Requirements for

Designing and Building Small Marine Crafts

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1 INTRODUCTION

1.1 Scope

The purpose of this document titled "Requirements for Designing and Building Small Marine Crafts" is to provide guidelines to small crafts builders to achieve necessary certification as well as guidance to recognized entities accredited by the Department of Municipalities and Transport (hereafter referred to as "the Department"), to consult and issue certification; mainly for recreational marine crafts (private and commercial) with overall length up to 24 m, including floating homes and floating restaurants, which are not covered by international conventions and regulations.

The classification and certification services aim at providing an appropriate safety level for these types of crafts, their use and design limitations. The classification and certification services described in this document apply to newbuilding of crafts.

Requirements set out in this document are minimum standards to comply with. However, it is the builders' obligation to comply with the latest mandatory national and international regulations as amended. In the event of a conflict between the requirements of this document and those in a federal or local legislation, the provisions of the federal and local legislation shall apply. The Department welcomes the notification of any such conflicts and shall amend this document accordingly.

This document does not apply to:

- Marine crafts of overall length above 24 m.

1.2 *Exemptions*

The Department may exempt certain requirements defined in this document for a marine craft, provided that it complies with all other suitable and sufficient requirements and conditions necessary for carrying out the designated voyages. However, these exemptions must first be assessed, verified, and approved by authorized entities accredited by the Department, before the Department issues the exemption.

1.3 Normative references

The referenced materials below, which are essential for the application of requirements defined in this document, may be consulted. Only the edition mentioned is to be relied upon, in the case of dated references.

Table 1-1 Normative references

Standards	Title
ASTM C 273	Standard test method for shear properties of sandwich core materials
ASTM C 393	Standard test method for core shear properties of sandwich constructions
BS 1088	Requirements for marine plywood
BS 1203	Hot-setting phenolic and aminoplastic wood adhesives
BS 1204	Phenolic and aminoplastic synthetic resin adhesives for wood
BS 4079	Rubber hoses and hose assemblies
BS 7160	Anchor chains for small craft
DIN 52183	Determination of moisture content in wood

Standards	Title
DIN 68364	Mechanical properties of different types of wood
EN 314	Determining the bonding quality of veneer plywood, by shear testing
EN 1869	Fire blanket
EN 24565	Small craft – Anchor chains
IEC 60529	Degrees of protection provided by enclosures (IP Code)
ISO 1172	Textile-glass-reinforced plastics – Prepregs, moulding, compounds, and laminates
ISO 2859	Sampling procedures for inspection by attributes
ISO 2896	Rigid cellular plastics – Determination of water absorption
ISO 4565	Small craft – Anchor chains
ISO 4589	Plastics – Determination of burning behavior by oxygen index
ISO 6185	Inflatable boats
ISO 7840	Small craft – Fire resistant fuel hoses
ISO 8099	Small craft – Waste systems
ISO 8178	Reciprocating internal combustion engines – Exhaust emission measurements
ISO 8666	Small craft – Principal data
ISO 8729	Ships and marine technology – Marine radar reflectors
ISO 8847	Small craft – Steering gear, cable and pulley systems
ISO 8848	Small craft – Remote mechanical steering systems
ISO 8849	Small craft – Electrically operated bilge pumps
ISO 9093	Small craft – Seacocks and through-hull fittings
ISO 9094	Small craft – Fire protection
ISO 9775	Small craft – Remote steering systems for outboard motors
ISO 10087	Small craft – Craft identification
ISO 10088	Small craft – Permanently installed fuel systems
ISO 10133	Small craft – Electrical systems – Extra-low-voltage D.C. installations
ISO 10239	Small craft – Liquified petroleum gas systems
ISO 10592	Small craft – Hydraulic steering systems
ISO 10105	Small craft – Ventilation of petrol engine and/or petrol tank compartments
ISO 10240	Small craft – Owner’s manual
ISO 11192	Small craft – Graphical symbols
ISO 11547	Small craft – Start-in-gear protection
ISO 11591	Small craft – Field of vision from the steering position
ISO 11592	Small craft – Determination of maximum propulsion power rating
ISO 11812	Small craft – Watertight or quick-draining recesses and cockpits
ISO 12215	Small craft – Hull construction and scantlings
ISO 12216	Small craft – Windows, portlights, hatches, deadlights and doors
ISO 12217	Small craft – Stability and buoyancy assessment and categorization
ISO 12402	Personal floating devices
ISO 13297	Small craft – Electrical systems

Standards	Title
ISO 13363	Rubber and plastics hoses for marine-engine wet-exhaust systems
ISO 13590	Personal watercraft – Construction and system installation requirements
ISO 13929	Small craft – Steering gear, geared link systems
ISO 14227	Small craft – Magnetic compasses
ISO 14509	Small craft – Airborne sound emitted by powered recreational craft
ISO 14945	Small craft – Builder's plate
ISO 14946	Small craft – Maximum load capacity
ISO 15083	Small craft – Bilge-pumping systems
ISO 15084	Small craft – Anchoring, mooring and towing – Strong points
ISO 15085	Small craft – Man-overboard prevention and recovery
ISO 15584	Small craft – Inboard petrol engines, engine-mounted fuel and electrical components
ISO 16147	Small craft – Inboard diesel engines, engine-mounted fuel and electrical components
ISO 16180	Small craft – Navigation lights – Installation, placement and visibility

1.4 Rule References

Table 1-2 Rule references

Rules/Standards	Title
DNV-RU-SHIP	DNV Rules for Classification, Ships
DNV-RU-HSLC	DNV Rules for Classification, High-Speed Light Craft
DNV-RU-YACHT	DNV Rules for Classification, Yachts
DNV-RU-UWT	DNV Rules for Classification, Underwater Technology
DNV-ST-0342	DNV Standard for Small Craft
DNV-ST-0411	DNV Standard for Certification of Tall Ship Rigs
DNV-ST-0412	DNV Standard for Certification of Large Modern Yacht Rigs
AMSA NSCV-F2	National Standard for Commercial Vessels of the Australian Maritime Safety Authority, Part F "Special vessels", Section 2 "Leisure craft", Chapter 12 "Standard houseboats"
COLREG	The International Regulations for Preventing Collisions at Sea (1972)
CEVNI Regulations	European Code for Interior Navigations for inland waterways
GCC Safety Rules	Safety regulations of the Gulf Cooperation Council (GCC) for cargo ships not covered by the provisions of IMO conventions and for small passenger ships carrying less than 200 passengers
HSC Code	International Code of Safety for High-Speed Craft (2000)
IACS Rec 99	Recommendations for the safety of cargo vessels of less than convention size (<500 GT)
IMO IA761E	Voluntary guidelines for the design, construction, and equipment of small fishing vessels
IMO IC874E	International Code on Intact Stability (IS), (2008), Issue 2020
LLC 66	Load Line Convention 1966, as amended
MSC/Circ.981	IMO Guidelines for the design, construction, and operation of passenger submersible craft

1.5 Definitions

Table 1-3 Definitions

Symbol	Unit	Description
L	m	Length of hull but excluding rub rails, outside rudders, outdrives, outboard motors, diving platforms, bowsprits, fittings.
L_{WL}	m	Length of hull along waterline measured at the foremost intersection of the stem with the flotation plane and the aftermost intersection of the hull and the flotation plane with the craft fully loaded at rest.
F_p		Intersection of the stem with the flotation plane of the craft fully loaded at rest.
B	m	Maximum beam of hull measured on the outside of the hull shell.
B_{WL}	m	Beam of hull in the waterline. For catamarans: sum of waterline beam for both hulls.
T	m	Maximum draught of hull in fully loaded condition.
D	m	Depth, measured as the vertical distance between the sheer line at the half-length of the waterline and the lowest point of the keel.
Δ	kg	Displacement in fully loaded condition.
V	knots	Maximum speed.
β	°	Deadrise angle is the angle of the bottom from the horizontal measured athwartship at a specific position.
LCG	m	Longitudinal position of the center of gravity from a chosen datum.
VCG	m	Vertical position of the center of gravity from a chosen datum.
RM	Nm	Righting moment.
GM	m	Transverse metacentric height.
GZ	m	Righting lever = righting moment (Nm)/(mass (kg) × 9.806).
Decked craft		Craft with deck that can be closed weather tight from stem to stern uninterrupted by other than a strong superstructure or a cockpit so designed that shipping sea will not fill spaces below deck.
Open craft		Craft that is not a decked craft.
Flooded craft		A craft in a condition in which it cannot be filled with more water.
Superstructure		Decked structure on the freeboard deck, extending from side to side of the ship or with the side plating not inboard of the shell plating more than 4% of the breadth (B).
Deckhouse		Decked structure above the strength deck with the side plating being inboard of the shell plating more than 4% of the breadth (B).
Long deckhouse		Deckhouse having more than 0.2 L of its length within 0.4 L amidships.
Short deckhouse		Deckhouse not defined as a long deckhouse.
Mean freeboard F	mm	$F = (f_f + f_m + f_a)/3$
f_f	mm	Freeboard measured at extreme forward end.

Symbol	Unit	Description
f_a	mm	Smallest freeboard measured at extreme aft end or, for craft with engine wells to the point where water first may enter the craft.
f_m	mm	Freeboard measured at $L_H/2$.
Headroom	m	Vertical distance between top of compartment floor and underside of the deck beam or deck head (whichever is the lower).
Readily accessible		Capable of being reached for operation, inspection, or maintenance without the use of tools or the removal of any craft structure or any item of portable equipment.
Accessible		Capable of being reached for operation, inspection, or maintenance without the removal any permanent craft structure.
M	kNm	Maximum longitudinal bending moment.
Z	mm^3	Section modulus of hull girder.
Recreational craft		Any craft of any type intended for sport and/or leisure of overall length of less than 24 m, regardless of means of propulsion.
Manufacturer		An organization that manufactures the material or product or carries out part production that determines the quality of a material or product or does the final assembly of a product.

2 GENERAL

2.1 Application

This document applies to recreational marine crafts (commercial and private) of less than 24 meters in length, including floating homes and floating restaurant which fall under the following categories:

Table 2-1 Field of application

Description	Type
Hull Type	Monohull or Multihull
Hull Materials	Aluminium Materials, Steel Materials, Fibre Reinforced Plastics, Thermoplastics, Wood and Other suitable material
Length	below 24 m
Speed	up to Maximum 50 knots
Propulsion	Sailing, Motor [Inboard or Outboard Engine]
Area of Operation	Area (AD0) = Offshore (up to the Economic Zone OR maximum 200 nm) Area (AD1) = Territorial Waters (up to 12 nautical miles from coast baseline) Area (AD2) = Coastal (up to 5 nautical miles from safe haven) Area (AD3) = Sheltered (enclosed waters such as protected shoreline, channels ports, and lakes)
Private Recreational Craft of less than 24 m length	This includes personal watercraft such as leisure boats, yachts, kayaks, canoes, rowing boats, jet skis, sailboats, motorized yachts, small floating homes, and similar
Commercial Recreational Craft of less than 24 m length	This includes small crafts including tourist watercraft, watercraft designated for parties, small floating restaurants, watercraft designated for recreational fishing or similar.

This document applies also to the following recreational and personal watercraft:

- Watercraft intended solely for racing, including rowing racing boats and training rowing boats, labeled as such by the manufacturer;
- Surfboards and kite boards designed solely to be propelled by wind and to be operated by a person or persons standing;
- Surfboards and sup boards;
- Foiling boards and electric foiling boards;
- Experimental watercraft, provided that, they are not placed on the market.

2.2 Requirements

In this document:

- Requirements with respect to certification systematic and formalities are given in Section 3.
- Requirements for survey and maintenance are given in Section 4.
- Essential requirements applicable to all crafts are given in Sections 5 and 6.
- Marine craft type-specific technical requirements are given in Section 7 through to Section 18.

Commercial recreational marine crafts of less than 24 m overall length shall comply with the GCC regulations for non-conventional vessels and IACS recommendation 99 as far as practicable.

Relevant requirements from the GCC regulations related to ship surveys and certification including, but not limited to, requirements of load line, construction and structure, divisions, equipment, stability and bilge pumping arrangements, machinery installations, electrical installations, fire protection, ship plans and documents (GCC Regulations 3 and 123), are to be complied with and considered where applicable.

Existing marine crafts, which are constructed prior to entry into force of the requirements defined in this document, shall comply with these requirements, as far as practicable, within a period of one year from the effective date or according to the time extension provided by the Department.

3 CERTIFICATION SYSTEMATICS

3.1 General

The certification service specified in this section is performed by authorized and approved entities in the country on behalf of the Department. The relation between the Customer and the authorized and approved entities is regulated in an agreement signed by both parties. The agreement specifies the scope of the service, the fee, terms of payment and legal obligations. The requirements which are in force at the date of the written agreement are the basis for the services and certification.

The certification service is performed on the basic assumption that all parties involved (designer, builder/yard, manufacturer, design-owner, sub-contractor, owner, etc.) fulfil their individual obligations. The certification service is not performed in substitution of other parties' role or obligations.

The procedures for providing certification services by the responsible entity, or in the certificates, reports, or documents issued related to that service, shall not stipulate the exemption of any designer, engineer, builder, manufacturer, shipyard, seller, owner, operator, or other parties from any obligations or consequences in case of failure, under any circumstances. Compliance with the requirements does not imply approval of the acceptance of the marine craft or the approval of costs, as these are the exclusive responsibilities of the owner.

3.2 Certification procedures

3.2.1 General

The certification procedures are based on modules. These procedures (modules) cover the design phase, the manufacturing phase or both. The procedures are based on the modules specified for conformity assessment in accordance with the Directives in the European Union.

Application for certification shall be sent to the responsible entity and include:

- Name and address of the applicant
- Name and address of the owner of the design
- Name and address of the builder (yard, manufacturer) craft specification and type designation
- Chosen procedure(s)
- Technical documentation

The Applicant must be authorized by the Owner of the design to act on his behalf. If the Applicant subcontracts the design or production, the Applicant remains responsible for the execution of conformity assessment for all technical documentation, sub-supplies, and the finished craft. Any subcontracting will be subject to a separate agreement, handling, and approval.

The responsible entity decides the extent of examinations, tests and inspections required to complete the relevant procedure (module) in each case.

Requirement for materials and manufacturing shall be surveyed and accepted according to requirements set out in **Section 9**.

3.2.2 Procedure for one-off craft

3.2.2.1 General

The procedure (**Module G**) is applicable for one-off certification, i.e. a design on which only one craft is built.

3.2.2.2 Procedure (Module G)

The responsible entity will verify that the technical documentation complies with the requirements.

The responsible entity will carry out surveys during production, examine the complete craft and carry out the appropriate tests as set out in the relevant requirements to ensure its conformity.

Upon successful completion of the certification procedure, the responsible entity will issue a *Product Certificate*.

3.2.3 Procedures for series of craft

3.2.3.1 General

The procedures (modules) described in [3.2.3.2], [3.2.3.3], and [3.2.3.4] are applicable to one design on which a series of craft is manufactured. **Module B** [3.2.3.2] covers the design phase and shall always be followed by a procedure covering the production phase (either **Module F** [3.2.3.3] or **Module D** [3.2.3.4])

3.2.3.2 Type approval (Module B)

The procedure (**Module B**) shall normally be used for approval of a design produced in series and must be followed by a procedure (module) covering the production phase.

The procedure shall be according to the following overall principles for Type Approval (TA):

- Application for TA
- Quotation
- Approval of the design
- Initial assessment
- Type testing
- Issuance of TA certificate

The responsible entity verifies that the Technical Documentation complies with the requirements.

The responsible entity verifies, by performing examinations and tests that a prototype complies with the applicable requirements and is built in accordance with the Technical Documentation.

Upon successful completion with the certification procedure, the responsible entity will issue a *Type Approval Certificate* with a validity of 5 years.

3.2.3.3 Product verification (Module F)

The procedure (**Module F**) covers the production phase and follows the procedure for Type Approval (**Module B**).

The builder shall take necessary actions to ensure that the manufacturing process ensures conformity of the products with the type as described in the approved technical documentation.

Normally all products will be individually examined and appropriate tests carried out in order to verify their conformity with the type as described in the type approval certificate and the approved technical documentation.

If statistical verification is agreed, the method shall be according to ISO 2859-1:

- Each relevant section shall be considered as an inspection item
- Sample size shall be based on ISO 2859, Table 9-1, General Inspection Level "I"
- Sampling plan shall be according to ISO 2859-1, Table 2-A
- Acceptance Quality Limit (AQL) shall be 1.0

If a lot is found not acceptable, all items shall be re-examined until the responsible entity is satisfied that all nonconforming items have been rectified/replaced. The responsible entity will determine whether the re-examination shall include all inspection items or only the particular types of non-conformities which caused initial non-acceptance.

Upon successful completion of the certification procedure, the responsible entity will issue a *Product Certificate* covering either each unit or a single defined lot.

3.2.3.4 Production verification (Module D)

The procedure (**Module D**) covers the production phase and follows the procedure for Type Approval (**Module B**).

The builder shall operate an approved Quality Assurance System (QA-system) for manufacturing, final product inspection and testing. The QA system shall be subject to monitoring as specified below.

The procedure may cover several designs with valid Type Approval Certificate.

The builder shall submit the documentation concerning the QA-system. The QA-system shall ensure compliance of the products with the type(s) as described in the Type Approval Certificate(s) and the approved Technical Documentation.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic and orderly manner in the form of written policies, procedures, and instructions.

The QA-system documentation must permit a consistent interpretation of the quality programs, plan, manuals and records.

The QA-system shall contain, in particular, an adequate description of the:

- Quality objectives and the organizational structure, responsibilities, and powers of the management with regard to product quality
- Manufacturing, quality control and quality assurance techniques, processes and systematic actions that will be used
- Examinations and tests that will be carried out before, during and after manufacture, and the frequency with which they will be carried out
- Quality records, such as inspection reports and test data, calibration data, qualification reports of personnel concerned, etc.
- Means to monitor the achievements of required product quality and the effective operation of the quality system

Upon successful approval of the QA-system the responsible entity will issue a *Quality System Production Certificate* valid for 4 years.

The Department will carry out audits to make sure that the builder maintains and applies the quality system. The audit will include spot checks on craft under building and review of quality records of built craft.

Additionally, the responsible Entity may pay unexpected visits.

3.3 Technical documentation

The Applicant shall submit Technical Documentation for approval irrespective of certification procedure. Technical Documentation shall enable understanding of the design and construction of the craft and shall confirm compliance with the requirements given in this document.

Requirements for documentation are found in the beginning of each section including, but not limited to:

- Safety of Personnel [8.1]
- Stability, Water- and Weathertight Integrity [9.1.2]
- Materials and Manufacturing [10.1] and [10.2], [10.3.1]
- Design Principals [11.1] (for speed exceeding 45 knots, see [11.2])
- FRP Structural Design [14.1.7] and [14.1.8]
- Machinery, Systems and Safety Equipment Chapter 17.1 through Chapter 17.10.

Documentation of Quality Assurance System (**Module D**) shall be according to Section [3.2.3.4].

3.4 Certificates

The type of certificates to be issued by the responsible entity will be:

- Type Approval Certificate ([3.2.3.2])
- Product Certificate ([3.2.2.2] or [3.2.3.3])
- Quality System Production Certificate ([3.2.3.4])

The certificates shall contain the following information as applicable:

- The name and address of the Builder (yard, manufacturer)
- The identification of the product- craft type designation and reference to Owner of the design
- Reference to the standard and regulations applied
- Specification of exemptions or equivalent standards
- Any restrictions/limitations in the use of the craft
- Validity
- Date of issue and signatures

3.5 Testing and trials

All equipment shall be function-tested after installation to demonstrate compliance with the requirements in this document. The testing shall include sea trial(s) with all equipment installed. All testings shall be carried out according to a plan approved by the surveyor. The surveyor may require witnessing of all or part of the testings and/or sea trials.

4 SURVEYS AND MAINTENANCE

4.1 Application

These requirements apply to the marine crafts subject to certification as per this document. The Department may delegate any work or function related to surveys for compliance with the requirements defined in this document to a responsible entity.

The requirements apply to new marine crafts and existing ones in service as far as practicable. Survey requirements are not compulsory for recreational craft solely in private use (but not charter craft).

Following the application of the Hull Identification Number (HIN), the owner/ or his official representative of the marine craft, shall submit the plans/documents as detailed in Chapter 11.1 to the responsible entity for approval/information.

New marine craft applying for registration for the first time with the Department, shall be certified according to the certification scheme as detailed in Section 3.

Upon satisfactory completion of the certification procedure, the marine craft shall be issued with a Product Certificate. The marine craft shall be subjected to an annual survey each year, bottom survey as required by the procedure and renewal survey at an interval of five (5) years.

A marine craft operating license will be issued by the Department, to each craft for a period of one (1) year, or as deemed appropriate by the Department, after complying with all requirements. For renewal/re-issue of operating license, the marine craft shall be subjected to periodical surveys as detailed in this Section 4, Sections 4.4, 4.5 and 4.6 as applicable.

Where applicable, the requirements for marine craft surveys required by the GCC code shall be complied with.

4.2 Expansion of surveys

The surveys provided in this section can be expanded to the extent as deemed necessary. Any parts found not complying with the applicable requirements are to be properly repaired or, preferably replaced with a new approved part.

4.3 Initial survey of existing vessels

Existing vessels, which are to be registered with the Department and which are not certified according to the requirements defined in this document, shall be subject to initial survey as detailed in this section. The scope of the surveys to be equivalent to renewal surveys. However, surveys may be expanded as deemed necessary, depending on age & type of vessel. Following surveys are to be undertaken as part of the initial survey.

4.3.1 Bottom survey

The boat bottom survey as detailed in Chapter 4.4.2 to be carried out to check the condition of the underwater hull & appendages.

The thickness determination may be carried out, as deemed necessary for boats with metallic construction.

4.3.2 Tail shaft

Marine crafts fitted with in board propulsion system, tail shaft survey to be carried out as detailed in Section 4.5.4.

4.3.3 Sea trials

Marine crafts with a propulsion system shall be subjected to sea trials to check the performance of the craft. Operational trials of the entire machinery and electrical installation (as applicable) to be carried out include:

- Propulsion system
- Steering system [Main and Emergency]
- Engine starting system
- Bilge & Ballast system
- Fuel System including quick closing valve
- Ventilation system
- Cooling system
- Exhaust system
- Anchoring and mooring system
- Fire protection system if fitted
- Other systems as fitted on board

The above systems are to be tested to the satisfaction of the surveyor. The scope may be increased as deemed necessary depending on the type of boat and systems installed on board.

4.4 Periodical hull surveys

4.4.1 Annual surveys

The vessels are to be subjected to an annual survey to confirm that the hull of the marine craft remains efficient for the operation of the marine craft. This survey includes:

- External examination of hull structure, including deckhouse, inside of engine room, and foundations.
- Watertight closures, such as hatches, skylights, air and sounding pipes, scuppers, discharge lines, doors etc. including their seals and locking devices.
- Sea valves and all inlet and outlet shell openings. All opening to the sea, including sanitary and other overboard discharges (together with the connected valves) are to be examined internally and externally and the fastenings to the shell plating.
- Anchoring equipment is to be examined and placed in satisfactory condition.

Depending on the material of the construction of the marine crafts, additional requirements as detailed in Chapter 4.6 are also to be verified during surveys.

4.4.2 Bottom surveys

The bottom survey is generally carried out along with the renewal survey at an interval of five (5) years. However, depending on the visual condition of the marine craft and as deemed necessary by the surveyor, the bottom survey may be carried out twice in the period of five (5) years. An additional bottom survey may be carried out along with 2nd annual survey / 3rd annual survey depending on the condition of the marine craft as deemed necessary.

Intermediate bottom surveys are recommended for marine crafts operating in unrestricted service.

The bottom survey may be carried out in dry condition such as in a drydock or on a slipway or by lifting the marine craft out of the water. The marine craft is to be placed on blocks/lifted to sufficient height with the necessary staging to permit the examination of elements such as shell plating including bottom and bow plating, stern frame and rudder, sea chests and valves, propeller etc.

In-water survey may be carried out upon application and acceptance by the Department or responsible entity as per the applicable procedures.

The outer shell is to be visually examined for excessive corrosion, or deterioration due to chafing or contact with the ground or for any undue deformation or buckling. Due attention is to be given to the end structures (stem and stern frame).

Considering the different construction materials, the following is to be examined:

- Metallic marine crafts: connection between bilge strakes and bilge keels
- GRP marine crafts: condition of gel coat (presence of cracking, blistering and other damage)
- Wooden marine crafts: condition of caulking and rivets
- Synthetic Rubber: sealing condition of the outer hull

Sea chests and their gratings, sea connections and overboard discharge valves and cocks and their fastenings to the hull or sea chests are to be examined.

Visible parts of the propeller, stern bush, propeller shaft boss, brackets and tightness system are to be examined. The clearances of the propeller shaft (or wear down gauge) are to be checked and recorded. Visible parts of other propulsion systems and propellers for steering purposes are also to be examined. Dismantling may be carried out, if considered necessary.

Visible parts of the rudder, rudder pintles, rudder stock and couplings as well as the stern frame are to be examined. If considered necessary, the rudder is to be lifted or the inspection plates removed for the examination of pintles. The clearances in the rudder bearings and the rudder lowering are to be checked and recorded. Where applicable, a pressure test of the rudder may be required as deemed necessary.

At the time of dry-docking surveys, the trials to check the performance of the marine crafts are to be carried out as applicable.

4.4.3 Renewal surveys

Marine crafts are to be subjected to renewal surveys at an interval of five years from the date of issuance of the *Product Certificate*. The renewal survey should include the following:

- Bottom survey to be carried out in conjunction with renewal surveys.
- Thickness measurement of metallic hull to be undertaken depending on the age of the marine craft as per class rules and by the surveyor as deemed necessary, as detailed in Table 4.1.
- All decks, casings and superstructures are to be examined. Particular attention is to be given to the corners of openings and other discontinuities in way of decks and topsides.
- Hose testing of all watertight/ weathertight enclosures if deemed necessary by the surveyors.
- Portable tanks and ballast internal examination to be carried out as far as possible.

- Examination of anchors, anchor windlass, hawse pipes, chain cables and hawsers. Anchors are to be replaced if their weights have been reduced by more than 10 % compared with the rule weight. Chain-link cables are to be renewed, if the prescribed cross-section of the chain links has been reduced by more than 12%.

Depending on the material of the construction of the marine crafts, additional requirements as detailed in Chapter 4.6 also to be verified during surveys.

Table 4-1 Thickness measurements at renewal surveys

I Renewal Survey (marine crafts 5 years old)	II Renewal Survey (marine crafts 10 years old)	III Renewal Survey (marine crafts 15 years old)	IV Renewal Survey (marine crafts 20 years old)
Suspected areas	Suspected areas	Suspected areas	Suspected areas
Tanks where coating not in GOOD conditions, as deemed necessary by the surveyor	Tanks where coating not in GOOD conditions, as deemed necessary by the surveyor	Tanks where coating not in GOOD conditions, as deemed necessary by the surveyor	Tanks where coating not in GOOD conditions, as deemed necessary by the surveyor
		All exposed main deck plating full length	All exposed main deck plating full length
		Shell plating in way of the waterline, full length	Shell plating in way of the waterline, full length
		Internals in forepeak & aft peak tank	Internals in forepeak tank & aft peak tank
			Representative exposed super-structure deck plating (poop, bridge, and forecastle deck)
			All keel plates full length. Also, additional bottom plates in way of cofferdams, machinery space, aft end of tanks.
			Plating of sea chests. Shell plating in way of overboard discharges as considered necessary by the attending Surveyor

4.5 Machinery surveys

This section applies to the marine crafts, which are fitted with the motor propulsion system.

4.5.1 Machinery surveys for existing marine crafts

Existing marine crafts, which are to be registered with the Department and which are not certified according to the requirements defined in this document, shall be subjected to initial survey as detailed in this section. The scope of the surveys to be equivalent to renewal surveys. However, surveys may be expanded as deemed necessary, depending on age and type of marine craft.

For marine crafts fitted with outboard engines, engine manufacturer/maker requirements, engine identification, engine installation as detailed in Chapter 6.1.1 as applicable to be carried out.

4.5.2 Annual machinery surveys

The machinery and electrical installations shall be examined, so far as can be seen, and placed in satisfactory condition as necessary. The survey should include the examination of the following:

- Main and auxiliary machinery with relevant components.
- Electrical installation, including relevant machinery, switchboards, and cabling.
- External examination of the entire propeller shaft system without withdrawal of the shaft.
- Fire protection and fire-fighting equipment.

4.5.3 Renewal machinery surveys

In addition to annual machinery survey requirements, following shall be examined:

- The rudder, the condition of the carrier and bearing and the effectiveness of the stuffing boxes are to be ascertained.
- Visual inspection of bilge and ballast lines, including pumps with operational trials of the system.
- Dismounting of sea valves if deemed necessary by surveyor after external inspection.
- Removal of propeller shaft if deemed necessary by the surveyor after external inspection.
- Dismounting of individual components of the machinery if deemed necessary by the surveyor after external inspection.
- Partial or complete disassembly of engine as deemed necessary by the surveyor, considering manufacturer’s recommendations and records of maintenance.
- Electrical installation including tests as recommended by the manufacturer.
- Operational trials of the entire machinery and electrical installation, with the marine craft afloat.

4.5.4 Tail shaft survey

Tail shaft survey shall also to be carried out in conjunction with renewal survey. Unless alternative means are provided to ensure tail shaft condition, tail shafts are to be sufficiently drawn to permit full examination.

- During the survey, in addition to the non-destructive examination of the forward part of the aft shaft taper, the after end of the cylindrical part of the shaft is also to be examined with the same method. Furthermore, wear down is to be measured and the stern tube bearings, oil glands, propellers and fastenings are to be examined.
- Water jet units are to be dismantled for examination of the impeller, casing, shafts, shaft seal and bearing, inlet and outlet channels, steering nozzle, reversing arrangement and control gear.

For marine crafts fitted with outboard engines, external examination to the extent possible to be carried out. In case of leakage, damage is observed the extent of survey may be increased as deemed necessary.

4.6 Survey requirements for marine crafts as per hull material

4.6.1 Surveys of marine crafts with steel and aluminium hull

4.6.1.1 Periodical hull surveys

The hull structure as detailed below shall be examined:

- Hull envelope including all internal and external structures.
- Superstructures, deckhouses and casings.
- All penetrations fitted and welded into bulkheads, decks and shell.

- The fittings of all connections to decks, bulkheads and shell, such as air pipes and side valves.
- Welded attachments to shell, decks and primary members but only as regards their interaction on the hull structure.

Thickness measurement as detailed in Chapter 4.4.3 to be undertaken for metallic hull construction.

4.6.2 Surveys of marine crafts with glass reinforces plastic hulls

4.6.2.1 Periodical hull surveys

Annual surveys:

- In the case of hulls made of sandwich type structures, it is to be carefully checked that the parts are not detached from the core. The check is to be performed by means of non-destructive methods by an approved service supplier/company.
- The connection between hull and deck is to be carefully checked, in particular, when hull and deck are made of different materials.

Renewal survey and bottom survey:

- In addition to the requirements for the annual surveys given above the presence of "osmosis" phenomena in the laminates of the underwater body and/or of cracks in the gel-coat is to be verified.
- To this end, the marine craft is to be made available for the bottom survey in dry condition before the application of any paint to allow a careful visual inspection.

4.6.3 Surveys of marine crafts with wooden hull

4.6.3.1 Periodical hull surveys

Annual surveys

The hull structural members are to be examined, in particular: beams, deck, girders, pillars, knees, frames (after removal of air-courses and ceiling at the discretion of the surveyor), breast hooks, deadwoods, keelson, inner planking (beam shelves, clamps, thick strakes of the ceiling, sparring, etc.), with particular attention to the examination of the butts of all longitudinal members.

Fastenings are also to be examined to verify their general condition.

The surveyor may require a check of the condition of the structure by means of a more extensive specific examination, such as removal of portions of the inner planking and testing of timbers by axe, chisel or another suitable tool.

Renewal survey and bottom survey

In addition to the annual survey requirements, the survey is to consist of the following checks:

Bottom survey

- Check condition of the outside planking and its caulking by means of suitable tests, as deemed necessary by the attending surveyor, on each side of the marine craft, amidships and at the ends, in the vicinity of the waterline and near the keel, with local removal of any metal sheathing, as necessary. When evidence of deterioration is found in the outside planking and its caulking, additional tests are to be made as necessary to determine the extent of renewal of planking or re-caulking required. If it is found that general re-caulking of the outside planking is necessary, the metal sheathing, if any, is to be entirely removed and the outside planking is to be thoroughly cleaned.

- Check condition of keel, deadwood, stem, sternpost, rudder and associated pintles and gudgeons and all sea openings.
- Examination of sea connections, of the attachments of valves to the marine craft shell and of gratings; where the valves fitted to the marine craft shell are of cast iron, they are to be opened for examination at every docking survey.

First (I) Renewal survey (marine crafts at 5 years old)

- The survey is to include examination and checks sufficiently extensive to ensure that the structures, systems and equipment of the marine craft are in good order or are restored to such condition as to allow the marine craft to operate safely.
- All ceilings and limber boards are to be removed; in addition, if considered necessary by the surveyor, a sufficient amount of the outer shell planking and inner sparring is to be removed to enable close examination of the frames.
- Any surfaces in contact with rust and the outside surface of the shell planking, from the light waterline to the covering boards, is to be well cleaned and scraped.
- The condition of fastenings is to be checked and, if considered necessary by the surveyor, a sufficient number of fastenings is to be drawn to enable their condition and that of the adjacent timber to be thoroughly checked. In this connection, attention is to be given to iron fastenings, especially in way of the waterline, and fastenings made of copper or yellow metal are to be tested and renewed when found to be broken or excessively worn.
- The sheer strake planking is to be tested by drawing a sufficient number of treenails, or by boring if no treenails are fitted; the holes resulting from the latter are subsequently to be closed by treenails or bolts.
- In case the keel and center keelson are connected by iron fastenings, a sufficient number of these fastenings is to be drawn out to check their condition; where this is impracticable, additional fastenings, as required by the Surveyor, are to be fitted in the connection of keel with center keelson, of stem and stern-post with aprons and inner stern-posts, and also in the connection of other main structural members.
- If visual examination or testing by sounding and boring reveals rot or decay due to woodworm, the affected areas and adjacent timbers are to be closely inspected and, if necessary for the purpose, additional parts are to be removed to decide the extent of renewal required.

Second (II) Renewal survey (marine crafts at 10 years old)

The requirements for first (I) renewal survey are to be complied with along with the following additional items:

- The whole of the internal structure and planking is to be cleaned and scraped.

- Particular attention is to be given to the condition of the upper deck or weather decks; planks showing evident signs of wear are to be bored, and renewed either wholly or in part when the deterioration exceeds 20 mm.

Third (III) Renewal survey (marine crafts at 15 years old and above)

The requirements for First (I) renewal survey and Second (II) renewal survey are to be complied with along with the following additional items:

- Several lengths of covering boards, all waterways are to be removed as considered necessary by the surveyor, to carefully check the condition of the timber in way of the ends of beams and frames.
- Superstructures and erections are to be scraped, particularly in those positions which are liable to greater deterioration, and parts are to be removed as required for renewal and/or repair.

4.6.4 Surveys of marine crafts with other suitable material

4.6.4.1 Periodical hull surveys

- Marine crafts with other hull material are to be checked as per manufacturer's recommendations.
- Condition check of tubes and seams for inflatable marine crafts.
- Condition check of the joints between the tubes and the hull for rigid inflatable marine crafts.
- An airtightness test at safe working pressure to be carried out during renewal survey or as per manufacturer's recommendation. Additional airtightness test may be carried out in annual survey as deemed necessary by surveyors depending on visual examination.

4.7 Surveys of sailing marine craft rigs and rigging

4.7.1 Modern yacht rigs

4.7.1.1 Periodical surveys

Modern yacht rigs and rigging shall be surveyed annually through inspection.

Surveys of the laid rig and rigging by inspection periodically every five (5) years.

4.7.2 Traditional sailing marine craft rigs

4.7.2.1 Periodical surveys

Traditional sailing marine craft rigs shall be surveyed according to requirements of a recognized standard [18.3.3].

4.8 Maintenance

4.8.1 General

Requirements on maintenance are outlined in the **Department's relevant regulations**.

5 ESSENTIAL REQUIREMENTS FOR DESIGN AND BUILDING

5.1 Service area notation

5.1.1 General

The service area notation ***AD*** (Abu Dhabi) followed by a number, or a letter will be assigned to marine crafts with modified requirements to arrangement, equipment or scantlings, in relation to the marine craft's trading area.

The service area restrictions, given in nautical miles and representing the maximum distance from nearest port or safe anchorage, are given in Table 5-1. For the various service area notations, the restrictions are related to the zones, areas and distance from safe haven.

The service area restrictions as related to the assigned service area notation will be included in the Certification Documents (*Type Approval Certificate* [3.2.3.2], *Product Certificate* [3.2.3.3]) and on the *Builders' Plate* [5.2.2].

For marine crafts classed with a recognized Class or IACS Classification Society, the service area notation of this specific class will be stated in the above *Certificates*, replacing the service area notations given in Table 5-1.

Table 5-1 Service area restrictions / notations

Design Category	Description	Service notations	Service/Trading area (nautical miles)
"Offshore"	Category of marine crafts considered suitable to operate in seas with significant wave heights above 4 m and wind speeds in excess of Beaufort Force 8, but excluding abnormal conditions, e.g., storms. **NOTE:** For the application of this part of ISO 12215, the calculation wave height is 7 m.	**AD0**	Up to "Economical Zone or maximum 200 nm"
"Territorial Waters"	Category of marine crafts considered suitable to operate in seas with significant wave heights up to 4 m and wind speeds of Beaufort Force 8 or less.	**AD1**	Up to 12 nm from coast baseline
"Coastal"	Category of marine crafts considered suitable to operate in seas with wave heights up to 2 m and a typical steady wind force of Beaufort Force 6 or less.	**AD2**	Up to 5 nm from safe haven
"Sheltered"	Category of marine crafts considered suitable to operate in in waters with significant wave heights up to and including 0.3 m with occasional waves of 0.5 m height, for example from passing marine crafts, and a typical steady wind force of Beaufort Force 4 or less.	**AD3**	Enclosed waters (e.g., protected shoreline, channels, ports, and lakes)

5.1.2 Modified requirements

Modified requirements related to the various service area notations are given in the relevant sections of this document. The modifications will affect:

- Design hull girder loads
- Design pressures on shell, weather decks, superstructures, and deckhouses
- Anchoring and mooring equipment
- Arrangement

- Stability
- Lifesaving appliances

Other service restrictions or operational limits included in the design assumptions for a marine craft will be stated in the *Product Certificate* [3.2.3.2] or [3.2.3.3], and/or on the marine crafts *Builders' Plate* [5.2.2].

5.2 General requirements

5.2.1 Marine craft identification

Each marine craft shall be marked with an identification number including the following information:

- Country code of the manufacturer of the marine craft
- Unique code of the manufacturer
- Unique serial number
- Month and year of production
- Model year

The marine craft identification coding shall satisfy the requirements of ISO 10087:2019.

5.2.2 Marine craft builders' plate

Each marine craft shall carry a permanently affixed plate mounted separately from the marine craft identification number, containing at least the following information:

(a) manufacturer's name, registered trade name or registered trademark, as well as contact address.
(b) certification mark.
(c) Marine craft service area restriction.
(d) manufacturer's maximum recommended load derived from point 5.3.6 excluding the weight of the contents of the fixed tanks when full.
(e) number of persons recommended by the manufacturer for which the marine craft was designed.

The marine craft builders' plate shall satisfy the requirements of ISO 14945:2004.

ISO 14945:2004 establishes requirements for the uniform display of information to be exhibited on the builder's plate of small craft with a hull length of up to 24 m, measured according to ISO 8666. Excluded are inflatable marine crafts covered by ISO 6185 and personal marine craft covered by ISO 13590.

In the case of post-construction assessment, the contact details and the requirements referred to in point (a) shall include those of the entity which has carried out the conformity assessment.

5.2.3 Protection from falling overboard and means of reboarding

Small marine crafts shall be designed to minimize the risks of falling overboard and to facilitate reboarding. Means of reboarding shall be accessible to or deployable by a person in the water unaided.

The marine craft shall comply with the requirements of ISO 15085:2003, as far as applicable.

ISO 15085:2003 specifies the design as well as the construction and strength requirements for safety devices and arrangements intended to minimize the risk of falling overboard, and requirements to facilitate reboarding. It describes means which can be used individually or combined to achieve these objectives and applies to small craft of up to 24 m length of hull.

ISO 15085:2003 is not applicable to the following marine craft types:

- Aquatic toys;
- Canoes, kayaks, or other marine crafts with a beam less than 1.1 m;
- Personal marine craft, covered by ISO 13590;
- Inflatable marine crafts with a hull length of less than 8 m, covered by ISO 6185.

5.2.4 Visibility from the main steering position

For small marine crafts, the main steering position shall give the operator, under normal conditions of use (speed and load), good all-round visibility.

The marine craft shall comply with the requirements of ISO 11591:2020.

ISO 11591:2020 specifies requirements for the field of vision from the steering position, forward (horizontally and vertically) and astern, for small craft up to 24 m length of the hull.

5.2.5 Owner's manual

Each product shall be provided with an owner's manual. Manufacturers (or Importers) shall ensure that the marine craft is accompanied by instructions and safety information in the owner's manual in a language or languages which can be easily understood by consumers and other end-users, as determined by the Department.

That manual shall provide all the information necessary for safe use of the product drawing particular attention to set up, maintenance, regular operation, prevention of risks and risk management.

The owner's manual shall comply with the requirements of ISO 10240:2019, as far as applicable.

5.3 Integrity and structural requirements

5.3.1 Structural integrity

The choice and combination of materials and its construction shall ensure that the marine craft is strong enough in all respects. Special attention shall be paid to the service area restrictions, and the manufacturer's maximum recommended load in accordance with [5.3.6].

5.3.2 Stability and freeboard

The marine craft shall have sufficient stability and freeboard considering the service area restrictions and the manufacturer's maximum recommended load in accordance with [5.3.6].

For marine crafts, other than an inflatable marine craft, a rigid inflatable marine craft or a personal marine craft, marks for maximum draught are to be arranged at bow and stern [9.1.1].

Commercial marine crafts of overall length of less than 24 m shall comply with the LL Convention 1966 (LLC), as amended, and the 2008 Intact Stability Code (IS Code).

5.3.3 Buoyancy and flotation

The marine craft shall be constructed as to ensure that it has buoyancy characteristics appropriate to the service area restrictions and the manufacturer's maximum recommended load in accordance with [5.3.6].

All habitable multihull recreational craft susceptible of inversion shall have sufficient buoyancy to remain afloat in the inverted position.

Small marine crafts of less than 6 m in length that are susceptible to swamping when used in their design category shall be provided with appropriate means of flotation in the swamped condition.

5.3.4 Openings in hull, deck, and superstructure

Openings in hull, deck(s) and superstructure shall not impair the structural integrity of small marine crafts or its weather-tight integrity when closed.

Windows, port lights, doors and hatch covers shall withstand the water pressure likely to be encountered in their specific position, as well as point loads applied by the weight of persons moving on deck.

Through hull fittings designed to allow water passage into the hull or out of the hull, below the waterline corresponding to the manufacturer's maximum recommended load in accordance with [5.3.6], shall be fitted with a means of shutoff which shall be readily accessible.

5.3.5 Flooding

Small marine crafts shall be designed to minimize the risk of sinking.

Where appropriate, particular attention shall be paid to:

- Cockpits and wells, which should be self-draining or have other means of keeping water out of the marine crafts interior
- Ventilation fittings
- Removal of water by pumps or other means

5.3.6 Maximum recommended load

Small marine crafts shall have sufficient stability and freeboard considering the service area restriction and the manufacturer's maximum recommended load in accordance with [5.3.6].

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

ISO 14946:2001 "Small Craft – Maximum load capacity" to be complied with whenever possible.

The ISO 14946:2001 lists items to be included in the maximum load of small craft without exceeding the limits set by other ISO standards for stability, freeboard, flotation, and crew. It further sets requirements for the seating of crew members.

The standard applies to small craft with a length of hull LH of up to 24 m in accordance with ISO 8666.

Excluded are inflatable marine crafts covered by ISO 6185 and personal marine craft covered by ISO 13590.

5.3.7 Life raft stowage

Small marine crafts of design categories ***AD0*** and ***AD1***, and small marine crafts of design categories ***AD2*** and ***AD3*** longer than 6 m shall be provided with one or more stowage points for a life raft (life rafts) large enough to hold the number of persons the marine craft was designed to carry as recommended by the manufacturer. Life raft stowage point(s) shall be always readily accessible.

5.3.8 Escape

All habitable small multihull marine crafts susceptible of inversion shall be provided with viable means of escape in the event of inversion. Where there is a means of escape provided for use in the inverted position, it shall not compromise the structure [5.3.1], the stability [5.3.2] or buoyancy [5.3.3] whether the small multihull marine craft is upright or inverted.

Every habitable small marine craft shall be provided with viable means of escape in the event of fire.

ISO 9094 “Small craft – Fire protection” and ISO 12216 “Small Craft – Windows, portlights, hatches, deadlights and doors” to be complied with, as far as applicable.

5.3.9 Anchoring, mooring, and towing

Small marine crafts, taking into account their design category and their characteristics, shall be fitted with one or more strong points or other means capable of safely accepting anchoring, mooring and towing loads.

5.4 Handling characteristics

The manufacturer shall ensure that the handling characteristics of the marine craft are satisfactory with the most powerful propulsion engine for which the marine craft is designed and constructed. For all propulsion engines, the maximum rated engine power shall be declared in the owner’s manual.

ISO 11592 “Small Craft – Determination of maximum propulsion power rating using maneuvering speed” to be complied with, as far as applicable.

5.5 Installation requirements

5.5.1 Engines and engine compartments

5.5.1.1 Inboard engine

All inboard mounted engines shall be placed within an enclosure separated from living quarters and installed so as to minimize the risk of fires or spread of fires as well as hazards from toxic fumes, heat, noise or vibrations in the living quarters.

Engine parts and accessories that require frequent inspection and/or maintenance shall be readily accessible. The insulating materials inside the engine compartment shall not sustain combustion.

5.5.1.2 Ventilation

The engine compartment shall be ventilated. The ingress of water into the engine compartment must be minimized.

5.5.1.3 Exposed parts

Unless the engine is protected by a cover or its own enclosure, exposed moving or hot parts of the engine that could cause personal injury shall be effectively shielded.

5.5.1.4 Outboard propulsion engine starting

Every outboard propulsion engine fitted on any marine craft shall have a device to prevent the engine being started in gear, except when the engine:

- Produces less than 500 Newton’s (N) of static thrust

- Has a throttle limiting device to limit thrust to 500 N at the time of starting the engine

5.5.1.5 Personal marine craft running without driver

Personal marine crafts shall be designed either with an automatic propulsion engine cut-off or with an automatic device to provide reduced speed, circular, forward movement when the driver dismounts deliberately or falls overboard.

5.5.1.6 Tiller-controlled outboard propulsion engines

Tiller-controlled outboard propulsion engines shall be equipped with an emergency stopping device.

5.5.2 Fuel system

5.5.2.1 General

The filling, storage, venting and fuel-supply arrangements and installations shall be designed and installed to minimize the risk of fire and explosion.

5.5.2.2 Fuel tanks

Fuel tanks, lines and hoses shall be secured and separated or protected from any source of significant heat. The material the tanks are made of, and their method of construction shall be in accordance with their capacity and the type of fuel.

Petrol fuel tank spaces shall:

- Be ventilated.
- Not form part of the hull.
- Be protected against fire from any engine and from all other sources of ignition;
- Be separated from living quarters.

Diesel fuel tanks may be integral with the hull.

5.5.3 Electrical system

Electrical systems shall be designed and installed to ensure proper operation of the marine craft under normal conditions of use and shall be such as to minimize the risk of fire and electric shock.

All electrical circuits, except engine starting circuits supplied from batteries, shall remain safe when exposed to overload.

Electric propulsion circuits shall not interact with other circuits in such a way that either would fail to operate as intended.

Ventilation shall be provided to prevent the accumulation of explosive gases which might be emitted from batteries. Batteries shall be firmly secured and protected from the ingress of water.

