracy of $\pm 2°$.

The heading control system shall be fitted with a regulator of permissible deviation from the preset heading (yaw), and the maximum amplitude of yaw shall not exceed the amplitude permitted under manual control. Means shall be incorporated in the heading control system to enable the rudder angle limitation and an alarm to indicate when the angle of limitation has been reached.

11.4.4 The heading control system shall be able to perform turns within the craft turning capabilities and in accordance with 11.4.1.2.

11.4.5 The heading control system shall be capable of adapting automatically or manually to different steering characteristics of the craft under various speeds, accelerations, loading conditions of the craft, sea and weather conditions. Means shall be provided to control and correct the system parameters.

11.4.6 Change-over from manual to automatic steering and vice versa shall be possible at any position of the rudder. The heading control system shall change to a preset heading without significant overshoot. Adequate indication shall be provided to show which method of steering is in operation. When changing from manual to automatic steering the heading control system shall take over the actual heading as the preset heading. Any possibility of inadvertent or unauthorized alteration of the preset course shall be prevented. Switching-over from automatic to manual control shall be possible under any circumstances, even in case of the automatic control system failure. In case of manual steering, a possibility shall be provided for preventing the automatic steering operation.

11.4.7 Controls intended for changing from manual to automatic steering method and vice versa shall be located in the master station and close to each other.

11.4.8 Controls intended for alteration of the heading shall be designed so as to ensure altering the preset heading to starboard by turning the heading setting control clockwise or tilting the control handle to the right-hand side or a command for turning starboard if a control is a digital device. Alteration of the preset heading to port side shall be ensured by turning the heading setting control counter-clockwise or tilting the control handle to the left-hand side or a command for turning to the port side if a control is a digital device.

The alteration of the preset heading shall be possible by adjustment of only one the preset heading control.

Controls at the remote control stations shall meet the requirements of this Chapter. Change of the system control to a remote control station shall be possible only from the master station.

11.4.9 The heading control system shall be electrically connected with a gyrocompass and receive information on the heading.

11.4.10 An alarm shall be provided in the heading control system to indicate failure of any heading monitor used for control. All warning alarms likely to appear when information transmitters are in operation shall be duplicated at the craft's course control station.

11.4.11 The heading control system shall be provided with audible and visual alarms to indicate failure or reduction of power supply.

11.4.12 An alarm shall be provided when the actual heading deviates from the preset heading beyond a preset limit, the heading track aid shall get information from an independent indicator.

11.4.13 Alarms shall be positioned at the steering control station.

11.4.14 Provision shall be made for connection of the heading control system with information sensors as required by 5.1.31, Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships.

11.5 Night vision equipment.

11.5.1 Night vision equipment shall be designed for continuous operation during night time (from sunset to dawn). Night vision equipment shall be designed so that it detects objects above water surface at a given distance from the ship which threaten shipping, such as small unlit boats, floating logs, oil drums, containers, buoys, ice, whales, etc. and shows them on the screen.

Night vision equipment shall determine position of such objects in relation to the ship and display them in real time.

11.5.2 After the equipment has been switched on it shall be operational in less than 15 min.

11.5.3 Night vision equipment shall detect the standard test target at a distance of at least 600 m with a minimum probability of 90 per cent under mean starlight conditions without clouds and without moon. The standard target shall be a black metal object of such a size that when at least 50 per cent is immersed, 1,5 m long and 0,5 m high remains above water at right angles to the desired direction of detection. The standard test target shall stay at least 24 h in water before testing.

11.5.4 Equipment shall enable detection and display of objects staying in:

horizontal field of view shall be at least 20°, 10° on either side of the bow;

vertical field of view shall be at least 12°, meanwhile observation of the horizon shall be provided.

Other sectors of view may be provided. They shall be activated by special non-locking switch which returns to the required field of view when released.

Watch navigator working place shall be equipped with the visual indication of the sector of view in use.

11.5.5 The axis of the field of view of the equipment shall be capable of being moved at least 20° horizontally to either side. The system shall be capable of panning at a minimum angular speed of 30°/s. This shift shall be made by a single control and the equipment shall be capable to revert automatically to the initial sector of view to the ahead position at a minimum angular speed of 30°/s.

11.5.6 The elevation axis of the field of view shall be capable of being adjusted by at least 10° to compensate for the trim of the craft.

11.5.7 The heading marker of the craft shall be indicated on the display with an error not greater than $\pm 1°$.

A visual indication of relative bearing with an error of not greater than $\pm 1°$ shall be provided, it shall appear while the axis of horizontal field of view has shifted to the corner when the heading marker disappears from the display.