5.5.4 Steering system

5.5.4.1 General

Steering and propulsion control systems shall be designed, constructed, and installed to allow the transmission of steering loads under foreseeable operating conditions.

5.5.4.2 Emergency Arrangements

Every sailing marine craft and every single-propulsion engine non-sailing marine craft with remote-controlled rudder steering systems shall be provided with emergency means of steering the marine craft at reduced speed.

5.5.5 Gas system

Gas systems for domestic use shall be of the vapour-withdrawal type and shall be designed and installed to avoid leaks and the risk of explosion and be capable of being tested for leaks. Materials and components shall be suitable for the specific gas used to withstand the stresses and exposures found in the marine environment.

Each gas appliance intended by the manufacturer for the application for which it is used shall be so installed in accordance with the manufacturer's instructions. Each gas-consuming appliance must be supplied by a separate branch of the distribution system, and each appliance must be controlled by a separate closing device. Adequate ventilation must be provided to prevent hazards from leaks and products of combustion.

All marine craft with a permanently installed gas system shall be fitted with an enclosure to contain all gas cylinders. The enclosure shall be separated from the living quarters, accessible only from the outside, and ventilated to the outside so that any escaping gas drains overboard.

In particular, any permanently installed gas system shall be tested after installation.

5.5.6 Fire protection

5.5.6.1 General

The type of equipment installed, and the layout of the small marine craft shall take account of the risk and spread of fire. Special attention shall be paid to the surroundings of open flame devices, hot areas or engines and auxiliary machines, oil and fuel overflow, oil and fuel pipes, and routing of electrical wiring in particular away from heat sources and hot areas.

5.5.6.2 Fire-fighting equipment

Small marine crafts shall be supplied with fire-fighting equipment appropriate to the fire hazard, and the position and capacity of fire-fighting equipment appropriate to the fire hazard shall be indicated. The marine craft shall not be put into service until the appropriate fire-fighting equipment is in place. Petrol engine compartments shall be protected by a fire extinguishing system that avoids the need to open the compartment in the event of a fire. Where fitted, portable fire extinguishers shall be readily accessible, and one shall be so positioned that it can easily be reached from the main steering position of the marine craft.

5.5.7 Navigation lights, shapes and sound signals

Where navigation lights, shapes and sound signals are fitted, they shall comply with the 1972 COLREG (The International Regulations for Preventing Collisions at Sea), as appropriate.

5.5.8 Discharge prevention and delivery ashore of waste

5.5.8.1 General

Marine craft shall be constructed to prevent the accidental discharge of pollutants (oil, fuel, oily bilge water, sewage waste etc.) overboard.

Any sewage fitted in a recreational craft shall be connected solely to a holding tank system or water treatment system.

Small marine crafts with installed holding tanks shall be fitted with a standard discharge connection to enable pipes of reception facilities to be connected with the recreational craft discharge pipeline.

In addition, any through-the-hull pipes for human waste shall be fitted with valves which are capable of being secured in the closed position.

5.5.8.2 MARPOL requirements

Marine crafts shall comply with MARPOL, as applicable:

MARPOL Annex I “Regulations for the Prevention of Pollution by Oil”

- Oil tankers of 150 GT and above
- Every other marine craft of 400 GT and above

MARPOL Annex V “Regulations for the Prevention of Pollution by Garbage”

- Every marine craft and fixed or floating platform of 12 m or more in length: displaying placards notifying crew and passengers of the discharge requirements of MARPOL, Annex V.
- Every marine craft and fixed or floating platform of 100 GT and above or carrying 15 or more persons: carrying a Garbage Management Plan which the crew shall follow.
- Every marine craft and fixed or floating platform of 400 GT and above and every marine craft which carries 15 or more persons to ports or offshore terminals under the jurisdiction of another party shall be provided with a Garbage Record Book.

6 ESSENTIAL REQUIREMENTS FOR EMISSIONS

6.1 Exhaust emissions

6.1.1 Propulsion engine identification

Each engine shall be clearly marked with the following information:

- Engine manufacturer's name, registered trade name or registered trademark and contact address; and, if applicable, the name and contact address of the person adapting the engine.
- Engine type, engine family.
- A unique engine serial number.
- Certification mark.

The marks referred to must be durable for the normal life of the engine and must be clearly legible and indelible.

If labels or plates are used, they must be attached in such a manner that the fixing is durable for the normal life of the engine, and the labels/plates cannot be removed without destroying or defacing them.

The marks must be secured to an engine part necessary for normal engine operation and not normally requiring replacement during the engine life.

The marks must be located to be readily visible after the engine has been assembled with all the components necessary for engine operation.

6.1.2 Exhaust emission requirements

6.1.2.1 Exhaust emission requirements applying to new buildings:

Propulsion engines for new buildings or in engine replacement projects shall be designed, constructed and assembled so that when correctly installed and in normal use, emissions shall not exceed the limit values obtained from Tables 6-1, 6-2 and 6-3:

Table 6-1 Exhaust emission limits for spark ignition (SI) engines

Type of engine	Rated engine power P_N (kW)	Carbon monoxide CO (g/kWh)	Hydrocarbon + Nitrogen Oxides HC + NO_x (g/kWh)
Stern drive and inboard engines	$P_N \leq 373$	75	5
	$373 < P_N \leq 485$	350	16
	$P_N > 485$	350	22
Outboard engines and PWC engines	$P_N \leq 4.3$	$500 - (5.0 \cdot P_N)$	30
	$4.3 < P_N \leq 40$	$500 - (5.0 \cdot P_N)$	$15.7 + \left(\frac{50}{P_N^{0.9}}\right)$
	$P_N > 40$	300	$15.7 + \left(\frac{50}{P_N^{0.9}}\right)$

Table 6-2 Exhaust emission limits for compression ignition (CI) engines (++)

Swept Volume S_V ***(litres/cyl)***	***Rated Engine Power*** P_N ***(kW)***	***Particulates*** ***PT*** ***(g/kWh)***	***Hydrocarbon + Nitrogen Oxides*** $HC + NO_x$ ***(g/kWh)***
SV < 0.9	$P_N \leq 37$	*The value referred to in Table 6-3*	
	$37 < P_N \leq 75$ (+)	*0.30*	*4.7*
	$75 < P_N \leq 3{,}700$	*0.15*	*5.8*
0.9 ≤ SV < 1.2	$P_N < 3{,}700$	*0.14*	*5.8*
1.2 ≤ SV < 2.5		*0.12*	*5.8*
2.5 ≤ SV < 3.5		*0.12*	*5.8*
3.5 ≤ SV < 7.0		*0.11*	*5.8*

(+) *Alternatively, compression-ignition engines with rated engine power at or above 37 kW and below 75 kW and with a swept volume below 0,9 L/cyl shall not exceed a PT emission limit of 0,20 g/kWh and a combined* $HC+NO_x$ *emission limit of 5,8 g/kWh.*

(++) *Any compression-ignition engine shall not exceed a Carbon monoxide (CO) emission limit of 5,0 g/kWh.*

Table 6-3 Values applying for Table 6-2, PN < 37 kW

Type	***Carbon monoxide*** $CO = A + B / P_N^n$			***Hydrocarbons*** $HC = A + B / P_N^n$			***Nitrogen Oxides*** NO_x	***Particulates PT***
	A	***B***	***n***	***A***	***B***	***n***		
Compression ignition	*5,0*	*0*	*0*	*1,5*	*2,0*	*0,5*	*9,8*	*1,0*

Where A, B and n are constants in accordance with the table, P N is the rated engine power in kW.

6.1.2.2 Test cycles

Test cycles and weighting factors to be applied: The requirements of ISO 8178-4:2007 shall be used.
For variable speed CI engines test cycle E1 or E5 shall be applied or alternatively, above 130 kW, test cycle E3 may be applied. For variable speed SI engines test cycle E4 shall be applied.

The Department may accept tests carried out on the basis of other tests cycles as specified in a harmonized standard and as applicable for the engine duty cycle.

6.1.2.3 Application of the propulsion engine family and choice of parent propulsion engine

The engine manufacturer is responsible for defining those engines from his range which are to be included in an engine family.

A parent engine shall be selected from an engine family in such a way that its emissions characteristics are representative for all engines in that engine family. The engine incorporating those features that are expected to result in the highest specific emissions (expressed in g/kWh), when measured on the applicable test cycle, should normally be selected as the parent engine of the family.

6.1.2.4 Test fuels

The test fuel used for exhaust emission testing shall meet the fuel characteristics specified in international standards, i.e. EU Directive, US Environmental Protection Agency, Barcleys official California Code of Regulations, or equivalent.

6.1.3 Durability

The manufacturer of the engine shall supply engine installation and maintenance instructions, which if applied should mean that the engine in normal use will continue to comply with the limits set out in Tables 6-1, 6-2 and 6-3 throughout the normal life of the engine and under normal conditions of use.

This information shall be obtained by the engine manufacturer by use of prior endurance testing, based on normal operating cycles, and by calculation of component fatigue so that the necessary maintenance instructions may be prepared by the manufacturer and issued with all new engines when first placed on the market.

The normal life of the engine is as follows:

(a) For CI engines: 480 hours of operation or 10 years, whichever occurs first;
(b) For SI inboard or stern drive engines with or without integral exhaust:
  i. for engine category $P_N \leq 373$ kW: 480 hours of operation or 10 years, whichever occurs first,
  ii. for engine category $373 < P_N \leq 485$ kW: 150 hours of operation or three years, whichever occurs first,
  iii. for engine category $P_N > 485$ kW: 50 hours of operation or one year, whichever occurs first;
(c) personal marine craft engines: 350 hours of operation or five years, whichever occurs first;
(d) outboard engines: 350 hours of operation or 10 years, whichever occurs first

6.1.4 Owner’s manual

Each engine shall be provided with an owner’s manual in a language or languages which can be easily understood by consumers and other end-users, as determined by the Department.

The owner’s manual shall:

(a) provide instructions for the installation, use and maintenance needed to assure the proper functioning of the engine to meet the requirements of Section 6.1.3 (Durability);
(b) specify the power of the engine when measured in accordance with the harmonized standard [6.1.2].

6.2 Noise emissions

Small marine crafts with inboard or stern drive engines without integral exhaust, personal marine craft and outboard engines and stern drive engines with integral exhaust shall comply with the essential requirements for noise emissions set out in this Part.

6.3.1 Noise emission level

Marine crafts shall be designed, constructed and assembled so that noise emissions shall not exceed the limit values in the following table:

Table 6-4 Maximum sound pressure level

Rated Engine Power (single engine) In kW	***Maximum Sound Pressure Level L_{pASmax} In dB***
$P_N \leq 10$	*67*
$10 < P_N \leq 40$	*72*
$P_N > 40$	*75*

where P_N = rated engine power in kW of a single engine at rated speed and L_{pASmax} = maximum sound pressure level in dB.

For twin-engine and multiple-engine units of all engine types an allowance of 3 dB may be applied.

As an alternative to sound measurement tests, recreational craft with inboard engine configuration or stern drive engine configuration, without integral exhaust, shall be deemed to comply with the noise requirements set out in table 6-4 if they have a Froude number of ≤ 1.1 and a Power to Displacement ratio of ≤ 40 and where the engine and exhaust system are installed in accordance with the engine manufacturer's specifications.

'Froude number' F_n shall be calculated by dividing the maximum recreational craft speed V (m/s) by the square root of the waterline length lwl (m) multiplied by a given gravitational acceleration constant, g, of 9,8 m/s^2.

'Power to Displacement ratio' shall be calculated by dividing the rated engine power P_N (in kW) by the recreational craft's displacement D (in tonnes).

6.3.2 Owner's manual

For recreational craft with inboard engine or stern drive engines without integral exhaust and personal marine craft, the owner's manual required under [5.2.5], shall include information necessary to maintain the recreational craft and exhaust system in a condition that will ensure compliance with the specified noise limit values when in normal use.

For outboard engines and stern drive engines with integral exhaust, the owner's manual required under [6.1.4] shall provide the instructions necessary to maintain the engine in a condition and will ensure compliance with the specified noise limit values when in normal use.

6.3.3 Durability

The provisions on the durability in [6.1.3] shall apply mutatis mutandis to the compliance with the requirements on noise emissions set out in this part.

7 ARRANGEMENT

7.1 General

7.1.1 Bulkheads

Craft with length 6 m < L < 15 m shall be arranged with at least 2 watertight bulkheads.

Craft with length L exceeding 15 m shall be arranged with at least 3 watertight bulkheads, of which one shall be a collision bulkhead with minimum distance 0.05Lwl and maximum distance 0.1Lwl from Fp.

Watertight bulkheads shall be carried up to freeboard (bulkhead) deck or may end at first deck above waterline based on special consideration of watertight division and integrity of the hull.

Engine compartment and cargo hold are to be separated from each other and from rest of the hull by watertight bulkheads. Minor steps or recesses in the bulkhead may be accepted. For craft with length, L, less than 15 m, the engine compartment may be accepted as a watertight box up to a level above the waterline based on special consideration.

Doors and hatches in watertight bulkhead may be accepted, except for the collision bulkhead.

Small openings for penetrating pipes and electrical cables shall normally be sealed and arranged in top of bulkheads. Openings in bulkheads shall be kept to a minimum.

7.2 Accommodation

7.2.1 General

Accommodation areas shall be without sharp corners and protruding parts and shall not be made of material which may break into dangerous fragments. It shall not contain unshielded high temperature areas, high pressure or rotating items, and shall not contain operating controls located in a way to be impeded by persons during normal and emergency conditions.

7.2.2 Seats

A seat shall be arranged for every person onboard.

A seat shall have the following minimum size:

- Beam 500 mm
- Depth 750 mm, free space for legs measured from persons back
- Height 900 mm, from seat to free height for head.

Sharp edges, arm rest etc. which may cause injury are not accepted.

The strength of a seat shall be in accordance with the relevant horizontal longitudinal acceleration of the craft. In general, a minimum static load of 1125 N may be used as basic for the scantling. The point of application of the horizontal longitudinal load shall be at the top of the backrest. Seats shall be designed for a vertical load equal to 2250 N. The point of application of the vertical load shall be at the center of the seat.

For craft with speed exceeding 15 knots, the seats on open decks shall be minimum 380 mm lower than top of bulwark/railing. Equivalent arrangements for protecting persons from falling overboard when seated can be accepted.

For craft with speed exceeding 45 knots the seats shall be equipped with seat belts.

7.2.3 Ventilation

- Accommodation spaces shall have separate inlet and exhaust of air, with the documented acceptable capacity of ventilation for comfort of persons with closed windows and doors.
- Heating, cooking and similar installations shall have separate ventilation.
- Inlets and outlets of ventilation shall be well separated from engine exhausts.
- All compartments, holds and void spaces shall normally have natural ventilation.
- Any space intended for flammable liquids etc. shall have separate ventilation.

7.2.4 Sanitary

All crafts shall normally be arranged with basic sanitary facilities. This requirement may be waived for craft for limited operation in harbor etc.

7.2.5 Exit, passages etc.

All accommodation, and machinery spaces that are possible to enter, shall normally be arranged with two exits, for which one may be an emergency exit. The exits shall be located as far as possible from each other and be suitable to use in an emergency situation.

Width of passages shall be minimum of 700 mm in general but may be reduced to 600 mm for spaces not normally used.

Accommodation for maximum 4 persons may be accepted with only one exit if this cannot be blocked in case of fire or other emergency and if it leads directly to an open deck.

7.2.6 Emergency exit

The emergency exit can be an approved hatch, door or window complying with the following:

- Minimum light opening 500 × 500 mm, or diameter 450 mm.
- Easy access with fixed step, ladder and handholds as necessary.
- Clearly marked and with appropriate instructions for use.
- Readily opened from both sides without tools in daylight and dark.
- Direct access to open deck, or via short passages without any lockable door.

7.2.7 Emergency light

Emergency light is to be arranged for accommodation and exits. See also Chapter [17.6.4.1] “Emergency power supply”.

7.3 Steering position

7.3.1 General

The design and layout of the steering position shall allow the crew to perform their duties without difficulty, fatigue, or loss of concentration. The headroom in a wheelhouse shall be minimum of 1980 mm.

The steering position shall normally not be used for purposes other than navigation, communication and functions essential to the operation of the craft.

Fixed seats shall be arranged for the crew.

7.3.2 Field of vision

The wheelhouse shall be so arranged and positioned to provide a view all around the horizon from the steering and navigation workstations.

The view of the sea surface from the operating station when seated, shall not be obscured by more than two craft lengths forward of the bow to not less than 90° on either side irrespective of the craft's draught and trim.

Blind sectors shall be as few and as small as possible, and not adversely affect the keeping of a safe look-out from the operating station. 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°. The clear sector between two blind sectors shall not be smaller than 10°.

Arrangement shall be provided so that the forward view is not adversely affected by solar glare. Neither polarized nor tinted window glass shall be fitted in the front and side of the wheelhouse. Removable sunscreens/curtains may be provided. Windows should preferably be angled top outboard approx. 15° from vertical to reduce reflection.

7.3.3 Instruments and equipment

The equipment and means for navigation, maneuvering, control, communication, and other essential instruments shall be located sufficiently close together to enable personnel to receive information and to use the equipment while seated. If necessary, some functions may be duplicated. A table for chart work shall normally be arranged.

Instrument, their panels and controls shall be permanently mounted in console(s) convenient for operation and maintenance. The surface of console tops and instruments shall prevent light reflections.

All instruments shall be logically grouped according to their functions, plainly visible and easily readable.

Means for screening and dimming of internal and external lights to minimize glare and reflections, shall be arranged.

All crafts shall be provided with a magnetic compass which can operate without electrical supply and which may be used for steering. This compass shall be mounted in a suitable binnacle containing the required corrective devices and shall be suitable for the speed and motion of the actual craft.

Electrical connections and components shall be protected according to [17.6.1.1] "General requirements, conformity with IEC 60529".

8 SAFETY OF PERSONAL

8.1 Safety plan

A safety plan for the craft shall be submitted for approval. The requirement may be waived for craft with length L not exceeding 8 m, or for craft of simple design and arrangement.

The safety plan shall describe the arrangements for the following items:

- Lifesaving equipment.
- Fire alarm and firefighting.
- Emergency exits.
- Emergency systems (alarms, fans, valves etc.).

In addition, the following may be included for information:

- Emergency instruction.
- First aids.

8.2 Railings, ladders, handholds, decks

8.2.1 Railings and handholds

All areas above and below deck intended for human occupation shall be equipped with either railings, bulwark, handholds of substantial design or other means of safe grip.

Decks shall normally be surrounded by railing or bulwark with a minimum of 750 mm height. Part of the railing may be dismountable.

The distance between vertical stanchions of railing shall normally not be more than 1200 mm.

The vertical distance between bars in rails shall normally not exceed 230 mm from deck level and 330 mm elsewhere.

8.2.2 Deck non-slip surface

Non-skid surfaces shall be arranged on all decks and floors intended for human occupancy or work.
Decks shall have a toe-rail of a minimum 25 mm height at the outboard edge or gunwale.

8.2.3 Outboard rescue ladder

For craft with length (L) exceeding 6 m, or craft with freeboard (F) exceeding 500 mm, an outboard rescue ladder or steps shall be arranged. The arrangement shall be suitable for a person in the water to onboard the craft. The lower step, or any suitable safe part of hull structure to step on, shall be arranged a minimum of 500 mm below waterline in light condition of the craft.

A foldable ladder, or other equivalent system, may be accepted when a safe release system is arranged for access from a position in the water.

8.2.4 Outboard hand grips

For crafts required to be fitted with buoyancy elements, arrangement shall be fitted to enable persons in the water to hold on to the craft in capsized condition.

8.3 Operation of deck gear

Winches, cranes and other deck-gear shall be arranged to facilitate safe working with respect to instruction, operation, view and shielding.

Winches with open lines, lifting platforms and all types of movable deck gear, shall be shielded or arranged with automatic emergency stop in the event of any person or other foreign object is caught by the lines or gear in operation. Winch barrel, and similar gears shall have protection against line end etc. hitting the person operating the winch or gear.

Instruction for safe operation of lifting gears, together with type notation and name of manufacturer, shall be given on a signboard on the gear at the place of operation.

Testing of safe workload for winches, cranes and other lifting gears shall be documented, and arrangements to avoid overload shall be fitted.

9 STABILITY, WATER- AND WEATHERTIGHT INTEGRITY

9.1 General

9.1.1 General requirements

It is necessary to re-calculate the stability of a marine craft carrying more than 12 passengers if it sustains external damage, see Section 18.

For marine crafts required to be arranged with buoyancy elements, the capability in flooded condition shall be documented and verified by full scale test. Enclosed superstructure, deckhouses and trunks may be included as buoyancy elements provided, they have approved strength and closing appliances.

For marine crafts with fenders along the sides of the hull the fenders may be included when calculating the stability of the craft. This applies to fenders that are secured or bonded to the hull such that they will not be dislodged when submerged. Fenders shall be solid or may be of foam-filled construction in which case the foam shall be bonded to the hull such that it will not be dislodged when submerged. It will be noted on the certificate(s) that the craft shall not be operated with damaged fenders.

Marks for maximum draught are to be arranged at bow and stern.

Permanent heel or trim which may generate danger for accumulation of water on deck is not accepted.

Person mass to be used in calculations and tests = 82.5 kg

9.1.2 Documentation

The following documentation shall be submitted for approval:

- Stability manual.
- Inclining test.
- Closing appliances.

The following documentation is assumed for information:

- General arrangement.
- Body/lines plan.
- Freeboard/weathertight integrity plan.

The stability manual shall cover all load conditions representative for the intended service of the marine craft, including drafts, trim and freeboard. The manual (or a separate appendix/ issue) shall also include relevant hydrostatic data, calculation of centers of gravities etc. Stability curves shall be made on a free to trim basis. (Cross curves are normally to be prepared on a designed trim basis).

The inclining test is generally to be carried out and documented according to ordinary practice for marine craft. For craft with length L less than 6 m, and crafts arranged with buoyancy, the ordinary inclining test may be replaced by a full-scale stability test.

9.2 Freeboard

9.2.1 Decked craft

The freeboard shall nowhere be less than 200 mm.

The height of the forecastle or bulwark at stem shall normally nowhere be less than 0.12 L above the deepest waterline. The height may be reduced to the level of freeboard deck at 0.25 L from the stem and aftwards.

A reduction of the height at the stem can be accepted based on an evaluation of the forecastle deck and its possibility to shed water overboard.

9.2.2 Open craft

The mean freeboard, (F), shall not be less than the larger of:

$F = \frac{4.5\ \Delta}{1000\ L\ B}$ (mm)

or

F_{min} = 500 (mm)

Craft not complying with the requirement above, shall be arranged with buoyancy elements according to [9.1.1].

Craft with length L < 6 m shall be arranged with buoyancy elements and satisfying either of the below requirements:

For craft arranged with buoyancy elements, the mean freeboard, (F), shall not be less than:

F = 200 B (mm)

or

F_{min} = 200 (mm).

Craft shall have a freeboard aft of not less than:

F_{aft} = 0.8 F

A craft that neither complies with the requirements to freeboard nor has buoyancy elements, shall be arranged as Decked craft.

9.3 Stability, decked craft

9.3.1 Stability requirements

The stability manual shall document the righting arm GZ for the following conditions:

a) Light marine craft with minimum equipment and cargo. Combined loads are not to exceed 10% of maximum load capacity.
b) Loaded with maximum equipment and cargo in holds and on deck. Combined loads are not to be less than 90% of maximum load capacity in the mode of departure and arrival.
c) Deck load with maximum equipment and cargo on deck and empty holds in the mode of departure and arrival.
d) Other relevant conditions shall be documented.
e) Emergency conditions - see [9.3.2].

The righting arm at 30° heel shall be minimum 0.20 m. The maximum value of the (GZ) curve shall occur at an angle not smaller than 25°. The (GZ) curve shall normally be positive up to 50° of heel.

When calculating the heeling moment due to operation of lifting gear, winch, towing hook etc., a dynamic factor of 1.4 is normally to be used to include effects from wind, waves etc. The angle of heel shall not exceed 10° for a maximum moment in the most unfavorable condition.

9.3.2 Emergency condition

In maximum load condition the craft shall not capsize or be flooded if all persons move to the same side, the angle of heel shall not exceed 10°, caused by a heeling weight:

$P = 82.5 \cdot n$ (kg)

where n = total number of persons.

The weight is to be located 1 m above deck along the gunwale.

9.4 Stability, open craft

9.4.1 Stability requirements

An inclining test may be carried out to determine the metacentric height GM in light marine craft condition. GM shall normally not be smaller than 0.50 m.

The inclining test may be omitted if it for the load condition can be demonstrated that the period of roll in seconds (from one side and back to the same side) is less or equal to the craft beam in meters.

The requirement to metacentric height, or period of roll, may be disregarded if it is documented that the GZ curves satisfy the requirements for Decked craft up to an angle of heel of 30°.

In maximum load condition the craft shall not capsize or be flooded if all persons move to the same side, the angle of heel shall not exceed 10°, caused by a heeling weight:

$P = 82.5 \cdot n$ (kg)

where n = total number of persons.

The weight is to be located 1 m above deck along the gunwale.

9.5 Stability, open craft with buoyancy

9.5.1 Stability in intact condition

In lightweight condition, the craft is not to be flooded, or the angle of heel shall not exceed 10°, for a heeling weight:

$P = 22 \times n$ (kg) (n = number of persons),

or

$P_{min} = 44$ (kg).

The heeling weight is to be placed at the gunwale at the maximum beam of the craft, and not less than $B_{max}/2$ from the centerline.

In maximum load condition the craft shall not capsize or be flooded if all persons move to the same side, the angle of heel shall not exceed 10°, caused by a heeling weight:

$P = 82.5 \times n$ (kg) (n = total number of persons).

The weight is to be located on the floor as near to the gunwale as possible, but minimum Bmax/4 from centerline and with a longitudinal position corresponding to the arrangement of the accommodation. Weights representing equipment shall be located at their respective positions.

9.5.2 Buoyancy in flooded condition

In maximum load condition (including any outboard engine) the flooded craft is to float approximately horizontal and not sink when loaded with additional weight:

$P = 27.5 \times n$ (kg) (n = total number of persons),

but not less than the larger of
$P = 55 + 55 (L – 2.5)$ (kg),
or
$P_{min} = 82.5$ (kg).

Weights shall be located at their respective positions on board.

9.5.3 Stability in flooded condition

In maximum load condition (including any outboard engine) the flooded craft shall have positive stability up to 50° of the heel when loaded with an additional weight located anywhere along the gunwale:

$PK = 11 + 5.5 \times n$ (kg) (n = total number of persons),

or

$PK_{min} = 27.5$ (kg).

9.6 Freeing ports and drainage

9.6.1 Freeing ports on decked craft

Freeing ports shall be spaced along the deck, with lower edge normally flush with deck level.

On craft with bulwark, forecastle, deckhouse or open structures forming wells, the total freeing port area on each side of the deck is to be minimum $A = 0.02$ VOL m^2. The volume VOL is calculated based on total deck area and height to top of bulwark, with deduction of the volume of hatches, deckhouse etc.

Flaps at freeing ports may be approved if an opening area is not reduced, jamming is prevented, and hinges are made of non-corrosive material. Locking of flaps is not permitted.

Freeing port openings shall be fitted with bars not more than 330 mm apart, and with maximum of 230 mm opening below the lowest bar.

9.6.2 Drainage of open craft

Drainage of deck shall be arranged from each side of the craft to the bilge, from which pumping shall be arranged. The drainage may also be directly overboard with a non-return arrangement.

Area of drainage shall be minimum A = 0.01 VOL m2, where VOL is the volume as defined as for decked craft.

9.7 *Weathertight integrity*

9.7.1 General

- Small openings for wire chains, scuppers etc., will be considered as closed if submerged at an angle of heel larger than 30°.
- Openings to spaces below freeboard deck, or to other spaces included as buoyancy in stability calculations, shall be fitted with weathertight closing appliances.
- Closing appliances shall be built with the same strength as the surrounding structure and be arranged to provide safety against different sea impact.
- Closing appliances shall as a minimum include gasket and two closing devices in addition to hinges.
- The appliance shall be tested with a water jet that shall have a vertical angle of 45° relative to the hatch. The water jet shall be a dense thin water jet delivering a flow of at least 10 l/min, aiming everywhere in an area located within 0.05 m on each side of the periphery of the appliance. Spraying shall continue for at least 3 min.

9.7.2 Hatches section

- Hatches which may be opened at sea shall be hinged or attached by chain and shall be capable of being secured in an open position.
- Hatch coamings shall normally have a height of at least 380 mm. For hatches located at least 380 mm above the freeboard deck, a reduction of the coaming height to a minimum of 150 mm may be accepted. The hatch can be flush with the deck under the condition that the hatch is not operated at sea.
- For a rectangular or square hatch’s cleats shall be fitted with a maximum spacing of 600 mm along the edges and a maximum of 150 mm from the corners.
- For circular hatches the cleats shall be fitted with maximum 450 mm spacing measured along the periphery.

9.7.3 Doors

- Doors shall be possible to operate from either side of the bulkhead.
- The sill height of door openings to spaces below freeboard deck shall be at least 380 mm.
- For doors located at least 380 mm above freeboard deck, a reduced height of sill may be accepted, but not less than 150 mm.
- Arrangement for removable washboard replacing a sill may be accepted based on special consideration.

9.7.4 Port and ramps

- Port and ramps in the marine craft side above weathertight deck may be accepted. Watertightness shall be arranged with gasket and hinges/clamps with spacing not exceeding 300 mm.
- The arrangement for safety of operation, stop arrangement and any indicators etc. shall be submitted for approval.
- The lower edge of openings shall not be less than 200 mm above the deepest waterline.

9.7.5 Ventilation

- Ventilation openings shall be arranged to avoid flooding of the craft and normally have a minimum height of 600 mm above the freeboard deck.
- Ventilation openings shall normally not be immersed at a heel angle smaller than 50°.

9.7.6 Air pipes

- Air pipes are defined as openings for ventilation normally not exceeding an area equivalent to a diameter of 50 mm.
- Air pipes shall be arranged with a non-return valve or goose necks to prevent water ingress.
- The height of air pipes shall normally not be smaller than 600 mm above the freeboard deck.
- Air pipes shall be protected from damage from work on the deck.

9.7.7 Windows

Windows in accommodation spaces may be fabricated from thermally or chemically toughened glass or polycarbonate. Windows shall not fracture in fragments.

Windows shall be fitted in rigid frames and secured from being pressed in. A rubber profile is acceptable if the window cannot be pressed in, and the glass thickness is increased by 20%. Windows may be glued according to a standard recognized by the Department.

The minimum thickness of windows shall be calculated according to the following formula:

$$t = \frac{b}{K} \sqrt{\beta \cdot P}$$

P = design pressure at the location of the window

β = according to Figure 9-1

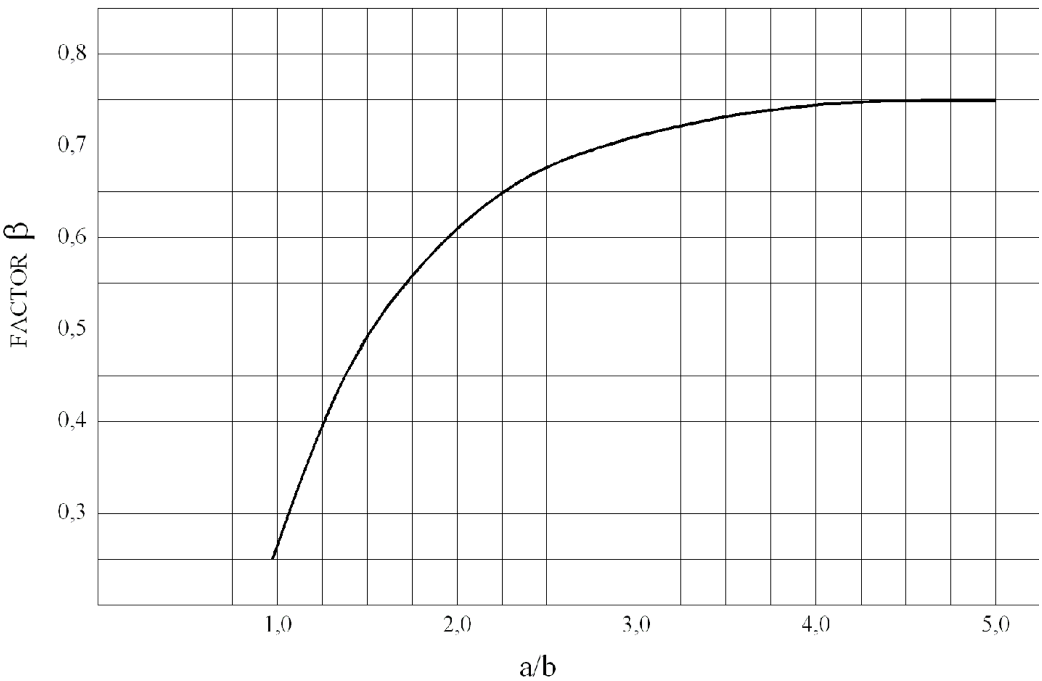


Figure 9-1 Factor β

a = the larger dimension of the window opening
b = the smaller dimension of the window opening
K = 225 for chemically toughened glass (CTG)
= 225 for thermally toughened glass (TTG)
= 190 for polymethylmethacrylate (PMMA)
= 190 for polycarbonate (PC).

PC and PMMA windowpanes shall overlap their frames with not less than 0.03b (mm)

For windows placed above positions exposed to sea-load, the thickness may be reduced by 25%.

Horizontal windows in positions exposed to impact from the operation are subject to special consideration.

9.8 Buoyancy elements

9.8.1 General

Requirements for buoyancy elements are given in [9.1.1] “General requirements”.

Buoyancy elements may consist of foam, prefabricated, or formed in position (in-situ), or tanks and double hull filled with air or buoyancy elements. Buoyancy elements must be fixed or permanently fitted and protected against mechanical damage and degradation from the environment.

Drainage shall be arranged for enclosed spaces used for buoyancy elements. Such spaces shall normally not be used for storage or other facilities.

9.9 Ballast

9.9.1 General

Ballast shall be arranged to prevent shifting of position. The arrangement should have access for inspection.

The ballast material shall be documented to have no corrosive or destructive effect on the hull structure materials.

Use of water as ballast may be accepted based on documentation of the arrangement, tanks, filling, and operation.

Ballast on cement-basis shall be specially documented with respect to arrangement and chemical reaction to hull material, drainage, and protection.

9.10 Stability and buoyancy of recreational craft

9.10.1 Stability and buoyancy assessment and categorization

For recreational craft including charter craft, as an alternative to or complementing the stability assessment as laid down in Section 9, the stability and buoyancy can be assessed according to ISO 12217 depending on the type of the marine craft: motor yacht or sailing yacht with a length greater than or equal 6m and marine crafts of hull length less than 6 m.

Motor marine crafts, length ≥ 6m

ISO 12217, Part 1: Stability and buoyancy assessment and categorization, non-sailing marine crafts of hull length greater than or equal to 6m.

Sailing marine crafts, length ≥ 6m

ISO 12217, Part 2: Stability and buoyancy assessment and categorization, sailing marine crafts of hull length greater than or equal to 6 m.

marine crafts, length < 6 m

ISO 12217, Part 3: Stability and buoyancy assessment and categorization, marine crafts of hull length less than 6 m.

9.11 Stability and buoyancy of commercial marine crafts

9.11.1 Load line recommendations

Commercial marine crafts with overall length of less than 24 meters, should comply with the relevant conditions of assignment and the assignment of freeboard, as specified in the International Load Line Convention 1966, as amended, as far as possible.

10 MATERIALS AND MANUFACTURING

10.1 General requirements

10.1.1 General requirements on metallic materials

10.1.1.1 Aluminium alloys

Structural aluminium material shall be resistant to corrosion in marine environments.

Structural aluminium material shall be delivered with a works certificate.

Acceptable alloy grades are given in the following table.

Table 10-1 Aluminium alloy grades

5000 Series	*6000 Series*
5052	*6060*
5154A	*6061*
5754	*6063*
5454	*6005A*
5086	*6082*
5083	
5383	

The use of 6000-series aluminium alloys in direct contact with sea water may be restricted depending on application and corrosion protection system.

Section 10.1 and Section 10.2 are not applicable to aluminium alloys for forgings and castings. For these products' suitable alloys according to recognized standards may be used.

10.1.1.2 Steel

Structural steel materials shall be weldable.

Structural steel materials shall be delivered with a works certificate.

Structural steel materials shall have a yield point of not less than 235 MPa.

10.1.2 General requirements on non-metallic materials

10.1.2.1 Application

This section applies to raw materials for FRP structures and thermoplastics. Other materials can be considered based on a case-by-case evaluation.

Raw materials shall be delivered under a certification scheme recognized by the Department or certified by an institution recognized by the Department. The following materials shall be certified:

- Fibre reinforcements
- Resin products
- Sandwich core materials
- Sandwich adhesives and cement
- Thermoplastics granulate/powder and sheets
- Adhesives (for adhesive bonding)
- Wood and timber products.

10.1.2.2 Marking of product

Each lot shall be marked with the manufacturers' name, type designation, approval certificate reference and date of manufacture.

Products lacking the marking specified above shall be subject to product control testing verified by an approved institution.

10.1.3 General requirements on manufacturing

10.1.3.1 Qualifications for the work and requirements for health and safety

Companies shall be qualified for the work to be carried out regarding their workshop equipment, internal quality control, manufacturing process, work safety as well as the training and qualification of the personnel carrying out and supervising the work.

Specified procedures shall be implemented for all tasks with significance to the quality of the end product. Where necessary to exercise a satisfactory control of the quality, these procedures shall be documented in writing in controlled documents.

Every employer shall ensure that suitable personal protective equipment (PPE) is provided to his employees who may be exposed to a risk to their health or safety while at work except where and to the extent that such risk has been adequately controlled by other means which are equally or more effective.

Making the workplace safe includes providing instructions, procedures, training, and supervision to encourage people to work safely and responsibly.

Even where engineering controls and safe systems of work have been applied, some hazards might remain. These include injuries to:

- Lungs, e.g. from breathing in contaminated air
- Head and feet, e.g. from falling materials
- Eyes, e.g. from flying particles or splashes of corrosive liquids
- Skin, e.g. from contact with corrosive materials
- Body, e.g. from extremes of heat or cold

Personal protective equipment (PPE) is needed in these cases to reduce the risks.

10.2 Metallic materials, machining, welding, and joints

10.2.1 Aluminium materials

10.2.1.1 General

Aluminium shall be stored in a way such that corrosion is avoided.

10.2.1.2 Machining and forming

Methods for machining and forming shall be in accordance with the material manufacturer's recommendations.

10.2.1.3 Joints – general

Joining of different materials shall not lead to galvanic corrosion.

In joints, aluminium to another metal, the materials shall be galvanically insulated.

10.2.1.4 Joints by welding

- All welding shall take place under dry conditions and at a minimum temperature of 5°C. The welding area shall be protected against drafts.
- Welding of construction parts shall be done by a welder or supervised by a welder with an approved certificate for the actual or similar alloy and method of welding.
- Welding procedures shall be followed on-site.
- MIG- or TIG- welding shall be used. MIG-welding is not recommended for thicknesses smaller than 2.0 mm and TIG-welding for thicknesses smaller than 0.7 mm.
- Spot-welding shall only be used after special consideration.
- Weld joints shall be prepared and beveled in accordance with a recognized standard. The edges of the surfaces to be joined shall be free from burrs.
- The surfaces to be joined shall be cleaned on the top and root sides. The oxide layer shall be removed by brushing, scraping or picking to a minimum distance of 10 mm from the joint. The surfaces shall be dry when welding starts.
- Welding consumables shall be kept clean and dry and otherwise be stored and handled in accordance with the maker's recommendations.

10.2.1.5 Joints by riveting

The rivet dimension, spacing and distance to the edge shall be in accordance with Figure 10-1. In rivet joints with small stresses in the plates, other dimensions and spacing may be tolerated.

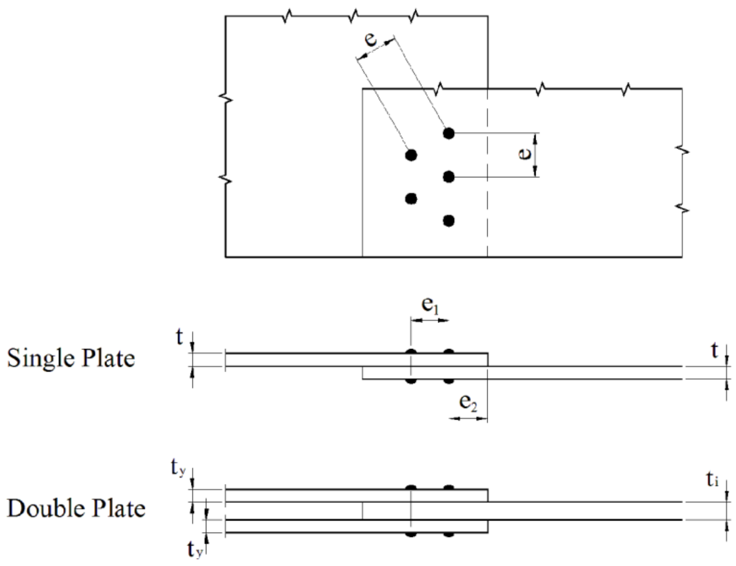


Figure 10-1 Examples of riveted joints

Watertight joints shall be at least two-rowed. The rivet spacing in these joints shall not exceed 4 times the rivet diameter.

The difference in diameter between rivet and hole shall not be larger than shown in the figure below. The holes shall be burred.

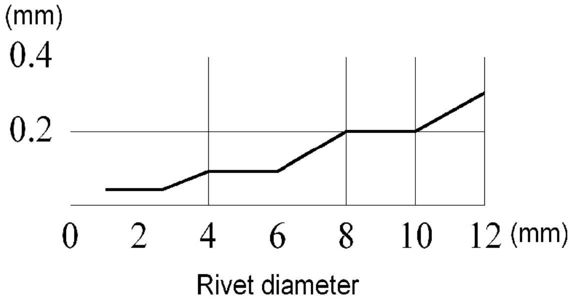


Figure 10-2 Difference in diameter (mm) between hole and rivet versus rivet diameter (mm)

Riveting shall be carried out in such a way that the surfaces make good contact. Example of tacking and riveting sequence is shown in the figure below.

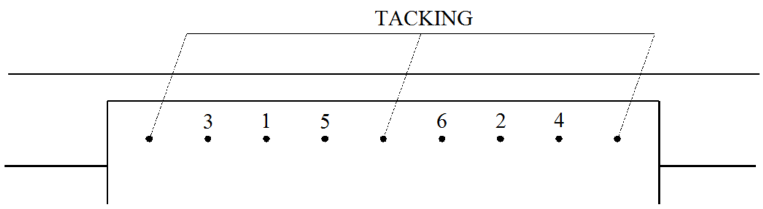


Figure 10-3 Tacking and riveting sequence

Blind rivets shall not be used in shell plating or stressed joints.

*Table 10-1 Rivet joints *)*

Rivet diameter, d	*Single plate joint*	$d = 2 \cdot t + 1$ $d = 3 \cdot t$	$t < 1$ mm for $t \geq 1$ mm
	Double plate joint	$d = 1.2 \cdot t + 1$ $d = 1.5 \cdot t$	$t < 3.3$ mm for $t \geq 3.3$ mm
Spacing for load-carrying rivets	*One row of rivets in the load direction*	$2.5 \cdot d \leq e \leq 6 \cdot d$	
	Two rows of rivets in the load direction	$4 \cdot d \leq e \leq 7 \cdot d$ $3 \cdot d \leq e_1 \leq 5 \cdot d$	
Edge distance	*Perpendicular and parallel to the direction of the load*	*The larger of:* $e_2 \geq 2 \cdot d$ $e_2 \geq 4 \cdot t$	

*) t, e, e1 and e2 see Figure 10-1 „Examples of riveted joints"

10.2.1.6 Joints by adhesive bonding

For adhesive bonds, static and dynamic strength including peel strength and impact resistance shall be documented.

The adhesive shall have such properties that the strength of the joint does not substantially deteriorate by temperature variations, water or other substances to which the joint will be exposed.

The bonding process shall be in accordance with the adhesive manufacturer's recommendations. Consideration must be given the pre-treatment of the surfaces to be bonded.

10.2.1.7 Other joints

Joints with through-bolts shall be designed as riveted joints. Self-tapping screws are only allowed above waterline in joints carrying insignificant loads.

Bolts and nuts in joints below waterline shall be of aluminium or stainless steel. Galvanized steel may be allowed elsewhere.

Below waterline connections to stainless steel shall be galvanically insulated from the shell plating.

10.2.2 Steel materials

10.2.2.1 General

Steel material shall be stored in a way that corrosion is avoided.

10.2.2.2 Welding

- Welding of construction parts shall be done by or supervised by a welder with an approved certificate for the actual or similar material and method of welding.
- Welding procedures shall be approved on-site.
- Welding electrodes shall be stored in a dry and clean place.
- Gas-shielded welding shall be performed indoors.
- Horizontal welding shall be used as far as possible
- The seams shall be cleaned and free from damaging paint, rust, and dirt before welding.

- Shop primer used shall be of a type that is possible to weld without leaving any damaging effect to the strength of the welding.

Welds shall have a minimum throat thickness according to the following table:

Table 10-2 Minimum throat thickness

Plate thickness (t) (mm)	Throat thickness, a (mm)
< 4	2.0
4 – 6.5	2.5
6.4 – 8	3.0
> 8	0.45 × thickness of thinnest plate

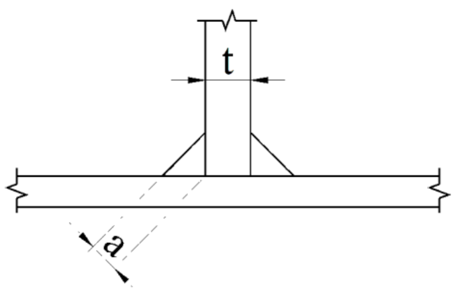


Figure 10-4 Throat thickness, a

The following items shall be welded with double side continuous fillet welding:

Table 10-3 Continuous welding

Continuous welding	Brackets for beams and other means of support
	Transverse frames below waterline and floors
	Foundations for engine(s), propulsion and equipment
	Keel and stem

For intermittent welding, the weld length and spacing shall be according to the following table:

Table 10-4 Intermittent welding

Thickness of plate: t (mm)	Weld length: l (mm)	Spacing: e (mm)
3 – 4.5	50	100
5 – 6.5	65	130
7 – 8.5	75	150
9 – 10.5	100	200

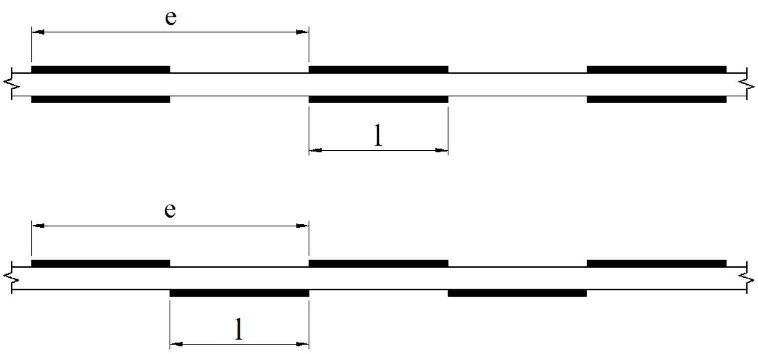


Figure 10-5 Intermittent welding

10.3 Fibre reinforced plastics

10.3.1 Material properties

10.3.1.1 General

This section applies to fibre reinforced thermosets.

The manufacturer shall keep necessary information regarding the raw material.

10.3.1.2 Properties of reinforcement fibres, resins, sandwich core materials and sandwich adhesives

The materials shall comply with the requirements given in one of the following standards:

- Relevant standard of an approved Classification Society
- ISO 12215-1
- ISO 12215-2
- other recognized standards.

10.3.1.3 Sandwich adhesives

If a standard for sandwich adhesives is not available, sandwich adhesives shall comply with the requirements given in Section 10.6 “Tables of material properties”.

Requirements for un-cured material are given in [10.6.2.1].

Requirements for cured material are given in [10.6.2.2].

The approval of sandwich adhesives is separated into two different quality grades:

Grade 1 = Required quality of sandwich adhesives for hull constructions

Grade 2 = Required quality of sandwich adhesives for less critical applications.

The approval shall be related to a set of physical properties which shall be specified in the *Type Approval Certificate*. The minimum properties shall be specified by the manufacturer and verified by the approval testing.

10.3.2 Manufacturing

10.3.2.1 Introduction

In this section requirements related to the manufacturing, quality assurance and quality control of FRP structures are given. It is to be recognized by the yard that there are limited or no means for nondestructive examination of FRP structures available. The yard shall therefore recognize the importance of exercising a rigorous control of all steps of the fabrication to ascertain that the finished product complies with its specification(s).

10.3.2.2 Storage of raw materials

Storage premises shall be so equipped and arranged that the material supplier's directions for storage and handling of the raw materials can be followed.

Storage premises for reinforcement materials shall be kept dry and clean so that the raw material is not contaminated. The materials shall be stored in unbroken original packaging before being used. Materials on which the original packaging has been broken shall be adequately protected against contamination when stored again after use.

Reinforcement materials shall normally be stored at the same temperature and humidity as the workshop in which they are going to be used. If the storage temperature is not the same the material shall be acclimatized at the workshop temperature and humidity prior to being deployed. The time of acclimatization shall be adequate for the amount of reinforcement: for unbroken packages, the acclimatization shall have a duration of at least two (2) days.

Resins, gelcoat, hardeners, additives etc. shall be stored according to the manufacturer's recommendations as regards temperature, shelf life etc. Raw materials which are stored at temperatures lower than + 18°C shall be acclimatized to the temperature of the workshop prior to being used. Tanks for resins etc. are to be handled during storage according to the manufacturer's recommendations and equipped and arranged accordingly.

Sandwich core materials shall be stored dry and protected against contamination and mechanical damage. Sandwich core materials shall normally be stored at the same temperature as the workshop in which they are going to be used. If the storage temperature is not the same the material shall be acclimatized for at the workshop temperature and humidity prior to being deployed.

Sandwich core materials shall be stored in such a way that out-gassing of the material is ensured prior to being used. Outgassing shall be carried out according to the manufacturer's recommendations. When new free surfaces are created in the material, e.g., by sanding, cutting, or machining, proper outgassing shall be ensured again.

Pre-pregs shall be stored according to the manufacturer's recommendation. For pre-pregs stored in refrigerated conditions, a log shall be carried for each package showing the time and at which temperature the package has been stored/used outside its normal storage conditions.

10.3.2.3 Manufacturing premises and conditions

- Manufacturing premises shall be so equipped and arranged that the material supplier's directions for handling the materials, the laminating process and curing conditions can be followed.
- The manufacturing premises shall be free from dust and other contamination that may in any way impair the quality of the end product.
- The air temperature in the moulding shops shall not be less than +18°C. The stipulated minimum temperature shall be attained at least 24 hours before commencement of lamination and shall be maintainable regardless of the outdoor air temperature.

- The temperature in the moulding shop shall not vary more than ±5°C. This limit can be exceeded provided it has no detrimental effect on the product and provided there is no risk for condensation of humidity.
- The relative humidity of the air shall be kept so constant that condensation is avoided and shall not exceed 80%.
- A higher relative humidity can be accepted on a case-by-case basis provided an adequate margin against the risk for condensation of humidity is provided.
- In areas where spray moulding is taking place, the air humidity shall not be less than 40%.
- The stipulated air humidity shall be maintainable regardless of outdoor air temperature and humidity.
- More stringent requirements to humidity shall be adhered to if recommended by the manufacturer.
- Other manufacturing conditions may be accepted based on a special agreement with the Department provided that condensation of humidity can be safely avoided.
- Air temperature and relative humidity shall be recorded regularly, and the records filed for a period of at least two (2) years. In larger shops there shall be at least one thermohydrograph for each 1500 m^2 where lamination is carried out. The location of the instruments shall be such as to give representative measurement results.
- Draught through doors, windows etc. and direct sunlight is not acceptable in places where lamination and curing are in progress.
- The ventilation plant shall be so arranged that the curing process is not negatively affected.
- Sufficient scaffoldings shall be arranged so that all lamination work can be carried out without operators standing on the sandwich core or on surfaces on which lamination work is taking place.
- During lamination of larger constructions, the temperature shall be recorded at least at two levels vertically in the workshop and the curing system shall be adjusted to compensate for possible temperature differences.
- Prefabrication of panels and other components shall be carried out on tables, fixtures etc. above the shop floor level.
- No fabrication shall be carried out on the shop floor.

10.3.2.4 General requirements to production and workmanship

Raw materials for all structural members covered by the rules shall be of approved type in accordance with Chapter [10.1.2]. The supplier’s directions for application of the materials shall be followed.

Specified procedures shall be implemented for all tasks with significance to the quality of the end product. Where necessary to exercise a satisfactory control of the quality, these procedures shall be documented in writing in controlled documents.

The reference direction of reinforcement shall after being laid not deviate from that specified by more than ±5°.

Adjacent sheets of reinforcement shall in the normal case overlap to give structural continuity. The overlap length shall be such that the shear capacity of the overlap is not smaller than the tensile strength (perpendicular to the overlap) of the overlapping plies. The shear strength of the matrix shall not be assumed larger than 8 MPa. A higher shear strength can be assumed subject to the approval of the Classification

Society. (e.g. for a 0/90° 1000 g/m^2 type glass reinforcement the overlap shall not be smaller than 30 mm.) In areas of low utilization, overlaps may be dispensed with subject to the approval of the Society. Overlaps shall be staggered through the thickness of the laminate. The distance between two overlaps in adjacent plies shall not be smaller than 100 mm.

Thickness changes in a laminate shall be tapered over a minimum distance equal to 20 times the thickness difference.

Thickness changes in sandwich core materials shall be tapered over a minimum distance equal to 3 times the thickness difference. A larger distance may be required to maintain the structural continuity of the skins.

10.3.2.5 Sandwich lay-up

Sandwich constructions can be fabricated either by:

- lamination on the core
- application of the core against a wet laminate
- by bonding the core against a cured skin laminate using a sandwich adhesive
- by resin transfer, i.e., resin transfer moulding of the core together with one or both of the skin laminates.

An efficient bond is to be obtained between the skin laminates and the core and between the individual core elements. The bond strength shall not be smaller than the tensile- and shear strength of the core. The application of a light CSM between the core and skin laminate may be advantageous in this respect.

Adequate tools for cutting, grinding etc. of various types of core material shall be specified in the production procedure.

All joints between skin laminates and core and between the individual core elements shall be completely filled with resin, sandwich adhesive or filler material. The joint gap between core blocks shall in general not be larger than 3 mm. Larger gaps may be accepted if necessary, based on the characteristics of the sandwich adhesive or filler (e.g., its viscosity) and the thickness of the core. For slamming exposed areas, a larger gap width should also be reflected in the qualification testing of the core material and the sandwich adhesive.

Core materials with open cells in the surface shall normally be impregnated with resin before it is applied to a wet laminate or before lamination on the core is commenced.

When the core is applied manually to a wet laminate the surface shall be reinforced with a chopped strand mat of 450 g/m^2 on plane surface and 600 g/m^2 on curved surfaces. If vacuum is applied for core bonding the surface mats may be dispensed with provided it is demonstrated in the qualification tests that an efficient bond between core and skin laminate is obtained.

If the core is built up by two or more layers of core and any form of resin transfer is used, arrangements shall be made to ensure proper resin transfer and filling between the core blocks. This should be achieved by scoring or holing the core blocks and by placing a reinforcement fabric between the core blocks to facilitate resin distribution.

Frameworks for core build up shall give the core sufficient support to ensure a stable geometrical shape of the construction and a rigid basis for the lamination work.

When a prefabricated skin laminate is bonded to a core, measures shall be taken to evacuate air from the surface between skin and core.

The core material shall be free from dust and other contamination before the skin laminates are applied or core elements are glued together. The moisture content shall be sufficiently low not to have any adverse effect on curing. The acceptable moisture content shall be specified by the manufacturer of the core material.

When vacuum-bagging or similar processes are used, it shall be ensured that curing in the sandwich adhesive has not been initiated before the vacuum is applied.

10.3.2.6 Manual lamination

The reinforcement material shall be applied in the sequence stated on the approved plan(s).

When the laminate is applied in a mould a CSM of max. 450 g/m2 shall be applied next to the gelcoat. The mat can be dispensed provided a satisfactory resistance against water can be ensured.

The resin shall be applied on each layer of reinforcement. Gas and air pockets shall be worked out of the laminate before the next layer is applied. Rolling of the layers shall be made carefully, paying special attention to sharp corners and transitions. The viscosity and gel-time of the resin shall be adequate to prevent drain-out of resin on vertical and inclined surfaces. The tools and methods used when working the laminate shall not damage the fibres.

The time interval between applications of each layer of reinforcement shall be within the limits specified by the resin supplier. For thicker laminates care shall be taken to ensure a time interval sufficiently large to avoid excessive heat generation.

Curing systems shall be selected with due regard to the reactivity of the resin and in accordance with the supplier's recommendations. Heat release during curing shall be kept at a safe level in accordance with the material manufacturer's recommendations. The quantity of curing agents is to be be kept within the limits specified by the supplier.

After completion of lamination, polyester laminates are cured for at least 48 hours at an air temperature of minimum +18°C. Curing at a higher temperature and a shorter curing time may be accepted based on control of the curing rate. For other types of resins curing shall be carried out according to the specified cure cycle and according to the resin manufacturer's recommendations.

10.3.2.7 Vacuum assisted resin transfer moulding (VARTM) and vacuum-bagging

Points of resin injection shall be located and opened and closed in a sequence such that complete filling of the mould without any air being trapped is ensured.

The resin shall be formulated, based on the resin manufacturer's recommendations, such that an adequate viscosity and gel-time is obtained to enable filling of the complete mould and such that the maximum temperature during cure is kept within acceptable limits, e.g., with respect to the temperature sensitivity of sandwich core materials.

The pressure level (vacuum) in the mould shall be specified prior to infusion. The pressure shall be adequate to ensure adequate consolidation of the laminate and that the specified mechanical properties are reached and that the mould is properly filled. The pressure shall be maintained throughout the mould during the cure cycle of the laminate, at least past the point of maximum temperature in the laminate, and the specified hold time. The vacuum shall be monitored by the use of pressure gauges distributed throughout the mould such that a reliable indication of the pressure distribution is obtained. This means that pressure gauges shall be placed far away from vacuum suction points. Adequate means to locate and repair leakage shall be deployed.

10.3.2.8 Spray moulding

The term spray moulding is understood to mean the simultaneous deposit of resin and fiberglass reinforcement. Manufacturers using this method are subject to special approval.

When approval of the spray moulding process is considered, special attention will be paid to production arrangement, ventilation equipment, the manufacturer's quality control and other factors of significance to the quality of the finished product.

Spray moulding of structural members shall be carried out only by specially qualified operators.

The equipment used for spray moulding shall give an even and homogenous buildup of the laminate. Any dosage devices shall ensure an even application of additives to the polyester resin. No fibres shall be shorter than 19 mm.

When spray moulding there shall be an even application over the entire surface. Regular rolling out of the sprayed-on layers shall be carried out. Next to the gelcoat rolling out shall be done for max. 1.5 mm thickness of finished laminate thickness, subsequently for at least each 2.5 mm of finished laminate thickness. The rolling out shall be done thoroughly to ensure adequate compression and removal of gas and air pockets. Special care shall be taken at sharp transitions and corners.

10.3.2.9 Curing

Cure cycles shall be documented by temperature records.

For cure taking place at room temperature in the workshop, the registrations made in the workshop are sufficient to document the cure cycle.

For cure at elevated temperature, fans with ample capacity shall be operated in the compartment in which the cure is carried out to ensure an even distribution of temperature. Continuous records of temperature throughout the complete cure cycle shall be provided. Recording points shall be distributed throughout the length, width and height of the cure compartment to the extent necessary to verify that the temperature distribution is even.

10.3.2.10 Secondary bonding

A secondary bonding is defined as any bond between two FRP structures which is made after one or both of the individual structures has effectively cured.

The surface ply of a laminate subject to secondary bonding and the first ply of the bonding laminate shall normally be of CSM. This mat can be dispensed with provided the necessary bond strength is reached.

Surfaces in way of secondary bonding shall be clean and free from dust and other forms of contamination.

Laminates on which secondary bonds are to be carried out shall have an adequate surface preparation, normally including grinding.

If "peel strips" are used in the bonding surface, the required surface treatment may be dispensed.

10.3.2.11 Adhesive bonding

Adhesive bonds shall be carried out according to the same procedure(s) as on which the design and qualification testing has been based and according to the recommendations from the manufacturer of the adhesive. Procedure(s) shall be submitted to the Classification Society prior to commencement of the bonding work. The procedure(s) shall give clear requirements to all factors that can affect the quality of the bond. As a minimum, the following shall be covered:

- Working conditions.
- Surface preparation.
- Application.
- Clamp-up.
- Curing cycle etc.

10.4 Thermoplastics

10.4.1 Polyethylene (PE) and Acrylonitrile Butadiene Styrene (ABS)

10.4.1.1 General requirements

The approval is given to the manufacturer who produces the raw material at the final stage before marine craft production. For rotational moulding, approval is granted to the granulate/powder manufacturer. For thermoforming of sheets, the approval is granted to the sheet manufacturer.

Ageing properties shall be verified on sheet material with pigments which shall be used in the production.

The content of pigments shall not exceed 4% and are to be evenly distributed in the material. Any possible detrimental effect on the strength of the material shall be recorded.

The impact strength of the material at low temperatures is approved in relation to the fracture character at pendulum notch impact testing. Brittle fracture at temperatures above 0°C shall not be accepted. If the transition between tough and brittle fracture occurs between 0°C and -20°C, the following statement shall be entered on the marine craft's certificate:

> *"The impact strength of the plastic material is reduced at low temperatures. The craft is not recommended to be used in cold temperatures."*

The ability of the material to withstand heating by sunlight is subject to approval based on the reduction in the material stiffness between 20°C and 65°C. A reduction in the shear modulus of the material greater than 80% shall not be accepted. If the reduction is between 30% and 80%, the following statement shall be entered on the marine craft's certificate:

> *"The material softens at high temperatures and may be permanently deformed by long-term loading at high temperatures."*

10.4.1.2 Documentation

Requirements for properties and documentation are specified in Chapter [10.6.3].

The test specimens shall be taken from the material, which is used in production, but the material shall not be weakened due to the manufacturing process.

The approval shall state the manufacturing process for which the material is approved.

10.4.1.3 Properties of polyethylene

Polyethylene shall comply with the requirements given in [10.6.3.2]. The test specimens shall be taken from material manufactured in accordance with a method representative for the marine craft production.

10.4.1.4 Properties of Acrylonitrile Butadiene Styrene (ABS)

ABS shall comply with the requirements given in Chapter [10.6.3.3]. The test specimens shall be taken from material manufactured in accordance with a method representative for the marine craft production.

The tolerance on the sheet thickness shall not exceed the following:

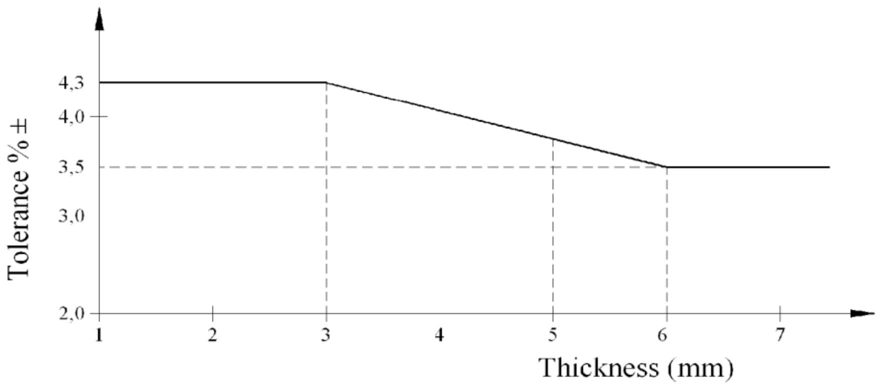


Figure 10-6 Tolerance on sheet thickness

Tolerance shall be based on measurements at 20 points evenly distributed over the width of the sheet. The average thickness shall not be less than the nominal sheet thickness.

Individual values for shrinkage during heating shall not exceed the following:

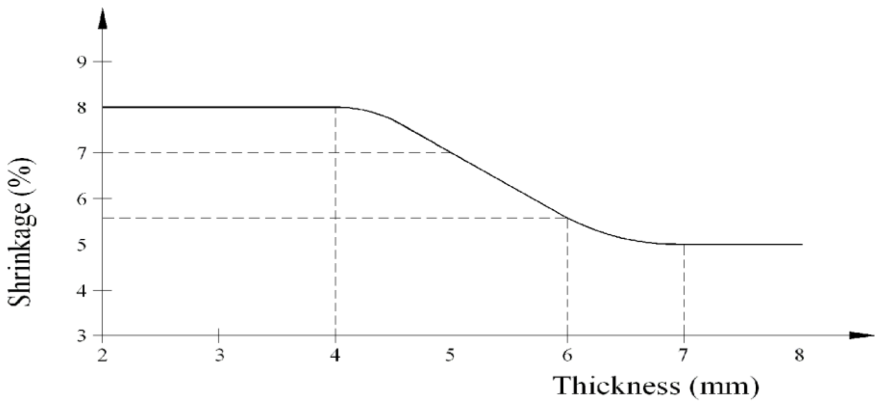


Figure 10-7 Shrinkage during heating

The shrinkage of the sheet shall be checked by taking at least 6 specimens measuring approximately 300 × 300 mm from places evenly distributed over the width of the sheet. On each specimen, the plate direction is to be indicated, and a circle of diameter 100 mm is marked. The specimens are then placed in talcum powder between metal plates for 30 minutes at a specified temperature. The metal plates shall have a thickness of 0.6 to 0.8 mm.

10.5 Other materials

10.5.1 Buoyancy materials

10.5.1.1 Requirements

By buoyancy, material is meant a low-density material e.g., foam with a specific gravity of less than 1.0, which provides buoyancy to the craft when flooded.

The water absorption of buoyancy materials shall not exceed 8% by volume after being submerged for 8 days according to ISO 2896. Material complying with IMO Resolution MSC.81(70) shall be deemed to satisfy this requirement.

Buoyancy materials shall be resistant to liquids e.g., petrol fuel. The requirement may be omitted if the material is totally encapsulated when fitted.

Results from tests or compliance to Resolution shall be documented.

10.5.2 Fabrics for Rigid Inflatable Boat (RIB) collars

10.5.2.1 General

Fabrics for RIB collars shall be selected by the manufacturer according to the stresses to which the craft is to be subjected (shape, dimensions, maximum load, installed power etc.), and also to the intended service conditions. Use under normal seagoing conditions shall not materially impair their performance.

Fabrics for RIB collars shall be tested according to ISO 6185-3. The test results shall be documented.

RIB collars shall retain their full serviceability within the operating temperature range of -20°C to +60°C.

10.5.3 Wood

10.5.3.1 General

Timber and plywood shall be suitable for the application and a marine environment.

Timber shall be free from sapwood, resin, cortex, splits, loose knots, insect attacks, rot or other imperfections that will affect the quality of the material.

All exposed timber and plywood shall be given weathertight protection, such as, paint, varnish or preservative, suitable for a marine environment.

10.5.3.2 Timber for load bearing components

Timbers for load bearing components shall be best quality, adequately dried, sound, free from sap, knots, and detrimental flaws. Twisted timber shall not to be used.

Any of the timbers suitable for marine craft building may be used. Their bulk density should be greater than 0,56 g/cm^3 with a moisture content of 12%.

Timber envisaged for use in this type of construction is to be cut in such a way that the inclination of the annual rings is no less than 30°. The fibres shall be oriented parallel to the edge of a lamella, if possible. Veneers for making plating may be sliced or sawn.

The timber shall be free from unacceptable characteristics or defects that might impair the quality.

Unacceptable defects in the wood are:

- Blueing
- Brittleness
- Rot
- Cracks, except for natural (air) cracks in the inner layers of multi-plywood or plywood, provided their depth does not exceed 2/3 of the thickness of the veneer.
- Sapwood

Wood with defects and growth damage which shows up during cutting to size must not be used for load bearing structural members.

Conditionally acceptable defects in the wood are branches/knots if:

- their maximum cross-sectional extent (visible extent) does not exceed 10 mm,
- they are firmly growth-bonded to the surrounding wood (loose knots are to be replaced by plugs),
- their distance from each other is no less than 500 mm,
- their distance from the edge of the component or veneer is not less than their maximum cross-sectional dimension. No consideration needs to be given to branches/knots whose maximum diameter is less than 5 mm if they are firmly growth-bonded to the surrounding wood.

Timber in durability groups 1, 2 and 3 in accordance with Table 10-12 [10.6.3.4] is preferably to be used. Timber in groups 4 and 5 requires special approval by the Department.

For non-load-bearing components, e.g., interior parts, no particular types of wood are specified.

10.5.3.3 Constructional timbers

Moisture content in constructional timber shall not be higher than 20%. Timber to be bonded by adhesive shall not have higher moisture content than 15%.

Constructional timber to be used in hull- and deck- planking and for lamination of frames shall have straight grains and be quarter sawn.

Constructional timber shall be stored in dry and well-ventilated premises free from direct sunlight. Each piece shall be stored flat and held apart from other pieces to give satisfactory air circulation.

10.5.3.4 Plywood

Plywood to be used in hull and deck structure shall comply with BS 1088, BS 4079 or other equivalent standards.

The facing veneers shall have a good, solid surface free from visible defects.

Plywood to be used for non-structural application may be of a lesser quality than stated above, but the adhesive used shall comply with BS 1203 or equivalent standard.

Plywood shall be stored flat on a level bed in dry and well-ventilated premises free from direct sunlight.

10.5.3.5 Adhesives for timber and plywood

Adhesives shall comply with BS 1204 or another equivalent standard.

Adhesives shall be stored according to the manufacturer's recommendation.

10.5.3.6 Workshop requirements and quality assurance

Glues and adhesives:

1. **Requirements:** Only mixed adhesives (phenolic and epoxy resins) and glues approved by the Department may be used. Adhesives and glues shall have passed the tests in accordance with EN 314 "Bond quality".
   Relevant confirmation and/or test certificates are to be submitted to the Department.
   In accordance with current practice, mixed adhesives will hereinafter also be referred to as glues.
2. **Storage, application:** The rules of the producers of the glue regarding storage and use of the glues and hardeners shall be observed. Glues and hardeners are to be stored in their original containers well sealed in a cool, dry place. The indicated shelf life must not be surpassed.

Principles for making glued wood joints:

1. **Preparation of the components:** The moisture content of the components to be glued must meet the following requirements:
   When being glued the wood moisture content must not be less than 8% and not more than 14%.
   The moisture content of components to be glued together is to be roughly equal; the difference may not exceed 4%.
   The final moisture content of the timber shall always be controlled before any further working/glueing.
2. **Temperature of the wood:** The temperature of the surfaces to be glued must match that of the surrounding environment; this must not be less than 15°C.
3. **Condition of the surface to be glued:** Surfaces to be glued must be free from any kind of foreign substance or contamination (e.g., grease, oil, paint, dirt, dust, wood or metal chips).
   Components to be glued shall be free from wood preservatives. In exceptional cases, i.e. if the components are treated with preservatives before glueing, the compatibility of these preservatives with the glue to be used shall be demonstrated to the Department by a procedure test.
4. **Environmental conditions:** The ambient air temperature must not drop below 15 °C during glueing and curing. The air humidity shall be at least 45 %.
5. **Preparation of the glue and glueing:** The glue is to be made up in accordance with the manufacturer's instructions and the usage guidelines shall be observed.
6. **Applying the glue, surplus glue, joint:** The glue ready for use is applied evenly with a roller or brush or other means to both surfaces to be joined. Sufficient glue is to be applied for a little surplus to be squeezed out of the joint when this is subject to pressure. The aim should be a thin joint; joints more than 1 mm thick are not permitted. During the time under pressure, care shall be taken to assure that the pressure on the veneers to be joined is adequate.

Work prerequisites and quality assurance:

1. Companies producing wooden hulls and components cold moulded by glueing shall be qualified for the work to be carried out regarding their workshop equipment, internal quality control, manufacturing process as well as the training and qualification of the personnel carrying out and supervising the work. Providing the prerequisites for approval have been met, suitability will be certified for the works on application by a shop approval.

Construction:

1. **Lamellated panels:** Shell, deck and cabin/superstructure panels shall meet the following requirements:
   The thickness of a layer of veneer should not be more than 1/3rd of the thickness of the laminated component.
   In the case of three-layer laminated panels, the following directions of the veneer layers referred to the longitudinal axis of the hull are recommended:
   - 1st layer: 45°
   - 2nd layer: 90° to 1st layer
   - 3rd layer: 90° to the previous layer or in line with hull axis

   In the case of the planking of greater thickness, the layers of veneer after the 2nd one are glued onto the mould each 90° out from the previous one.
2. **Lamellated internal structural members:** The thickness of individual layers depends on the size and shape of the component and lies between 5 and 25 mm.
3. **Bending radii:** The bending radius of an individual veneer or ply/layer must not be lower than the following value:
   $r = t \cdot 110$ [mm]
   t = thickness of the individual veneer
4. **Component connection:** The length of spliced/scarified joints must be at least 8 times the height.
   Unidirectional components or laminae may be glued together using interlocking wedge-shaped dovetails with the same pitch and profile. In doing so, the following principles shall be observed:
   - Dovetail profiles must correspond to the stress group I according to DIN 68140,
   - Only width dovetailing may be used,
   - Dovetail joints of successive laminae shall be staggered by at least 20 dovetail lengths; these must not be used in outer layers of shell and deck nor inner layers of the shell around the bilges.

   Load-carrying components shall be glued at the corners with the aid of beads or clips.
   The area of the surfaces to be glued depends on the binding strength (EN 314) of the glue and the load.
   Component connections of novel design about which there is not sufficient practical experience require special proof of their strength. Such proof may be provided mathematically or by the results of a procedure test carried out in the presence of the surveyor or by an official material testing establishment.

Details of design and construction:

1. In areas where concentrated forces are introduced into the structure from rig, rudder, fin keel, propulsion units, etc. hulls shall be designed as appropriate for the forces arising and shall be locally reinforced, if necessary.

In the case of special designs, the Department reserves the right to call for proof by direct calculation of adequate structural safety. Materials suitable for seawater shall be used for screwed and bolted joints.

10.6 Tables of material properties

10.6.1 Reinforcement fibres, resin and sandwich core materials

10.6.1.1 Mechanical properties

Minimum mechanical properties are given in the standards that are accepted for certification of the material in question.

10.6.2 Sandwich adhesives

10.6.2.1 Un-cured condition

Table 10-7 Sandwich adhesives, uncured

Property	Unit	Test method	Requirement
Density		ISO 3521	Manufacturer's nominal value ±10% To be given for information.
Viscosity		ASTM D 1084 method B (for free-flowing adhesives)	Manufacturer's nominal value ±20% To be given for information. To be given on works certificate.

10.6.2.2 Cured condition

Table 10-8 Sandwich adhesives, cured material

Property	Unit	Test method	Required values for approval testing *) May be required tested at production of the craft		
			Grade 1	Grade 2	
Tensile strength, flatwise	MPa	ASTM C 297(specimen: 5×5 cm, speed: 1 mm/min.) - at 23°C: - at heat resistance temperature:	≥ 1.0 > 80% of Msmv	≥ 1.0 > 80% of Msmv	
Heat resistance	Temp., °C min.	Percentage retention of tensile strength (ASTM C 297 specimen: 5×5 cm, speed: 1 mm/min., min. 45°C) after being conditioned to heat resistance temp.	45	45	
Tensile strength and fracture elongation	MPa %	ISO 527 (Specimen thickness 4 mm)	Msmv to be given for information	Msmv to be given for information	*

		- at -10°C - at 23°C - at heat resistance temperature	≥ 2.0 ≥ 3.5 ≥ 3.5	≥ 1.0 ≥ 2.0 ≥ 2.0	*

Table 10-8 Sandwich adhesives, cured material (continued)

Property	**Unit**	**Test method**	**Required values for approval testing *) May be required tested at production of the craft**		
Shear strength	MPa	ISO 1922 1) (23°C)	≥ 0.4	≥ 0.4	
Overall volume shrinkage	%	ISO 3521 2)	Msmv to be given for information	Msmv to be given for information	
Water resistance	%	Percentage retention of tensile strength (ASTM C 297 specimen: 5×5 cm, speed: 1 mm min., 23°C) after 4 weeks in water at 40°C.	≥ 80	≥ 80	
Msmv: Manufacturer's specified minimum value *1) The test samples are to be made of two pieces of high-density core material, preferably PVC foam, with the sandwich adhesive located in the mid plane parallel to the steel supports. The sandwich adhesive layer shall be > 1 mm thick.* *2) Curing shrinkage is relevant for gap filling adhesives only.*					

10.6.3 Polyethylene (PE) and Acrylonitrile Butadiene Styrene (ABS)

10.6.3.1 Properties in general for PE and ABS

Table 10-9 Properties and documentation of PE and ABS

Properties	**Test method**	**Results to be given for information except where noted. * Also required by delivery**	
Tensile properties	ISO 527-2 (Test specimen type 2, 5-50 mm/min.)	Curve at 20°C and 65°C	
Shear modulus	ISO 761-2 (torsion pendulum)	Curve for temperature range -20°C -65°C	
Creep	ISO 899-1 (carried out on at least 3 stress levels and 2 test pieces per level)	Isochronous stress deformation diagram for 1000, 100, 10, 1 and 0.1 hours at 20°C and 65°C	
Fatigue	Fatigue test carried out with constant stress or deformation amplitude	Curves up to at least 100.000 loading cycles at 20°C	* ABS
Hardness	ISO 868 (Shore D)	Given at 20°C, read after 15 seconds	

Falling weight impact	ASTM D 3029 (method A). The radius of the drop hammer's striking surface is to be 12.5 mm	Fracture energy by the visible crack as fracture criterion, given at 0°C and 20°C and with relevant material thickness	

Table 10-9 Properties and documentation of PE and ABS (continued)

Properties	Test method	Results to be given for information except where noted. * Also required by delivery	
Pendulum impact	With V-notch 45° in accordance with ISO 180. For particularly flexible materials an alternative test method (tensile impact strength) may be used	Fracture energy at 0°C as well as a description of fracture type. The notch impact strength is only stated for non-aged materials	
Ageing	ISO 179-1 (Charpy) without notch: Natural ageing DIN 53386, item 6.1. Accelerated ageing: DIN 53387	Plotted fracture energy for aged materials as a function of logarithmic time. The time is normally to cover 48 months of natural ageing or 5 000 hours of accelerated ageing. A shorter time can be approved if the ageing process is clarified at an earlier stage	
Fuel resistance	Stressed material submerged in normal engine fuel	Description of surface cracking	
Melt index	ISO 1133-1	To be given for polyethylene	
Chemical resistance	ISO 175	List of chemicals which may damage the material	
Density	ISO 1183-2	To be given for polyethylene	PE *
Oxygen index	ASTM D 2863	Value	PE *

10.6.3.2 Properties for polyethylene

LDPE = Low density polyethylene
MDPE = Medium density polyethylene

Table 10-10 Properties of polyethylene

Property	Requirement LDPE	Requirement MDPE	Unit	Comments
Density	- 0.930	0.930 - 0.945	g/cm^3	
Melt index	Stated value ±1.0 Though max. 3.5	As LDPE	g/10 min.	
Tensile yield stress	min. 7.5 min. 4.5	min. 13.0 min. 8.0	N/mm2 N/mm2	At 20°C At 65°C
Elasticity modulus in tensile yield	min. 180	min. 350	N/mm2	At 20°C

Property	Requirement LDPE	Requirement MDPE	Unit	Comments
Tensile creep strength	max. 2.5 at stress 2.0	2.0 at stress 3.0	% N/mm2	Deformation after 100 hours at 20°C
Hardness	Stated value ±3	As LDPE	Shore D	Tested at 20°C and read after 15 sec.

Table 10-10 Properties of polyethylene (continued)

Property	Requirement LDPE	Requirement MDPE	Unit	Comments
Impact strength (drop test without notch)	min. 15	min. 15	J/mm thickness	Freely supported test piece 0°C
Notch impact strength (pendulum test with notch)	Not brittle fracture	Not brittle fracture	Visual	Required only for marine crafts with single skins 0°C
Pore contents	max. 15 max. 20	As LDPE As LDPE	% of thickness % of thickness	In structural parts In marine craft elsewhere
Impact tensile strength of aged material	Not brittle fracture min. fracture energy 1.0 J/cm^3	As LDPE J/cm2	Visual	Aged material corresponding to 4 years of natural ageing, tested at 0°C and with a test speed 2 × 10^5 %/mm

10.6.3.3 Properties for Acrylonitrile Butadiene Styrene (ABS)

Table 10-11 Properties of ABS

Properties	Requirements
Tensile yield stress	Min. 30 N/mm^2 at 20°C Min. 18 N/mm^2 at 65°C
Modulus of elasticity	Min. 1600 N/mm^2 at 20°C
Creep	Max. 1.0% deformation after 100 hours at a stress of 7.0 N/mm^2 at 20°C
Bending fatigue strength	At a deformation amplitude of 1% and frequency 0.5 Hz the material is to withstand 50 000 load cycles before fracture
Notch impact strength	Min. 2 kJ/m2 at 20°C in accordance with ISO 179 without notch
Impact strength (pendulum) of aged material	After ageing corresponding to 4 years' natural ageing, the material is to have a fracture energy of at least 2.5 kJ/m2

10.6.3.4 Timber durability groups and characteristics

Table 10-12 Timber durability groups and characteristic values in accordance with DIN 68364

Wood type	Durability Group [1]	Bulk density [2]	Mean breaking strength: Tension	Mean breaking strength: Compression	Mean breaking strength: Bending	Young's modulus: E_L Long.	Young's modulus: E_T Rad.	Shear modulus: G_{LT} [3]	Transverse contraction
		g/cm³	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	
Coniferons									
European spruce	4	0,47	80	40	68	10000	800	600	0,33
Fir	4	0,47	80	40	68	10000			
Pine	3-4	0,52	100	45	80	11000	1000		0,30
Oregon pine	3	0,54	100	50	80	12000	900	800	0,46
Larch	3	0,59	105	48	93	12000			
Spruce	4	0,47	85	35	65	9500	870	680	0,34
Deciduous									
Khaya-Mahogany	3	0,50	75	43	75	9500	1040	830	0,59
True-Mahogany	2	0,54	100	45	80	9500	990	770	0,44
Sapele-Mahogany	3	0,64	85	57	69	9800			
Sipo-Mahogany (Utile)	2	0,59	100	58	100	11000	1300	1140	0,53
Meranti, red	3	0,59	129	53	105	13000	1250		
Iroko	1-2	0,63	79	55	95	13000	1450	1080	0,59
Makore	1-2	0,66	85	53	103	11000	1390	1160	0,42
Oak	2	0,67	110	52	95	13000	1580	1150	
Beech	5	0,69	135	60	120	14000	2280	1640	0,52
Birch	5	0,65	137	60	120	14000	1130	1200	0,36
Ash	5	0,69	130	50	105	13000	1500	880	0,55
Teak	1	0,69	115	58	100	13000	1490	1040	0,55
Yang	3	0,76	140	70	125	16000	1850		

[1] Criterion for the durability group is the service life and the resistance of the wood against fungi and animal pests (but not the marine borer, teredo navalis) in contact with soil under central European conditions; the meanings are:
1 = high resistance
2 = resistance
3 = moderate resistance
4 = little resistance
5 = no resistance

[2] Bulk density in reference atmosphere standardized condition with 12 % moisture content in accordance with DIN 52183.

[3] In the radial plane.

11 DESIGN PRINCIPLES

11.1 Documentation

11.1.1 Plans and particulars

The following plans shall be submitted for approval:

- Mid marine craft section including main particulars (Lwl, Bwl, Δ, L) and maximum speed V
- Profile and decks
- Longitudinal and transversal stiffening members
- Shell expansion and framing including openings
- Watertight bulkheads and transom including openings and their closing appliances
- Tank structure
- Engine room structures including foundation for heavy machinery components
- Aft peak structures
- Forepeak structures
- Superstructures and deckhouses including openings with sill heights and their closing appliances
- Hatchways, hatch covers and ports including securing and tightening appliances
- Propeller shaft material
- Propeller shaft brackets with their attachments to the hull
- Appendages with their attachments to the hull
- Rudder and rudder stock with details of bearings and seals
- Arrangement and particulars of anchoring and mooring equipment

Guidance note:

Identical or similar structures in various positions are recommended covered by the same plan.

The following plans shall be submitted for information:

- General arrangement
- Tank arrangements
- Capacity plan
- Body plan
- Arrangement of cathodic protection

Additional documentation required is listed in the appropriate sections.

11.1.2 Strength calculations

Strength calculations shall normally be submitted for reference to demonstrating that stresses are within required limits.

12 DESIGN LOADS

12.1 General

12.1.1 Application

The design loads in this section shall only be applied in association with the strength formulas given in this section.

12.1.2 Local reinforcements

Structure with local loads from cargo, fenders, deck-gears, foundations etc., shall be reinforced for the actual loads. Forces from cranes shall be multiplied by a factor of 1.4. Glass reinforced plastics and wooden crafts shall be reinforced in areas of local wear.

> **Guidance note:**
>
> Crafts intended for beaching shall have rubbing strips and reinforced stem.

12.2 Design category coefficient

12.2.1 Design category coefficient k_{DC}

Final global loads and design pressure is adjusted by a coefficients according to design category.

The design category coefficient k_{DC}, defined in Table 12-1, takes into account the variation of the global loads and the design pressure loads due to sea with design category.

Table 12-1 Values of kDC according to design category

Design category	"Offshore"	"Territorial Waters"	"Coastal"	"Sheltered"
Service area notation	AD0	AD1	AD2	AD3
Value of k_{DC}	1	0,9	0,75	0,6

12.3 Design loads

12.3.1 Longitudinal strength

The maximum longitudinal bending moment for craft operating entirely in displacement mode shall not be taken less than:

$M = 0.016 \cdot k_{DC} \cdot L_{WL}^3 \cdot B_{WL}$ (kNm)

For other craft the maximum longitudinal bending moment shall not be taken less than the larger of:

1) $M = 0.016 \cdot k_{DC} \cdot L_{WL}^3 \cdot B_{WL}$ (kNm)
2) $M = 0.0025 \cdot k_{DC} \cdot \Delta \cdot L_{WL}$ (kNm)

In no case shall the maximum longitudinal bending moment be taken less than 100 kNm.

The maximum longitudinal bending moment shall be applied to the central 25% of L with a linear reduction to zero at the fore and aft end of the craft.

12.3.2 Sea pressure on hull bottom

The design sea pressure, Pb, acting on the hull bottom shall not be taken less than:

$P_b = PF_b \cdot k_{DC} \cdot k_{lb} \cdot k_{\beta} \cdot k_a$ (kN/m^2)

PF_b = pressure factor taken from fig. below

V = max. speed

k_{DC} = design category factor (Table 12-1)

k_{lb} = longitudinal distribution of sea pressure, to be taken from figures below. Intermediate values to be found by interpolation

k_β = correction for deadrise angle applicable to crafts with speed $V > 3\sqrt{L}$ and length $L > 9$ m, taken from the figure below. The deadrise angle shall not be taken greater than 22 degrees

k_a = area reduction factor considering the size of the design area, A_d, relative to the reference area A_r, to be taken from the figure below

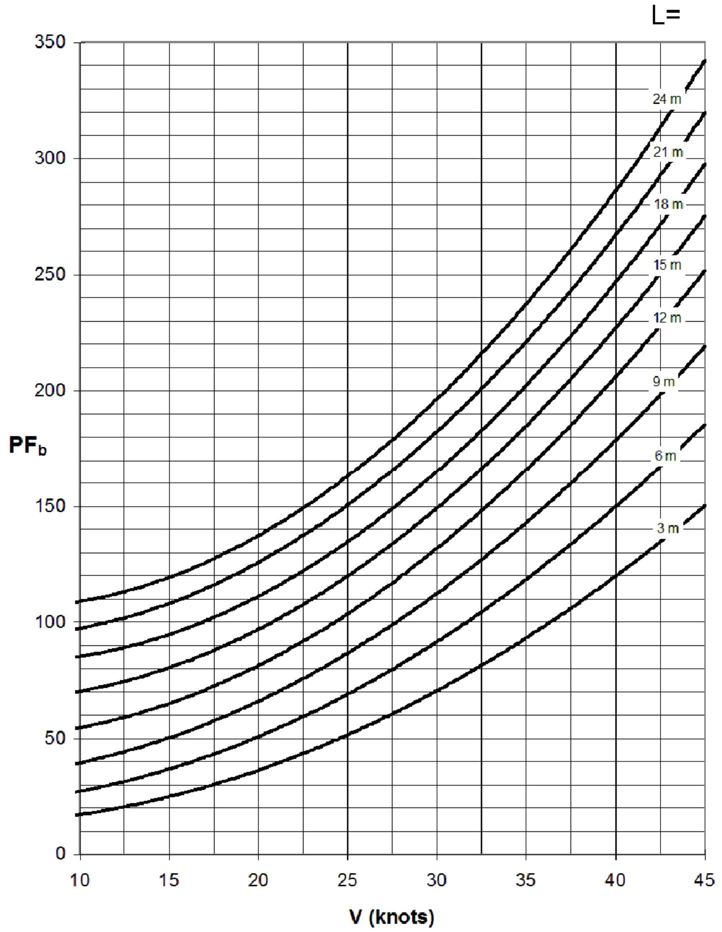
A_d = s^2 (m^2) for plates and panels

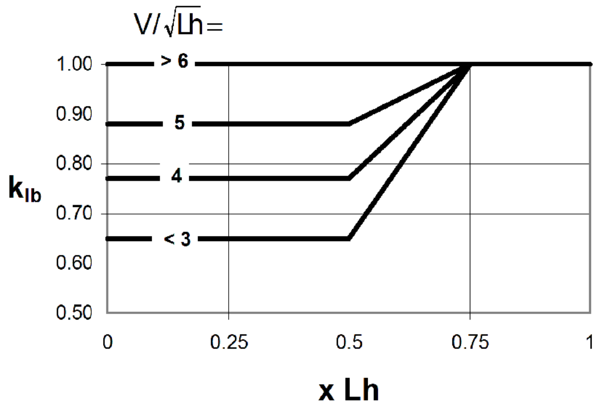
A_d = $s \cdot l$ (m^2) for frames/stiffeners

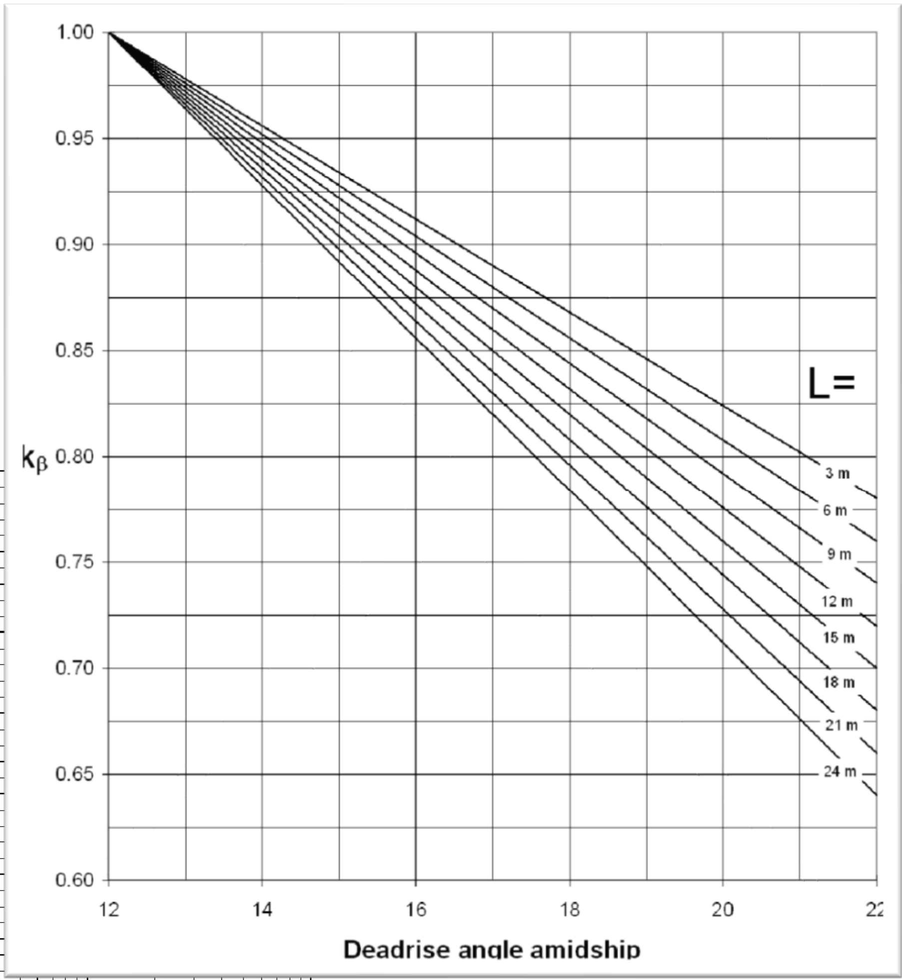
A_r = $0.2 \cdot L \cdot B$ (m^2)

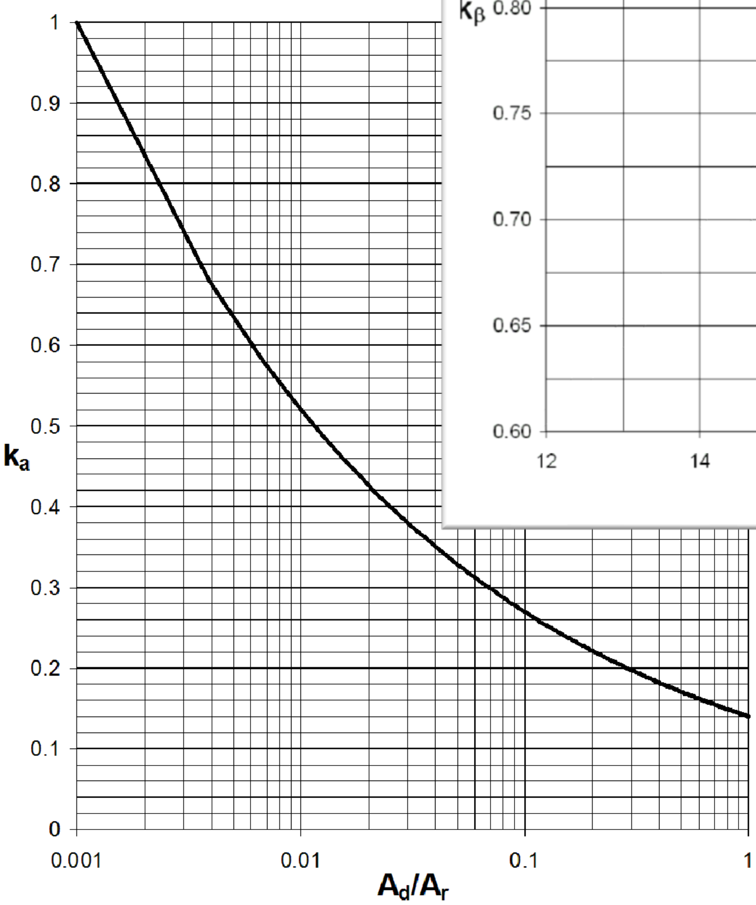
s = shortest panel edge or load breadth for stiffening members in meters

l = span length of stiffening members in meters.