11.5.8 Sensor of the night vision equipment shall be designed so that it operates at the following weather conditions:

pitching and/or rolling up to 10°;

relative velocity of the head wind and / or true wind up to 100 knots;

icing;

spattering or thumbing of the sensor lens.

It shall be possible to clean sensor lens from the ship control station.

If the sensor rotating mechanism fails, it shall be possible to fix it in the forward direction.

11.5.9 The equipment shall be designed so that to exclude or reduce to minimum such hindrances like dazzle or reflection of light, glow or other visual interferences.

11.5.10 Equipment shall have indication that it is up and running.

11.5.11 Night vision equipment shall include a visual indication of any failure.

11.5.12 Number of controls shall be minimal. Clear notes and/or conventional symbols shall indicate their purpose.

It is not recommended to use controls of dual purpose as well as to apply Menus for operation of equipment.

11.5.13 Controls shall be clearly visible in darkness. If they are fitted with lighting it shall be adjustable.

11.5.14 Information display of night vision equipment shall not twinkle or blind craft operating crew. Screen diagonal shall be sufficient to show image of at least 180 mm by diagonal.

11.5.15 If any function of the night vision equipment is realized by means of software, it shall:

display the user interface status;

contain self-description of the functions implemented by means of software;

be protected from casual and/or unauthorised changes;

meet requirements of Part XV "Automation" of Rules for the Classification and Construction of Sea-going Ships.

11.5.16 If manufacturer recommends to carry out maintenance works of the equipment regularly, it shall be fitted with the elapsed operation time counter.

PART XIX. SIGNAL MEANS

1 GENERAL

1.1 Unless expressly provided otherwise, signal means of HSC shall meet the requirements of Part III "Signal Means" of Rules for the Equipment of Sea-Going Ships.

2 EQUIPMENT OF CRAFT WITH SIGNAL MEANS

2.1 In addition to those lanterns which are indicated in 2.2.4 of Part III "Signal Means" of Rules for the Equipment of Sea-Going Ships a set of spare lanterns for air-cushion vehicles shall include a yellow flashing light.

2.2 At least 12 red rocket parachute flares shall be stowed in the craft control station.

2.3 One portable signalling lamp capable of operating independently of the craft main electrical supply shall be provided and maintained ready for use in the control station at all times.

2.4 HSC shall be equipped with at least one adequate searchlight, which shall be controllable from the control station.

3 FITTING OF SIGNAL MEANS ON BOARD

3.1 Fixed installation of a craft bell is not required but a device shall be provided for quick installation thereof in its regular place.

The bell and the device shall be stowed in close vicinity of the installation place.

3.2 The forward masthead light or if there is only one masthead light on HSC with a length to breadth ration less than three may be positioned at a height less than required in 4.2.1.1, Part III "Signal Means" of Rules for the Equipment of Sea-Going Ships, provided the angles at the base of the isosceles triangle viewed from the craft ends and formed by side lanterns and topmast lantern are not less than 27°.

3.3 The yellow flashing light in air-cushion vehicles shall be installed so that there is no flashing light reflection from craft structures or is kept to a minimum, which impair observation of the surroundings.

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В приложении приводится текст изменений Частей XVI "Спасательные средства" упомянутых выше Правил РС.

Необходимо выполнить следующее:

Применять в практической деятельности изменения, приведенные в Приложении

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Приложение к циркулярному письму 010-6.2МК-419ц от 19.10.2009 г.

Изменение ПРАВИЛ КЛАССИФИКАЦИИ И ПОСТРОЙКИ ВЫСОКОСКОРОСТНЫХ СУДОВ 1998 года и 2008 года

Часть XVI Спасательные средства

Раздел «2 Средства связи и сигнальное оборудование»

Пункт 2.1. Существующий текст подпункта .2 заменяется следующим текстом:

".2 на каждом борту каждого пассажирского высокоскоростного судна и каждого грузового высокоскоростного судна валовой вместимостью 500 и более должно иметься, по крайней мере, одно устройство указания местоположения спасательного средства для целей поиска и спасания. Такое устройство указания местоположения спасательного средства для целей поиска и спасания должно отвечать требованиям раздела 10 Части IV "Радиооборудование" Правил по оборудованию морских судов. Устройства указания местоположения спасательных средств для целей поиска и спасания должны размещаться в таких местах, чтобы их можно было быстро перенести в любое коллективное спасательное средство. Альтернативно одно устройство указания местоположения спасательного средства для целей поиска и спасания должно располагаться в каждом коллективном спасательном средстве".