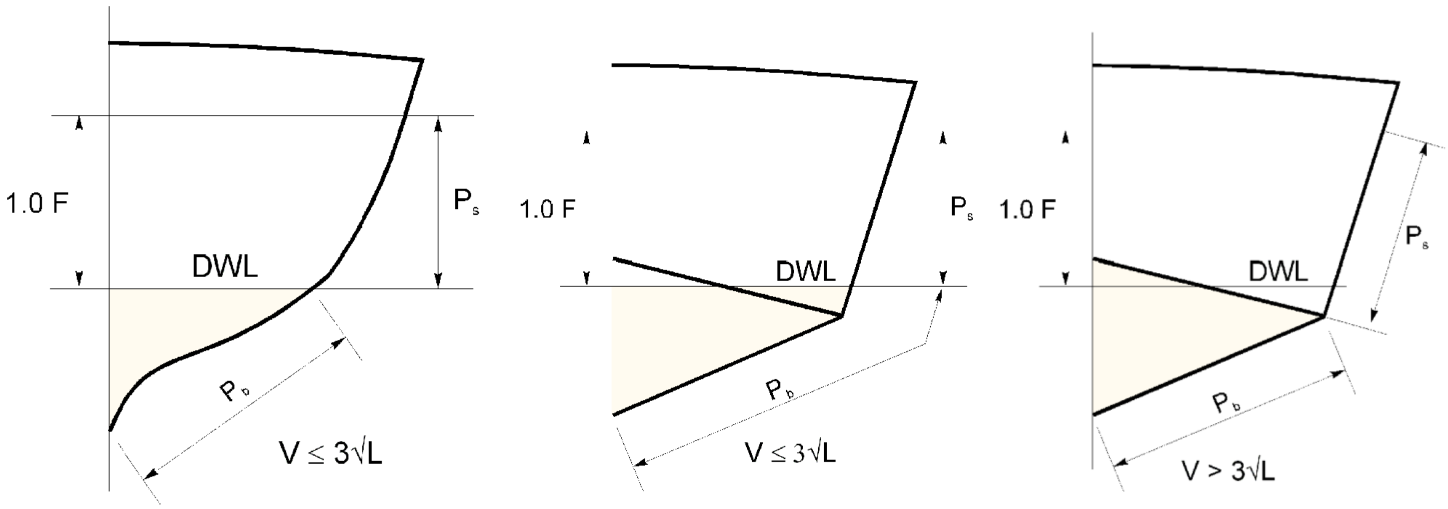

V/√Lh=
1.00
0.90
0.80
0.70
0.60
0.50
> 6
5
4
< 3
k_lb
0
0.25
0.5
0.75
1
x Lh


1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
kβ
L=
3 m
6 m
9 m
12 m
15 m
18 m
21 m
24 m
12
14
16
18
20
22
Deadrise angle amidship


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
k_a
0.001
0.01
0.1
1
A_d/A_r

The vertical extension of the design sea pressure, P_b, shall be as follows:

- up to the deepest w.l. for crafts with $V \leq 3^{\sqrt{L}}$
- up to the chine for crafts with $V > 3^{\sqrt{L}}$



12.3.3 Sea pressure on hull side

The design sea pressure acting on the hull side shall not be taken less than:

$P_s = PF_s \cdot k_{DC} \cdot k_{ls} \cdot k_v \cdot k_a$ (kN/m^2)

PF_s = pressure factor taken from figure below

V = max. speed

k_{DC} = design category factor (Table 12-1)

k_{ls} = longitudinal distribution factor to be taken from the figure below

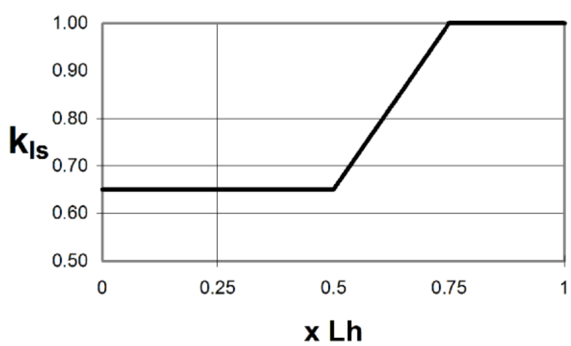
k_v = $\frac{Fv-h}{Fv}$ for vertical distribution factor

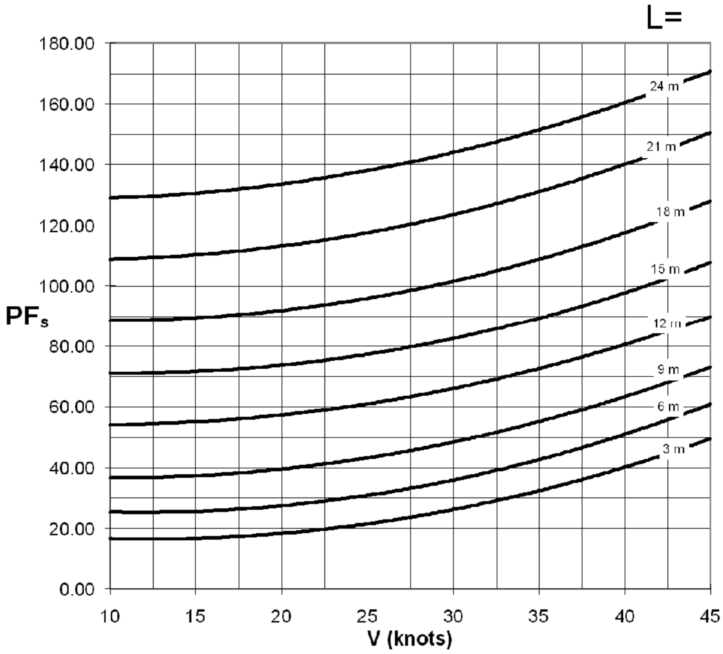
= minimum 0.5 for design category A and B.

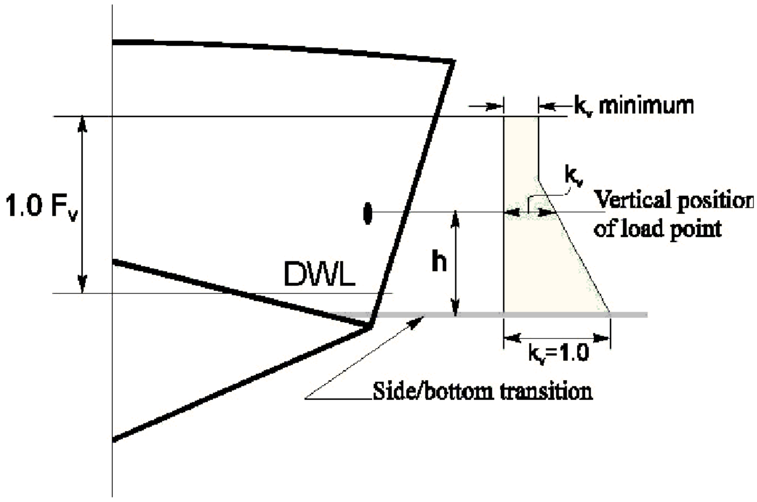
F_v = $\frac{4.5 \cdot \Delta}{100 \cdot L \cdot B}$

h = distance from side/bottom transition to the load point (m).

PF_s, F, h, k_{ls} and k_v are shown on the figures below.







12.3.4 Design loads on decks and superstructures

The design sea pressure acting on decks shall not be taken less than:

P_d = $k_{DC} \cdot k_d \cdot L + 4.5$ (kN/m^2)

k_{DC} = design category factor (Table 12-1)

k_d = 0.2 for exposed main weather deck and superstructure deck forward of 0.25 L from FP

= 0.1 for exposed superstructure decks elsewhere.

The design load for accommodation decks and decks intended for cargo shall be taken as:

$$P_{dc} = 10\mathrm{H}\,(1 + 0.2\frac{\mathrm{V}}{\sqrt{L}})$$

H = deck cargo in t/m^2

= 0.35 t/m^2 for accommodation decks.

The design sea pressure on superstructures and deck houses shall not be taken less than given in Table 12-2:

Table 12-2 – Design sea pressure on superstructure and deck houses

Position	p (kN/m²)
Front bulkhead	0.3 L + 6
Sides and aft bulkhead	0.15 L + 3
Deck house roof, 1st tier	0.1 L + 3
Deck house roof, elsewhere	0.1 L + 1.5

12.3.5 Design loads for bulkheads and tanks

The design load for watertight bulkheads shall not be taken less than:

P_{bh} = $10 \cdot h_b$ (kN/m^2)

h_b = vertical distance in m from load point to top of bulkhead.

The design load for tanks for oil, freshwater, water ballast, etc. shall not be taken less than:

P_t = $10 \cdot h_s + 10$ (kN/m^2)

= $7 \cdot h_t$ (kN/m^2)

= min. 15 (kN/m^2)

h_s = vertical distance in m from the load point to the top of tank

h_p = vertical distance in m from load point to top of air pipe or filling pipe whichever is the greater.

12.3.6 Design loads for waterjets

The interface between the waterjet and the hull shall be designed for the reaction forces in the jet and the design pressure at the location.

12.3.7 Design loads for recreational craft

For **recreational craft** including **charter craft**, as an alternative to or complementing the design loads as laid down in **Section 12,** the design loads can be determined according to ISO 12215 depending on the type of the marine craft: monohull or multihull, motor yacht or sailing yacht, with an overall length between 2.5 m and 24 m.

Monohulls

ISO 12215, Part 5: Design pressure and local loads, for monohulls (motor craft and sailing craft), designed to operate either in displacement mode or in planning mode.

Multihulls

ISO 12215, Part 7: Design pressure, local loads and global loads, including the effect of rig and sail forces, for multihulls (sailing catamarans and sailing trimarans).

Sailing craft appendages

ISO 12215, Part 9: Design stresses, load cases and design loads for keel, centerboard and their attachments and assessment of structural components for sailing craft appendages.

Scantlings of the hull, however, shall be determined to this document, **Section 13** “Aluminium and steel structural design”, **Section 14** “FRP Structural design”, **Section 15** “Thermoplastic structural design” and **Section 16** “Traditional wooden hull design”.

Compliance with these requirements does not eliminate the possibility of damage from accidental overloads, careless handling, trailing loads, chocking loads, grounding or berthing. In some instances, the requirements may come out lower than fabrication requirements such as welding ability and should therefore be increased accordingly.

For craft < 6 m, in particular, robustness criteria may be the governing aspect for scantling determination, e.g., beaching, grounding, trailer and fender loads.

13 ALUMINIUM AND STEEL STRUCTURAL DESIGN

13.1 General

13.1.1 Structural aluminium material

The scantling requirements are based on a correction factor f_1 for material strength. f_1 shall be taken according to the following tables:

Table 13-1 Factor f1 for wrought aluminium alloy sheets, strips and plates, t: 2 mm ≤ t ≤ 40 mm

Designation	Temper	f_1
VL-5052	H32 H34	0.61 0.69
VL-5154A	0, H111	0.35
VL-5754	H24	0.69
VL-5454	H32 H34	0.73 0.79
VL-5086	H116, H32 H34	0.80 0.88
VL-5083	H116, H321	0.89
VL-5383	H116, H34	0.89
Note: For tempers 0 and H111, the factor f_1 is to be taken from Table 13-4.		

Table 13-2 Factor f1 for extruded aluminium alloy profiles, rods and tubes, t: 2 mm ≤ t ≤ 25 mm

Designation	*Temper*	f_1
VL-6060	T5	0.55
VL-6061	T4 T5/T6	0.46 0.76
VL-6063	T5 T6	0.44 0.60
VL-6005A	T5/T6	0.76
VL-6082	T4 T5/T6	0.46 0.90
Note: Table 13-2 only applies when the main loading direction is longitudinal to the extrusion, see also Table 13-3.		

Table 13-3 Factor f1 for extruded aluminium alloy profiles, rods and tubes, t: 2 mm ≤ t ≤ 25 mm, transverse to extruding direction

Designation	Temper	f_1
VL-6060	T5	0.51
VL-6061	T4 T5/T6	0.46 0.71
VL-6005A	T5/T6 6 < t < 10 10 < t < 25	0.76 0.67
VL-6082	T5/T6	0.85

Table 13-4 Factor f1 in the welded condition

Designation	Temper	Filler	f_1
VL-5052	0, H111, H32, H34	5356	0.27
VL-5154A	0, H111	5356-5183	0.35
VL 5754	0, H111, H24	5356-5183	0.33
VL 5454	0, H111, H32, H34	5356-5183	0.35
VL-5086	0, H111, H116, H32, H34	5356-5183	0.42
VL-5083	H116, H321 H116, H321	5356 5183	0.53 0.60
VL-5383	H116, H34	5183	0.64
VL-6060	T5	5356-5183	0.27
VL-6061	T4 T5/T6	5356-5183	0.48 0.48
VL-6063	T5 T6	5356-5183	0.27
VL-6005A	T5/T6	5356-5183	0.48
VL-6082	T4 T5/T6	5356-5183	0.46 0.48

The scantling requirements in this section are based on the properties of aluminium material as fabricated (no deformation hardening) with minimum properties in accordance with the tables below.

Table 13-5 Mechanical properties of wrought aluminium alloy sheets, strips and plates 2 mm ≤ t ≤ 40 mm

Alloy	Temper	Tensile strength (N/mm²)	Yield strength *) (N/mm²)
5052		170	65
5154A		215	85
5754		190	80
5454		215	85
5086		240	95
5083		275	125
5383		290	145

*) Applies to welded condition.

Table 13-6 Mechanical properties for extruded aluminium alloy profiles, rods and tubes 2 mm ≤ t ≤ 25 mm

Alloy	Temper	Tensile strength (N/mm²)	Yield strength (N/mm²)
6060	T5 or T6	190	150
6061	T4 T5 or T6	180 260	110 240
6063	T5 T6	150 205	110 170
6005A	T5 or T6	260	215
6082	T4 T5 or T6	205 310	110 260

Table 13-7 Mechanical properties for closed extruded aluminium alloy profiles, rods and tubes, 2 mm ≤ t ≤ 25 mm, Transverse to extrusion direction

Alloy	Temper	Tensile strength (N/mm^2)	Yield strength (N/mm^2)
6060	T5	175	135
6061	T4 T5 or T6	165 245	110 205
6063	T5 T6	150 205	110 170
6005A	T5 or T6 6 mm < t < 10 mm 10 mm < t < 25 mm	 260 230	 215 195
6082	T5 or T6	290	240

13.1.2 Structural steel

The scantling requirements are based on the correction factor f_1 for material strength. f_1 shall be taken according to the following table:

Table 13-8 Factor f1

Minimum yield strength (N/mm^2)	f_1
235	*1.00*
265	*1.13*
315	*1.34*
355	*1.51*
390	*1.66*

13.2 Structural arrangement

13.2.1 Structural design in general

The marine craft's arrangement shall take into account:

- Continuity of longitudinal strength, including horizontal shear area to carry a strength deck along
- Transverse bulkheads or strong webs
- Web/pillar rings in engine room
- Superstructures and deckhouses
- Direct support
- Transitions
- Deck equipment support
- Multi-deck pillars in line, as practicable
- External attachments, inboard connections

Brackets are to extend to the nearest stiffener, or local plating reinforcement shall be provided at the toe of the bracket.

Generally, connections of outfitting details to the hull shall be such that stress-concentrations are minimized and welding to high stressed parts is avoided as far as possible.

Connections shall be designed with smooth transitions and proper alignment with the hull structure elements. Terminations shall be supported.

Connections to the top flange of girders and stiffeners shall be avoided if not well rounded. Preferably, supporting of outfitting shall be welded to the stiffener web.

The effective span of a stiffener (l) or girder (s) depends on the design of the end connections in relation to adjacent structures. Unless otherwise stated the span points at each end of the member, between which the span is measured, shall be determined as shown on the following figure. It is assumed that brackets are effectively supported by the adjacent structure.

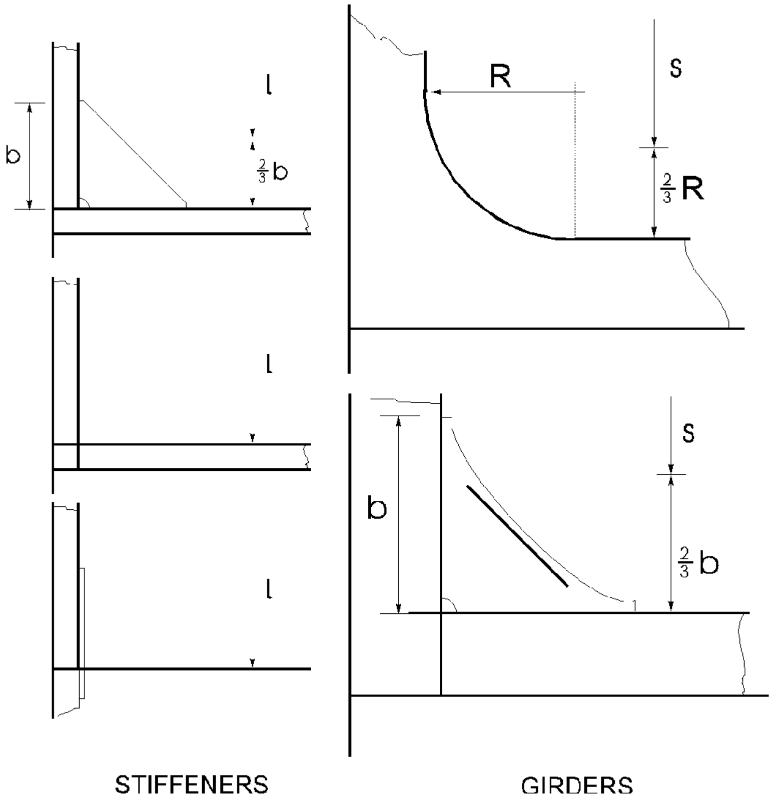


Figure 13-1 Effective span of stiffeners and girders

13.2.2 Global strength

The section modulus of hull girder shall not be less than:

$$Z = 6250\frac{M}{f_1} \quad (mm^3)$$

along the central 25% of the length of the hull girder. Outside the central part, the section modulus may be reduced linearly to zero at the fore and aft end of the craft.

The effective sectional area of continuous longitudinal strength members is in general the net area after deduction of openings.

Superstructures which do not form a strength deck are not to be included in the net section. This applies also to deckhouses and bulwarks.

The effect of openings is assumed to have longitudinal extensions as shown by the shaded areas in the figure below i.e., inside tangents at an angle of 30° to each other.

Example for transverse section III:

BIII = b’ + b’’ + b’’’

For twin hull crafts the effective breadth of wide decks without longitudinal bulkhead support will be considered.

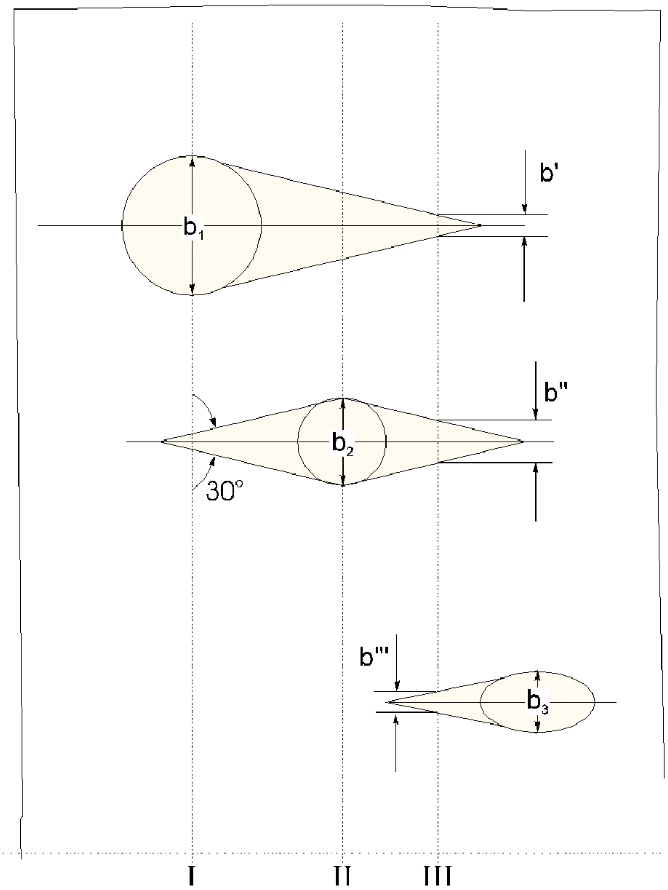


Figure 13-2 Effect of openings

13.2.3 Bottom structures

The bottom structure shall comply with the requirements given in [13.3] and [13.4]. The local strength of the keel shall be sufficient to withstand loads in connection with docking attachment of external ballast keel, etc.

Bottom structures may be longitudinally or transversely stiffened.

In planning craft single bottom as well as double bottoms are normally to be longitudinally stiffened.

The longitudinal shall preferably be continuous through transverse members. If they are to be cut at transverse members, i.e., watertight bulkheads, continuous brackets connecting the ends of the longitudinal shall be fitted or welds shall be dimensioned accordingly.

Longitudinal stiffeners shall be supported by bulkheads and web frames.

Displacement crafts with single bottom and transverse frames shall have floors at each frame. The floors shall be continuous from side to side.

Web frames are to be continuous around the cross-section i.e., floors side webs and deck beams are to be connected. Intermediate floors may be used.

In the engine room, plate floors shall be fitted at every frame. In way of thrust bearings, additional strengthening shall be provided.

Longitudinal girders shall be carried continuously through bulkheads. In craft built in sandwich construction longitudinal girders may be fitted to support the bottom panels.

A center girder shall be fitted for docking purposes if the external keel or bottom shape does not give sufficient strength and stiffness.

Openings shall not be located at ends of girders without due consideration being taken to shear loadings.

Under the main engine, girders extending from the bottom to the top plate of the engine seating shall be fitted.

Engine holding down bolts shall be arranged as near as practicable to floors and longitudinal girders.

In way of thrust bearing and below pillars additional strengthening shall be provided.

Manholes shall be cut in the inner bottom, floors and longitudinal girders to provide access to all parts of the double bottom. The vertical extension of lightening holes shall not exceed one half of the girder height. The edges of the manholes shall be smooth. Manholes in the inner bottom plating shall have reinforcement rings. Manholes shall not be cut in the floors or girders in way of pillars.

In double bottoms with longitudinal stiffening, the floors shall be stiffened at every bottom longitudinal.

In double bottoms with transverse stiffening, longitudinal girders shall be stiffened at every transverse frame.

The longitudinal girders shall be satisfactorily stiffened against buckling.

13.2.4 Side structures

The scantlings of side structures shall comply with the requirements given in Chapters [13.3] and [13.4].

The craft’s sides may be longitudinally or vertically stiffened.

The continuity of longitudinal shall be as required for bottom and deck longitudinal respectively.

Vertical side frames shall normally be connected to floors and deck beams with well-rounded transitions and a continuous flange laminate.

13.2.5 Transom

The scantlings of transom not subject to loads from engine or rudder installations shall comply with the requirements of Chapters [13.3] and [13.4].

The scantlings of trust bearing transom for outboard engine or stern drive mounts will be subject to a case-by-case approval.

13.2.6 Deck structure

The scantlings of deck structures shall comply with the requirements given in Chapters [13.3] and [13.4].

Decks may be longitudinally or transversely stiffened.

Longitudinal shall preferably be continuous through transverse members. If they are to be cut at transverse members, i.e., watertight bulkheads, continuous brackets connecting the ends of the longitudinal shall be fitted.

The plate thickness shall be such that the necessary transverse buckling strength is achieved, or transverse buckling stiffeners may have to be fitted intercostals.

The thickness of bulwark plates shall not be less than required for side plating in a superstructure in the same position.

A strong section shall be continuously welded to the upper edge of the bulwark. Bulwark stays shall be in line with transverse beams or local transverse stiffening. The stays shall have sufficient width at deck level. The deck beam shall be continuously welded to the deck in way of the stay. Bulwarks on forecastle decks shall have stays fitted at every frame.

Stays of increased strength shall be fitted at the ends of bulwark openings. Openings in bulwarks shall not be situated near the ends of superstructures.

Where bulwarks on exposed decks form wells, ample provision shall be made to freeing the decks for water.

13.2.7 Bulkhead structure

The scantlings of bulkhead structures shall comply with the requirements given in Chapters [13.3] and [13.4].

Number and location of transverse watertight bulkheads shall be in accordance with the requirements given for the various craft types.

The stiffening of the upper part of a plane transverse bulkhead shall be such that the necessary transverse buckling strength is achieved.

Longitudinal and transverse bulkheads may be corrugated.

For corrugated bulkheads the following definition of spacing applies (see figure below):

s = s_1 for section modulus calculations
= 1.05 s_2 or 1.05 s_3 for plate thickness calculations.

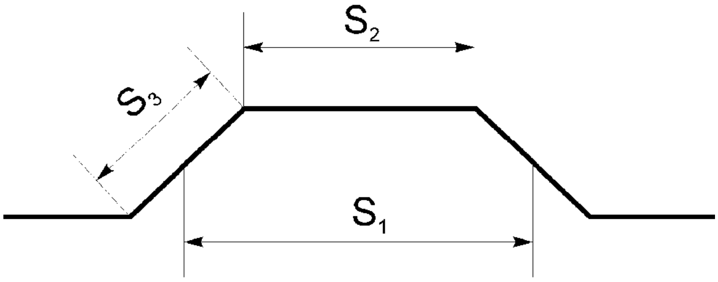


Figure 13-3 Definitions of spacing for corrugated bulkheads

Bulkheads supporting decks shall be regarded as pillars. The compressive loads and buckling strength shall be calculated as indicated in E assuming:

i = radius of gyration in cm of stiffener with adjoining plate. Width of adjoining plate shall be taken as 40·t, where t = plate thickness.

Local buckling strength of adjoining plate and torsional buckling strength of stiffeners shall be checked in accordance with [13.5].

13.2.8 Superstructure and deckhouses

The scantlings of superstructures and deckhouses shall comply with the requirements of Chapters [13.3] and [13.4].

In superstructures and deckhouses, the front bulkhead shall be in line with a transverse bulkhead in the hull below or be supported by a combination of girders and pillars. The after-end bulkhead shall be effectively supported. Exposed sides and internal longitudinal and transverse bulkheads shall be located above girders and frames in the hull structure and shall be in line with the various tiers of accommodation. Where such structural arrangement in line is not possible, there shall be other effective support.

Equally sufficient transverse strength shall be provided by means of transverse bulkheads or girder structures.

At the break of superstructures, which have no set-in from the marine craft's side, the side plating shall extend beyond the ends of the superstructure and shall be gradually reduced in height down to the deck or bulwark. The transition shall be smooth and without local discontinuities. A substantial stiffener shall be fitted at the upper edge of plating. The plating shall be additionally stiffened.

In long deckhouses, openings in the sides shall have well rounded corners. Horizontal stiffeners shall be fitted at the upper and lower edge of large openings for windows.

Openings for doors in the sides shall be substantially stiffened along the edges. The connection area between deckhouse corners and deck plating shall be increased locally.

Deck girders shall be fitted below long deckhouses in line with deckhouse sides.

Deck beams under the front and aft ends of deckhouses shall not be scalloped for a distance of 0.5 m from each side of the deckhouse corners.

For deckhouse side stiffeners the scantlings may not be greater than required for twin deck frames with equivalent end connections.

Casings supporting one or more decks above shall be adequately strengthened.

13.3 Steel and aluminium plating

13.3.1 General

In this section, the general requirements for the local strength of laterally loaded plates are given.

13.3.2 Plate thickness

Plate thicknesses shall be not less than the largest value found from the following formulae:

$t_{min} = t_0 + k \cdot L \cdot \frac{1}{\sqrt{f_1}} + t_c$ (mm)

$t_p = 1.7 \cdot f_p \cdot s \cdot \sqrt{P} + t_c$ (mm)

t_0 and k are given in the Table 13-9 and Table 13-10.

The combined correction factor f_p is given by:

$f_p = \sqrt{\frac{f_2 \cdot f_3}{f_1}}$

f_1 as defined in Chapter 13.1, items [13.1.1] and [13.1.2].

The aspect ratio correction factor f_2 is to be taken as:

f_2 = $(1.1 - 0.25\ s/l)^2$
= maximum 1.0
= minimum 0.72.

The correction factor f_3 for plate curvature is to be taken as:

f_3 = 1 - h/s
= minimum 0.8.

The corrosion allowance is to be taken as:

t_c = corrosion allowance for steel construction as given in Table 13-14. To be taken as equal to zero for aluminium and stainless-steel constructions.

Table 13-9 t0 and k for Aluminium construction

	L < 15 m		*L > 15 m*	
	t_0	k	t_0	k
Hull bottom	*1.5*	$0.23 \cdot k_v$	*4.3*	*0.04*
Hull side	*1.0*	*0.23*	*3.8*	*0.04*
Transom, not supporting engine	*1.0*	*0.23*	*3.8*	*0.04*
Exposed deck, cargo deck	*0.8*	*0.21 + 0.21 H*	*3.7*	*0.03*
Accommodation deck	*0.8*	*0.21*	*3.5*	*0.03*
Superstructure and deckhouses	*0.4*	*0.21*	*3.1*	*0.03*
Structural / watertight bulkheads	*0.4*	*0.21*	*3.1*	*0.03*
Tanks (except freestanding)	*0.4*	*0.23*	*3.1*	*0.05*

Table 13-10 t0 and k for Steel construction

	L < 15 m		*L > 15 m*	
	t_0	k	t_0	k
Hull bottom	*1.0*	$0.23 \cdot k_v \cdot k_d$	*3.8*	*0.04*
Hull side	*0.5*	$0.23 \cdot k_d$	*3.3*	*0.04*
Transom, not supporting engine	*0.5*	*0.23*	*3.3*	*0.04*
Exposed deck, cargo deck	*0.3*	*0.21 + 0.1 H*	*3.2*	*0.03*
Accommodation deck	*0.3*	*0.21*	*3.0*	*0.03*
Superstructure and deckhouses	*0*	*0.21*	*2.7*	*0.03*
Structural / watertight bulkheads	*0*	*0.21*	*2.7*	*0.03*
Tanks (except freestanding)	*0*	*0.23*	*2.7*	*0.05*

$K_v = 0.86 + 0.014 \cdot V$ for decked craft

$K_v = \sqrt{\frac{\Delta}{(12 \cdot L \cdot B)^{1.5}}}$ for open craft

H = deck cargo in (ton/m²)

h and s are defined in the figure below.

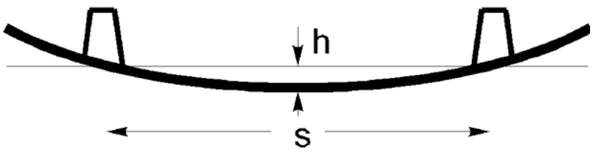


Figure 13-4

13.4 Frames, girders, and stiffeners

13.4.1 General

In this section, the general requirements for the strength of laterally loaded frames, beams, and other stiffeners in steel and aluminium constructions are given.

13.4.2 Section modulus

The section modulus of stiffening members is not to be less than:

$$W = 6.25 \cdot \frac{1}{f_1} \cdot m \cdot P \cdot b \cdot l^2 \cdot 10^{-3} \text{ (cm}^3\text{)}$$

m- values for the most common structural members are found from Table 13-11.

b = load breadth in meters

l = stiffener span in meters

For curved frames see Figures 13-5, 13-6, 13-7 and 13-8.

f_1 as defined in [13.3.2].

For concave frames, the length l which determines the scantlings is given by:

$$l = l_0 - 3 \cdot f + 0.3 \cdot R \text{ meters}$$

l_0 = length in meters of the straight part of the frame at the bottom. When the bilge radius is constant, is measured as shown in Figure 13-5. When the radius varies, is measured as shown in Figure 13-6 below.

R = bilge radius in meters.

For S-shaped frames the length which determines scantlings is measured as shown in the figures below.

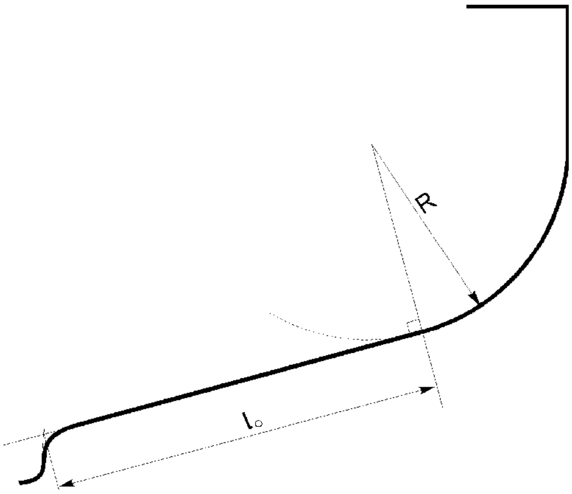


Figure 13-5

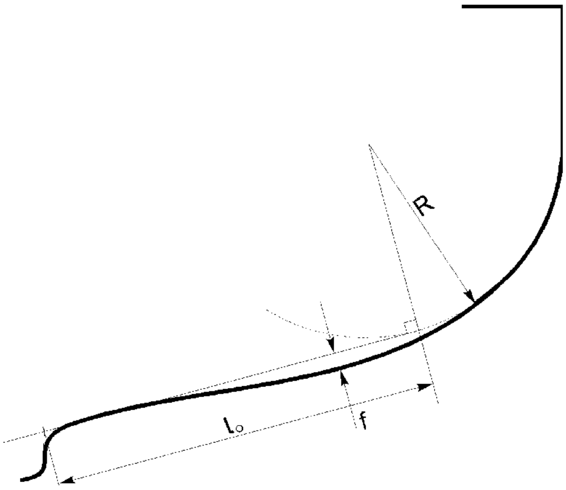


Figure 13-6

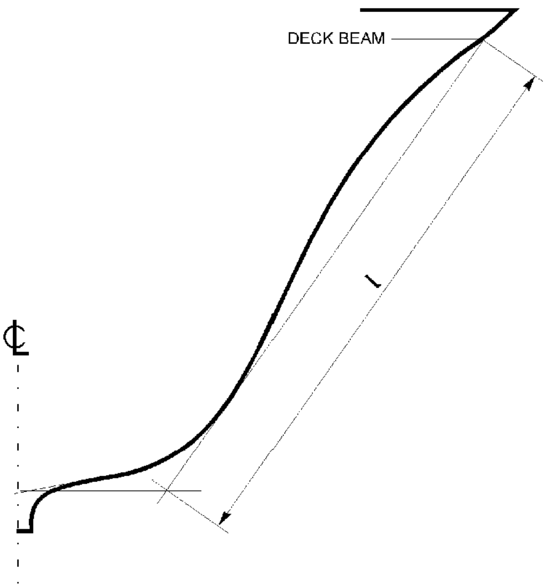


Figure 13-7

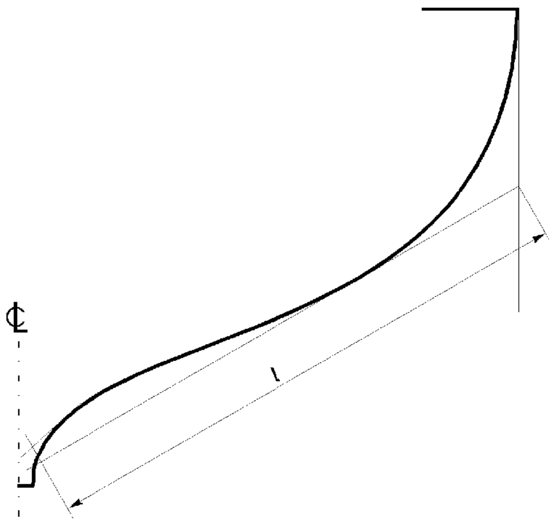


Figure 13-8

The m- values are normally to be taken as follows for the various structural members:

Table 13-11 m-values

Item	m
Continuous longitudinals	85
Non-continuous longitudinals	100
Transverse	100
Vertical members, ends fixed	100
Vertical members, simply supported	135
Bottom longitudinal	85
Bottom transverse	100
Side longitudinal	85
Side vertical	100
Deck longitudinal	85
Deck transverse	100
W.T. bulkhead, fixed ends	65
W.T. bulkhead, fixed one end	85
W.T. bulkhead, simply supported ends	125
Tank and cargo bulkheads, fixed ends	100
Tanks and cargo bulkheads, simply supported ends	135
Deckhouse stiffener	100
Casings	100

The formula given in [13.4.2] is to be regarded as the requirement about an axis parallel to the plating.

As an approximation the requirement to standard section modulus for stiffeners at an oblique angle with the plating may be obtained if the formula in [13.4.1] is multiplied by the factor:

$$\frac{1}{\cos \alpha}$$

α = angle between the stiffener web plane and plane perpendicular to the plating.

For angles α < 15° corrections are normally not necessary.

When several members are equal, the section modulus requirement may be taken as the average requirement for each individual member in the group. However, the requirement for the group is not to be taken less than 90% of the largest individual requirement.

Effective plate flange may normally be taken equal to the stiffener spacing.

The thickness of web and flange is not to be less than:

for flats:
t_{web} = 1/15 × flat depth.
for other sections:
t_{web} = 1/50 × web depth, provided net shear area > 0.075 l_{sp}
t_{flange} = 1/15 × flange width from web.

13.5 Pillars

13.5.1 General

In this section the general requirements to steel pillars supporting structure or equipment are given.

Whenever possible, deck pillars are to be located in line with pillars above or below. Otherwise beams or girders in deck in way will have to be reinforced.

13.5.2 Scantlings

Solid steel or aluminium pillars shall have dimensions according to the table below:

Table 13-12 Solid steel / aluminium pillars

Load (kN) Steel / Aluminium	Pillar length (m)			
	2.0	2.5	3.0	3.5
	Diameter (mm)			
30 / 12	50	53	56	59
40 / 16	53	56	60	64
60 / 24	56	60	65	69
80 / 32	59	64	69	73
100 / 40	62	68	73	78
130 / 52	65	71	77	82
160 / 64	68	75	81	86
200 / 80	71	78	84	90
240 / 96	74	81	88	94

Table 13-12 Solid steel / aluminium pillars (continued)

Load (kN) Steel / Aluminium	**Pillar length (m)**			
	2.0	**2.5**	**3.0**	**3.5**
	Diameter (mm)			
290 / 116	77	84	91	98
340 / 136	80	88	95	102
400 / 160	83	91	99	106

Tubular pillars shall have dimensions according to the table below, based on the scantlings of solid pillars:

Table 13-13 Tubular pillars

Diameter of equiv. solid pillar (mm)	Pillar length (m)			
	2.0	2.5	3.0	3.5
50	70 × 6.0	70 × 6.0	70 × 6.0	
55	70 × 6.0	70 × 6.0	70 × 6.0	
60	80 × 6.5	75 × 6.0	75 × 6.0	75 × 6.0
65	90 × 6.5	80 × 6.5	80 × 6.5	80 × 6.0
70	100 × 7.0	90 × 6.5	90 × 6.5	89 × 6.5
75	115 × 7.0	110 × 6.5	110 × 6.5	100 × 6.5
80	130 × 7.5	120 × 7.0	115 × 7.0	105 × 6.5
85	145 × 8.0	130 × 7.5	125 × 7.0	115 × 7.0
90	160 × 8.5	145 × 8.0	135 × 7.5	125 × 7.0

Table 13-14 Corrosion allowance tC for aluminium and steel material

Carbon steel	**Stainless steel**	**Aluminium**	
0.5 mm	zero	zero	in general
0.7 mm	zero	zero	for lubrication oil tanks, gas oil tanks or equivalent
1.0 mm	zero	zero	for ballast water tanks, sewage tanks, sea chests
1.0 mm	zero	zero	for deck plating below elastically mounted deckhouse
2.0 mm	zero	zero	for chain locker, stern tube

14 FRP STRUCTURAL DESIGN

14.1 General

14.1.1 Application

Requirements in this section apply to fibre-reinforced plastic (FRP) single skin and sandwich constructions.

Additional or modified requirements may be given in association with the various type and service notations.

Alternative scantling determination methods may be accepted upon consideration in each individual case.

14.1.2 Assumptions

A single skin construction is considered to be a structure consisting of a FRP shell laminate supported and stiffened locally by a system of closely spaced FRP stiffeners.

A sandwich construction is considered to be structural element consisting of three components: A FRP skin laminate on each side of a low-density sandwich core. It is assumed that the properties and the proportions of the component materials are such that in case a sandwich panel is exposed to a lateral load the bending moments are carried by the skins and the shear forces by the sandwich core. The condition for compliance with this assumption is given in Chapter [14.4] "Sandwich constructions". It is further assumed that an efficient bond between skins and sandwich core is obtained.

14.1.3 Definitions

The following symbols are applied:

σ_{nu} = breaking strength of FRP laminate in tension or compression in MPa

E_n = modulus of elasticity of FRP laminate in tension or compression in MPa

σ_{bu} = breaking strength in bending of FRP laminate in MPa

E_b = modulus of elasticity in bending of FRP laminate in MPa

τ_u = breaking strength in shear of sandwich core material in MPa

f_n = $\frac{80}{\sigma_{nu}}$ correction factors for strength

f_b = $\frac{130}{\sigma_{bu}}$ correction factors for strength, bending

t = laminate thickness in mm, either for a single skin plate or a sandwich skin laminate

s = shortest panel edge for single skin and sandwich panels

b = load breadth for stiffening members in meters

l = span length of stiffening members in meters

14.1.4 Calculation methods

To determine stresses and deflections in FRP single skin and sandwich constructions either direct calculations using the full stiffness and strength properties of the laminate in all directions or a simplified method in accordance with [14.3] "Single skin construction", [14.4] "Sandwich constructions" and [14.5] "Frames, girders, stiffeners" will be accepted.

The simplified method may be employed on the following conditions:

- the principal directions of the laminate reinforcement are parallel to the panel edges
- the difference in elastic modulus in the two principal directions is not more than 20%
- the skin laminates of sandwich panels are thin, i.e., d/t > 5.77.

Direct calculations based on the full strength and stiffness properties in all directions shall be carried out in accordance with the procedures recognized by the Department.

14.1.5 Structural design in general

Attention is drawn to the importance of structural continuity in general.

The structural arrangement shall take into account:

- Continuity of longitudinal strength, including horizontal shear area to carry a strength deck along transverse bulkheads or strong webs
- Web/pillar rings in engine room
- Twin hull connections
- Superstructures and deckhouses:
- Direct support
- Transitions
- Deck equipment support
- Multi-deck pillars in line whenever possible
- External attachments, inboard connections

Corners and dimensional transitions shall be well rounded to avoid stress concentrations.

Tensile loads perpendicular to the plan of the laminate should be avoided.

Thickness differences in laminates should be tapered over a length of at least 20 × thickness difference.

Overlap between layers of reinforcement shall be such that the in-plane shear strength of the joint is at least equal to the axial strength of the reinforcement. for most standard reinforcements this is achieved with an overlap of 40 mm.

In bolt and rivet connections the distance from the laminate edge to the center of the hole shall be 3.0 × and 2.5 × hole diameter respectively.

Distance between rivets shall be at least 2.5 × hole diameter and for bolts at least 3.0 × hole diameter. Bolts and rivets shall normally be fitted with washers with a diameter of 2.0 × hole diameter in both ends.

14.1.6 Materials

Structural materials shall be approved by an approved organization.

14.1.7 Mechanical properties of laminate

The requirements for structural laminates are based on the following minimum mechanical properties:

- Tensile strength, σ_{nu} = 80 MPa
- Tensile modulus, E_n = 7000 MPa
- Bending strength, σ_{bu} = 130 Mpa
- Bending modulus, E_b = 6000 Mpa.

The mechanical properties used for the scantling determination shall normally be derived from tests, these tests are to be conducted in accordance with the International Standards given below.

The test specimen shall be representative of the product as manufactured.

The mean value of the results from the tests shall comply with the requirements for minimum mechanical properties as stated above. No single value shall be less than 80% of the value used as basis for determination of scantlings.

The mechanical properties used in the calculations shall be:

- For strength, 90% of the mean ultimate strength
- For elastic modulus, the mean value.

The fibre content by mass shall be at least 27% measured in accordance with ISO 1172. All individual test result values are to comply with the specified requirements.

Tensile strength, σ_n , and modulus, E_n , is determined in accordance with ISO 527. The test specimens should be taken in both directions.

Flexural strength, σ_b , and modulus, E_b , is determined in accordance with ISO 178. The test specimens should be taken in both directions.

14.1.8 Mechanical properties of sandwich core material

For hull structural applications core material of Grade 1 is required. For other applications core material of Grade 2 may be accepted.

It shall be verified by shear testing in accordance with ISO 1922 or ASTM C 273 that the bonds between skin and core and between individual core elements have at least the same shear strength as specified for the core material in question.

The shear strength and modulus of core materials are to be specified and verified by testing in accordance with the above standards.

It shall be verified by four-point sandwich beam bending tests in accordance with ASTM C 393 that the applied sandwich adhesive does not crack or de-bond at a lower load level than the core materials itself.

The testing is normally to be carried out at 20°C, if considered necessary the testing may be required to be carried out at other operating temperatures.

14.1.9 Global strength

The section modulus of the hull girder shall not be less than:

$Z = 38\,000 \cdot f_n \cdot M \ (mm^3)$

along the central 25% of the length of the hull girder. Outside the central part, the section modulus may be reduced linearly to zero at the fore end and aft end of the craft.

When calculating the moment of inertia and section modulus of the mid marine craft section, the effective sectional area of continuous longitudinal strength members is in general the net area after deduction of openings.

Superstructures which do not form a strength deck are not to be included in the net section. This applies also to deckhouses and bulwarks.

The effect of openings is assumed to have longitudinal extensions as shown by the shaded areas in Figure 14-1 below i.e. inside tangents at an angle of 30° to each other. Example for transverse section III:

$b_{III} = b' + b'' + b'''$

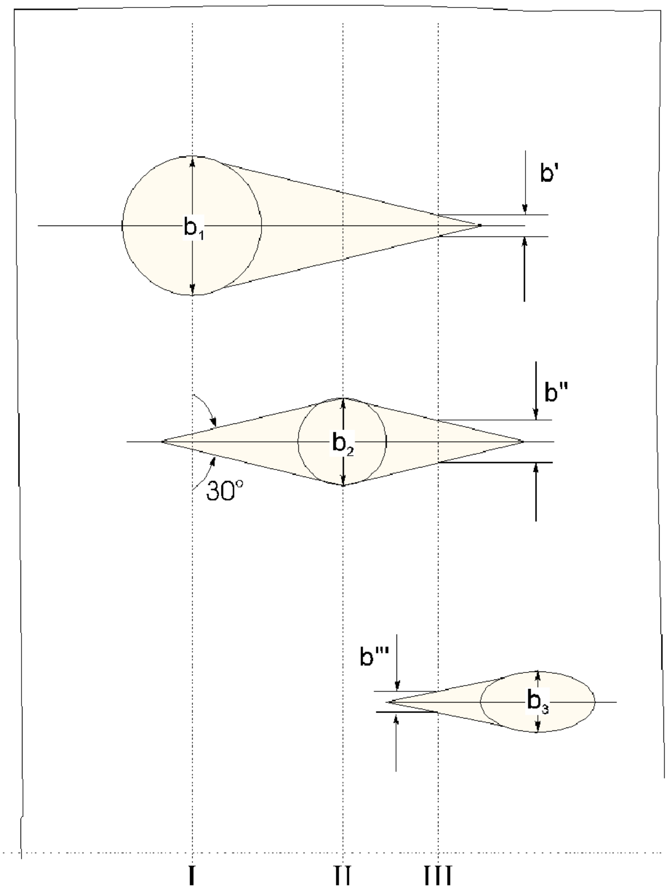


Figure 14-1 Effect of openings

For twin hull crafts the effective breadth of wide decks without longitudinal bulkhead support will be considered.

14.2 Structural arrangement

14.2.1 Bottom structure

The bottom single skin or sandwich panels shall comply with the requirements given in [14.3] “Single skin construction” and [14.4] “Sandwich construction”. The local strength of the keel shall be sufficient to withstand loads in connection with docking attachment of external ballast keel and other loads.

Bottom structures may be longitudinally or transversely stiffened.

In planning craft single bottom as well as double bottoms shall normally be longitudinally stiffened in single skin constructions. In craft with sandwich construction transverse stiffening may be accepted.

The longitudinal should preferably be continuous through transverse members. At their ends longitudinal are to be fitted with brackets or to be tapered out beyond the point of support.

Longitudinal stiffeners are to be supported by bulkheads and/or web frames.

Displacement crafts with single bottom and transverse frames shall have floors at each frame. The floors shall be continuous from side to side. The scantlings of the floors may be taken in accordance with Table 14-1 “Thrust bearing transom”. The table values are applicable when the distance between transverse bulkheads or other equivalent support for the longitudinal girders does not exceed the breadth of the craft. If the girder span is greater than the breadth of the craft, the floors web plate height and flange area shall be increased as stated in the table's note. Alternatively, the scantlings of the floors shall be established in accordance with subsection [14.5] “Frames, girders, stiffeners”.

Longitudinal girders are to be carried continuously through bulkheads. In craft built in sandwich construction longitudinal girders may be fitted to support the bottom panels.

A center girder is to be fitted for docking purposes if the external keel or bottom shape does not give sufficient strength and stiffness.

Openings should not be located at ends of girders without due consideration being taken to shear loadings.

The scantlings of longitudinal girders may be taken in accordance with Table 14-2 “Floors in single bottom” or alternatively according to [14.5] “Frames, girders, stiffeners”.

Main engines are to be supported by longitudinal girders with suitable local reinforcement to take the engine and gear mounting bolts. Rigid sandwich core materials to be applied in all through bolt connections.

Web frames are to be continuous around the cross section of the craft, i.e., web- and flange laminates of floors, side webs and deck beams are to be efficiently connected together. If intermediate floors are fitted, their ends should be well tapered or connected to local panel stiffening.

In the engine room, floors are to be fitted at every frame. The floors are preferably to be carried continuously through the engine girders. In way of thrust bearings additional strengthening must be provided.

In double bottoms manholes are to be made in the inner bottom, floors and longitudinal girders to provide access to all parts of the double bottom. The vertical extension of openings shall not exceed one half of the girder height. Exposed edges of openings in sandwich constructions shall be sealed with resin impregnated mat. All openings shall have well rounded corners.

Crafts built in sandwich construction and following the equation:

$$\frac{\mathrm{V}}{\sqrt{\mathrm{L}}} > 4.5$$

shall have the fore stem designed so that a local impact at or below the waterline will not result in skin laminate peeling due to hydraulic pressure. The vertical extension of the collision protection shall be from the keel to a point 0.03 L (m) above the waterline at maximum operating speed.

14.2.2 Side structure

The hull sides may be longitudinally or vertically stiffened. The continuity of longitudinal is to be as required for bottom and deck longitudinal respectively.

The single skin or sandwich panels of the hull sides shall comply with the requirements of subsections [14.3] “Single skin construction” and [14.4] “Sandwich constructions”).

Vertical side frames shall normally be connected to floors and deck beams with well-rounded transitions and a continuous flange laminate.

14.2.3 Transom structure

The scantlings of transom not subjected to loads from engine or rudder installations shall comply with the requirements of [14.3] “Single skin construction” and [14.4] “Sandwich constructions”.

Trust bearing transom for outboard engine or stern drive mounting is preferable to be built as a sandwich panel with a sandwich core of waterproof plywood or equivalent material. The thickness of the transom for engine power specified by the manufacturer, should not be less than given in the following table:

Table 14-1 Thrust bearing transom

Engine power(kW)	*Total thickness of transom (mm)*	
	Outboard mounting	*Stern drive mounting*
< 3	*12*	*17*
3 - 7	*15*	*20*
7 - 18	*25*	*30*
18 – 30	*30*	*35*
30 – 60	*35*	*40*
60 – 95	*40*	*45*
> 95	*Scantlings to be specially considered in each individual case.*	

The inner laminate on the sandwich core is normally to have a thickness not less than 0.7 times the thickness of the side laminate, and the outer laminate a thickness not less than 0.7 of the bottom laminate. The inner laminate shall extend forward along the sides and the bottom of the marine craft and shall be gradually tapered in thickness.

14.2.4 Deck structure

Decks may be longitudinally or transversely stiffened.

Deck panels of single skin or sandwich construction shall comply with the requirements of [14.3] “Single skin construction” and [14.4] “Sandwich constructions”.

Longitudinal should preferably be continuous through transverse members. At their ends, longitudinal are to be fitted with brackets or be tapered out beyond the point of support.

Bulwark sides are considered to be a part of the hull side and shall have scantlings accordingly. A strong flange is to be made along the upper edge of the bulwark. Bulwark stays are to be arranged in line with transverse beams or local stiffening. The stays are to have sufficient width at deck level. If the deck is of sandwich construction, solid sandwich core inserts are to be fitted at the foot of the bulwark stays. Stays of increased strength are to be fitted at the ends of bulwark openings. Openings in bulwarks should not be situated near the ends of superstructures.

14.2.5 Bulkhead structure

The scantlings of bulkhead structures shall comply with the requirements of [14.3] “Single skin construction” and [14.4] “Sandwich constructions”.

Number and location of transverse watertight bulkheads are to be in accordance with the requirements given for the various craft types specified in Section 7 “Arrangement”.

Bulkheads supporting decks are to be regarded as pillars. The buckling strength will be considered in each individual case.

14.2.6 Superstructures and deckhouses

The scantlings of superstructures and deckhouses shall comply with the requirements of [14.3] “Single skin construction” and [14.4] “Sandwich construction”.

Superstructure is defined as a decked structure on the freeboard deck, extending from side to side of the marine craft with the side plating not inboard of the shell plating more than 4% of the breadth (B).

Deckhouse is defined as a decked structure above the strength deck with the side plating being inboard of the shell plating more than 4% of the breadth (B).

Long deckhouse - deckhouse having more than 0.2 L, of its length within 0.4 L amidships.

Short deckhouse - deckhouse not defined as a long deckhouse.

In superstructures and deckhouses, the front bulkhead is to be in line with a transverse bulkhead in the hull below or be supported by a combination of girders and pillars. The after-end bulkhead is also to be effectively supported. As far as practicable, exposed sides and internal longitudinal and transverse bulkheads are to be located above girders and frames in the hull structure and are to be in line in the various tiers of accommodation.

Sufficient transverse strength shall be provided by means of transverse bulkheads or girder structures.

At the break of superstructures, which have not set in from the marine craft's side, the side plating is to extend beyond the ends of the superstructure and be gradually reduced in height down to the deck or bulwark. The transition shall be smooth and without local discontinuities.

In long deckhouses, openings in the sides shall have well rounded corners. In deckhouses of single skin construction horizontal stiffeners shall be fitted along the upper and lower edge of large openings for windows. Openings for doors in the sides shall be substantially stiffened along the edges.

Casings supporting one or more decks above shall be adequately strengthened.

Table 14-2 Floors in single bottom

	Height of floor at marine craft's centerline × web-thickness (mm × mm) Flange area (cm^2)				
B·d	**2**	**3**	**4**	**5**	**6**
0.5	120 × 6 1.5	150 × 6 2			
1.0	120 × 7 2	170 × 7 2	230 × 7 4		
1.5	140 × 8 3	190 × 8 3.5	250 × 8 5	295 × 8.7 9	
2.0		210 × 9.7 4	270 × 9.5 6	320 × 10.5 10	345 × 12.3 14
2.5		230 × 11 5	290 × 11 7.5	340 × 12 11.0	375 × 13.5 15
3.0			310 × 12 9	360 × 13.5 12	400 × 15 16
3.5				385 × 14.8 13	425 × 16.5 17.5
	Basic frame spacing s in mm				
	350	350	350	360	380
B = breadth of marine craft in meters *d = draught in meters to lower side of bottom laminate (measured at centerline).*					

Guidance note:

Notes to Table 14-2:

1) For frame spacings differing from those indicated in the table, the table values for web thickness and flange area are corrected in proportion to the frame spacings.
2) In marine crafts with rise of floor amidships greater than half the rule height of the floor, the flange area may be reduced by 40 H/d%.

   H/d = rise of floor amidships/draught to lower side of bottom laminate at center.
3) When the span l_s of center girder is greater than the breadth B of the marine craft, the table values for flange area and web thickness of floors are multiplied by a factor f_1 taken from the following table.

l_s/B	1.10	1.25	1.50	2.00
f_1	1.13	1.25	1.37	1.50

4) Web thickness ts is measured as shown in the sketch.

Table 14-3 Longitudinal bottom girders

	Flange area in cm² / web thickness in mm				
B·d	**2.5**	**3**	**4**	**5**	**6**
0.5	3.0 / 6.0	3.0 / 5.0			
1.0	3.5 / 6.0	3.6 / 8.3	8.0 / 10.0		
1.5	5.0 / 8.0	5.0 / 11.0	11.9 / 12.2	18.0 / 13.0	
2.0		6.1 / 13.3	14.0 / 15.0	23.0 / 15.2	35.0 / 16.3
2.5		7.0 / 15.2	15.5 / 17.5	27.0 / 18.0	41.0 / 18.7
3.0			18.4 / 19.6	31.0 / 20.4	46.0 / 21.0
3.5				35.0 / 22.3	51.0 / 23.0
B = breadth of marine craft in meters *d = draught in meters to lower side of bottom laminate (measured at centerline).*					

Guidance note:

For girder spans greater than marine craft's breadth, the table values for flange area and web thickness of the girder are multiplied by the factor f_1 given in note 3) to Table 14-2.

Side Girders

Marine craft's breadth B in meters	*4*	*5*	*6*
f_2	*0.40*	*0.47*	*0.50*

For side girders:

Flange area = f_2 × flange area of center girder

Web thickness = 0.9 × web thickness of center girder.

14.3 Single skin construction

14.3.1 General

In this section, the general requirements for the local strength of stiffened single skin constructions are given.

Buckling strength of single skin panels subjected to longitudinal hull girder or local compression loads will be individually considered.

14.3.2 Laminate thickness

The thickness of structural laminates, excluding topcoat and gelcoat, shall not be less than the largest value found from the following formulas:

$t_{l\,min} = (t_0 + k \cdot L) \cdot \sqrt{f_b}$ (mm)

$t_p = k_p \cdot f_p \cdot s \cdot \sqrt{P}$ (mm)

t_0 and k are given in Table 14-4.

k_p = 3.82 for bottom panels
= 4.73 for side panels
= 4.11 for panels elsewhere and for all stiffening members.

f_p ist taken from the formula below; f_b, s and P are given in [14.1.3] "Definitions".

Table 14-4 Laminate thickness

	L < 15 m		L > 15 m	
	t_0	k	t_0	k
Hull bottom	2.5	$0.5 \cdot k_v$	8.6	0.17
Hull side	2.0	0.58	8.1	0.17
Transom, not supporting engine	2.0	0.58	8.1	0.17
Exposed deck	1.7	0.42	6.8	0.08
Cargo deck	1.7 + H	0.42	7.3	0.08
Accommodation deck	1.7	0.42	6.8	0.08
Superstructure and deckhouses	1.7	0.42	6.8	0.08
Structural / watertight bulkheads	1.1	0.42	6.2	0.08
Tanks (except freestanding)	1.1	0.45	6.2	0.11

K_v = $0.86 + 0.014 \cdot V$
H = deck cargo in ton/m²

The combined correction factor, fp, is given by:

$$f_p = f_{p1} \cdot f_{p2} \cdot \sqrt{f_b}$$

The aspect ratio correction, f_{p1}, is to be taken from the diagram below:

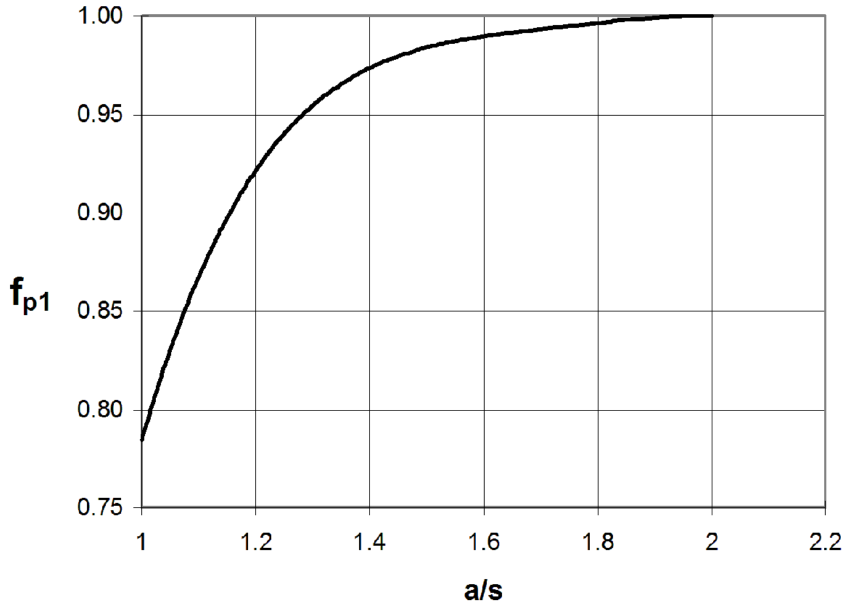


Figure 14-2 Aspect ratio correction fp1

a and s are the longest and shortest panel edge respectively.

The panel curvature correction, f_{p2}, is to be taken as:

f_{p2} = 1 - h/s

$f_{p2\ min}$ = 0.8.

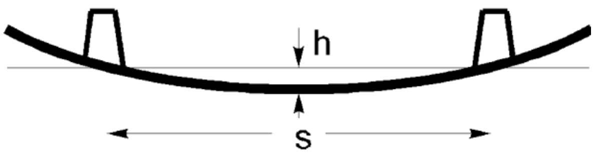


Figure 14-3 Panel curvature correction fp2

Reduced thicknesses may be accepted provided equivalent impact resistance can be documented.

14.3.3 Local laminate reinforcement

The structural laminates shall locally be reinforced to a thickness not less than:

$t_{l\ min} = (t_0 + k \cdot L) \cdot \sqrt{f_b}$ (mm)

t_0 and k are given in the following table:

Table 14-5 Laminat reinforcement

	L < 15 m		***L > 15 m***	
	t_0	k	t_0	k
Keel type 1 and 2	2.9	$0.9 \cdot k_v$	14.5	0.14
Keel type 3	3.5	$1.1 \cdot k_v$	17.5	0.17
Fore and aft stem	2.9	0.9	14.5	0.14
Chine and transom corners *)	2.4	$0.7 \cdot k_v$	12.0	0.11

Bottom laminate in way of rudder stock, shaft brackets, etc.	3.5	$1.1 \cdot k_v$	17.5	0.17
*) *Breadth to each side shall be min. 25 B (mm), but not less than 100 mm*				

Extension of keel laminate is shown below.

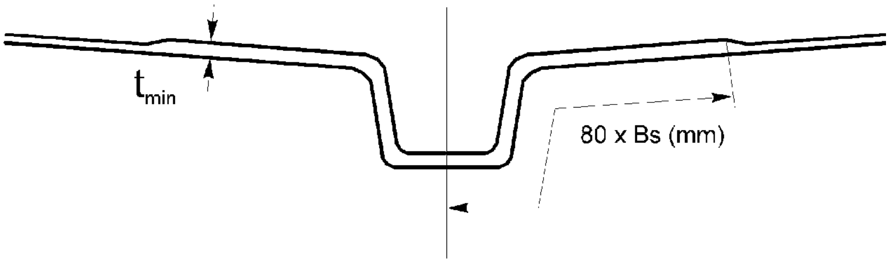


Figure 14-4 Keel type 1

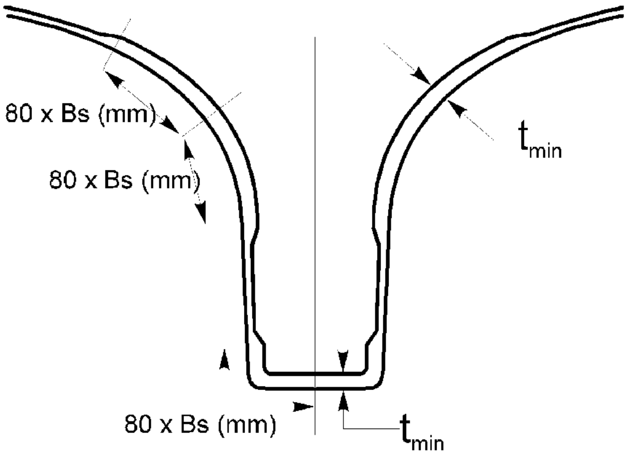


Figure 14-5 Keel type 2

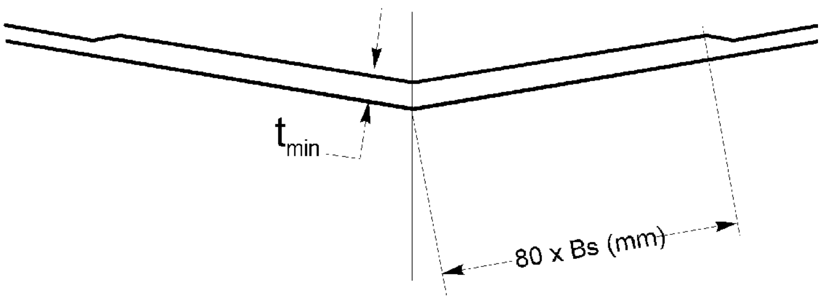


Figure 14-6 Keel type 3

14.4 Sandwich construction

14.4.1 General

In this section the general requirements for the local strength of sandwich constructions are given.

Buckling strength of sandwich constructions subjected to longitudinal hull girder or local compression loads will be individually considered.

14.4.2 Panel requirements

The thickness of skin laminates of sandwich panels shall not be less than:

$t_{s\,min} = \frac{k\, t_{l\,min}}{f_c}$ (mm)

$t_{l\,min}$ = minimum thickness found from [14.3.2]

f_c = $0.94 + 0.12 \cdot \sigma_c$

σ_c = compressive strength of the core material in MPa.

k is found from the Table 14-6 below.

Table 14-6 Panel requirements

Structural members	k	
	Exposed 1)	Protected 2)
Hull bottom	0.40	0.30
Hull side and transom *)	0.42	0.31
Cargo deck	0.63	0.48
Exposed deck	0.63	0.48
Accommodation deck	0.40	0.30
Superstructures and deckhouses	0.40	0.30
Structural / watertight bulkheads	0.40	0.30

1) The term exposed means a side of a panel which is subject to permanent liquid submergence or which can be exposed to local mechanical abrasive or impact loads.

2) The term protected means a side of a pane which is not subject to loads as described above.

**) Transom, not thrust bearing*

The section modulus and moment of inertia of a 1 cm wide panel strip shall be not less than:

$W = 0.04 \cdot f_w \cdot P \cdot s^2$ (cm³)

$f_w = f_{w1} \cdot f_n$

$I = 0.0364 \cdot f_i \cdot p \cdot s^3$ (cm⁴)

$f_i = f_{i1} \cdot f_{i2} \cdot f_{i3}$

The correction factors for panel aspect ratio, fw1, and fi1, are found from the diagram below:

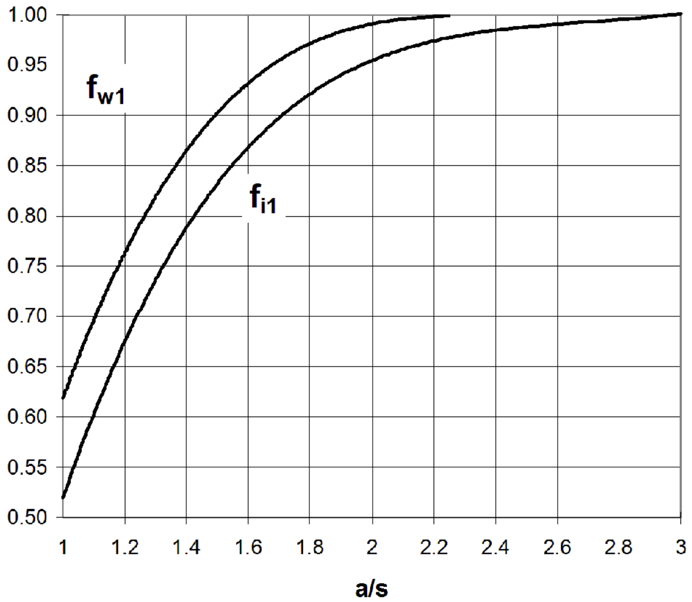


Figure 14-7 Correction factor

a and s: longest and shortest panel side, respectively.

The correction factor for laminate strength, f_n, is given in [14.1.3].

The correction factor for laminate stiffness, f_{i2}, shall be taken as:

$f_{i2} = \frac{7000}{E_n}$

The stiffness factor, f_{i3}, shall be taken as:

f_{i3} = 1.0 for decks and floor panels
= 0.5 elsewhere.

If the stiffness of the panel is increased due to curvature, a lower moment of inertia may be accepted.

W and I properties for panels with skin laminates of equal thicknesses are given below.

The shear strength of the core material shall be not less than:

$\tau_u = \frac{1.5\, f_{T1}\ P_s}{d}$ (MPa)

For core materials in bottom panels of planning craft documentation of dynamic properties of the material may be required.

The shear strength of bottom panels shall not be less than: 0.04 V (MPa), minimum 0.7 MPa.

The shear strength of other panels shall not be less than: 0.4 MPa.

The thickness of the core shall not be less than 10 · s (mm).

d = panel thickness in (mm) measured as the distance between the centerline of the laminates, as shown in [18.4.2.5].

The correction factor for panel aspect ratio, f_{T1}, is found from the diagram below.

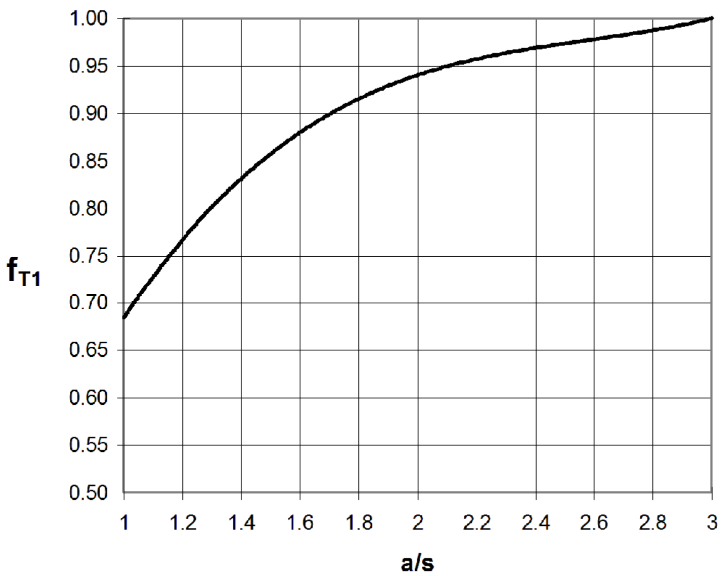
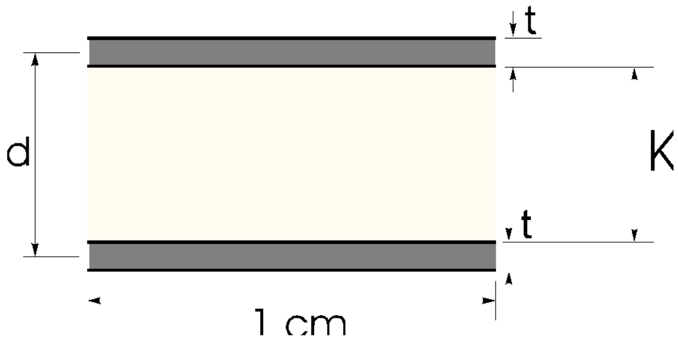


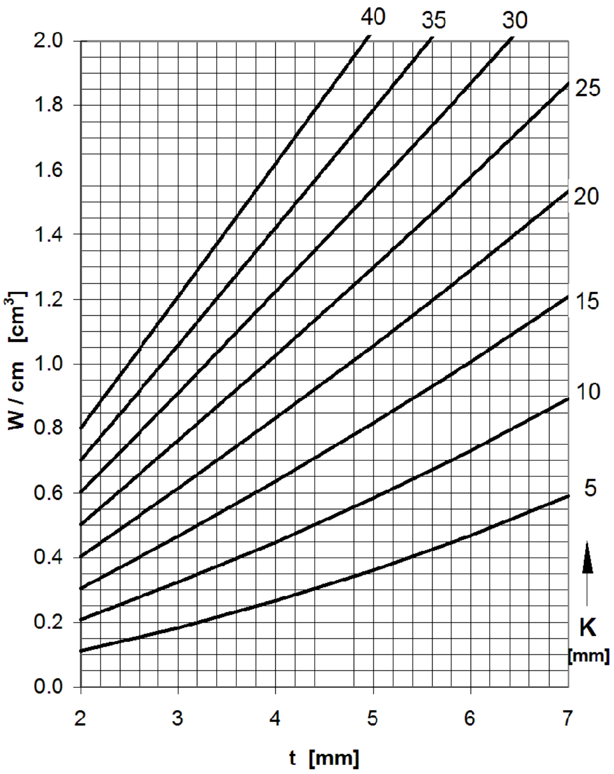
Figure 14-8 Correction factor for panel aspect ratio

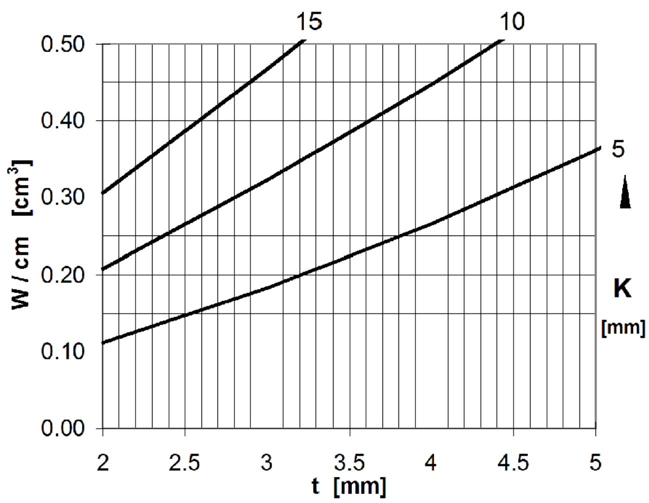
a and s: longest and shortest panel side, respectively.

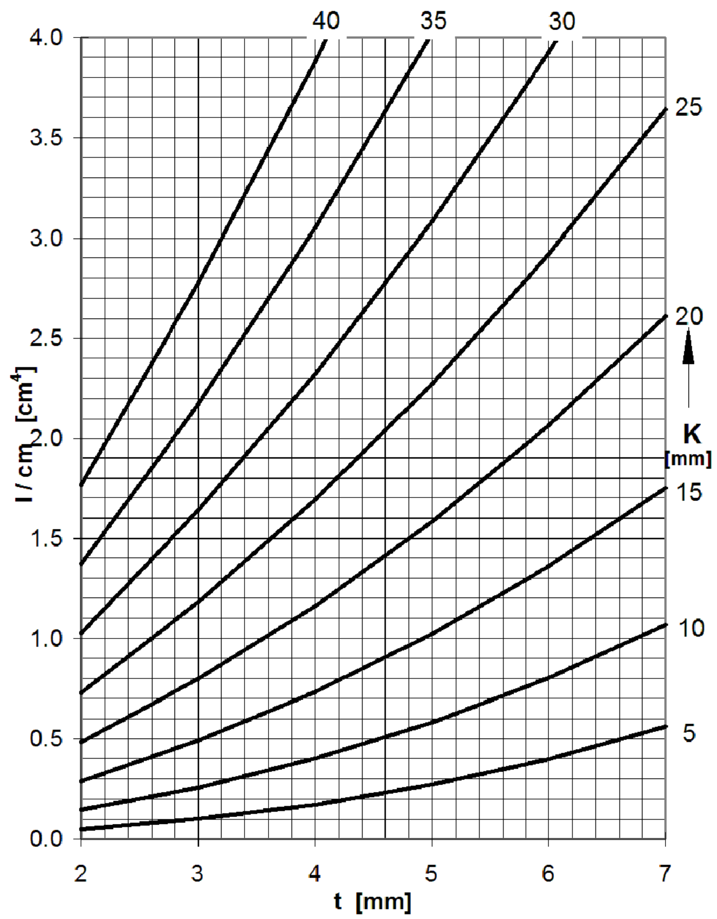
Reduced thicknesses may be accepted provided equivalent impact resistance can be documented.

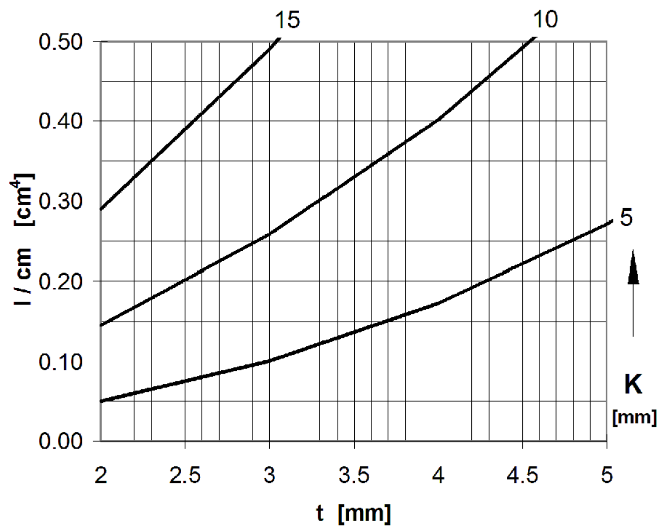
Section modulus (W) and moment of inertia (I) of a 1 cm wide sandwich panel with skin laminate of equal thickness, are given in the figures below as a function of core thickness K and skin laminate thickness t.


t
d
K
t
1 cm


40
35
30
25
20
15
10
5
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
W / cm [cm³]
K
[mm]
2
3
4
5
6
7
t [mm]


15
10
5
0.50
0.40
0.30
0.20
0.10
0.00
W / cm [cm³]
K
[mm]
2
2.5
3
3.5
4
4.5
5
t [mm]





14.4.3 Local panel reinforcements

The sandwich panel skin laminates shall locally be reinforced to a thickness not less than:

$t_{s\,min} = \frac{k\, t_{1min}}{f_c}$ (mm)

$t_{1\,min}$ = minimum thickness according to [14.3.2] "Laminate thickness".

f_c = $0.94 + 0.12 \cdot \sigma_c$

where σ_c is compressive strength of the core material in MPa.

k is found from the table below:

Table 14-7 Local panel reinforcements

Item	k	
	Exposed [1)]	Protected [2)]
Keel type 1 and 2	0.4	0.3
Keel type 3	0.6	0.3
Fore and aft stem	0.4	0.3
Chine and transom corners [*)]	0.4	0.3
Bottom laminate in way of rudder stock, shaft brackets, etc.	0.4	0.3

[1)] *The term exposed means a side of a panel which is subject to permanent liquid submergence or which can be exposed to local mechanical abrasive or impact loads.*

[2)] *The term protected means a side of a pane which is not subject to loads as described above.*

[*)] *Breadth to each side shall be min. 25 B (mm), but not less than 100 mm.*

14.5 Frames, girders and stiffeners

14.5.1 General

In this section, the general requirements for the strength of laterally loaded frames, beams and other stiffeners in single skin and sandwich constructions are given.

Stiffening profiles are normally to be attached to the base panel by secondary bonding.

Where continuous stiffening profiles of the same height and built with a weak sandwich core material, are crossing each other, additional load bearing core inserts may be required to provide sufficient shear strength.

14.5.2 Section modulus

The section modulus of stiffening members is not to be less than:

$$W = 4.0 \cdot m \cdot f_n \cdot P \cdot b \cdot l^2 \ (cm^3)$$
$$I = 36.4 \cdot d \cdot f_i \cdot P \cdot b \cdot l^3 \ (cm^4)$$

b = load breadth in meters

l = stiffener span in meters, for curved frames see Figures 14-9, 14-10, 14-11 and 14-12.

m- and d- values for the most common structural members are found in the Table 14-8.

f_n and f_i correction factors for laminate properties are given further below.

For curved frames the length l which determines the scantlings is given by:

$$l = l_0 - 3 \cdot f + 0.3 \cdot R \text{ meters}$$

l_0 = length in meters of the straight part of the frame in bottom.

When the bilge radius is constant, l_0 is measured as shown in Figure 14-9 below. When the radius varies, l_0 is measured as shown in Figure 14-10 below.

R = bilge radius in meters.

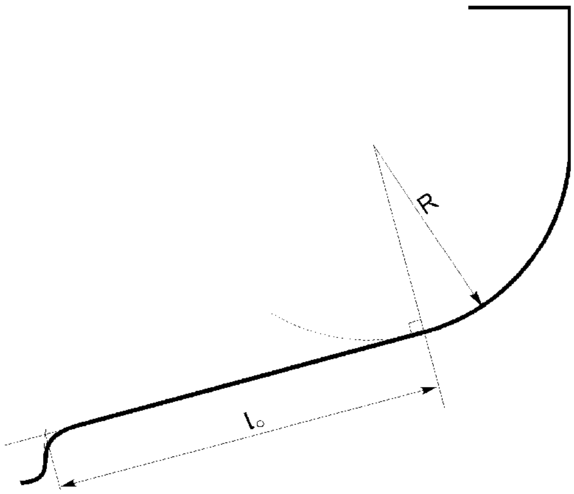


Figure 14-9

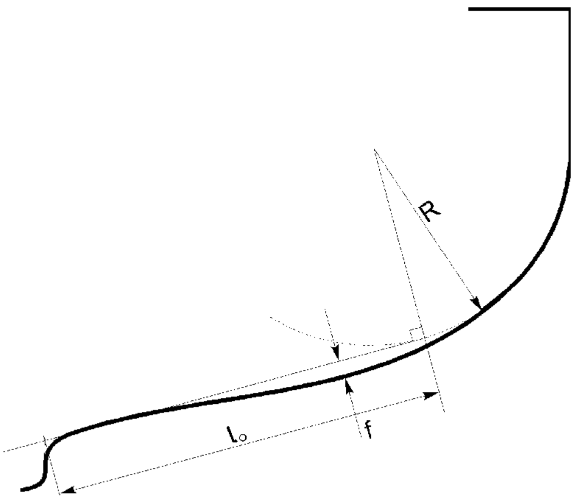


Figure 14-10

For S-shaped frames the length which determines scantlings is measured as shown in Figure 14-11 and Figure 14-12.

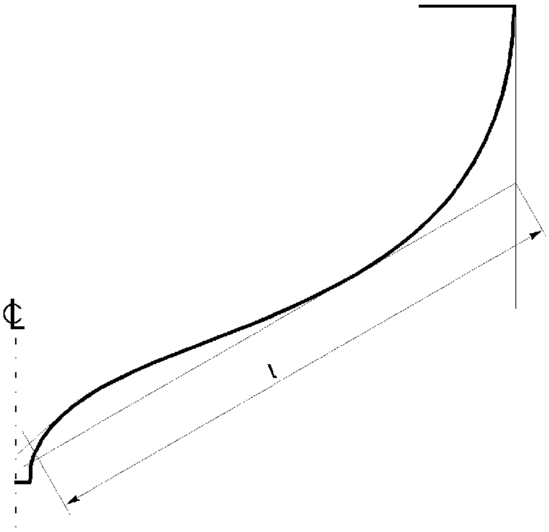


Figure 14-11

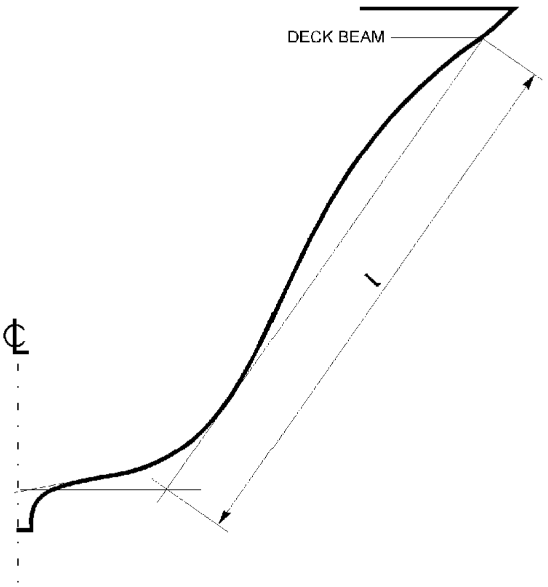


Figure 14-12

The m- and d-values shall normally be taken as follows for the various structural members:

Table 14-8 Section modulus parameters

Item	m	d
Continuous longitudinals	0.85	0.4
Non-continuous longitudinals	1.00	1.0
Transverse	1.00	1.0
Vertical members, ends fixed	1.00	1.0
Vertical members, simply supported	1.35	2.0
Bottom longitudinal	0.85	0.4
Bottom transverse	1.00	1.0
Side longitudinal	0.85	0.4
Side vertical	1.00	1.0
Deck longitudinal	0.85	0.4
Deck transverse	1.00	1.0
W.T. bulkhead, fixed ends	0.65	
W.T. bulkhead, fixed one end	0.85	
W.T. bulkhead, simply supported ends	1.25	
Tank and cargo bulkheads, fixed ends	1.00	1.0
Tanks and cargo bulkheads, simply supported ends	1.35	2.0
Deckhouse stiffener	1.00	1.0

The correction factors for laminate properties shall be taken as follows:

f_n = $\frac{80}{\sigma_{nu}}$ correction factors for strength

f_l = $\frac{7000}{E_a}$ correction factors for tensile modulus

If the various parts of the stiffener, including the plate flange, have different strength and stiffness "equivalent sectional areas" shall be used when calculating the section modulus of the stiffener.

The "equivalent sectional area" is found by multiplying the actual area with the stiffness ratio E_a/E_r. A condition for employing this method is that the strength ratio σa/σr is not less than the stiffness ratio above.

E_a, σ_a = tensile modulus and strength respectively of the laminate considered

E_r, σ_r = tensile modulus and strength respectively of the reference laminate for which the section modulus requirement is calculated.

Section modulus W for profiles with panel as a function of flange area A_{fl} sandwich core height H and web thickness t_s is given in the following graphs:

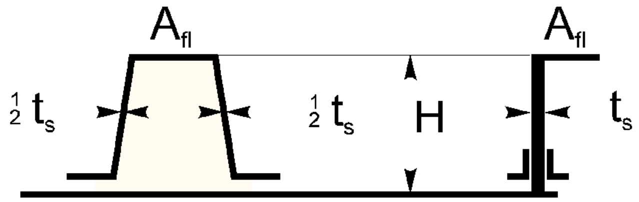


Figure 14-13 Definition of Afl, H and ts

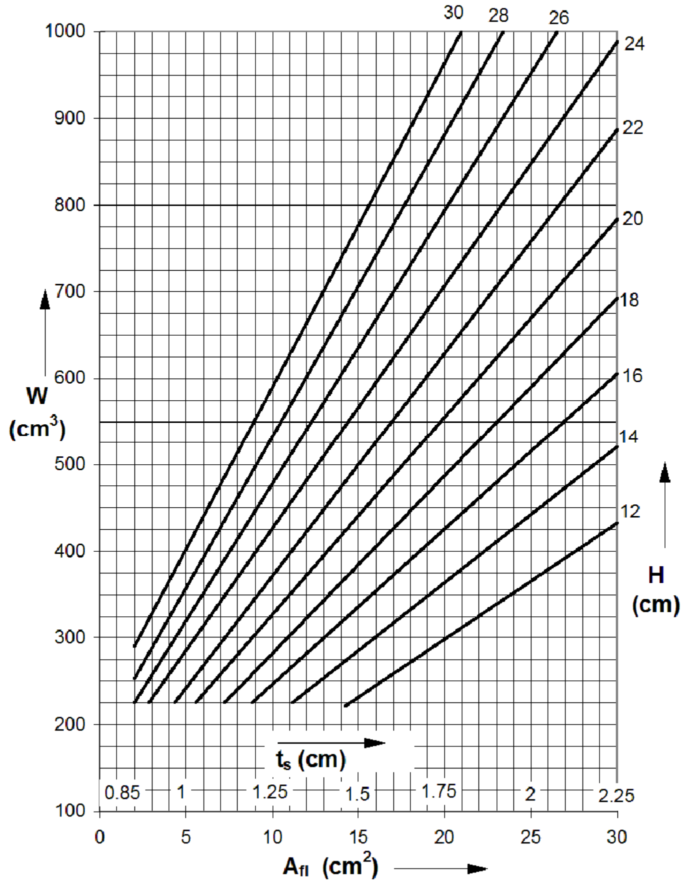


Figure 14-14 Section modulus W of profiles

Section modulus W of skin laminate steps as a function of step height and laminate thickness t.

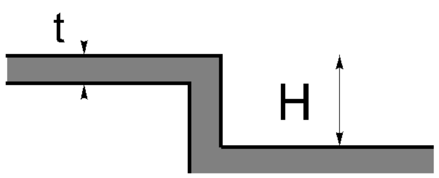


Figure 14-15

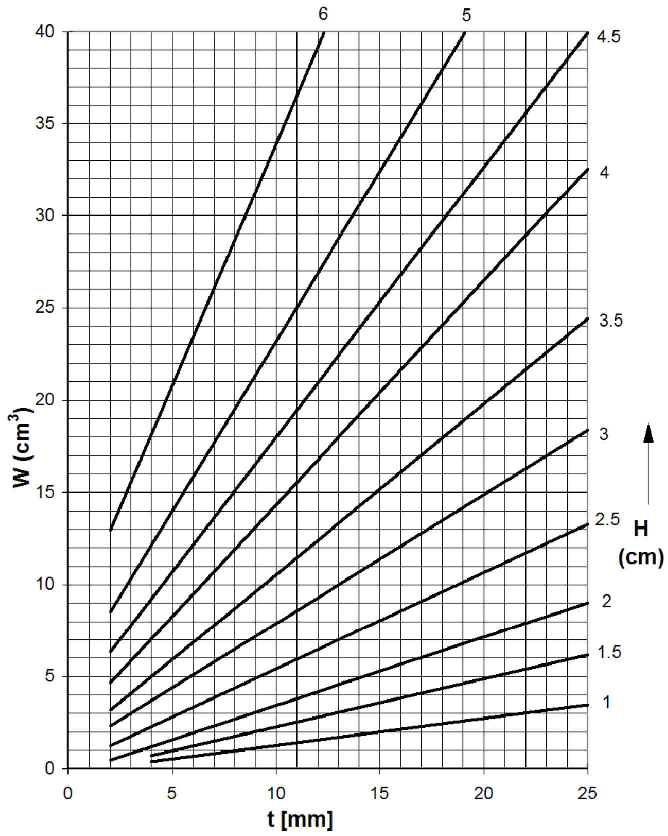

W (cm³)
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
t [mm]
6
5
4.5
4
3.5
3
2.5
2
1.5
1
H
(cm)

Figure 14-16

15 THERMOPLASTIC STRUCTURAL DESIGN

15.1 General

15.1.1 Premises

Premises for manufacturing of marine crafts of thermoplastics shall be suitable for the production process applied.

Uncontrollable draughts must be avoided in the vicinity of the production machinery and in cooling rooms.

Premises and production machinery shall be arranged to avoid the risk of pollution by oil spill, dust etc.

15.1.2 Marking of produced marine crafts

If the applied structural material has properties of significance for the use of the marine craft which differ from the standard given for marine crafts of glass fibre-reinforced polyester, appropriate information will be given on the certificate.

The marine craft is to have a durably fitted plate or similar which clearly states the structural material of the marine craft.

The marine craft manufacturer shall supply the following with each marine craft: information on the marine craft's presupposed use, directions for maintenance and repair as well as information on substances which may have detrimental effects on the marine craft's structural material.

15.2 Rotation moulding of polyethylene marine crafts

15.2.1 Moulding condition

- Release compositions applied to the mould are not to have any detrimental effects on the marine craft material, e.g., stress cracking.
- Regenerated raw material will not be accepted for use in hulls manufactured by rotation moulding.
- The rotation procedure shall be the same for moulding of all marine crafts of the same type.
- The weight quantity of powder in the mould is not to be less than 1% below the specified value.
- The temperature shall be automatically controlled. The temperature and its specified permissible variations will be subject to approval in each case, based on the limitations of the raw material properties. The temperature at each measuring point is not to vary by more than +5°C for each moulding process.
- The sintering time and the after-sintering time is stipulated on the basis of thickness measurements on the marine craft type in question to ensure that an even distribution of the material in the mould is obtained. The process time is not to vary by more than + I minute from the approved time. Any welding together of inner and outer mould is to be approved in each separate case.
- The cooling-down process is to be the same for each marine craft of the same type and will be stipulated on the basis of the sintering temperature, marine craft type and raw material so that deformations in the material are avoided.
- If alterations are made in the manufacturing method, the Society is to be informed for considering whether special tests will be required to check the material quality.

15.2.2 Moulded marine crafts

The material in the finished moulded marine crafts is to be without any visible surface flaws of significance to the marine craft's service. Surfaces and cross-sections are not to show any sign of either insufficient fusion of the powder particles or thermal degradation of the material.

Pores or air bubbles should not be so numerous or of such size that the material properties are significantly reduced. The amount and size allowed shall be stipulated for each type of material.

The material in the moulded marine crafts must comply with the requirements to minimum mechanical properties specified for the raw material in question.

Completed marine crafts should not have significant deformations, and all welded joints are to be tight.

15.2.3 Internal control

The marine craft manufacturer shall keep a journal of the raw material supplier's certificate data, and store samples from each material delivery.

The marine craft manufacturer is to record the following process data for each individual marine craft:

- weighed quantity of powder
- temperature
- sintering and after-sintering time
- cooling-down time

Each marine craft shall also be visually checked for surface flaws and tightness of welded joints.

Each marine craft shall be marked with its production number, which also shall identify the mould in which the marine craft has been manufactured. The marking is to be made in a durable way.

Thickness measurements shall normally be carried out on marine crafts that are cut into several sections. Such measurements shall be carried out on one out of 200 marine crafts manufactured in each mould.

15.3 Thermoforming of ABS-sheets

15.3.1 Forming of sheets

The forming process shall be such that the material properties are not significantly reduced during the production process. After checking the thickness of some completely formed marine crafts, the thickness of the sheets to be used in the production of the marine craft type shall be decided.

The temperature distribution on the sheet shall be the same for all marine crafts formed. The temperature of the sheet and the mould must be within the limits specified for the relevant material.

After forming the hull, the yield point of the material under tensile testing is not to deviate by more than 20% from the yield stress in the production direction. The mean value from 5 test specimens shall be used as a basis.

Stressed structural parts shall be formed without sharp edges. The radius of any curvature on the mould side shall not be less than twice the rule thickness and on the opposite side not less than 5 times the rules thickness. Sharper edges may, however, be accepted if special reinforcements reduce the stress concentration.

15.3.2 Internal control of the marine craft manufacturing

The marine craft manufacturer shall keep a journal of the sheet supplier's certificate data.

Each thermoformed sheet shall be visually checked for surface flaws.

At positions agreed with the Surveyor, the skin thickness on the marine crafts in production should be checked by measurement at least once a day, and at least once for every 50 marine crafts. The results shall be recorded.

15.4 Marine craft construction

15.4.1 Design

The design of the marine craft shall be suitable for the manufacturing process and the raw material being used.

When forming marine crafts of thermoplastics, it is to be taken into consideration that the mechanical properties of the material vary with the temperature and the duration of the loading.

Hard points in the structure are to be avoided whenever possible. Stiffening is to be evenly distributed over the hull, to the extent this is practicable.

The design is to be such that sufficient hull stiffness is obtained. Large flat surfaces are to be avoided whenever possible.

15.4.2 Assembly

No materials built into the marine craft must have detrimental effects on the other materials applied.

The skins in double-hulled constructions and in sandwich constructions shall be watertight. Screws or bushings in the skins must also be watertight.

Where exposed, the connection between inner and outer skin shall be watertight.

15.4.3 Rule thickness

Rule thickness is the value stated in Chapters [15.5.2] “Polyethylene” and [15.6.3] “ABS”.

A measured thickness is regarded as satisfactory when the average of the values measured at 20 points is not less than the rule thickness and if none of the values measured at the individual points is more than 15% below rule thickness.

Local reinforcements that are welded or glued to the hull, may upon special consideration be regarded as part of the skin thickness.

15.5 Polyethylene

15.5.1 Manufacturing

Requirements to moulding time, temperatures and cooling time are determined based on quantity of powder used and the rotation speed, on the background of inspection of complete moulded marine crafts.

Raw materials should be approved in accordance with Section 10.4.

If the marine craft manufacturer is to grind granulate to powder, the grinding and sieving equipment are first to be approved by a competent entity.

A pigment of an approved type and in the approved quantity is to be added to the powder. During or after the grinding the powder is to be sifted through a mesh of not more than 800 m.

Material moulded in accordance with the marine craft manufacturer’s actual procedure shall at least have properties as given in the tables in Chapters [10.6.3.1] – [10.6.3.3].

15.5.2 Scantlings, low density polyethylene (LDPE) and medium density polyethylene (MDPE)

The thickness of the outer hull bottom and side shall not be less than:

$$t_y = ks\sqrt{\frac{PF}{L\ 6.7}}(14 + 3.6\ L)\ \text{mm}$$

Where,

k = 1.0 for LDPE

k = 0.85 for MDPE

s = stiffener spacing in meter

PF = pressure factor for bottom, respectively side (PF and PFs), taken from the figures in [12.2.2] “Sea pressure on hull bottom” to [12.2.3] “Sea pressure on hull side”.

The thickness of the inner hull is not to be less than:

t_i = 0.8 t_y mm.

Rotation moulded marine crafts should have a hull weight of at least k × 45 kg. The marine craft should be stiffened in such a way that keel, bottom or side sheets are not to be deformed or de-placed by normal load without reducing the usage of the marine craft.

Transom for engine mounting is normally to be stiffened over its full breadth. Scantlings based on practical testing with simulated loads from the engine may be accepted.

15.5.3 Surveillance of the production

Moulding time, temperature, density and melt-index of the materials shall be recorded.

The inner surfaces and weldings are to be visually inspected and the hull thicknesses measured by cutting various sections of the marine craft.

15.6 Acrylonitrile Butadiene Styrene (ABS) and equivalent materials

15.6.1 Manufacturing conditions

Requirements to forming temperature and sheet thickness are determined each marine craft type based on inspection of the completed marine crafts.

15.6.2 Material requirements

Raw materials shall be approved according to Section 10.4 “Thermoplastic”.

Material tests are carried out on sheets produced with low internal stresses and low orientation. When testing the shrinkage of the sheet, the test specimens are to be heated to 150°C.

When using foam in structural members, the following requirements are to be complied with:

Table 15-1 Foam properties

Properties	Requirements Foam
Compressive strength	0.4 N/mm2
Shear strength	0.4 N/mm2
Connection skin/core	Fracture in glued joints is not to occur

15.6.3 Scantlings

The following scantling requirements are based on a marine craft speed not exceeding V = 10 knots.

Thickness of outer hull:

- The bottom thickness is not to be less than:

  t_b = 1.5 + 0.4 L + 0.06 V [mm]

  $t_{b\ min}$ = 2.6 [mm].

- The side thickness is not to be less than:

  t_s = 1.5 + 0.4 L [mm]

  $t_{s\ min}$ = 2.4 [mm].

- The thickness of the inner hull is not be less than:

  t_i = 0.9 t_s [mm]

  $t_{i\ min}$ = 2.2 [mm].

If the marine craft is intended for a speed exceeding V = 10 knots, the material thickness will be considered in relation to the stiffening system and the marine craft speed in each case.

marine crafts built in accordance with the above requirements shall have at least one longitudinal stiffening or the equivalent. The need for any additional stiffening will be considered in each case.

The transom is normally to be stiffened over its full breadth if use of outboard engine is intended.

Scantlings based on practical tests with simulated loads from the engine, may be accepted.

All stiffening shall be of such shape that stress concentrations are avoided as far as practicable.

15.6.4 Surveillance of the production

The yield stress of the material before and after forming is checked by random sample testing.

By random sample testing at the raw material manufacturer, the sheet thickness, shrinkage, and impact strength tested with drop weight shall be checked.

16 TRADITIONAL WOODEN DESIGN

16.1 General

16.1.1 Scope

These rules apply to the scantling determination of the structure of sailing yachts, motorsailers and motor yachts, dhows and other traditional marine crafts of normal monohull form, traditionally carvel or clinker built on transverse frames.

16.1.2 Basic principles for scantling determination

Determination of the component scantlings of structural members shall be carried out in accordance with the Tables 16-6 through 16-20 respecting the scantling numerals $B/3 + H_1$ or $L\,(B/3 + H_1)$. Structural members of hulls with larger dimensions or unusual proportions shall have the scantlings determined by individual calculations.

The scantlings given in Tables 16-6 through 16-20 for the structural members listed below apply to timber with a bulk density of:

Table 16-1 Standard bulk density

Structural member	***Standard bulk density [g/cm³] 1)***
Keel *Stem* *Floors* *Frames* *Transom beams*	*0.70*
Shell *Sheer plank* *Reinforced deck beams* *Beam knees* *Carlines* *Engine seatings* *Deadwood*	*0.56*
Decks *Deck beams* *Planks, shelves*	*0.45*
1) In standard atmosphere condition with a moisture content (according to "VG") of 12 %.	

If the bulk density of the wood intended to be used differs from the values in the above Table, the scantlings/section moduli listed in the Tables are to be increased/decreased proportionally with the bulk density ratio ρ standard/ρ actual.

Keel, stem/sternpost and other hull structural members may be lamellated.

16.1.3 Type of wood and materials

16.1.3.1 Wood

Timbers for load bearing components shall be best quality, adequately dried, sound, free from sap, knots and detrimental flaws. Twisted timber shall not to be used. Requirements in accordance with [10.5.3.2] are to be observed.

Timber in durability groups 1, 2 and 3 in accordance with Table 10-12 [10.6.3.4] is preferably to be used. Timber in groups 4 and 5 requires special approval by the Department.

For non-load-bearing components, e.g. interior parts, no particular types of wood are specified.

16.1.3.2 Plywood

Structural members from plywood exposed to the weather, such as decks, superstructures, deckhouses, etc. shall comply BS 1088, BS 4079 or other equivalent standard.

The facing veneers shall have a good, solid surface free from visible defects.

16.1.4 Workshop requirements and quality assurance

Requirements in accordance with [10.6.3.6] are to be observed.

16.2 Shell

Shell planks shall be quartersawn (riftsawn). Thickness and width are listed in Table 16-20 and 16-21. Planks around the bilge should be narrower than those for other areas. Plank thicknesses are the ones after shaping. If the frame spacing is increased compared with Table values, plank thickness is to be increased in proportion, a reduction of plank thickness is permissible if frame spacing is reduced.

For double-planked marine crafts whose scantling numeral ***L(B/3 + H₁)*** is greater than 28, the total thickness of the shell may be reduced by 10% in accordance with Table 16-06.

Shell planking is to be fitted in as long lengths as possible. Planks in one strake may however be joined by glued joints or butt straps.

Where there are joints in two neighboring strakes of planking, these must be at least three frame spaces apart. If there is one strake in between, they must be two frame spaces apart; if two, one frame space.

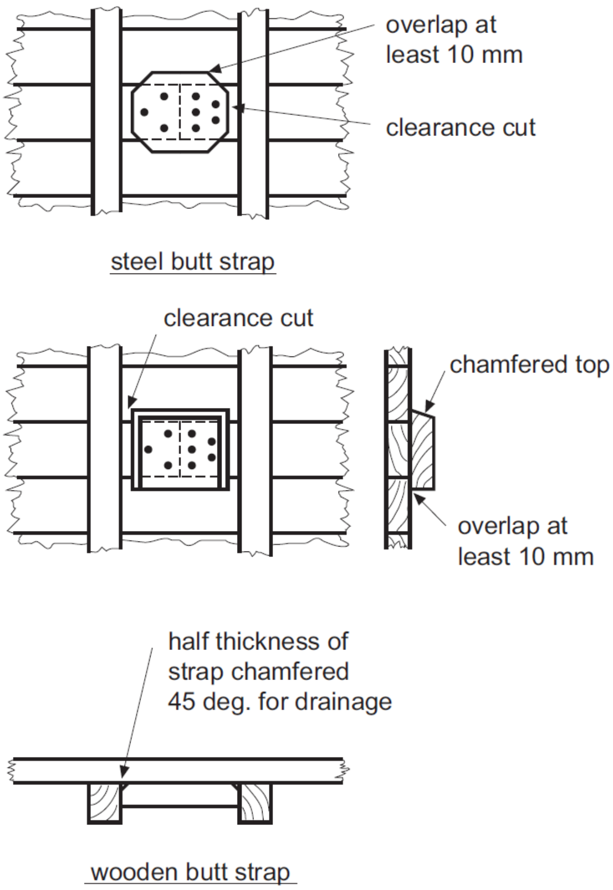


Figure 16-1

If the shell planking does not have glued joints, the planks are to be connected by butt straps. The distances between butts are in Table 16-2 below:

Table 16-2 Distances of butt straps

	Spacing of butts in shell planking		
	Plank thickness		
	under 20 mm	20 – 33 mm	over 33 mm
if strakes adjoin	1.00 m	1.20 m	1.50 m
if there is one intermediate strake	0.70 m	0.90 m	1.20 m
if there are two intermediate strakes	0.40 m	0.60 m	0.90 m

Plank butts in the plane of the same frame are only permitted if there are three intermediate strakes.

The butts in the shell planking are to be so arranged that they are not in the same plane as those of the beam shelf, the keel, and the sheer plank.

Butt straps of wood or sea-water-compatible metal are to be arranged in between frames with drainage at both ends. They should be wide enough to overlap adjoining strakes by at least 10 mm. Wooden straps should be of the same thickness as the shell; metal ones are to have an equivalent strength. For arrangement details of butt straps see Figure 16-1.

Planks and butt straps are to be joined by means of threaded bolts, as follows:

Table 16-3 Number of bolts in plank ends

Width of plank [mm]	Number of bolts in each plank end
up to 100	3
100 up to 200	4
200 up to 250	5

16.3 Bulkheads

16.3.1 Bulkhead plating

The thickness of the bulkhead plating shall not be less than:

s = a · $\sqrt{(h_1 \cdot k)}$ · C [mm]

a = stiffener spacing in [m]

h_1 = pressure head in [m] measured from bulkhead bottom edge to bulkhead deck

k = 12 as standard value for teak, kambala, oak, sipo-mahogany
= 16 as standard value for less firm wood, e. g. khaya-mahogany, sound pine

C = 4.0 in case of collision bulkhead
= 2.9 for other bulkheads

The bulkhead plating need not be thicker than the shell if frame spacing and stiffener spacing correspond.

16.3.2 Bulkhead stiffeners

The section moduli of the stiffeners shall not be less than:

$W = k \cdot C \cdot a\ (h_2 + 0.5) \cdot l^2$ [cm³]

h_2 = pressure head in [m] measured from the center of the stiffener up to the bulkhead deck
l = length of stiffener in [m]

k = 12 for stiffeners of teak, kambala, oak, sipomahogany and laminated stiffeners
= 16 for stiffeners of less firm wood, e. g. khaya-mahogany, sound pine.

16.3.3 Non-watertight bulkheads

Components of non-watertight transverse or longitudinal bulkheads, wing bulkheads or such which serve to stiffen the hull are to be dimensioned in accordance with the same formulae.

16.4 Floors

Floors shall be fitted over 0,75 LWL of the mid-body of the craft at each frame; see Figure 16-2. In the case of yachts with curved or lamellated frames, whose scantling numeral ***L (B /3 + H₁)*** is less than 20, floors may be spaced 1½ frames apart within 0,75 LWL in accordance with Table 16-06; under the mast tabernacle however floors are required at each frame.

In the afterbody, a spacing of two frames suffices beyond 0,75 LWL, a spacing of three frames beyond LWL; in the forebody beyond LWL a spacing of two frames. Where sterns hang over, as with conventional yacht sterns and retracted transoms, no floors are needed in the overhang beyond LWL provided the frames are carried continuously from one side to the other.

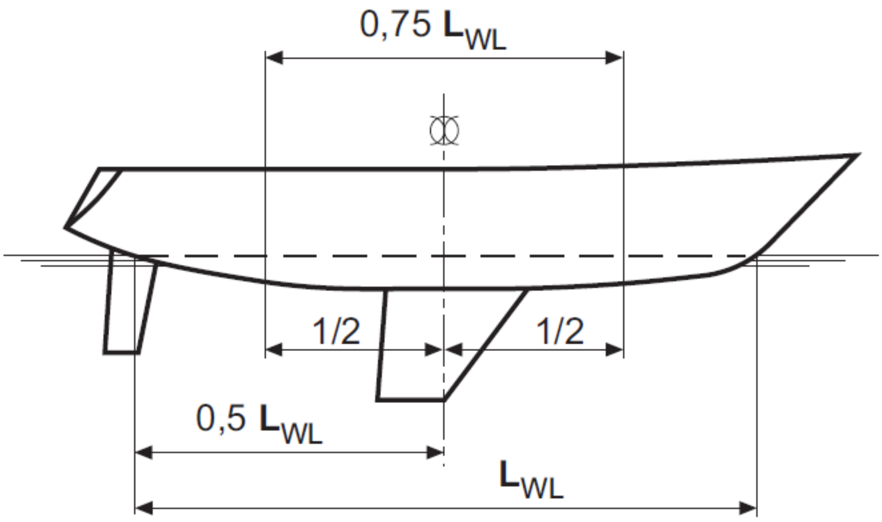


Figure 16-2

Floors may be in the form of flat bar steel, angle bar steel and wood, steel plates or wooden planks. In place of steel flat bar, angle bar or plate floors, floors of the same strength of other metal may be fitted. Wooden floors shall be sawn from knee timber; the grain shall substantially run parallel with the shell. The grain of wooden plank floors runs horizontally.

For marine crafts where the scantling numeral ***L (B/3 + H₁)*** is more than 25, wooden floors, steel plate floors or wooden plank floors shall be fitted in the area of the fin keel.

Steel plate or wooden plank floors shall be fitted underneath the mast, and underneath the seatings of more powerful propulsion engines.

Floor scantlings are given in Tables 16-08 and 16-09 based on the scantling numeral $B/3 + H_1$ and floor spacing, for the mid-body area of 0,75 LWL. If the spacing is greater than that in the Table, the floor scantlings are to be increased in the same proportion. For the floors beyond 0,75 LWL whose spacing is increased in accordance with [16.4], increase in scantlings is not required.

Beyond LWL, arm lengths may be reduced to 1/3 of the associated frame lengths.

Steel flat and angle bar floors may be fitted on top of or alongside the frames.

Angle bar floors fitted alongside the frames are to be bolted to the frame and the shell.

The arms of flat bar steel floors may be tapered off to the scantlings given in Table 16-09 for arm ends, from the first third onwards. Similarly, the projecting leg of angle bar floors may be tapered off to leg thickness from the first third of the arm length onwards.

The scantlings for wooden floors given in Tables 16-08 and 16-09 apply to the center of the floor. Towards the ends of the arms, the height may gradually be reduced to that of the frame. If ballast keel bolts are taken through wooden floors, the floor width is to be increased by half a bolt diameter.

The heights given in Table 16-08 for steel plate or wooden plank floors are the heights above the top edge of the wood keel. Beyond LWL, the height may gradually be reduced to twice that stated for naturally grown frames. The floors are to be extended high enough for the associated frames to be rigidly joined to them.

If ballast keel bolts are taken through the wooden plank floors, the thickness of the floors is to be increased correspondingly. It is to equal four times the bolt diameter.

Steel plate floors are to be joined to the wood keel and the shell by angle bars of the shape of the stipulated steel frames. However, the profile flanges in contact with the keel must be wide enough to be at least 1/3 of the flange width between bolt hole and profile edge. The upper edges of plate floors are to be flanged. Plate floors may in the region of 0,6 B amidships, have lightening holes no greater in height than half the local web height.

16.5 Frames

Frames may either be prebent, bent-in, lamellated grown, of metal or made by a combination of these. Frame spacing is given in Table 16-06. Frame spacing may be altered if the thickness of shell planking is increased (see [16.2]). Frame scantlings are to be determined from Tables 16-10 and 16-11 based on the scantling numeral $B/3 + H_1$ and the frame spacing chosen.

Forward and aft of the length LWL, the section modulus of bent, lamellated or steel frames may be reduced by 15 %; that of grown frames by 20 %.

Where bent frames have sharp bends, it is recommended that metal strips be fitted.

The cross section of bent and lamellated frames shall be the same from keel to deck. They are to be made of a single piece.

Grown frames shall have the same width from keel to deck, the height on the other hand may be gradually reduced from the top edge of the floor to the deck, down to the frame height shown in Table 16-11.

For grown frames, timber shall be used whose grain follows the shape of the frame. If such timber is not available in adequate lengths, the frames may be strapped. The following straps are permitted: the two ends overlap by at least 3,5 times the frame width, or the two parts butt and are joined along the sides by a strap with a cross section equal to the frame's and with a length 7 times the frame width.

Metal frames shall be welded to floor plates and beam knees.

Sailing marine crafts with an ***L (B/3 + H₁)*** up to 14 shall have two reinforced frames in way of the mast; larger ones at least three. In place of the reinforced frames, intermediate ones may be fitted which have the same cross section as the neighboring ones.

For marine crafts with an $\boldsymbol{L\ (B/3 + H_1)}$ greater than 26, reinforced or intermediate frames are additionally to be provided at the ends and in the middle of longer deck openings. The minimum number of reinforced or intermediate frames is to be taken from the following Table 16-4.

Table 16-4

$L\ (B/3 + H_1)$	Number of reinforced or intermediate frames
> 26	4
> 35	5
> 47	6
> 62	7
> 80	8
> 115	9

Bulkheads or partial bulkheads of adequate strength may replace the reinforced frames.

The section modulus of the reinforced frames is to be at least 30% greater than that of normal frames. In the area of the beam shelves, the height of the reinforced frames may be reduced to that of the other grown frames.

If possible, the reinforced frames shall be fitted in conjunction with reinforced deck beams, with which they are to be connected by hanging knees.

In the case of marine crafts with an $\boldsymbol{L\ (B/3 + H_1)}$ greater than 62, one of the reinforced frames in way of the mast shall be a web frame; where $\boldsymbol{L\ (B/3 + H_1)}$ exceeds 78, at least two must be in the form of web frames. Metal web frames comprise of a metal floor, a web plate and a reverse frame or a flange located at the inner edge of the web frame.

Steel web frames shall comply with the following *Table 16-5:*

$L\ (B/3 + H_1)$	Web plate
m^2	mm
over 62	200 · 4
over 70	220 · 4
over 78	230 · 5
over 88	250 · 5

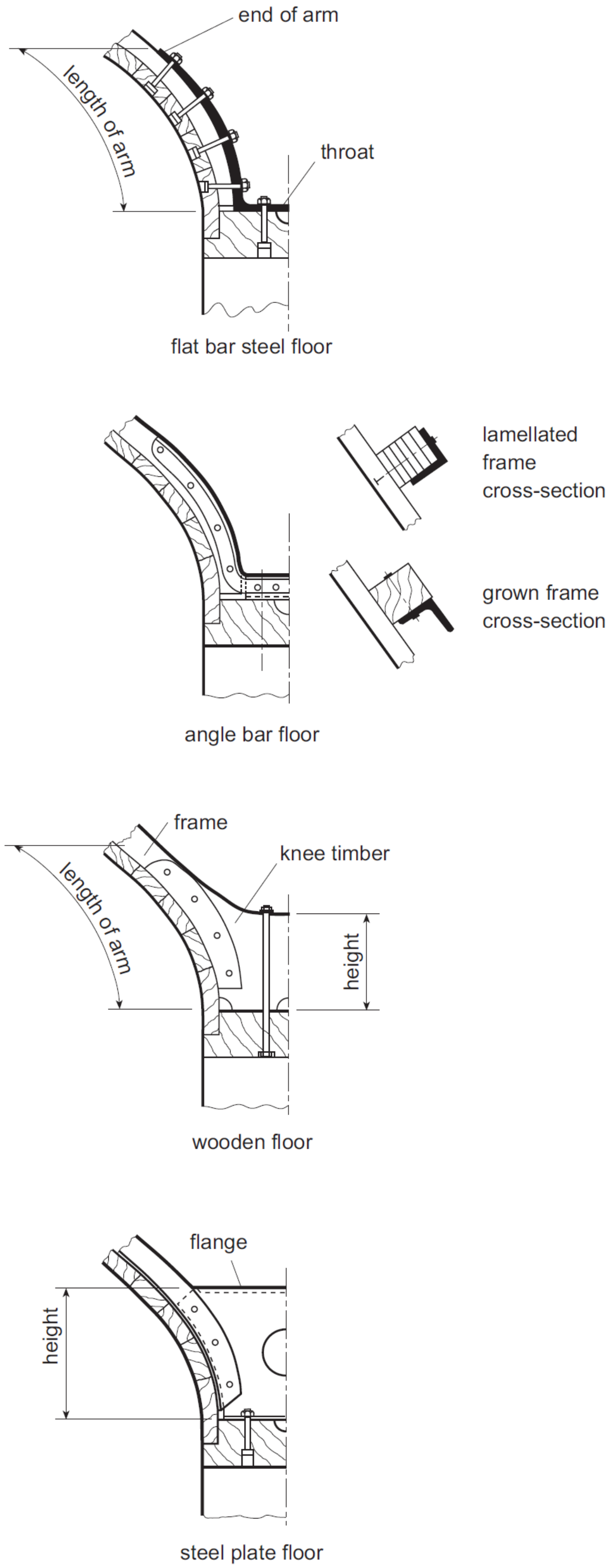

end of arm
length of arm
throat
flat bar steel floor
lamellated
frame
cross-section
grown frame
cross-section
angle bar floor
frame
knee timber
length of arm
height
wooden floor
flange
height
steel plate floor

Figure 16-3

The web plates may have round lightening holes with a diameter of 1/3rd of the web height. Hole edges shall be at least 1/4th of the web height apart.

The web frames are to be firmly welded to the floors and connected to the reinforced deck beams by hanging knees.

In lieu of steel web frames, wooden web frames of the same strength and also bulkheads or partial bulkheads of adequate strength are permitted.

16.6 Beam shelves and bilge planks

The cross sections required for the beam shelves and bilge planks on each side of the hull are given in Table 16-6. The shelves/planks shall extend from the stem to the transom. Beyond 0,75 LWL towards the ends, their cross section may gradually be reduced to 75 %. They shall be fitted in the maximum possible lengths. If they are butt joined or scarified, the butt length shall be at least six times the height of the shelf/plank. Butts shall not be located in way of the mast, the chain plates or other areas where forces are introduced into the structure. The port and starboard beam shelves shall be linked by bow pointers or stem knees at the stem and shall be connected to the transom by knees.

The beam shelves may be all in one piece or divided into a primary and a minor or secondary shelf, in which case the cross section of the primary shelf is to be about 65 % of the total given.

Preferably the deck beams shall not be embedded in the beam shelves. If they nevertheless are, the cross-section according to the Table must remain unimpaired underneath the beams.

In way of the mast and the chain plates, secondary shelves shall be additionally fitted whose cross-section is 75% of that of the shelf in accordance with Table 16-6. The length of these secondary shelves shall be at least 0,3 LWL. If the shelves have been subdivided into primary and secondary ones, half the beam shelf cross-section is sufficient for the additional secondary shelves near the mast. marine crafts with plywood decks do not require the additional secondary shelves near the mast, nor are they needed where there are plywood decks on which strip planking has been laid if the thickness of the plywood is at least 50 % of the deck plank thickness in accordance with Table 16-6.

16.7 Deck structure

16.7.1 Decks

7.1.1 Deck planks must be quartersawn (riftsawn) planks. Plank thickness is given in Table 16-6.

7.1.2 The widths of strip planking planks shall approximately match with the requirements of Table 16-7.

7.1.3 Plywood decks are permitted. The thickness of the plywood panels must be at least 65 % of the thickness given in Table 16-6 for deck planks. Joints in the plywood deck are to be scarified. Scarfs in plywood must be at least ten panel thicknesses long.

7.1.4 Decks are to have a hardwood (mahogany, oak, teak or similar) plank sheer/gunwale capping plank around the outboard edge, at least as thick as the shell according to the Table and at least 3 to 5 times as wide as it is thick. In the case of plywood decks this plank of solid wood is only required for marine crafts with a scantling numeral $L (B/3 + H_1)$ greater than 25. The outer cut edges of plywood decks must be protected by means of fillets.

16.7.2 Deck beams and beam knees

Deck beam scantlings are to be determined in accordance with Table 16-12, based on their respective length and the beam spacing. The relevant beam length is that between the outer edges of the beam shelves. In the case of half beams or supported beams the relevant length is that between the shelf outer edge and the cabin or hatch longitudinal coaming or the support. The minimum length to be inserted is 0.5 B.

Note: The deck loads given in Table 16-12 are empirical values and have no connection with the design loads on deck and superstructures [12.2.4].

Beam spacing may be increased to about 1.25 times the frame spacing in accordance with Table 16-6; in very large yachts even up to 1.4 times. The beam section modulus is to be determined based on the actual spacing.

The heights of the deck beam cross sections determined in accordance with [16.7.2] may be reduced to 75% towards the beam ends.

The end beams of deck openings whose length exceeds one space between beams shall be reinforced. For determining their scantlings, the length of deck to be supported by these beams is to be inserted as the beam spacing.

The continuous deck beams in way of the mast and the beams at the ends of large deck openings, e.g those at the forward edge of the cabin and the after edge of the cockpit, are to be reinforced. If the beams are supported by bulkheads, their section modulus shall be increased by 50 %; if they are unsupported, by 150%. For calculating the section modulus of the deck beams at the ends of the cabin, the beam spacing inserted is to be equal to the frame spacing in accordance with Table 16-6.

Beams underneath anchor winches and deckhouses may be reduced at the ends to the height of adjacent beams to avoid weakening the beam shelves.

The height of reinforced deck beams may be reduced at the ends to the height of adjacent beams to avoid weakening the beam shelves.

The reinforced deck beams shall butt against the frames if possible. They are to be joined to these, or to sole pieces, by hanging knees.

The minimum number of hanging knees is given in Table 16-13, their arm lengths and scantlings in Table 16-14. In lieu of hanging knees, adequately strong bulkheads of partial bulkheads are also permitted.

The cross section of flat bar steel hanging knees may be gradually reduced to 40% beyond the first third of the arm length of the neck cross section. Similarly, the projecting legs of angle bars may be tapered off beyond the first third of the arm length to leg thickness at the ends. Beyond LWL, the arm length of the hanging knees need not be more than 1/3rd of the frame or beam length.

At the ends of larger deck openings, horizontal wooden knees are to be fitted between deck beams and beam shelves at the corners. These knees are not needed in the case of plywood decks.

Floor beam scantlings may be determined in accordance with Table 16-12. Based on their length and spacing their section modulus may be reduced up to 75%.

16.7.3 Diagonal braces

Sailing craft and motorsailers with an ***L (B/3 + H$_1$)*** greater than 35, diagonal braces shall be arranged on the frames in way of the mast which are to end at the futtock chain plates. The futtock chain plates are to be extended to the frames forward and aft of the shroud chain plates. Their width is to be about 1.4 times the frame spacing.

In the case of sailing craft and motor-sailers with an ***L (B/3 + H₁)*** greater than 70, the deck beam in way of the mast is to be provided with a cross of diagonal braces. Such braces are not needed in the case of plywood decks.

The scantlings of diagonal braces are given in Table 16-13.

16.8 Keel

Height and width of the wood keel halfway along LWL are given based on the scantling numeral $\boldsymbol{L\ (B/3 + H_1)}$. The height applies to the full length of the wooden keel; the width may be tapered off towards the ends, down to stem/sternpost width. In the case of centerboard yachts, the cross-section of the wooden keel in way of the centerboard case is to be increased by 10%. The height of lamellated wooden keels may be 5% less than that of solid ones.

The frames are not to be embedded in the wood keel or the stem/ sternpost.

The width of the keel rabbet shall be at least equal to half the tabular height of the wood keel, but anyway it shall be wide enough for the screws to be staggered (zig-zag).

The wooden keel shall consist of a single piece, if ever possible.

For marine crafts whose $\boldsymbol{L\ (B/3 + H_1)}$ is less than 35, the wooden keel shall be one piece. marine crafts with an $\boldsymbol{L\ (B/3 + H_1)}$ of 35 to 100 may have a two-piece wooden keel with a scarf joint; even larger marine crafts, a three-piece keel with scarf joints. The scarfs shall be in the area of the metal fin, if ever possible.

The scarfs are to take the form of hook scarfs or in the case of larger marine crafts double-hook scarfs. The scarf length shall be at least six times the keel height. The keel scarfs shall have softwood stop waters in the rabbet, see [16.11] and Figure 16-4.

The wooden keel may be built up by glueing together separate laminated planks running horizontally.

If the mast stands on the stem-keel scarf or in the vicinity of this, a mast stool shall be provided on the floors. In smaller yachts this stool should at least extend over 3 floors; in larger ones, over 5 or 6. Mast steps must not be cut directly into the keel or keel scarfs.

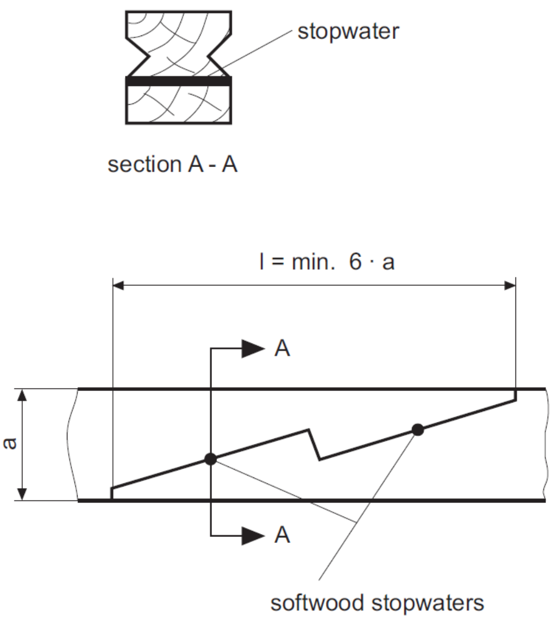


Figure 16-4 Hook scarf

16.9 Stem/sternpost and transom beam

The height of the stem on the design waterline must be at least 1.2 times the height of the wooden keel in accordance with Table 16-15. Between the rabbets the thickness of the stem shall be at least twice that of the shell planking. The width of the rabbet shall be at least 1.5 times the shell planking thickness. The leading edge of the stem and the trailing edge of the sternpost may be tapered.

The stem scarfs shall be made as hook scarfs or glued joints. The length of the scarf shall equal 6 times the stem height. In way of the rabbets, softwood stop waters shall be fitted in the stem scarfs and the scarfs between stem and keel sole.

If the mast stands on the stem, this shall be reinforced in particular regarding its height; additionally, a mast stool shall be provided. Mast steps may not be cut into the stem.

If shafting is led through the sternpost, this shall be widened so as to leave at least 0.4 of the tabular sternpost widths either side of the stern tube where this is taken through.

Stems/sternposts may be glued together from separate lamellated planks.

The transom beam shall be rigidly connected to the sternpost. The cross section of the transom beam at the forward end and in the area where the rudder stock/tube is taken through must at least equal the square of the height of the stem in accordance with [16.9]. Towards the after end the cross section may be reduced to 75%. The height of the transom beam shall be at least 2.5 times the height of the bent-in frames. The seat of the transom beam must be of adequate length. Care is to be taken to make sure that the bolting is adequate (recessed bolts if appropriate).

16.10 Coachroof, deckhouses

Apertures in the deck shall be bordered by frames consisting of hatch end beams and deck carlines.

The scantlings of deck beams at the ends of superstructure, hatches and cockpits shall be determined in accordance with [16.6].

The cross sections of the deck carlines shall approximately match the data in Table 16-16; the height of the deck carlines shall be about half the height of the beams and their width shall be 4.5 times the thickness.

The thickness of side walls and deck planking of the superstructure is given in Table 16-16.

Superstructure side walls with extra-large windows are to be strengthened.

The spacing of the superstructure deck beams (cabin beams) shall be about 25 % less than the frame spacing in accordance with Table 16-6; in the case of plywood decks however the beam spacing may be increased depending on the thickness of the deck and the camber of the cabin beam. The cabin beam scantlings are to be determined in accordance with Table 16-12, based on their spacing and their length, but their section modulus may be 20% less.

Deck beams at the ends of apertures in the cabin deck shall be reinforced or supported as appropriate to the length of the aperture.

Hatch coamings shall be of adequate strength.

16.11 Bolting connection of structural members

16.11.1 General

The necessary data about interconnection of the individual members are given in Tables 16-17 to 16-20. The bolts used shall be of sea water resistant materials.

Nuts shall be of the same material as the bolts, if possible. Washer diameters shall be about three times the bolt diameter; washer thickness about 25% of the bolt diameter.

16.11.2 Floors

Number and diameter of the bolts connecting the floors to shell and keel are given in Table 16-18.

Floors fitted alongside the frames shall be fastened to the shell and the frames. They shall be fastened to each shell plank by one bolt and to the frames by at least 3 or 4 bolts.

Steel floor plates shall be welded to the steel frames.

Frames in the afterbody extending from one side of the yacht to the other without any floors shall be fastened to the transom beam by bolts in accordance with Table 16-18.

16.11.3 Shell and frames

Each shell plank shall be fastened to each frame by at least 2 screws. The screws are to be staggered (zigzag) to prevent the frames from splitting. Screw diameters are given in Table 16-19.

The length of the wood screws shall be at least 2 to 2.5 times the thickness of the shell planks.

The butt straps are to be fastened to each of the planks by screws of the same diameter as those for shell-to-frame connection in accordance with Table 16-19.

If grown frames have butt-strapped joints, the straps shall be fastened to each frame part by 3 bolts in the case of scantling numerals $B/3 + H_1$ up to 2; by at least 4 bolts in the case of larger scantling numerals.

The shell planking shall be fastened to the wooden keel and the stem/sternpost by wood screws. These screws shall be at least of the same diameter and length as those between shell and frames. The distance between adjacent screws shall not be more than 12 screw diameters. The screws are to be staggered to avoid the wood splitting.

Screws through the shell may be countersunk if they are capped with a plug whose height equals the screw shank diameter.

16.11.4 Deck beams, hanging knees and beam shelves

Each deck beam is to be joined to the beam shelf; the half deck beams also to the carlines. In yachts up to an $L (B/3 + H_1)$ = 60, wood screws shall be used; in those with higher scantling numerals, bolts and nuts shall be used.

The hanging knees shall be fastened to the frames and deck beams by rivets or wood screws in accordance with Table 16-20.

If hanging knees are replaced by bulkheads, the connection of these to frame, shell, deck beam and deck shall be of the same strength as would be that with hanging knees.

The beam shelves shall be screwed to every frame.

16.11.5 Deck beams

The gunwale/covering board is to be screwed to the shell. The diameters of the wood screws are given in Table 16-19. The length of the screws shall be at least twice the thickness of the planks and the distance between screws equal to twelve screw diameters. The gunwale/covering board shall be fastened to every deck beam.

The deck planks shall be fastened to each deck beam by screws or hidden nails. If the latter solution is used, and if the deck beam spacing is greater than the tabular frame spacing, the planks shall additionally be fastened to one another sideways between the beams by a sea water resistant nail. The ends of the deck planks shall have an adequate supporting surface.

Deck margin planks shall be screwed to the carlines/ledges and the deck beams.

The screw diameters are given in Table 16-19.

11.5.5 The length of wood screws in solid wood decks is to be at least twice the plank thickness. Screws in plywood decks may be shorter in line with the reduced thickness of the deck.

16.11.6 Diagonal braces

Diagonal braces shall be fastened to the frames/deck beams and each shell or deck plank by at least one screw in accordance with Table 16-19.

16.12 Workmanship

The workshops for building wooden yachts shall be fully enclosed spaces with heating as well as supply and exhaust ventilation. If load bearing structural members of a yacht hull shall be glued or laminated, the requirements of Chapter 10.5.3.6 shall be observed.

The scantlings given in the Tables are minimum values. If required to guarantee the adequate strength of a screwed/bolted or riveted connection between individual members, the component scantlings may have to be increased - e.g. for the connection of the shell to the stem and the sternpost, where a rabbet of adequate width shall be provided.

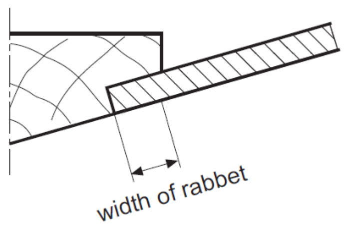


Figure 16-5 Width of rabbet

Load bearing structural members of the marine craft shall be made with an adequate accuracy of fit. They are to be preserved to prevent water penetration.

Holes for wood screws shall be drilled with a conical drill. Maximum attention shall be paid to the watertightness of hull and superstructure. It is therefore necessary to take into consideration the properties of the wood, in particular its swelling and shrinkage properties which vary in the three dimensions, even when cutting the component to size. As wood - in particular hardwood - swells and shrinks tangentially much more than radially, deck and shell planking, and that of watertight bulkheads, shall consist of quartersawn (riftsawn) planks. It is advised to cut deadwood tangentially.

To guarantee watertightness between the scarfs of keel and stem/sternpost, stopwaters shall be provided where the rabbet crosses the scarf or a stop of the keel or stem/sternpost. Stopwaters should be of softwood, which does not rot much nor becomes brittle when air is excluded from it. Spruce or pine are suitable. Stopwaters shall have a diameter of at least 10 mm in small marine crafts; up to a maximum of 22 mm in large ones. They shall have a press fit, hammered in at totally dry state into clean holes cut with a sharp drill.

To allow for proper drainage of water to the bilges, and to prevent dirt accumulating in corners, care shall be taken to assure that any condensation or leakage water can run down to the lowest point of the bilges, to the strum box. This means that limber holes shall be provided in the floors, large enough to be easily cleaned.

Inside the marine craft, good circulation of air through any areas and corners with a plank lining is to be ensured by means of ventilation openings, fingerholes and by making clearance cuts. It is recommended that all joinery such as lockers, cupboards, etc. be installed removable to permit subsequent conservation of the parts they conceal.

The connection between superstructure sidewalls and deck shall be made with special care and using proven methods, to avoid any leaks.

16.13 Scantlings of structural members

Table 16-6 Beam shelves, bilge planks, shell and deck

L (B/3 + H_1)	Frame spacing	Beam shelves	Bilge planks	Shell	Deck
m2	mm	cm2	cm2	mm	mm
7	120	17	—	11	18
8.5	130	19	—	12	18
10	140	21	—	13	18
11.5	150	24	—	14	18
13	160	28	—	15	18
14.5	170	31	—	16	18
16	180	34	—	17	18
17.5	190	37	—	18	18
19	200	40	—	19	18
20.5	210	43	—	20	19
22	220	46	—	21	20
23.5	230	49	—	22	21
25	240	52	—	23	22
27	250	56	—	24	23
29	260	60	—	25	24
31	270	64	—	26	25
33	280	69	—	27	26
35	285	73	—	28	27
37	295	77	59	29	28

Table 16-6 Beam shelves, bilge planks, shell and deck (continued)

L (B/3 + H_1)	Frame spacing	Beam shelves	Bilge planks	Shell	Deck
m2	mm	cm^2	cm^2	mm	mm
39	305	80	62	30	29
41	310	84	64	31	30
43	320	88	67	32	30
46	330	94	70	33	31
49	340	100	73	34	32
52	345	106	76	35	33
55	355	112	80	36	34
58	360	117	84	37	35
61	370	123	87	38	36
64	380	129	90	39	37
67	385	135	93	40	38
75	405	149	102	42	40
85	420	167	112	44	42
96	440	185	123	46	44
108	455	204	134	48	46
122	475	225	147	50	48
140	495	250	162	52	50
If the frame spacing is increased, the thickness of the shell planking and the deck is to be increased in the same ratio. A reduction of plank thickness and the deck are permissible if the frame spacing is reduced. The spacing given is for carvel built marine crafts. The frame spacing of clinker-built marine crafts may be increased by 65% whilst keeping the shell plank thickness at the value given in column 5.					

Table 16-7 Width of shell- and strip deck plates

Plank thickness	Max. widths of planks	
	Shell	Deck
mm	mm	mm
12	75 to 85	40
16	85 to 100	42
20	100 to 110	46
25	110 to 120	50
30	120 to 135	54
36	130 to 150	57
41	140 to 160	60
46	150 to 170	62
52	160 to 180	64

Table 16-8 Floors

$B/3 + H_1$		Steel plate floors		Wooden plank-floors	
	Frame spacing	Height	Thickness	Height	Thickness
m	mm	mm	mm	mm	mm
1.4	115	140	2.5	140	24
1.4	130	145	2.5	145	24
1.5	140	145	2.5	145	24
1.5	145	150	3	150	26
1.6	155	150	3	150	27
1.6	165	155	3	155	28
1.7	170	155	3	155	30
1.7	180	160	3.5	160	30
1.8	195	160	3.5	160	30
1.8	200	165	3.5	165	32
1.9	210	170	3.5	170	32
1.9	220	175	3.5	175	34
2.0	220	175	3.5	175	35
2.0	230	180	4	180	35
2.2	240	190	4	190	38
2.4	250	200	4	200	37
2.6	260	210	4	210	41
2.8	270	220	4	220	40
3.0	275	235	4	235	44
3.2	290	245	4	245	47
3.4	305	255	4	255	49
3.6	320	270	4.5	270	52
3.8	340	280	4.5	280	55
4.0	360	290	4.5	290	57
4.4	385	320	5	320	63
4.8	415	345	5	345	69
5.2	425	375	5	375	75
5.6	435	400	5.5	400	80
If the frame spacing is changed, the thickness of the floors is to be altered in the same ratio.					

Table 16-9 Beam shelves, bilge planks, shell and deck

$B/3 + H_1$	Frame spacing	Arm length	Flat bar steel floors		Angle bar floors	Wooden floors	
			Throat	Arm end	W	Height	Thickness
m	mm	mm	mm	mm	cm^3	mm	mm
1.4	115	175	22 · 5	17 · 4	0.60	37	15
1.4	170	175	23 · 7	20 · 5	0.85	48	18
1.5	130	180	20 · 7	17 · 5	0.92	46	17
1.5	195	180	25 · 8	24 · 5	1.37	53	23
1.6	140	190	21 · 8	20 · 5	1.27	50	20
1.6	210	190	26 · 10	22 · 7	1.90	58	28
1.7	145	200	26 · 7	22 · 5	1.54	53	23
1.7	220	200	28 · 10	24 · 7	2.30	68	27
1.8	155	210	26 · 8	21 · 6	1.95	58	25
1.8	230	210	31 · 10	28 · 7	2.90	77	28
1.9	165	225	30 · 8	24 · 6	2.38	63	27
1.9	250	225	36 · 10	31 · 7	3.60	82	31
2.0	180	235	26 · 10	22 · 7	2.88	69	29
2.0	270	235	36 · 12	32 · 8	4.35	89	33
2.2	200	260	33 · 10	28 · 7	3.92	82	32
2.4	220	280	37 · 12	33 · 8	4.65	91	37
2.6	240	300	38 · 14	31 · 10	6.02	98	44
2.8	260	320	44 · 14	37 · 10	7.40	100	50
3.0	275	340	47 · 15	35 · 12	8.66	109	54
3.2	290	360			9.91	118	58
3.4	305	380			11.40	125	62
3.6	320	400			13.20	131	67
3.8	340	420			14.60	141	71
4.0	360	440			17.70	150	75
4.4	385	480			21.00	167	84
4.8	415	520			24.40	180	93
5.2	425	560			27.50	195	99
5.6	435	600			29.80	209	101
If the frame spacing is changed, the thickness of the floors or the section moduli for steel angle bar floors given in column 6 are to be altered in the same ratio.							

Table 16-10 Frames: Section moduli without effective width of plate

$B/3 + H_1$	Section moduli referred to a basic frame spacing of 100 mm			
	Curved	Laminated	Naturally grown	Steel profiles
	W100	W100	W100	W100
m	cm^3	cm^3	cm^3	cm^3
1.4	0.70	0.68	2.0	0.105
1.5	0.85	0.83	2.5	0.127
1.6	1.02	0.99	3.1	0.150
1.7	1.20	1.17	3.7	0.177
1.8	1.39	1.36	4.3	0.206
1.9	1.59	1.55	4.9	0.236
2.0	1.81	1.75	5.6	0.266
2.1	2.04	1.97	6.2	0.300
2.2	2.29	2.19	7.0	0.334
2.3	2.56	2.42	7.8	0.370
2.4	2.85	2.66	8.6	0.409
2.5	3.17	2.94	9.5	0.453
2.6	3.51	3.25	10.4	0.502
2.7	3.88	3.58	11.4	0.555
2.8	4.27	3.94	12.5	0.606
2.9	4.70	4.32	13.7	0.671
3.0	5.16	4.74	14.9	0.739
3.1	5.65	5.17	16.2	0.807
3.2	6.18	5.65	17.6	0.884
3.3	6.75	6.15	19.2	0.965
3.4	7.37	6.71	20.8	1.055
3.6	8.75	7.93	24.5	1.25
3.8	10.32	9.30	28.8	1.48
4.0	12.09	10.82	33.6	1.73
4.2	14.06	12.57	39.0	2.01
4.4	16.32	14.43	45.0	2.32
4.6	18.60	16.49	51.6	2.66
4.8	21.17	18.61	58.8	3.02
5.0	23.95	21.00	66.8	3.43
5.2	26.97	23.55	75.5	3.84
5.4	30.23	26.30	84.9	4.32
5.6	33.71	28.20	94.9	4.82
5.8	37.43	32.30	105.5	5.35
The frame section moduli are given for a basic spacing of 100 mm. If the spacing selected differs from that, the section moduli are to be increased in the same ratio.				

Table 16-11 Grown frames: section moduli and cross section

W	Breadth × Height
cm^3	mm
3.00	23 · 28 / 23
3.60	24 · 30 / 24
4.44	26 · 32 / 26
5.23	27 · 34 / 27
6.05	28 · 36 / 28
7.21	30 · 38 / 30
8.54	32 · 40 / 32
9.97	33 · 42 / 33
11.20	35 · 44 / 35
12.86	36 · 46 / 36
14.60	38 · 48 / 38
16.69	40 · 50 / 40
18.50	41 · 52 / 41
20.9	43 · 54 / 43
23.0	44 · 56 / 44
25.2	45 · 58 / 45
28.2	47 · 60 / 47
32.4	49 · 63 / 49
37.0	51 · 66 / 51
42.9	54 · 69 / 54
48.5	56 · 72 / 56
54.3	58 · 75 / 58
61.0	60 · 78 / 60
68.0	62 · 81 / 62
75.4	64 · 84 / 64
84.5	67 · 87 / 67
93.0	69 · 90 / 69
106	72 · 94 / 72
120	75 · 98 / 75
135	78 · 102 / 78
149	80 · 106 / 80
167	83 · 110 / 83
186	86 · 114 / 86
209	90 · 118 / 90
232	93 · 122 / 93
254	95 · 126 / 95
276	98 · 130 / 98
303	101 · 134 / 101
328	103 · 138 / 103
358	106 · 142 / 106

Table 16-12 Beam shelves, bilge planks, shell and deck

Beam length	Section moduli referred to a basic beam spacing of 100 mm			
	Wooden beams	Laminated beams	Steel sections	Deck load
	W_{100}	W_{100}	W_{100}	p
m	cm^3	cm^3	cm^3	kN/m^2
0.8	0.52	0.47	0.081	1.84
1.0	0.86	0.78	0.132	1.93
1.2	1.28	1.15	0.18	2.02
1.4	1.84	1.66	0.248	2.11
1.6	2.84	2.23	0.335	2.20
1.8	3.30	2.97	0.446	2.29
2.0	4.20	3.78	0.568	2.38
2.2	5.27	4.75	0.712	2.48
2.4	6.52	5.87	0.882	2.57
2.6	7.90	7.10	1.068	2.67
2.8	9.51	8.56	1.29	2.75
3.0	11.25	10.25	1.52	2.84
3.2	13.25	11.92	1.79	2.94
3.4	15.44	13.90	2.09	3.04
3.6	17.80	16.00	2.41	3.12
3.8	20.40	18.35	2.76	3.22
4.0	23.30	20.95	3.15	3.30
4.2	26.40	23.75	3.57	3.40
4.4	29.75	26.80	4.02	3.49
4.6	33.30	30.00	4.50	3.59
4.8	37.20	33.50	5.03	3.67
5.0	41.40	37.30	5.60	3.76
5.2	45.70	41.10	6.18	3.85
5.4	50.50	45.40	6.82	3.95
5.6	55.60	50.00	7.51	4.05
5.8	61.20	55.00	8.27	4.13
6.0	67.30	60.50	9.10	4.23
6.2	73.50	66.00	9.94	4.33
6.4	79.70	71.60	10.79	4.42
6.6	86.50	77.80	11.63	4.52

For each beam the section moduli may be determined based on its specific length, but lengths less than half the breadth of the craft should not be inserted.

The section moduli are given for a basic beam spacing of 100 mm; they shall be increased in the ratio of the selected spacing to the basic spacing. Additionally, for beams shorter than the craft breadth B the section moduli shall be multiplied by the deck loading p1 corresponding to the breadth B and be divided by the deck load p2 corresponding to the beam length in question.

Example:	*Beam length*	=	*2.40 m*
	Breadth B	=	*4.00 m*
	Beam spacing	=	*370 mm*
	W_{100}	=	*6.52* cm^3
	p1	=	*3.30* kN/m^2
	p2	=	*2.57* kN/m^2
	W	=	*6.52 · 370/100 · 3,30/2.57 = 31* cm^3

Table 16-13 Diagonal braces and numbers of hanging knees

L (B/3 + H_1)	**Diagonal braces**	**Hanging knees**
m^2	mm	number
to 13	—	3
to 20	—	4
to 27	—	5
to 30	—	6
to 35	50 · 4	6
to 40	50 · 4	6
to 45	60 · 4	6
to 50	50 · 4.5	7
60	80 · 4.5	7
70	90 · 5	8
80	100 · 5	8
90	100 · 6	9
100	110 · 6	9
110	120 · 6	10
120	130 · 6	10
130	145 · 6	11

Table 16-14 Beam shelves, bilge planks, shell and deck

B/3 + H1	Flat bar steel knee [1)] Width × Thickness	Angle bar W	Arm length	Bracket Thickness	Wooden Leg Thickness	Knee length
m	mm	cm^3	mm	mm	mm	mm
1.60	19 · 7	0.8	290	2.5	16	85
1.75	19 · 8	0.9	300	2.5	18	95
1.90	22 · 8	1.0	310	2.5	20	105
2.10	25 · 9	1.3	325	3	22	115
2.30	26 · 11	1.6	340	3	26	130
2.50	28 · 12	1.8	360	3.5	28	145
2.70	30 · 13	2.1	380	3.5	30	160
2.90	*30 · 15*	*2.4*	*400*	*3.5*	*32*	*175*
3.15	*33 · 16*	*2.8*	*420*	*4*	*35*	*190*
3.40	*37 · 17*	*3.3*	*440*	*4*	*38*	*205*
3.65	*40 · 18*	*3.7*	*460*	*4*	*41*	*220*
3.90	*44 · 19*	*4.1*	*480*	*4*	*44*	*235*
4.15	*47 · 21*	*4.7*	*500*	*5*	*47*	*250*
4.40	*49 · 23*	*5.3*	*520*	*5*	*50*	*265*
4.65	*53 · 24*	*5.8*	*540*	*5*	*53*	*280*
4.90	*55 · 26*	*6.5*	*560*	*5*	*56*	*300*
5.20	*60 · 27*	*7.3*	*580*	*6*	*59*	*320*
5.50	*65 · 28*	*8.2*	*600*	*6*	*62*	*340*
5.80	*66 · 30*	*9.0*	*620*	*6*	*65*	*360*

Table 16-15 Wooden keel and stem/sternpost

L (B/3 + H_1)	Sailing marine crafts	Wooden keel amidships	Motor marine crafts
	width	height [1)]	width
m^2	mm	mm	mm
7	123	57	123
8	131	59	131
9	139	61	139
10	145	64	145
11	152	66	152
12	159	68	159
13	165	70	165
14.5	175	74	172
16	185	77	178
17.5	195	81	182
19	205	84	185
20.5	214	87	187
22	223	90	189

L (B/3 + H_1)	Sailing marine crafts width	Wooden keel amidships height [1)]	Motor marine crafts width
m^2	mm	mm	mm
23.5	232	93	191
25	241	96	193
26.5	248	99	195
28	255	102	196
29.5	262	105	197
31	269	108	198
32.5	275	111	199
34	282	114	200
35.5	288	117	201
37	294	119	202
39	301	122	203
41	309	125	204
43	315	128	205
45	323	131	206
47	330	134	207
49	337	137	208
51	342	140	209
54	350	144	210
57	358	147	212
60	366	151	213
63	374	155	214
66	381	158	215
69	387	161	216
72	394	164	217
76	401	168	218
80	409	171	219
84	416	175	220
88	424	179	222
92	431	182	224
96	439	185	226
100	446	188	228
105	454	192	230
110	461	195	233
115	469	198	236
120	476	201	239
125	483	204	242
130	490	207	245

L (B/3 + H_1)	Sailing marine crafts width	Wooden keel amidships height [1)]	Motor marine crafts width
m^2	mm	mm	mm
135	497	210	248
140	505	213	251
Towards the ends, the width of the wooden keel may be tapered off to that of the stem/sternpost. The height of laminated wooden keels may be reduced by 5%.			
[1)] Applies to sailing and motor marine crafts.			

Table 16-16 Superstructure, carlines

L(B/3+H_1)	Superstructure side walls		Superstructure deck		Carlines
	Solid wood	Plywood	Solid wood	Plywood	
m^2	mm	mm	mm	mm	cm^2
7	18	9	8	6	7
8.5	18	10	8	6	7
10	19	11	9	6	9
11.5	19	12	9	6	11
13	20	13	10	6	12
14.5	20	13	10	7	13
16	21	14	11	7	14
17.5	21	14	12	8	15
19	22	15	12	8	16
20.5	22	15	13	8	17
22	23	15	14	9	18
23.5	23	15	14	9	19
25	23	15	15	10	20
27	24	16	15	10	21
29	24	16	16	10	22
31	24	16	16	11	23
33	24	16	17	11	24
35	24	18	17	11	25
37	25	18	18	11	26
39	25		18	12	26
41	25		19	12	27
43	25		19	12	28
46	25		20	13	29
49	26		20	13	30
52	26		21	13	31
55	26		21	13	32
58	27		21	14	33

L(B/3+H_1)	Superstructure side walls Solid wood	Superstructure side walls Plywood	Superstructure deck Solid wood	Superstructure deck Plywood	Carlines
m^2	mm	mm	mm	mm	cm^2
61	27		22	14	34
64	27		22	14	35
67	27		23	15	36
71	28		23	15	37
75	28		24	15	38
80	29		24	15	39
85	29		24	16	40
90	30		25	16	41
96	30		25	16	42

Table 16-16 Superstructure, carlines (continued)

L(B/3+H_1)	*Superstructure side walls Solid wood*	*Superstructure side walls Plywood*	*Superstructure deck Solid wood*	*Superstructure deck Plywood*	*Carlines*
m^2	*mm*	*mm*	*mm*	*mm*	*cm^2*
102	*31*		*25*	*16*	*43*
108	*31*		*26*	*16*	*44*
115	*32*		*26*	*17*	*45*
122	*33*		*27*	*17*	*45*
130	*34*		*27*	*17*	*46*
140	*35*		*27*	*17*	*47*

Table 16-17 Beam shelves, bilge planks, shell and deck

L (B/3 + H_1)	Keel, stem/sternpost, deadwood, transom beam	Horizontal knee
m^2	Bolt diameter in mm Ø	
to 10	9	6
10 to 12	10	6
12 to 15	11	6
15 to 19	12	6
19 to 23	13	8
23 to 28	14	8
28 to 32	15	8
32 to 37	16	8
37 to 41	17	8
41 to 46	18	8
46 to 60	20	10
60 to 75	22	10
75 to 140	25	10

Table 16-18 Connecting floors with keel and shell and frames

$B/3 + H_1$	Bolts		Bolts			
	In the arms		In the throat for 0,8 LWL		at the ends of the marine craft	
	Number	mm Ø	Number	mm Ø	Number	mm Ø
to 1.5	3	5.5	1	8	1	8
1.5 to 1.75	3	5.5	2	8	1	8
1.75 to 1.9	3	6	2	8	1	9
1.9 to 2.1	3	6	2	9	1	9
2.1 to 2.3	4	6	2	9	1	10
2.3 to 2.5	4	6.5	2 3	10 9	1 2	10 7
2.5 to 2.7	4	7	2 3	11 10	1 2	11 8
2.7 to 2.9	4	8	2 3	11 10	1 2	11 8
2.9 to 3.15	4	9	2 3	12 11	1 2	12 9
3.15 to 3.4	4	9	2 3	12 11	1 2	12 9
3.4 to 3.65	5	10	2 3	13 12	1 2	13 9
3.65 to 3.9	5	10	2 3	14 13	1 2	14 10
3.9 to 4.15	5	11	2 3	15 14	1 2	15 11
4.15 to 4.4	5	11	3	15	2	12
4.4 to 4.65	5	12	3	16	2	13
4.65 to 4.9	5	12	3	17	2	14
4.9 to 5.2	5	13	3	18	2	15
5.2 to 5.5	5	14	3	19	2	16
5.5 to 5.8	5	15	3	20	2	17

Table 16-19 Screws in shell and deck

Plank thickness	Shell with frames Screws	Deck planks to deck and shell beams screws
mm	mm Ø	mm Ø
to 15	4	4
15 to 17	4	4
17 to 19	4.5	4
19 to 23	5	4.5
23 to 26	5.5	5
26 to 29	6	5.5
29 to 32	6.5	6
32 to 35	7.5	7
35 to 38	8	7.5
38 to 41	8.5	8
41 to 44	9	8.5
44 to 47	10	9
47 to 50	10.5	9.5
50 to 53	11	10

Table 16-20 Screwing hanging knees and shelves to frames and deck beams

B/3 + H1	*Number*	*Screws*
m		*mm Ø*
to 1.5	*3*	*4.5*
1.5 to 1.75	*3*	*5*
1.75 to 1.9	*3*	*5.5*
1.9 to 2.1	*3*	*6*
2.1 to 2.3	*3*	*7*
2.3 to 2.5	*4*	*8*
2.5 to 2.7	*4*	*8*
2.7 to 2.9	*4*	*9*
2.9 to 3.15	*4*	*10*
3.15 to 3.4	*4*	*10*
3.4 to 3.65	*5*	*11*
3.65 to 3.9	*5*	*11*
3.9 to 4.15	*5*	*12*
4.15 to 4.4	*5*	*12*
4.4 to 4.65	*6*	*13*
4.65 to 4.9	*6*	*13*
4.9 to 5.2	*6*	*14*
5.2 to 5.5	*6*	*15*
5.5 to 5.8	*6*	*16*

17 MACHINERY, SYSTEMS AND SAFETY EQUIPMENT

17.1 Machinery

17.1.1 Certification

17.1.1.1 Engines

The machinery installation and engine spaces shall match the requirements of ISO 9094, ISO 10088, ISO 11105, ISO 15584 and ISO 16147 as applicable.

ISO 9094:2015 defines a practical degree of fire prevention and protection intended to provide enough time for occupants to escape a fire onboard small craft.

ISO 10088:2013 specifies the requirements for the design, materials, construction, installation and testing of permanently installed fuel systems as installed for internal combustion engines.

ISO 11105:2020 specifies requirements for the ventilation of petrol engine and petrol tank compartments in small craft having petrol engines for propulsion, electrical generation, or mechanical power, to prevent the accumulation of explosive gases in these compartments. Personal marine craft are not covered in this document.

ISO 15584:2001 specifies requirements for engine-mounted fuel and electrical components of inboard petrol engines.

ISO 16147:2020 specifies requirements for engine-mounted fuel and electrical components of inboard diesel engines.

Engines shall be of a recognized type adapted for maritime use. Engines with a power exceeding 2,500 kW shall be Type Approved by a classification society or another recognized organization.

17.1.2 Propulsion and auxiliary engines

17.1.2.1 Engines

Inboard diesel engine(s) shall normally be used for main propulsion. Outboard petrol engines may be accepted when L × B is smaller than 40. Requirements to outboard petrol engine installations are given in Section [17.3]. Inboard petrol engines are not allowed.

17.1.2.2 Engine room

The engine room shall not be used for other purposes. The normal service points of the engine shall be readily accessible. Rotating parts shall be shielded to prevent personal injury.

Windows scuttles or similar in engine room shall have the same fire rating as surrounding structure.

The engine room shall be equipped with artificial lighting.

Ventilation of the engine room for the engine's air consumption and cooling shall be arranged according to the engine manufacture's recommendations. The engine room/space shall have ventilation to the outside. The total cross-sectional area of intake ventilation openings and ducts shall not be smaller than 7 cm2/kW.

Ventilation openings shall be equipped with fire closing appliances that can be operated from outside the engine room and secured in open and closed position.

17.1.2.3 Engine controls

Engines shall be possible to monitor from the helm position. The following indicators or alarms shall be visible/audible:

- Speed of revolutions (may be omitted for auxiliary engines)
- Lubrication oil pressure
- Cooling water temperature
- Alarm for loss of exhaust cooling

The instrumentation shall be equipped with adjustable lighting.

Marine crafts with an open steering position and a maximum speed exceeding 25 knots shall have a safety contact at the steering position which will stop the propulsion engine if the helmsman should fall overboard.

17.1.2.4 Exhaust

Each engine shall have a separate exhaust system. Exhaust lines shall be accessible for inspection.

Exhaust line with a surface temperature exceeding 80°C shall be equipped with protection against touching. Exhaust piping shall not be arranged in such a way that other materials or structures reach temperatures above 65°C.

Materials in seawater cooled exhaust systems shall be corrosion resistant. Special attention shall be given to avoid galvanic corrosion.

Seawater cooled exhaust systems shall be equipped with an alarm at the steering position for loss of seawater cooling or for high temperature in the exhaust pipe.

Exhaust outlets shall be at least 100 mm above loaded waterline, or the exhaust line shall consist of a metallic pipe brought at least 100 mm above loaded water line.

At one location the lower inside surface of the exhaust pipe shall be at least 350 mm above loaded water line. From this location the pipe shall fall continuously to the exhaust outlet.

Flexible rubber and plastic hoses for wet-exhaust system shall be a class B hose according to ISO 13363.

17.2 Driven units

17.2.1 Shafting

17.2.1.1 Diameter

The diameter of steel shafting shall be in accordance with the engine manufacturer's recommendation, and not smaller than:

$$d = 90 \cdot \left(\frac{P}{RPM} \right)^{1/3} \cdot \left(\frac{600}{R_m + 160} \right)^{1/3} \quad (mm)$$

P = maximum continuous power of driving engine (kW)

RPM = shaft revolutions pr. minute

R_m = tensile strength (MPa).

The dimensions of shafting fabricated from other materials are subject to special consideration.

17.2.2 Shaft brackets and stern tubes

17.2.2.1 General

Shaft bearings shall be sufficiently lubricated.

One-armed shaft brackets shall have a section modulus W at the craft's bottom not smaller than:

$$W = \frac{l \cdot d^2}{112 \cdot R_m} \quad (cm^3)$$

d = shaft diameter (mm)

l = length of bearing (mm)

R_m = tensile strength (MPa).

At the bearing the section modulus shall not be smaller than 0.6 W.

17.2.3 Gears, propellers and waterjets

Gears, propellers and waterjets shall be supplied by recognized manufacturers. The equipment shall be approved by responsible entity, either by a type-approval or on a case-by-case basis.

17.3 Outboard installations

17.3.1 General

17.3.1.1 General

Outboard installations shall comply with the requirements in this section.

Marine crafts equipped with outboard engines with a power exceeding 15 kW shall be equipped with permanent wheel steering. Permanent wheel steering may be required for other marine crafts if found necessary for safety reasons. Rudder stops shall be fitted when wheel steering is fitted.

Craft with outboard engine shall meet the requirements in ISO 11547 'Small craft – Start–in-gear protection'.

17.3.2 Arrangement

17.3.2.1 Installation

For outboard engines with power less or equal to 15 kW where the engine is fastened without through-bolts, the transom shall be fitted with a well fastened plate as a protection for the fastening screws for the engine. The upper part of the plate shall have a ridge of at least 5 mm to prevent the engines fastening screws from slipping over the edge.

Outboard engines with power greater than 15 kW shall be fastened to the stern using through bolts.

Outboard engines with power greater than 15 kW shall be provided with remote steering and controls.

Craft fitted with outboard engines where the power exceeds 100 kW are to be fitted in an engine well. The engine well shall be drained to the sea.

17.3.2.2 Steering

The steering gear shall be designed for a force K not less than:

K = 10·P (N)

where P is the engine power in kW.

Consoles and all components at the steering position shall be built, stiffened and secured in such a way that they can absorb the forces to which they are exposed, including dynamic loads from the helmsman considering the marine crafts movement in seas.

17.3.2.3 Fuel tanks

Petrol tanks shall be secured to hull structure and installed in a separate enclosure with natural ventilation to the outside of the marine craft. Filling pipes shall be fitted and carried to open deck. Cross sectional area of supply ducts shall be according:

A = 3000 ln (V/0.14), min 3000 mm^2 per opening or duct

where A is the combined area of openings or ducts in mm^2 and V is the net compartment volume in m^3.

Petrol tanks shall be fabricated from steel or aluminium. Diesel tanks shall be fabricated from steel, aluminium or FRP. All couplings shall be fitted to the top of the tank. Petrol tanks shall not have any arrangement for drainage.

In fuels systems for petrol all metallic components, from filling spigots on deck to, and including the engine, shall be connected by means of electric conductor(s).

17.3.2.4 Safety

Flame dampers, carburetors or other components in the engine system shall be installed to not represent a safety hazard.

Penetrations to the engine well for outboard engines shall be effectively sealed by means of rubber sleeves or similar equipment.

17.4 Steering

17.4.1 Definitions

17.4.1.1 Definitions applying in this section

K = steering force on tiller at point of actuation (N)

F = steering force on rudder (N)

A = rudder area (m^2)

V = maximum craft speed (knots)

S_a = length of tiller from rudder stock center to point of actuation (mm)

S_b = distance from pressure center of rudder to lower rudder bearing for spade rudders, to upper bearing for balance rudder (mm)

S_v = distance from rudder pressure center to axis of rotation, not to be taken smaller than 40% of the chord length aft of the leading edge for plate rudders, not to be taken smaller than 30% of the chord length aft of the leading edge for profile rudders (mm)

P = maximum engine power output (kW)

M = combined bending moment and torque on rudder stock (Nmm)

d = diameter of rudder stock (for solid stock) (mm)

$\sigma_{0.2}$ = yield stress of rudder stock or other item, as applicable (MPa).

17.4.2 Arrangements

17.4.2.1 General

The steering arrangement shall ensure safe maneuvering of the craft at the maximum engine power for which the craft is certified. The steering system shall be protected.

It shall be possible to steer the craft by means of an emergency arrangement also when the normal means of actuating the rudder/waterjet has failed.

Rudder stops shall be fitted.

17.4.3 Forces on steering system

17.4.3.1 Rudder steering

The steering force K with rudder shall not be taken smaller than:

$$K = F \cdot \frac{S_v}{S_a} \quad [N]$$

with F not taken smaller than:

$$F = 110 \cdot A \cdot V^2 \quad (N)$$

The means of actuating the rudder shall have a capacity corresponding to not less than 2 times the maximum torque on the rudder stock.

17.4.3.2 Waterjet installations

The steering forces from water jets shall be specified by the manufacturer of the water jet.

17.4.4 Rudder stock

17.4.4.1 General

The combined bending moment and torque, M, on the rudder stock shall not be taken smaller than:

for balance rudders

$$M = \left(\frac{FS_b}{4} + \frac{F}{2}\left(S_b + 2S_v^2\right)^{\frac{1}{2}} \right) \quad [Nmm]$$

for spade rudders

$$M = \left(\frac{FS_b}{2} + \frac{F}{2}\left(S_b^2 + 2S_v^2\right)^{\frac{1}{2}} \right) \quad [Nmm]$$

The diameter d of the rudder stock shall not be smaller than:

$$d = 2.2\left(\frac{M}{\sigma_{0.2}}\right)^{\frac{1}{3}}$$

for solid stocks.

Hollow stocks shall satisfy the following criteria:

d_o = outer diameter of stock

d_i = inner diameter of stock.

The length of the bearings shall normally not be smaller than d. The nominal contact pressure on the bearing (stock diameter × length of bearing) shall normally not exceed:

- 7.0 (MPa) for steel against steel
- 4.5 (MPa) for steel against white metal

- 5.5 (MPa) for steel against synthetic materials, water lubricated.

17.4.5 Rudder

17.4.5.1 General

Rudders can be fabricated from steel, aluminium or fibre reinforced thermosets (FRP). FRP can be used in profile rudders only.

The plate thickness t in plate rudders shall not be smaller than:

t = 3 + 0.125 d (mm)

The plate thickness of profile rudders shall not be smaller than:

t = 4 (mm)

In addition to the requirements to minimum thickness the following requirements shall be

The section modulus W of the rudder at any horizontal section through the rudder shall not be smaller than given by:

$$W = \frac{M_{bend}}{\sigma_{all}}$$

M_{bend} = bending moment at the cross section due to maximum rudder lift force

σ_{all} = allowable bending stress.

σ_{all} shall not be taken larger than:

- 50% of specified minimum yield strength for steel.
- 50% of minimum yield strength in welded condition for aluminium.
- 33% of ultimate tensile/compressive strength as relevant for FRP

17.4.6 Steering system

17.4.6.1 Standards

The components of the steering system shall comply with the standards ISO 8847, ISO 8848, ISO 9775, ISO 10592 and ISO 13929, as far as applicable.

17.4.6.2 Hydraulic steering system with or without external source of power

The capacity of the steering system shall be documented.

The complete installation shall be tested for leaks.

The acceptable function of the steering system shall be verified by practical operational tests at sea trial.

Hand operated hydraulic steering systems shall be CE-marked according to Council Directive 94/25/EC or any equivalent Certification Scheme recognized by the Department and installed according to the manufacturers recommendations.

17.4.6.3 Cable steering system

The capacity of the steering system shall be documented.

Cable steering systems shall be CE-marked according to Council Directive 94/25/EC or any equivalent Certification Scheme recognized by the Department and installed according to the manufacturers recommendations.

The acceptable function of the steering system shall be verified by practical operational tests at sea trial.

17.4.6.4 Steering wheel

Steering wheels shall be CE-marked according to Council Directive 94/25/EC or any equivalent Certification Scheme recognized by the Department. For not certified steering wheels the requirements below apply.

For small high-speed craft, the steering wheel shall be tested with force equal to 700 N in the forward and aft-ward direction applied at the weakest point of the steering wheel periphery. The test is to be carried out at room temperature. The steering wheel shall exhibit no breakage or permanent deformation after the test.

For open steering positions, a steering wheel fabricated from plastic materials without a structural metal frame shall not show any major decrease in strength after ageing in xenon light corresponding to 4 years of natural ageing. This requirement may be deleted for black wheels.

17.4.7 Alternative design standard for recreational craft

For **recreational craft** including **charter craft**, as an alternative to the requirements laid down in this chapter 17.4, the standard ISO 12215-8 “Small craft – Hull construction and scantlings – Part 8: Rudders” can be applied. The ISO 12215-8 gives requirements on the scantlings of rudders fitted to small craft with a length overall between 2.5 m and 24 m. It applies both to monohulls and multihulls.

17.5 Piping systems and tanks

17.5.1 General

17.5.1.1 General

Materials used in piping systems shall be suitable for the carried liquid and external environment to which it is exposed. Corrosion and variation in temperature shall be considered. Different materials shall not be combined such that there is a possibility for galvanic corrosion.

All components in the installation shall have sufficient strength and be so mounted that the system including its foundations will withstand the accelerations and vibrations to which it may be exposed as well as the design pressure. They shall be protected against mechanical damage. Expansion loops or equivalent arrangements shall be provided to allow expansion/contraction of pipes.

Flexible hoses used in fuel system, seawater cooling system, bilge system and other systems where a failure of the connection will lead to flooding shall be fitted with two stainless steel hose clips or pressed on end couplings.

Pipes or hoses shall not be installed over switchboard or electrical distribution panels.

Commercial recreational marine crafts with overall length of less than 24 m shall comply with the IACS Recommendation 99, Chapter IV, Section 2, Item 2.1.2 “Materials” (pipes, penetrates, insulation of pipes).

17.5.2 Bilge system

17.5.2.1 Arrangement

The bilge system shall normally consist of rigid pipes fabricated from steel, FRP or thermoplastics. Metallic materials are to be used in the engine room. The bilge system shall be permanently installed. If flexible hoses are used attention shall be given collapse due to suction.

On board all marine crafts where the bilge water may be contaminated with oily water, the bilge water shall be collected in dedicated bilge water holding tanks possible to empty from above deck.

The bilge system shall be able to empty all compartments except tanks.

Separate suction lines to be fitted to each watertight compartment and be equipped with a valve between the main bilge line and the individual suction line with the possibility to operate the valve from the above floors. Emptying by use of the bilge system of small compartments may not be required based on special consideration.

One bilge pump driven directly by the engine or by electric motor shall be installed. The bilge pump shall have a capacity Q not smaller than stated in Table 17-1:

Table 17-1 Bilge pump capacity

Loa (m)	*Capacity (l/minute)*
< 8	*60*
8 – 10	*80*
10 – 12	*120*
12 – 15	*180*
15 – 24	*250*

The bilge pump shall be possible to operate from the steering position. For craft with L larger than 6 m minimum of two pumps shall be fitted, each with at least 50% of the capacity given above.

Alternative to the arrangement using one bilge pump, separate bilge pumps may be installed for one or more compartments with the possibility to operate pumps from the steering position.

The bilge pumping system shall satisfy requirements of ISO 150832:2020.

ISO 15083:2020 specifies requirements for pumping or alternative means designed to remove normal accumulations of bilge water for small craft.

Electrically operated bilge pumps shall satisfy the requirements of ISO 8849:2020.

ISO 8849:2020 specifies requirements for electrically operated bilge pumps intended for use in removing bilge water. It applies to:

- Direct current (DC) bilge pumps which operate at a nominal voltage not exceeding 50 V; and
- Single-phase alternating current (AC) bilge pumps which operate at a nominal voltage not exceeding 250 V.

It does not cover pumps intended for damage control.

17.5.2.2 Alarm

Engine and cargo spaces shall be fitted with a bilge alarm. This does not apply to open craft.

17.5.3 Fuel system

17.5.3.1 Arrangement

The fuel system shall satisfy the requirements of ISO 9094, ISO 10088 and ISO 11105. It includes:

- ISO 9094:2015 defines a practical degree of fire prevention and protection intended to provide enough time for occupants to escape a fire onboard a small craft.
- ISO 10088:2013 specifies the requirements for the design, materials, construction, installation and testing of permanently installed fuel systems as installed for internal combustion engines.

- ISO 11105:2020 specifies requirements for the ventilation of petrol engine and petrol tank compartments in small craft having petrol engines for propulsion, electrical generation or mechanical power, to prevent the accumulation of explosive gases in these compartments.

Personal marine craft are not covered in this document.

Fuel strainers, filters and water separators shall be easily accessible and possible to replace, drain and clean with the engine in operation.

Fuel tanks shall not be located above the engine.

Fuel tanks may be integral or separate.

Separate tanks shall be mounted such that air can circulate freely around the tank and that they can be readily inspected or movable for inspection.

For larger marine crafts it is recommended to have two fuel tanks interconnected to each other so that if one system fails, the other system is available.

Commercial marine crafts with overall length of less than 24 m shall comply with the IACS Recommendation 99, Chapter IV, Section 2, Item 2.1.5 “Oil Fuel Arrangements”.

17.5.3.2 Fuel tanks

Fuel tanks shall be fabricated from steel, aluminium, polyethylene or FRP. Tanks in engine room shall be fabricated from steel or aluminium.

The plate thicknesses (mm) shall not be smaller than:

- Carbon steel: 3.0 (mm)
- Stainless steel: 3.0 (mm)
- Aluminium: 4.0 (mm)
- FRP: 4.0 (mm)
- PE: 5.0 (mm).

Fuel tanks shall have an inspection hatch. For removable tanks, an inspection hatch is not required.

Wash bulkheads shall allow adequate circulation of the fuel along the top and bottom of the tank.

Each tank shall have a separate filling pipe and air vent. The air vent shall be mounted in a way to prevent water from entering the tank. The filling pipe shall have an internal diameter of at least 38 mm. The vent pipe shall have an internal diameter of at least 16 mm. If the filling pipe has a screw coupling or similar device for the filling line, the internal cross-sectional area of the vent pipe shall not be smaller than 125% of the internal cross-sectional area of the filling pipe.

The amount of fuel in the tank arrangement shall be possible to verify at any given time, e.g., by fitting a level gauge to each tank. External sight glass shall have a self-closing valve.

17.5.3.3 Fuel piping

Fuel lines may consist of metal pipes or flexible hoses, or a combination thereof. Fuel lines shall not pass over engine(s) or be arranged such that a leakage can occur on sources of ignition (e.g., hot surfaces).

The engine shall be connected to the fuel line by a short flexible hose.

Flexible hoses shall satisfy the requirements of ISO 7840 Small craft fire-resistant fuel hoses type A1 or A2 and be marked in accordance with this standard.

Fuel lines shall be equipped with a metallic shut-off valve mounted on the tank. The valve shall be possible to close from above deck.

At least two hose clips fabricated from stainless steel shall be used at each connection on flexible hoses. Spigots shall be sufficiently long to accept the hose clips and have grooves or a bead.

Flexible hoses for pressurized system(s) shall be fitted with pressed on end fittings.

17.5.3.4 Testing

After installation, a leakage test shall be carried out of the whole installation with a pressure equal to 20 kPa.

17.5.4 Seawater cooling system

17.5.4.1 General

Flexible hoses may be fitted. Flexible hoses shall be mounted in such a way that they are protected against mechanical damage. Flexible hoses shall comply with the same requirements given for flexible hoses used in fuel systems. Flexible hoses shall be secured with at least two stainless steel hose clips or pressed-on couplings.

Seawater intakes shall have strainers or filters. All filters shall be fitted such that they can be cleaned while the engine is running.

17.5.5 Freshwater systems and grey water system

17.5.5.1 General

Freshwater tanks shall be accessible for cleaning.

Integral freshwater tanks shall not be located contiguous to fuel or grey water tanks.

Toilet and wastewater shall be collected in dedicated holding tanks possible to empty from above deck. The waste-water system shall comply with the requirements of ISO 8099-1:2018.

ISO 8099-1:2018 specifies requirements for the design, construction, and installation of systems for temporary retention of sewage for subsequent disposal.

For existing marine crafts, a retrofit of a toilet and waste-water tank is not required. Instead of retrofitting a holding tank, a portable system for collecting the toilet waste can be foreseen.

Marine crafts built before 1965 or with a displacement of less than 400 kg are exempted from this requirement.

For larger marine crafts the toilet and waste-water holding tanks shall have a capacity of a minimum of 60 liters per person on board.

17.5.6 Shell penetrations

17.5.6.1 General

Penetration located lower than 200 mm above the deepest waterline shall be arranged with a closing valve or other equivalent means for preventing water from passing inboard. The valve shall be readily accessible for operation from a position above the floor, or immediately below via an easily operable and marked hatch in the floor plate.

Penetration located less than 200 mm above the deepest waterline and connected to a system with open inboard end located below the lowest part of bulkhead-deck, and penetration located in a position immersed at an angle of heel of 10º, shall in addition to closing valve be arranged with non-return valve.

Valve shall have a system name and indicator showing closed and open positions.

Material of valve and hull flange shall be of steel, bronze or other equivalent accepted ductile material resistant to corrosion.

Seacocks and through-hull fittings shall satisfy the requirements of ISO 9093:2020.

ISO 9093:2020 specifies requirements for through-hull fittings, seacocks, hose connections, their fittings, and their installation in small marine crafts. This document does not apply to engine and heater exhaust fittings, and sail drive through-hull fittings.

17.6 Electrical systems

17.6.1 General

17.6.1.1 General requirements

The present section does not apply to electrical components on the propulsion or auxiliary engine(s). Equipment considered to represent a safety hazard may be required replaced or modified regardless of where it is mounted.

The present section does not cover personnel protection with respect to exposure to electromagnetic fields, e.g., from radar and CRT screens.

Electrical connections and components shall be protected from the expected conditions in conformity with IEC 60529:

- Minimum IP X7 if exposed to short-term immersion
- Minimum IP X5 if exposed to splashing water
- Minimum IP X2 if located in protected locations inside the craft.

Electrical equipment located in an environment with explosion hazards shall be Ex approved. Battery installations and gas installations are considered explosion hazard areas.

17.6.1.2 Protection

Circuit breakers shall not be placed in tank compartments or compartments for equipment that may generate explosive gases (e.g., battery installation, gas installations).

Safety equipment e.g., radio, sound horn, searchlight etc. and consumers withdrawing a current larger than 5 A shall be equipped with separate circuit breakers.

Navigation lights shall have separate circuit breakers. If the functioning of the navigation light cannot be monitored from the steering position each light shall be equipped with an optical or audible alarm to the steering position indicating if the light is functioning. Malfunctioning of the system for indication shall not influence the function of the navigation light.

17.6.1.3 Switchgear and control gear assembles

Switchboards shall be protected against leaks and spray from sea and piping and shall be accessible for maintenance and replacement and visual inspection during operation.

Each group on the switchboard shall be independently available for the measurement of insulation.

17.6.2 DC systems – voltage ≤ 50 V

17.6.2.1 General

Direct current systems which operate at nominal potential not exceeding 50 V shall comply with ISO 10133 and the requirements given in this section.

A circuit plan shall be supplied with the craft when delivered and be available onboard. All markings shall be permanent.

17.6.2.2 Battery installations

Battery installations with a capacity exceeding 5 kWh shall be placed in compartments with ventilation to the outside of the craft. Battery installations placed in accommodation areas shall be ventilated separately to the outside of the craft.

Each battery shall be marked indicating the connected consumers and how connections between batteries shall be carried out.

Batteries installed inside the same watertight compartment as the propulsion engine(s) shall be mounted such that they are not short-circuited when the compartment is filled with water up to the loaded waterline. Alternatively, emergency batteries for supply to emergency lighting, navigation equipment and radio, may be placed above the main deck.

For main engines with electric starters, the starter shall be possible to connect to two separate groups of batteries. One of the groups shall be assigned to starting and shall not be used to supply other consumers. The other group may be used for consumers and which have a capacity that is sufficient to start the main engine.

17.6.2.3 Distribution systems

For propulsion engines with a power output less than 100 kW, the engine may be used as conductor when starting the engine.

Gas alarms, theft alarms, heating equipment and automatic bilge pumps may be connected between the battery/generator and the main switchboard but must have separate protection with circuit breakers.

Cable penetrations in watertight bulkheads and decks shall be watertight.

The following cables shall be carried as separate, insulated single conductors:

- Conductor to connect generator to batteries.
- Conductor to connect battery to the electrical starter.
- Conductor to connect battery or generator to switchboard.

The conductor between the battery and electrical starter shall not be protected by circuit breaker. The conductor shall comply with the engine manufacturer’s recommendations.

Interior lighting are to be distributed on at least two separate circuits.

17.6.3 DC systems – voltage ≤ 240 V

17.6.3.1 General

Alternating current systems which operate at a nominal voltage not exceeding 250 V shall comply with ISO 13297 and the requirements given in this section. Such systems shall be installed as single-phase systems.

A circuit plan shall be supplied with the craft when delivered and be available onboard. All markings shall be permanent.

Electrical equipment located in an environment with explosion hazards shall be Ex approved. Battery installations and gas installations are considered explosion hazard areas.

17.6.3.2 Distribution systems

Cable penetrations in watertight bulkheads and decks shall be watertight.

Interior lighting shall be distributed on at least two separate circuits.

17.6.3.3 Shore connection

The cable(s) for shore connection shall have a solid sheath resistant to oil and weathering. The socket inlet is to be protected from spray water and rain.

Equipment connected to the shore connection shall become earthed to the shore connection.

17.6.4 Emergency power supply

17.6.4.1 Emergency power supply

An alternative power supply shall be available and capable of supplying the following consumers for a period of at least 3 hours:

- Emergency lights in wheelhouse, accommodation, and engine room (for small craft portable flashlights may be accepted as emergency lights)
- Navigation lights or not under command lights
- Fire detection and alarm systems
- Remote control devices for fire extinguishing systems, if electrical
- Radio facilities.

The alternative power supply shall be fitted outside the engine room and above the flooded waterline with the engine room flooded.

17.7 Fire safety

17.7.1 General

17.7.1.1 Definitions

Definitions and nomenclature in the present section follow the definitions and nomenclature in the FTP Code for the craft structure.

The following designations are used to classify and identify fires of different nature:

- Class A: fires involving solid material, usually of organic nature
- Class B: fires involving liquids or liquefiable solids
- Class C: fires involving electrical equipment
- Class D: fires involving combustible metals (i.e., magnesium).

17.7.1.2 Fire safety in general

Fire safety shall be achieved by the use of passive and active means. Passive means is structural fire protection and control of installations and combustible materials. Active means is fire-fighting equipment.

Fire prevention and protection shall satisfy the requirements of ISO 9094:2015.

ISO 9094:2015 defines a practical degree of fire prevention and protection intended to provide enough time for occupants to escape a fire on board small craft

Commercial marine crafts with overall length of less than 24 m shall comply, as far as practicable, with the IACS Recommendation 99, Chapter IV "Fire Fighting".

17.7.2 Structural fire protection

17.7.2.1 Engine and tank spaces

Engine spaces in crafts fabricated from FRP shall be enclosed with fire protection of a minimum 15 minutes rating. Arrangement and materials for structural fire protection shall be approved. The fire protection shall cover the entire boundary of the engine space above the lowest waterline.

For small crafts (normally L < 15 m) other arrangements than specified may be accepted based on special consideration (e.g., intumescing paint, fire retarding resin on interior surface of FRP laminates).

Fuel and lubrication oil tanks located entirely or partly above the floor in the engine space shall have fire-resisting division of at least B-15 rating.

Openings for ventilation of the engine space shall be equipped with closing appliances readily operable from the outside of the engine space.

Tank spaces separated from engine spaces need not follow the same requirements as given for engine spaces but shall be ventilated to the outside of the craft.

17.7.2.2 Control of combustible materials

Acoustic insulation material used in engine spaces shall as a minimum have a non-fuel-absorbent surface towards the engine and an oxygen index of at least 21 in accordance with ISO 4589-3 at an ambient temperature of 60°C.

17.7.3 Portable fire extinguishers

17.7.3.1 General

The craft shall be equipped with portable fire-fighting extinguishers in accordance with the **Department's relevant regulations and requirements.**

The extinguisher(s) fitted shall individually or as combined be suitable for fighting ABC-fires.

No individual extinguisher shall be rated less than 30A/180B.

Any individual portable carbon dioxide (CO_2) extinguisher shall have a maximum capacity of 2 kg.

17.7.3.2 Location of portable fire extinguishers

The total number of portable fire extinguishers shall be adequate to meet the following requirements. A single extinguisher may meet more than one of the requirements.

Readily accessible portable fire extinguisher(s) shall be located:

- Within 2 m unobstructed distance from the main helm position
- Within each 20 m^2 of the accommodation area
- Within (l/3) m from the center of any berth, measured horizontal
- Within 2 m unobstructed distance from any permanent installed cocker/stove or open flame device.

Portable CO_2 extinguishers shall only be fitted in accommodation spaces when flammable liquids are present (e.g., galley) or where energized electrical equipment is located (e.g., electric motor space, battery space, switchboard).

Where CO_2 extinguishers are used, there shall be only one CO_2 extinguisher in each hazard area. A warning notice shall be affixed near the extinguisher.

If the portable fire extinguisher is located where it is exposed to splashed or sprayed water, the nozzle and triggering device shall be shielded.

The extinguisher may be stowed in a locker or other enclosed space. The locker or opening part of the space must be labeled.

17.7.4 Fire detection

17.7.4.1 Engine spaces

The engine spaces must be equipped with a fire detection system with both audible and visible alarms at the helm position. The detection system may be part of a fixed fire extinguishing system.

17.7.5 Fixed fire extinguishing systems

17.7.5.1 General

Engine spaces shall be protected by a fixed fire-fighting extinguishing system.

The system shall be a manual system or a manual/automatic combined system if applicable. A manual release system shall be activated from the helm position. The release mechanism shall be protected against sea spray and unintended release. The operation instruction shall be posted close to the release mechanism.

Automatic release of the system shall be indicated by both audible and visual alarms at the helm position. Both engine and powered ventilation shall have automatic shutdown upon discharge of automatic systems.

The extinguishing medium shall be suitable for fighting AB-fires.

The amount of extinguishing medium and emptying time shall be adequate for the space considered such that the fire is efficiently extinguished.

The fixed fire extinguishing system shall be of one of the following types:

- Aerosol system
- Co2 system
- Gaseous agent
- High expansion foam system
- Water mist systems

Cylinders for the extinguishing medium shall be protected against sea-spray, mechanical damage and temperatures exceeding 50°C. Cylinders shall not be located in accommodation areas.

Nozzles shall be located in a way that an even distribution of the extinguishing medium is achieved.

17.7.5.2 Aerosol systems

Aerosol system shall be type approved according to IMO MSC/Circ. 1007.

The system may be either a manual or a manual/automatic combined system.

17.7.5.3 CO_2 systems

- The system shall be manually operated only.
- Discharge shall be indicated by both audible and visible alarm.
- The amount of extinguishing medium shall be minimum 0.6 kg/m3 net volume and not less than 2 kg in total.
- CO_2 cylinders shall not be located in the engine room.
- CO_2 cylinders or fittings on distribution lines are not allowed be located in a way that any extinguishing medium can enter into the accommodation area in the event of leakage in the system.
- CO_2 systems shall have a separate fire detection system.

17.7.5.4 Gaseous agent systems

Gaseous agent system shall be type approved according to IMO MSC/Circ. 848, as amended by Circ. 1267.

The system may either be a manual or a manual/automatic combined system.

17.7.5.5 Foam systems

The system may either be a manual or a manual/automatic combined system.

17.7.5.6 Water mist systems

Water mist system shall be type-approved according to IMO Circ. 1165.

Guidance note:
Water mist systems tested according to other standards (e.g., Factory Mutual) may be accepted.

The system may either be a manual or a manual/automatic combined system.

A water mist system shall be designed for a protection time of at least 20 minutes.

Water based systems requiring fresh water shall be connected to dedicated water tanks with capacity for minimum of 5 minutes operation for the largest space, and automatic switch-over to sea-water supply. Alternatively, manual switchover may be used if the capacity of the freshwater tank is increased to 15 minutes.

17.8 Other systems

17.8.1 Cooking and heating appliances

17.8.1.1 General

Stoves and heating units shall be securely fastened.

Where flues are installed, they shall be insulated or shielded to avoid overheating or damage to adjacent material or to the structure of the craft.

17.8.1.2 Units using liquid fuel

Open-flame burners shall be fitted with a drip-pan.

Drip-pan shall have at least 20 mm high coaming able to collect the fuel in case of leakages.

Where open-flame-type water heaters are installed, adequate ventilation and flue protection shall be provided.

Where a pilot light is installed, the combustion chamber room shall be sealed, except for cookers.

Appliances using petrol for priming, or as a fuel, shall not be installed.

17.8.1.3 Liquid fuel tanks

For tanks and supply lines, the applicable requirements of Section 17.5 "Piping Systems and Tanks" apply.

Non-integral tanks shall be securely fastened and shall be installed outside Zone II, figure below.

A readily accessible shut-off valve shall be installed on the tank. If this is outside the galley, a second valve shall be fitted in the fuel line in the galley space, outside zone II, figure below, and not behind the cooker. This requirement does not apply where the tank is located lower than the cooker/heater and there is no possibility of back siphoning.

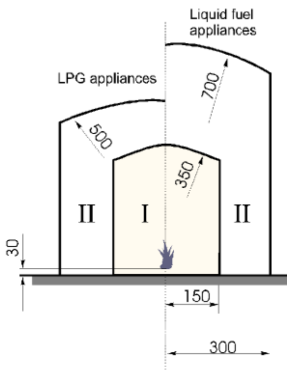
Filler openings for tanks shall be visibly identified to indicate the type of fuel to be used with the system.

17.8.1.4 Materials near open flame appliances

Materials and finishes used in the vicinity of open-flame cooking and heating devices within the ranges defined in figure below shall comply with the following requirements, taking into account the movement of the burner up to an angle of 20° where gimballed stoves are fitted.

The requirements do not apply to the cooker itself:

- Free-hanging curtains or other fabrics must not be fitted in Zone I or II.
- Exposed materials installed in Zone I must be glass, ceramics, aluminium, ferrous metals, or other materials with similar fireproof characteristics, or be thermally insulated.
- Exposed materials installed in Zone II must be glass, ceramics, metals, or other materials with similar fireproof characteristics, or be thermally insulated from the supporting substrate to prevent combustion of the substrate, if the surface temperature exceeds 80°C.



17.8.2 LPG installation

17.8.2.1 General

LPG systems shall be in accordance with ISO 10239, which covers

- Working pressure of the system
- Stowage of gas containers
- Material and routing of lpg supply line
- Installation, ventilation
- Appliance and their connection
- Leakage tests

17.9 Life-saving appliances

17.9.1 General

A marine craft should be equipped with life-saving appliances (life rafts, lifebuoys, buoyant lines, lifejackets, flares and smoke signals, portable VHF, EPIRB, etc.) in accordance with the **Department's relevant regulations and requirements.**

17.10 Navigation and radio equipment

17.10.1 Radio equipment

17.10.1.1 Radio installation

A marine craft should carry equipment for transmitting and receiving on the VHF Maritime Mobile band and for receiving regular shipping weather forecasts for the area of operation.

When the main aerial is fitted to a mast which is equipped to carry sails, an emergency aerial should be provided.

A marine craft other than one operating in area category ***AD2*** or ***AD3***, should be provided with a radio installation capable of transmitting and receiving messages to and from a radio communications center on land.

Having regard to the range limitations of VHF, radio equipment should be provided which has a range capability commensurate with that need for the intended area of operation.

A marine craft operating within area category ***AD2***, but in areas where there is a low density of shipping and radio communications centers on land and when the certainty of good VHF overage is in doubt, should be provided with a radio installation capable of transmitting and receiving messages to and from a radio communications center on land.

When the electrical supply to radio equipment is from a battery, charging facilities, or a duplicate battery of capacity sufficient for a voyage, should be provided. Battery electrical supply to radio equipment should be arranged such that radio communications should not be interrupted.

A card or cards giving a clear summary of the radio-telephone distress, urgency and safety procedures should be displayed in full view of the radiotelephone operating positions(s).

Commercial recreational marine crafts with overall length of less than 24 m shall comply, as far as practicable, with the IACS Recommendation 99, Chapter VI “Radio Installations”.

17.10.1.2 EPIRB’s

A marine craft should be equipped an EPIRB in accordance with the **Department’s relevant regulations and requirements**.

The EPIRB should be installed in an easily accessible position ready to be manually released, capable of being placed in a life-raft, and capable of floating free and automatic activation if the marine craft sinks.

On marine crafts of less than 15 meters in length and carrying 14 or less persons the EPIRB may be stowed in an accessible place and be capable of being placed readily in a life-raft without being capable of floating free.

17.10.2 Navigation lights and sound signals

Placement, installation and visibility of navigation lights shall satisfy the requirements of ISO 16180:2013.

ISO 16180:2013 specifies requirements and gives guidelines for the placement, installation and visibility of navigation lights as described in COLREG for the recreational craft of less than 24 m in length of hull, as described in ISO 8666. Annex A of ISO 16180:2013 lists additional information to be included in the owner's manual.

Sound signaling equipment should comply with the relevant regulations. A marine craft of less than 12 meters in length is not obliged to carry the sound signaling equipment by the Regulations on the condition that some other means of making an efficient sound signal is provided.

If it can be demonstrated to the Department that, for a particular marine craft, full compliance with the Regulations is impracticable, application for an exemption should be made to the Department.

Commercial recreational marine crafts with overall length of less than 24 m shall comply with the IACS Recommendation 99, Chapter VII “Navigational Equipment”.

17.10.3 Navigational equipment

17.10.3.1 Magnetic compass

A marine craft should be fitted with an efficient magnetic compass and valid deviation card (updated annually) complying with the following requirements as appropriate:

(1) In a steel marine craft, it should be possible to correct the compass for coefficients B, C and D and heeling error, according to standards for magnetic compass adjustment:
    - Fore-and-aft permanent magnetic “B” deviations
    - Athwartship permanent magnetic “C” deviations
    - Symmetrical horizontal “D” induced magnetism
    - Vertical heeling component;

(2) The magnetic compass or a repeater should be fitted with an electric light and so positioned as to be clearly readable by the helmsman at the main steering position;

(3) Means should be provided for taking bearings whenever possible over an arc of the horizon of 360 degrees. (This requirement may be met by the fitting of a pelorus or, in a marine craft other than a steel marine craft, a hand bearing compass.)

The magnetic compass shall satisfy the requirements of ISO 14227:2001.

The ISO 14227:2001 specifies the general requirements for the construction as well as the performance of type tests of magnetic compasses on board small craft of hull length up to 24 m. It refers to liquid magnetic compasses, which can be inspected (e.g., not sealed), either equipped with a direct reading system, or of the reflecting/projecting type.

17.10.3.2 Other equipment

A marine craft which operates in areas categories ***AD0***, ***AD1*** or ***AD2*** should be provided with:

(1) a radio navigation aid appropriate for the area of operation;

(2) an echo sounder; and

(3) a distance measuring log; except that this need not be provided where the navigational aid in (1) provides reliable distance measurements in the area of operation of the marine craft

17.10.4 Miscellaneous equipment

17.10.4.1 Nautical publications

A marine craft should carry nautical publications as specified in the **Department’s relevant regulations and requirements**.

17.10.4.2 Signaling lamp

Marine crafts should carry a signaling lamp as per the **Department's relevant regulations and requirements.**

17.10.4.3 Radar reflector

Marine crafts should carry a radar reflector as per the **Department's relevant regulations and requirements.**

17.10.4.4 Measuring instruments

Marine crafts should carry a barometer as per the **Department's relevant regulations and requirements.**

17.10.4.5 Searchlight

Marine crafts should be provided with an efficient fixed and/or portable searchlight suitable for use in man-overboard search and recovery operations as per the **Department's relevant regulations and requirements.**

17.10.5 Anchors and cables

17.10.5.1 General

The requirements given in Table 17-3 for anchor masses and anchor cable diameter are for a marine craft of normal form which may be expected to ride-out storms whilst at anchor and when seabed conditions may not be favorable.

Table 17-3 Anchors and cables

	Anchor Mass		Anchor Cable Diameter			
$\frac{Loa + Lwl}{2}$	Main	Kedge	Main		Kedge	
			Chain	Rope	Chain	Rope
(meters)	(kg)	(kg)	(mm)	(mm)	(mm)	(mm)
6	8	4	6	12	6	10
7	9	4	8	12	6	10
8	10	5	8	12	6	10
9	11	5	8	12	6	10
10	13	6	8	12	6	10
11	15	7	8	12	6	10
12	18	9	8	14	8	12
13	21	10	10	14	8	12
14	24	12	10	14	8	12
15	27	13	10	-	8	12
16	30	15	10	-	8	12
17	34	17	10	-	8	14
18	38	19	10	-	8	14
19	42	21	12	-	10	14
20	47	23	12	-	10	14
21	52	26	12	-	10	14
22	57	28	12	-	10	16
23	62	31	12	-	10	16

24	68	34	12	-	10	16

Notes:

1. Chain cable diameter given is for short link chain. Chain cable should be sized in accordance with EN 24565:1989 (covering ISO 4565:1986 and covered by BS 7160:1990 – Anchor chains for small craft), or equivalent.
2. The rope diameter given is for nylon construction. When rope of another construction is proposed, the breaking load should be not less than that of the nylon rope specified in the table.
3. When anchors and cables are manufactured to imperial sizes, the metric equivalent of the anchor mass and the cable diameter should not be less than the table value.

17.10.5.2 Design requirements for safe operation

When an anchor mass is more than 30 kg, a windlass should be provided for handling the anchor.

There should be a strong securing point on the foredeck and a fair lead or roller at the stem head which can be closed over the cable.

The strong securing point shall satisfy the requirements of ISO 15084:2003.

ISO 15084:2003 specifies requirements for strong points for attaching chains, cables and lines for anchoring, mooring and towing small marine crafts. It does not specify the requirement for the strong point from which the craft can tow other marine crafts. This standard is applicable to small marine crafts with a hull length up to 24 m.

Requirements for anchors and cables:

1) All area of operation categories

   A marine craft should be provided with at least two anchors (one main and one kedge or two main) and cables, subject to [17.10.5.1] and in accordance with the requirements of Table 17-3.

   Anchors of equivalent holding power may be proposed and provided, subject to approval by **the Department**.

2) Restricted operation

   A marine craft of area category ***AD3*** restricted to operations in favorable weather and daylight should be provided with at least two anchors (one main and one kedge or two main), the masses of which may not be less than 90% of the requirements of Table 17-3, corresponding cables and subject to approval by **the Department**.

17.10.5.3 Anchors

The anchor sizes given in Table 17-3 are for high holding power (HHP) types.

The following types of anchors have so far been accepted as anchors with high holding power (HHP):

- BRUCE anchor
- CQR (plough) anchor
- Danforth anchor
- D'Hone anchor

- Heuss special anchor
- Pool anchor
- Kaczirek bar anchor

A stock anchor may be used if its weight is 1.33 times that in the Table 17-3; when a fisherman type of anchor is provided, the weight shall be 1.75 times that in the Table 17-3. The diameter of the anchor cable need not be increased. Other types of anchor require special approval.

When a marine craft has an unusually high windage, due to high freeboard or large superstructures, the mass of anchor given in Table 17-3 should be increased to take account of the increase in wind loading.

The diameter of the anchor cable should be appropriate to the increased mass of anchor.

17.10.5.4 Cables

The length of anchor cable attached to an anchor should be appropriate to the area of operation but generally should be not less than 4 x the marine craft length overall or 30 meters, whichever is the longer, for each of the main and kedge anchors.

In a marine craft of 15 meters in length and over, the anchor cable for the main anchor should be of chain.

In a marine craft of less than 15 meters in length, the cable for main anchors and kedge anchors may be of chain or rope.

When the anchor cable is of rope, there should be not less than 10 meters of chain between the rope and the anchor.

17.10.5.5 Towline

A marine craft should be provided with a towline of not less than the length and diameter of the kedge anchor cable. The towline may be the warp for the kedge anchor.

18 SPECIAL MARINE CRAFT TYPES AND EQUIPMENT

18.1 Recreational craft

18.1.1 General

Recreational craft which are certified according to EU Council Directive 2013/53/EU as amended (RCD) or other certification schemes prescribed by the Department are accepted as equivalent to this document.

18.1.2 Motor-, Sailing- and Passenger yachts

Motor, Sailing and Passenger yachts of special design which the Department deems that they are not falling under this document shall be certified according to a recognized standard prescribed by the Department.

Applicability of a recognized standard to special designs shall be decided based on consideration of the technical background of the different requirements. Increased scope of analysis beyond what is defined in these rules may be required to ensure equivalent safety.

> **Guidance note:**
> A recognized standard can be e.g. DNV Rules for Classification, Yachts (DNV-RU-YACHT), High-Speed Light Craft (DNV-RU-HSLC) with specific type and service notations.

18.1.3 Personal marine craft, kayaks, canoes, rowing marine crafts, jet skis or similar

Personal marine craft, kayaks, canoes, rowing marine crafts, jet skis or similar shall comply with the following Sections of this document as far as applicable:

- Essential Requirements for Design and Building (Section 5),
- Essential Requirements for Emissions (Section 6),
- Requirements on Material and Manufacturing (Section 9),
- Design Principles (Section 11).

Personal marine craft (kayaks, canoes, rowing marine crafts, jet skis or similar) shall comply with ISO 12215. Annex A of the ISO 12215 may be applied to these crafts.

Inflatable marine crafts to comply with ISO 6185:2001 - Part 1, Part 2, Part 3 or Part 4; in accordance with the motor power rating and hull length. Personal marine craft to comply with ISO 13590:2003 “Construction and system installation requirements”.

18.1.4 Dynamically supported craft

Recreational craft which is designed as dynamically supported craft e.g., Hydrofoil Craft, Air Cushion Vehicles (ACV) or Surface Effect Ship (SES) shall comply with the additional stability requirements set out in the 2000 HSC Code for the corresponding type of craft, when operating in the displacement mode, in the planning mode and a transitional regime.

Applicability of the additional stability criteria shall be decided by the Department based on consideration of the technical background of the different requirements. Increased scope of analysis beyond what is defined in these rules may be required to ensure equivalent safety.

18.2 Commercial marine crafts

18.2.1 General

Commercial recreational marine crafts which are certified according to the Rules for Classification of an IACS Classification Society can be accepted as equivalent to the requirements of this document. With the application for certification the Customer shall provide a gap analysis to the Department, demonstrating equivalence of the class requirements to the requirements of this document.

Commercial recreational marine crafts which are certified according to the Safety Regulations of the Gulf Cooperation Council (GCC) are accepted as equivalent to this document.

Commercial recreational marine crafts of special design which the Department deems that they are not falling under this document shall be certified according to a recognized standard prescribed by the Department.

Applicability of a recognized standard to special designs shall be decided based on consideration of the technical background of the different requirements. Increased scope of analysis beyond what is defined in these rules may be required to ensure equivalent safety.

> **Guidance note:**
> A recognized standard can be e.g. DNV Rules for Classification, Ships (DNV-RU-SHIP), High-Speed Light Craft (DNV-RU-HSLC) with specific type and service notations.

18.2.2 Passenger marine crafts

18.2.2.1 General

These rules apply to marine crafts intended for transportation of more than 12 passengers, certified as Passenger vessel.

The requirements given in this Chapter are supplementary to the requirements in the preceding **Sections 1-17**.

Passenger is defined as every person other than:

- The master and members of the crew or other persons employed or engaged in any capacity on board a marine craft on the business of that marine craft
- A child under one year of age.

18.2.2.2 Passenger and crew accommodation

The Passenger and crew accommodation shall be designed and arranged so as to protect the occupants from unfavorable environmental conditions and to minimize the risk of injury to occupants during normal and emergency conditions.

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.

Passenger accommodation shall not contain operating controls unless the operating controls are so protected and located that their operation by a crew member is unlikely to be impeded by passengers during normal and emergency conditions of operation.

Adequate means to notify passengers to be seated shall be provided. Normally an intercom-system is required.

The **number of passengers** used for the maximum loading condition of the marine craft shall be established from the number of permanent seats onboard.

For high-speed light craft only seats of aircraft type should be counted.

For light craft even other types of seats may be used if this is found acceptable when the risk of injuries on passengers in the event of a collision is found possible.

The **windows** in passenger and crew accommodation shall be made of material which will not break into dangerous fragments if fractured. For strength of windows, see [9.7.7].

At high speed and light craft **one seat** shall be provided for each passenger and crew member that the marine craft is certified to carry.

At high-speed craft sleeping seats of aircraft type may be used. No sleeping berth accommodation shall be provided for the passengers at high-speed craft. No sleeping berth accommodation shall be provided for the crew at high-speed craft, unless a comprehensive review of the fire safety measures, and evacuation procedures has been made.

Seats shall be of a form and design such as to minimize the possibility of injury and to avoid trapping of the occupants particularly in emergency conditions. Dangerous projections and hard edges shall be eliminated. Adjustable, folding or rotatable seats, if fitted, shall be provided with locking mechanisms which shall be designed so as to lock automatic in either the stowed or ready positions when the control is released.

Seats shall not move or distort under normal service conditions. They may, however, distort under abnormal loads, in which case the risk of injury to occupants or persons thrown against them shall be minimized.

The installation of seats shall be such as to allow adequate access to any part of the accommodation space. In particular, they shall not obstruct access to, or use of, any essential or emergency equipment or required means of escape.

Onboard high speed craft **safety belts** shall be provided for all seats from which the craft may be operated.

The need to provide safety belts for other persons on board the craft having regard to other protection and the accelerations likely to be experienced shall be examined. For high-speed craft seats facing towards solid bulkheads or other constructions which may cause injuries in case of collision shall be arranged with safety belts.

Safety belts, when correctly adjusted, shall prevent the wearer's trunk from coming into contact with potentially dangerous objects under normal and emergency conditions.

Safety belts and their attachments shall be sufficiently strong to withstand the loads likely to arise due to a collision.

High speed craft which may be exposed to **acceleration** levels which may cause injuries on passengers, shall have the possibility to measure the acceleration level onboard. Craft with design collision level above 12G is also to have arrangements to monitor vertical acceleration level in service.

Provision shall be made to prevent shifting of **baggage, store and cargo compartment** contents, having due regard to occupied compartments and accelerations likely to arise. If safeguarding by the positioning is not practicable, an adequate means of restraint for the baggage, stores and cargo shall be provided.

Controls, electric equipment, high temperature parts, pipelines or other items, the damage or failure of which could affect the safe operation of the craft, shall not be located in baggage, store and cargo compartments unless such items are adequately protected so that they cannot be damaged or, where applicable, operated inadvertently by loading, unloading or by the movement of the contents of the compartment. Loading limits, if necessary, shall be durably marked in those compartments.

Having regard to the purpose of the craft, the closures of the exterior openings of the luggage and cargo compartments as well as special category spaces shall be appropriately weathertight.

On high-speed craft passengers shall not be carried on **open deck** unless provided with passenger seats and shielded from wind.

Open decks which are not intended for passenger transport and doors leading to such decks shall be marked with signboards restricting passengers to be on deck at sea.

Decks, walkways, stairs etc. which are intended for passenger transport shall be of non-skid type. Indoor floors may have carpets.

All passenger accommodations, passenger decks etc. shall be surrounded by an adequate **railing** of minimum 1 000 mm height. Entrances, stairs, gangways etc. shall have handholds on both sides.

18.2.2.3 Doors, stairs, escape routes

For passenger vessels, not being certified as high-speed craft, the following applies:

Spaces or group of spaces which are provided for **30 or more passengers** or are equipped as such, or which have beds for 12 or more passengers shall be provided with at least two widely separated and ready **means of escape**. On board of day trip marine crafts, one of the means of escape may be replaced by two emergency exits.

For spaces below the freeboard deck one of the required means of escape may be a watertight door to the adjacent watertight compartment from which the uppermost deck can be reached. The second means of escape shall lead directly to a safe area above the bulkhead deck or open deck. This does not apply to single cabins.

Means of escape shall be arranged in a practical way and shall have a clear width of at least 0.8 m and a clear height of at least 2 m. The width of doors to cabins may be reduced to 0.7 m.

Spaces and group of spaces provided for **more than 80 passengers** shall have escape ways with a clear width of at least 0.01 m per passenger. This does also apply to doors within the means of escape.

Doors shall always open in the direction of means of escape and shall be clearly marked as such.

Doors of passenger rooms shall comply with the following requirements:

- With the exception of doors leading to connecting corridors, they shall be capable of opening outwards or be constructed as sliding doors
- Cabin doors shall be made in such a way that they can also be unlocked from the outside at any time.

Stairs and their landings in the passenger areas shall comply with the following requirements:

- They shall be constructed in accordance with recognized standards.
- They shall have a clear width of at least 0.80 m or, if they lead to connecting corridors or areas used by more than 80 passengers, at least 0.01 m per passenger.
- They shall have a clear width of at least 1.00 m if they provide the only means of access to a room intended for passengers.
- They shall not lie in the damage area, unless there is at least one staircase on each side of the marine craft in the same zone.

Escape routes shall comply with the following requirements:

- Stairways exits and emergency exits shall be so disposed that, in the event of a fire in any given area, the other areas may be evacuated safely.
- The escape routes shall lead by the shortest route to evacuation areas.
- Escape routes shall not lead through engine rooms or galleys.
- There shall be no rungs, ladders or the like installed at any point along the escape routes.
- Doors to escape routes shall be constructed in such a way as not to reduce the minimum width of the escape route.
- Escape routes and emergency exits shall be clearly signed. The signs shall be lit by the emergency lighting system.

18.2.2.4 Intact and damage stability

The requirements of 2000 HSC Code 2.6 (including Annex 7 and 8, as applicable) and 2.10 - 2.13 shall be complied with in addition to the stability requirements for certification.

For marine crafts certified as passenger vessels and service restriction, ***AD2*** or ***AD3*** in national trade, requirements related to damage are assumed to be applicable between bulkheads only (1-compartment status). The distance between the bulkheads shall be longer than the defined length of damage.

All external openings submerged in the equilibrium position at intermediate or final stages after damage, shall be of watertight closing.

All external openings submerged within the minimum residual range beyond the maximum equilibrium position after damage shall be fitted with closing appliances at least of weathertight standard.

Pipes, ducts etc. shall, to the extent possible, be positioned outside the damage penetration zone. Small pipes through which progressive flooding may not occur may be located within the damage penetration zone.

The scope of the internal watertight integrity survey shall be as follows:

- The internal watertight integrity plan shall be verified as internal watertight subdivision, position and type of internal closing appliances as well as any applicable alarms, indicators, remote controls and signboards of these
- Any pipes, ducts and tunnels in the damage penetration zone shall be verified as being in accordance with the plan.

Additional requirements are given in the 2000 HSC Code.

18.2.2.5 Electrical installations

Passenger marine crafts shall comply with the requirements of Chapter [17.6] “Electrical Systems” with the modifications specified in this section.

The **main electric power supply** system shall have the capacity to supply power to all services necessary for maintaining the marine craft in normal operational and habitable conditions without recourse to an emergency source of power. Exemptions are made for consumers for which mandatory requirements permit emergency power only and for one of redundant consumers necessary for dead marine craft recovery.

There shall be **component redundancy** for main sources of power, transformers and power converters in the main power supply system so that with any source, transformer or power converter out of operation, the power supply system shall be capable of supplying power to the following services:

- those services necessary to provide normal operational conditions for propulsion and safety
- starting the largest essential or important electric motor on board, except auxiliary thrusters, without the transient voltage and frequency variations exceeding specified limits
- ensuring minimum comfortable conditions of habitability which shall include refrigerators for air conditioning (not required for cooking, heating, refrigeration, general mechanical ventilation, sanitary and fresh water).
- for a duplicated essential or important auxiliary, one being supplied non-electrically and the other electrically, it is not expected that the electrically driven auxiliary is used when one generator is out of service
- for dead marine craft recovery.

Fire or other incidents in the space(s) containing the main source of power, associated transforming equipment and the main switchboard, shall not render the emergency power supply system inoperative.

The **main switchboard** shall be located as close as practicable to a main source of power. Location in a separate space may be accepted, provided that the switchboard is in a location with no major fire hazard and that the generator cables are not routed through any spaces of major fire hazard.

Fire or other incidents in the space containing the emergency source of power shall not render the main electrical power system inoperative.

The following may be accepted for passenger marine crafts less than 24 m in length:

- Main and emergency source of power shall be located in separate spaces.
- Other equipment for the main and the emergency electrical power supply system may be placed in the same space but shall be placed in different enclosures (panels).

Passenger marine crafts shall be provided with a self-contained **emergency source of electrical power** and a transitional source of electrical power.

The emergency source of electrical power shall have sufficient energy to supply the required consumers for at least the period given in Table 18-1.

Table 18-1 Required period of emergency electrical power

Service restriction	Required period [hours]
AD0	12
AD1	6
AD2	3

In addition, **Ro-Ro passenger vessels**, shall have electrical emergency lighting in all passengers public spaces and alleyways capable of operating for at least three hours under any condition of heel even if all other sources of electrical power have failed.

The source of power for the emergency lighting shall be accumulator batteries located within the lighting units. The accumulator batteries shall be continuously charged from the emergency switchboard. Any failure of the supplementary emergency lighting shall be immediately apparent. The accumulator batteries shall be replaced at intervals adapted to the service life of the batteries in the ambient conditions in which they are used.

All alleyways, recreational spaces and service spaces normally used by the crew shall be provided with portable and rechargeable battery-operated lamps.

18.2.2.6 Machinery and systems

Machinery auxiliaries, control and electric equipment location serving independent system shall not be placed in the same fire zone.

At least two power bilge pumps should be fitted connected to the bilge main, one of which may be driven by the propulsion machinery. Alternatively, the arrangement may be in accordance with the requirements of 2000 HSC Code 10.3.14 (see Pt.4 Ch.6 Sec.4 [1.1]).

(2000 HSC Code 10.9.1)

The arrangements should be such that at least one power bilge pump should be available for use in all flooding conditions which the craft is required to withstand as follows:

1. One of the required bilge pumps should be an emergency pump of a reliable submersible type having an emergency source of power; or
2. Bilge pumps and their sources of power should be so distributed throughout the length of the craft that at least one pump in an undamaged compartment will be available.

(2000 HSC Code 10.9.2)

On multihull craft, each hull should be provided with at least two bilge pumps.

(2000 HSC Code 10.9.3)

Distribution boxes, cocks and valves in connection with the bilge pumping system should 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 should 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 should 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 2000 HSC Code 10.3.3. In that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the datum.

(2000 HSC Code 10.9.4)

All cocks and valves referred to in 2000 HSC Code 10.9.4 which can be operated from above the datum should have their controls at their place of operation clearly marked and should be provided with means to indicate whether they are open or closed.

(2000 HSC Code 10.9.5)

18.2.3 Floating houses, floating restaurants and excursion marine crafts

18.2.3.1 General

The requirements given in this Chapter apply to floating houses, floating restaurants and excursion marine crafts, disregarding the number of residents, guests or passengers they are certified for.

The requirements given in this Chapter are supplementary to the rules in the preceding **Sections 1-17**.

Floating restaurants, floating houses and excursion marine crafts (including public water transport, tourist marine crafts, party marine crafts) intended for operation on inland navigation waters and in national service only, and carrying more than twelve (12) guests, residents or passengers shall be certified according to this document as "Passenger marine crafts" (Chapter 18.2.2), with service area notation ***AD3***.

18.2.3.2 Arrangement

Sleeping berths: A suitable sleeping berth must be provided for each person staying on board overnight.

Seating must be provided for each person. Seating must be in a location that is protected from the force of the sea and where the likelihood of falling overboard or injury is minimal. If continuous seating is used, there must be at least a 475mm width of seating for each person.

Guardrails shall be designed with vertical course to prohibit children from climbing on the guardrails.

> **Guidance note:**
> A reference standard can be e.g. the requirements of the National Standard for Commercial Vessels of the Australian Maritime Safety Authority, Part F "Special vessels", Section 2 "Leisure craft" (AMSA NSCV-F2), Chapter 12 "Standard houseboats", Item 12.3.8 "Bulwarks and guardrails".

Arrangements for embarkation: The means of embarking floating houses, floating restaurants and excursion marine crafts must take into account:

- Variations in height of the landing surface (this may include a structure or another marine craft); and
- Tidal range; and
- Movement of the marine craft due wind, wave or current; and
- The surfaces that a person boarding, or disembarking is likely to walk on; and
- The likely competence and physical characteristic of the persons likely to be boarding or disembarking the marine craft.

18.2.3.3 Structure

The hull and scantlings must meet the applicable requirement of this document. In case of a twin-hull like pontoon body structure the cross structure of must be designed to withstand a bending moment equal to the product of the fully loaded displacement and the beam between the pontoon centers.

$M = \Delta \cdot d$

where

M = the calculated bending moment in kNm
Δ = the mass displacement of the marine craft in the fully loaded condition in tones
d = the distance between the center of the marine crafts pontoons

18.2.3.4 Machinery and propulsion

A floating house, floating restaurant or excursion marine craft not meant for solely stationary service must have sufficient maneuvering power to maintain its course against 20 knots wind coming from any direction.

18.2.3.5 Bilge system

A floating house or floating restaurant must have a bilge pump with a capacity as specified in Table 17-1 located in each:

- unsealed compartment;
- compartment containing propulsion machinery or sea water pumping systems; and
- compartment containing overboard discharges or seawater intakes.

Each bilge pump must have a strainer fitted to the suction pipe to prevent the pump choking and if an extra low voltage electric motor powers the bilge pump — the pump must meet ISO 8848.

18.2.3.6 Buoyancy, stability, loading and floatation

Reserve buoyancy: It shall be demonstrated to the Department that the buoyant volume of floating houses and restaurants has sufficient reserve buoyancy.

> **Guidance note:**
> A recognized standard can be e.g. the requirements of the National Standard for Commercial Vessels of the Australian Maritime Safety Authority, Part F "Special vessels", Section 2 "Leisure craft" (AMSA NSCV-F2), Chapter 12 "Standard houseboats", Item 12.11.1 "Reserve buoyancy" according to Schedule 3.

Intact stability:

In maximum load condition floating houses and restaurants shall not capsize or be flooded if all persons move to the same side, the angle of heel shall not exceed 7°, caused by a heeling weight:

$P = 82.5 \cdot n$ (kg)

where n = total number of persons.

The weight is to be located 1 m above the uppermost deck in the worst possible location for heel and trim.

The minimum freeboard of the hull on the heeled or immersed side, measured from the inclined waterline to the intersection of the edge of the main deck line and sheer line of the main hull at its lowest point, must be ≥25% of the freeboard in the upright condition when fully loaded.

Stability after flooding:

The subdivision of the hull(s) by watertight bulkheads is to be arranged so that in case of the flooding of any one compartment the floating house or restaurant must not heel or trim so that the waterline crosses a line taken at 76 mm below the top of the hull(s).

The line mentioned in the above subsection (the margin line) must be at least 76 mm below the highest point of the enclosed buoyant volume at any point along the length of the hull.

18.2.4 Dynamically supported craft

Commercial crafts designed as dynamically supported craft e.g., Hydrofoil Craft, Air Cushion Vehicles (ACV) or Surface Effect Ships (SES) shall comply with rules set out in the preceding Section 1 through **Section 17** and in addition with the requirements set out in the 2000 HSC Code for the corresponding type of craft.

Applicability of additional requirements shall be decided by the Department based on consideration of the technical background of the different requirements. Increased scope of analysis beyond what is defined in these rules may be required to ensure equivalent safety.

18.2.5 Passenger submersible craft

Passenger submersible crafts shall comply with the IMO Guidelines for the design, construction and operation of passenger submersible craft and shall be certified according to a recognized standard prescribed by the Department.

Guidance note:

A recognized standard can be e.g., the DNV GL Rules for Classification, Underwater Technology (DNVGL-RU-UWT) with type notation ***Underwater Vehicle*** (DNVGL-RU-UWT-Pt.1 Ch.2, Sec.3(3) “Underwater Vehicles”).

18.2.6 Small fishing marine crafts

Small fishing marine crafts shall comply with the voluntary IMO Guidelines for the design, construction and equipment of small fishing marine crafts and shall be certified according to a recognized standard prescribed by the Department.

Guidance note:

A recognized standard can be e.g., the rules of the Norwegian Maritime Directorate (NMA) covering the segment from 6 to 15 m and segments above.

18.3 Sailing rigs

18.3.1 General

Permanently installed sailing rigs on small marine crafts shall be certified according to a recognized standard prescribed by the Department.

Guidance note:

A recognized standard can be e.g., the DNV GL Rules for Classification, Yachts (DNVGL-RU-YACHT-Pt.6 Ch.1).

18.3.2 Design loads and requirements

For sailing rigs the design loads and/or the design requirements apply as set out in the DNV GL Standards

- DNV-ST-0411 “Standard for Certification of Tall Ship Rigs” and
- DNV-ST-0412 “Standard for Certification of Large Modern Yacht Rigs” respectively.

18.3.3 Periodical surveys

For traditional sailing marine craft rigs, the requirements to periodical surveys apply as set out in DNV Rules for Classification, Yachts

- DNV-RU-YACHT, Part 7 “Fleet in Service”, Chapter 1 “Survey requirements”, Section 6 [9] “Additional surveys, sailing rigs”.

Appendix A: Checklist for Certification (Type- and Unit Examination as per Section 3)

CHECKLIST FOR CERTIFICATION
Building and Design Code for Small Marine Crafts

☐ ☐	**TYPE EXAMINATION (Module B)** **UNIT VERIFICATION (Module G)**	**DMT Case No.:**

Type Designation:	
☐	**Private Recreational craft below 24 m**
	☐ Small craft below 6 m (including kayaks, canoes, rowing marine crafts, jet skis or similar)
	☐ Sailing yachts above 6 m and below 24 m
	☐ Motor yachts above 6 m and below 24 m
	☐ Passenger yachts above 6 m and below 24 m
☐	**Commercial Recreational craft below 24 m**
	☐ Commercial recreational marine crafts below 24 m
	☐ Commercial passenger marine crafts below 24 m
	Commercial recreational marine crafts of special design (please tick in addition, as applicable)
	☐ Commercial recreational marine craft equipped with sailing rig
	☐ Dynamically supported craft (air cushion vehicle, hydrofoils, surface effect ships or similar)
	☐ Submersible and semi-submersible craft
	☐ Small fishing marine craft
☐	**Stationary floating objects below 24 m**
	☐ Floating restaurant, floating house or similar
Manufacturer:	

Technical File examined: Performed by: Date/Sign:	**Prototype Verification:** Performed by: Date/Sign:

Comments to be given in a separate report

ESSENTIAL SAFETY REQUIREMENTS		Accepted		NA	Comments	
		Tech. file	Proto-type		Tech. file	Proto-type
2 General requirements						
2.1	**Marine craft identification**	**Standard:** ISO 10087				
	Composition	☐	☐	☐	☐	☐
	Size, Permanency, Location	☐	☐	☐	☐	☐
2.2	**Builder's plate**	**Standard:** ISO 11192, ISO 14945				
	Location, fixing	☐	☐	☐	☐	☐
	Displayed information	☐	☐	☐	☐	☐
2.3	**Protection from falling overboard and means of reboarding**	**Standard:** ISO 15085				
	Definition of the working deck area(s)	☐	☐	☐	☐	☐
	Access to fore anchoring area / strong point	☐	☐	☐	☐	☐
	Slip resistant surface	☐	☐	☐	☐	☐
	Foot stop	☐	☐	☐	☐	☐
	Hand holds	☐	☐	☐	☐	☐
	Guard rail	☐	☐	☐	☐	☐

ESSENTIAL SAFETY REQUIREMENTS		Accepted		NA	Comments	
		Tech. file	Proto-type		Tech. file	Proto-type
	Hooking points	☐	☐	☐	☐	☐
	Jack-line anchoring points	☐	☐	☐	☐	☐
	Fast motor craft passenger body support	☐	☐	☐	☐	☐
	Means of reboarding	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
2.4	**Visibility from the main steering position**	**Standard:** ISO 11591				
	Field of vision – forward horizontal / vertical	☐	☐	☐	☐	☐
	Field of vision - astern	☐	☐	☐	☐	☐
	Marking of other helms positions with limited vision	☐	☐	☐	☐	☐
	Field of vision – assessed by practical test	☐	☐	☐	☐	☐
	Position of throttle and shift controls	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
2.5	**Owner's manual**	**Standard:** ISO 10240				
	Each craft is provided with an owner's manual	☐	☐	☐	☐	☐
	Format and style, text and drawings	☐	☐	☐	☐	☐
	Content	☐	☐	☐	☐	☐
3 Integrity and Structural Requirements						
3.1	**Structure**	**Standard:** this document, ISO 12215				
	Structure calculations / drawings	☐	☐	☐	☐	☐
	Materials – mechanical properties for calculation	☐	☐	☐	☐	☐
	Materials – documentation	☐	☐	☐	☐	☐
3.2	**Stability and freeboard**	**Standard:** this document, ISO 12217, IS Code (2008)				
	Down flooding – test	☐	☐	☐	☐	☐
	Down flooding – calculations	☐	☐	☐	☐	☐
	Stability – test	☐	☐	☐	☐	☐
	Stability - calculations	☐	☐	☐	☐	☐
	Vanishing stability - test	☐	☐	☐	☐	☐
	Vanishing stability - calculations	☐	☐	☐	☐	☐
	Stability index (STIX)	☐	☐	☐	☐	☐
	Knock down receovery test	☐	☐	☐	☐	☐
	Wind stiffness test	☐	☐	☐	☐	☐
	Capsize recovery test	☐	☐	☐	☐	☐
	Recess size	☐	☐	☐	☐	☐
	Detection and removal of water	☐	☐	☐	☐	☐
	Offset load	☐	☐	☐	☐	☐
	Rolling in waves	☐	☐	☐	☐	☐
	Resistance to waves	☐	☐	☐	☐	☐
	Heel due to wind	☐	☐	☐	☐	☐
3.3	**Buoyancy and flotation**	**Standard:** this document, ISO 12217, IS Code (2008)				
	Swamped stability test	☐	☐	☐	☐	☐
	Swamped buoyancy test (load test)	☐	☐	☐	☐	☐
	Swamped buoyancy test (one person test)	☐	☐	☐	☐	☐
	Flotation material & elements	☐	☐	☐	☐	☐

ESSENTIAL SAFETY REQUIREMENTS		Accepted		NA	Comments	
		Tech. file	Proto-type		Tech. file	Proto-type
3.4	**Openings in hull, deck and superstructure**	**Standard:** this document, ISO 9093, ISO 11812, ISO 12216				
	Doors	☐	☐	☐	☐	☐
	Windows	☐	☐	☐	☐	☐
	Hinged deck hatches	☐	☐	☐	☐	☐
	Sliding appliances	☐	☐	☐	☐	☐
	Deadlights	☐	☐	☐	☐	☐
	Multi hull escape hatch	☐	☐	☐	☐	☐
	Prefabricated hatches and port lights - certification	☐	☐	☐	☐	☐
	Quick draining recesses – water tightness	☐	☐	☐	☐	☐
	Through hull fittings - design	☐	☐	☐	☐	☐
	Sea cocks - design	☐	☐	☐	☐	☐
	Through hull fittings / sea cocks – attachment to the hull	☐	☐	☐	☐	☐
	Sea cocks – fitted where required	☐	☐	☐	☐	☐
	Sea cocks – readily accessible	☐	☐	☐	☐	☐
	Hose connections	☐	☐	☐	☐	☐
	Exhaust outlet	☐	☐	☐	☐	☐
3.5	**Flooding**	**Standard:** this document, ISO 11812, ISO 15083				
	Quick draining recesses – bottom height	☐	☐	☐	☐	☐
	Quick draining recesses – drainage	☐	☐	☐	☐	☐
	Quick draining recesses – sills	☐	☐	☐	☐	☐
	Quick draining recesses – water tightness	☐	☐	☐	☐	☐
	Acceptable flood preventing through ventilation systems	☐	☐	☐	☐	☐
	Bilge pumps – type, number and location	☐	☐	☐	☐	☐
	Bilge pumps – capacity	☐	☐	☐	☐	☐
	Bilge pumping system – design and construction	☐	☐	☐	☐	☐
	Bilge pumping system – installation	☐	☐	☐	☐	☐
	Bilge pumping system – information in Owner’s Manual	☐	☐	☐	☐	☐
3.6	**Manufacturer’s maximum recommended load**	**Standard:** this document, ISO 14946				
	Max. number of persons – assigned seating space	☐	☐	☐	☐	☐
	Max. number of persons – stability criteria complied with	☐	☐	☐	☐	☐
	Max. load – determination	☐	☐	☐	☐	☐
	Max. load – stability criteria complied with	☐	☐	☐	☐	☐
	Displayed information on the builder’s plate	☐	☐	☐	☐	☐
	Information in Owner’s Manual	☐	☐	☐	☐	☐
3.7	**Liferafts stowage**	**Standard:** this document				
	Provided with sufficient and readily accessible stowage point(s)	☐	☐	☐	☐	☐
	Information in Owner’s Manual	☐	☐	☐	☐	☐
3.8	**Escape**	**Standard:** this document, ISO 9094, ISO 12216				
	Escape routes – if fire	☐	☐	☐	☐	☐
	Escape routes – if inverted, mutli-hull	☐	☐	☐	☐	☐
	Escape exits – size	☐	☐	☐	☐	☐
	Escape exits – readily accessible / vertical distance	☐	☐	☐	☐	☐
	Escape exits – labeling	☐	☐	☐	☐	☐
	Information in Owner’s Manual	☐	☐	☐	☐	☐

ESSENTIAL SAFETY REQUIREMENTS		Accepted		NA	Comments	
		Tech. file	Proto-type		Tech. file	Proto-type
3.9	**Anchoring, mooring, and towing**	**Standard:** this document, ISO 15084				
	Number of strong points	☐	☐	☐	☐	☐
	Size, strength, and material of strong points	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
4 Handling Characteristic						
	Sea trial – handling characteristics	☐	☐	☐	☐	☐
	Sea trial – max. propulsion power	☐	☐	☐	☐	☐
	Power label	☐	☐	☐	☐	☐
	"Emergency stop" labeled	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5 Installation Requirements						
5.1	**Engines and engine spaces**	**Standard:** this document, ISO 9094, ISO 10088, ISO 11105, ISO 15584 and ISO 16147				
5.1.1	*Inboard engine*					
	Main propeller designed for marine use and fitted on proper engine base	☐	☐	☐	☐	☐
	Engine compartment separated from living quarters	☐	☐	☐	☐	☐
	Stowage compartment separated from engine compartment	☐	☐	☐	☐	☐
	Gas-tight subdivision (petrol engines)	☐	☐	☐	☐	☐
	Ignition protection (petrol engines)	☐	☐	☐	☐	☐
	Insulation – noise and vibrations	☐	☐	☐	☐	☐
	Insulation – material inside engine compartment	☐	☐	☐	☐	☐
	Access to engine parts and accessories	☐	☐	☐	☐	☐
	Exhaust system	☐	☐	☐	☐	☐
5.1.2	*Ventilation*					
	Prevention of water ingress	☐	☐	☐	☐	☐
	Natural ventilation system	☐	☐	☐	☐	☐
	Powered ventilation system (petrol engines)	☐	☐	☐	☐	☐
	Blower warning label (petrol engines)	☐	☐	☐	☐	☐
5.1.3	*Exposed parts*					
	Shielding of moving and hot parts of engine	☐	☐	☐	☐	☐
	Non-skid surface / handholds in engine compartment	☐	☐	☐	☐	☐
5.2	**Fuel system**	**Standard:** this document, ISO 9094, ISO 10088 and ISO 11105				
5.2.1	*General*					
	Fuel tanks and lines not adjacent to hot surfaces, engines, exhaust lines	☐	☐	☐	☐	☐
	Prevention of water ingress through tank ventilation	☐	☐	☐	☐	☐
	Bonding of petrol fuel fills system	☐	☐	☐	☐	☐
	Determination of fuel level / quantity	☐	☐	☐	☐	☐
	Fuel hoses – certification mark	☐	☐	☐	☐	☐
	Fuel fill lines	☐	☐	☐	☐	☐
	Fuel fill points – location / labeling	☐	☐	☐	☐	☐
	Fuel vent lines	☐	☐	☐	☐	☐
	Fuel vent line terminations - location	☐	☐	☐	☐	☐
	Fuel distribution and return lines / components	☐	☐	☐	☐	☐
	Fuel hose fittings and clamping	☐	☐	☐	☐	☐
	Fuel valves	☐	☐	☐	☐	☐
	Fuel filters / water separator	☐	☐	☐	☐	☐

ESSENTIAL SAFETY REQUIREMENTS		Accepted		NA	Comments	
		Tech. file	Proto-type		Tech. file	Proto-type
	Fuel system pressure test	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5.2.2	*Fuel tanks*					
	Permanent tank – material, design and marking	☐	☐	☐	☐	☐
	Permanent tank, prefabricated – certification mark	☐	☐	☐	☐	☐
	Permanent tank – testing	☐	☐	☐	☐	☐
	Permanent tank – installation	☐	☐	☐	☐	☐
	Portable tank – positioning, fastening device	☐	☐	☐	☐	☐
	Ventilation of petrol tank compartments	☐	☐	☐	☐	☐
	Apparatus fuel tank / line installation	☐	☐	☐	☐	☐
5.3	**Electrical system**	**Standard:** this document, ISO 10133				
	Batteries – permanent electrical system / outboard engine >26 kW	☐	☐	☐	☐	☐
	Batteries – position / fastening	☐	☐	☐	☐	☐
	Batteries – ventilation and protection from ingress of water	☐	☐	☐	☐	☐
	Battery disconnect switch	☐	☐	☐	☐	☐
	Conductors – insulation material	☐	☐	☐	☐	☐
	Conductors - size	☐	☐	☐	☐	☐
	Conductors - identification	☐	☐	☐	☐	☐
	Conductors – support, fastening, protection against damaging	☐	☐	☐	☐	☐
	Over current protection – position / size	☐	☐	☐	☐	☐
	Panel boards – access, front and rear	☐	☐	☐	☐	☐
	Panel boards – separate for d.c. and a.c. system	☐	☐	☐	☐	☐
	Wiring connections and terminals - type	☐	☐	☐	☐	☐
	Ignition protection – certification mark / documented equipment	☐	☐	☐	☐	☐
	Grounding of a.c. system	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5.4	**Steering system**	**Standard:** this document, ISO 8847, ISO 8848, ISO 9775, ISO 10592, ISO 13939				
5.4.1	*General*					
	Steering system – certification mark	☐	☐	☐	☐	☐
	Steering system - installation	☐	☐	☐	☐	☐
	Satisfactory steering console (outboard motor >15 kW)	☐	☐	☐	☐	☐
5.4.2	*Emergency arrangements*					
	Emergency steering fitted	☐	☐	☐	☐	☐
	Readily accessible	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5.5	**Gas system**	**Standard:** this document, ISO 10239				
	Vapor-withdrawal type gas system	☐	☐	☐	☐	☐
	Pressure reduction system	☐	☐	☐	☐	☐
	LPG supply line system – piping	☐	☐	☐	☐	☐
	LPG supply line system – hoses and hose lines	☐	☐	☐	☐	☐
	LPG supply line system – materials	☐	☐	☐	☐	☐
	LPG supply line system – installation	☐	☐	☐	☐	☐
	LPG supply line system – shut-off valves	☐	☐	☐	☐	☐
	Appliances	☐	☐	☐	☐	☐

ESSENTIAL SAFETY REQUIREMENTS		Accepted Tech. file	Accepted Proto-type	NA	Comments Tech. file	Comments Proto-type
	LPG cylinders – location and installation	☐	☐	☐	☐	☐
	Ventilation of accommodation spaces / labeling	☐	☐	☐	☐	☐
	LPG installation system tests	☐	☐	☐	☐	☐
	Electrical devices – ignition protection	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5.6	**Fire protection**	**Standard:** this document, ISO 9094				
5.6.1	*General*					
	Craft layout / design – bilges	☐	☐	☐	☐	☐
	Craft layout / design – petrol engines and tank compartments	☐	☐	☐	☐	☐
	Materials and finishes near open flame	☐	☐	☐	☐	☐
	Cooking and heating appliances – type	☐	☐	☐	☐	☐
	Position of openings for dry exhaust	☐	☐	☐	☐	☐
	Fire detection device	☐	☐	☐	☐	☐
5.6.2	*Fire-fighting equipment*					
	Portable fire extinguishers – general requirements	☐	☐	☐	☐	☐
	Portable fire extinguishers – type and capacity	☐	☐	☐	☐	☐
	Portable fire extinguishers – location	☐	☐	☐	☐	☐
	Fire port, petrol engine <120 kW / diesel engine, open marine craft	☐	☐	☐	☐	☐
	Fire port to fuel space, outboard engine, open marine craft	☐	☐	☐	☐	☐
	Fire port, petrol engine <120 kW / engine inside marine craft	☐	☐	☐	☐	☐
	Fire port, identification, size, design	☐	☐	☐	☐	☐
	Fixed fire extinguishing system – application, also diesel >120 kW	☐	☐	☐	☐	☐
	Fixed fire extinguishing system – installation	☐	☐	☐	☐	☐
	Fixed fire extinguishing system – discharge and control	☐	☐	☐	☐	☐
	Fixed fire extinguishing system – operation / labeling	☐	☐	☐	☐	☐
	Fire blanket or fire extinguisher when open flame cooking stove	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐
5.7	**Navigation lights**	**Standard:** this document, ISO 16180				
	Compliance with ISO 16180, '72 COLREG or CEVNI regulations	☐	☐	☐	☐	☐
	Documented navigation light approval	☐	☐	☐	☐	☐
	Specified height of top light above side light	☐	☐	☐	☐	☐
5.8	**Discharge prevention**	**Standard:** this document, ISO 8099				
	Oil / fuel spill prevention – fuel filling	☐	☐	☐	☐	☐
	Oil / fuel spill prevention – engine compartment	☐	☐	☐	☐	☐
	Oil / fuel spill prevention – compartments for small fuel tanks	☐	☐	☐	☐	☐
	Toilet waste – holding tanks, permanently/temporarily provision	☐	☐	☐	☐	☐
	Toilet waste – sealed shut valve arrangement	☐	☐	☐	☐	☐
	Toilet waste – pump out deck fitting	☐	☐	☐	☐	☐
	Information in Owner's Manual	☐	☐	☐	☐	☐

EMISSIONS Exhaust propulsion engine					
Is Declaration of Conformity available in which the manufacturer conforms that the engine will meet the exhaust emission requirements of when installed in accordance with the engine manufacturer's supplied instructions?	☐	☐	☐	☐	☐

Is engine provided with an owner's manual which provide instruction for the installation and maintenance needed to assure proper functioning of the engine?	☐	☐	☐	☐	☐

EMISSIONS Noise					
Outboard engines, stern drive engines with integral exhaust					
Does the owner's manual include information on maintenance to ensure continued compliance with the noise emission limits?	☐	☐	☐	☐	☐
Inboard engines or stern drive engines without integral exhaust					
Are the key parameters the same or compatible with those of a "certified reference marine craft"	☐	☐	☐	☐	☐
Is the Froude number ≤ 1.1; and Is the power displacement ratio ≤ 40	☐	☐	☐	☐	☐
If yes to above, no further conformity assessment for noise emission is required.					
Is sound emission assessed according to ISO 14509, module Aa/G with satisfactory result?	☐	☐	☐	☐	☐

COMPONENTS					
Are declarations of conformity available for					
- Ignition protected equipment for inboard and stern drive engines	☐	☐	☐	☐	☐
- Start-in-gear protection devices for outboard engines	☐	☐	☐	☐	☐
- Steering wheels, steering mechanism, and cable assemblies	☐	☐	☐	☐	☐
- Fuel tanks and fuel hoses	☐	☐	☐	☐	☐
- Prefabricated hatches and port lights	☐	☐	☐	☐	☐

Appendix B: Application for Exemptions (Recreational Craft, Experimental Marine Craft and Other)

APPLICATION FOR EXEMPTIONS
Recreational craft, experimental marine craft and other

Type Designation:				**DMT Case No.:**
☐	**Recreational craft below**			
	☐ Marine craft intended solely for racing, labelled as such by the manufacturer			
	☐ Surfboards and kite boards, solely propelled by wind			
	☐ Surfboards and SUP boards			
	☐ Foiling boards and electric foiling boards			
	☐ Experimental marine craft			
	☐ Marine craft self-built for own use			
	☐ Other (please specify)			

Requirement	**Compliant**	**N/A**	**Application for exemption**	**Alternative standard (please specify)**
5. Essential Requirements for Design and Building				
5.1 Service area notation	☐	☐	☐	
5.2 General requirements	☐	☐	☐	
5.3 Integrity and structural requirements	☐	☐	☐	
5.3.1 Structural integrity	☐	☐	☐	
5.3.2 Stability and freeboard	☐	☐	☐	
5.3.3 Buoyancy and flotation	☐	☐	☐	
5.3.4 Openings	☐	☐	☐	
5.3.5 Flooding	☐	☐	☐	
5.3.6 Maximum recommended load	☐	☐	☐	
5.3.7 Life raft stowage	☐	☐	☐	
5.3.8 Escape	☐	☐	☐	
5.3.9 Anchoring, mooring, and towing	☐	☐	☐	
5.4 Handling characteristics	☐	☐	☐	
5.5 Installation requirements	☐	☐	☐	
6. Essential Requirements for Emissions				
6.1 Exhaust emissions	☐	☐	☐	
6.2 Noise emissions	☐	☐	☐	
10. Materials and manufacturing	☐	☐	☐	
11. Design principles	☐	☐	☐	
Manufacturer:				

Technical File examined:	**Prototype Verification:**
Performed by:	Performed by:
Date/Sign:	Date/Sign:

Comments to be given in a separate report

END