RULES FOR THE CLASSIFICATION OF FAST PATROL VESSELS

Effective from 1 January 2016

Part B

Hull and Stability

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GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorized to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

- (i) Rules for the Classification of Ships or other special units;
- (ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
- (iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
- (iv) Guides to carry out particular activities connected with Services;
- (v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
- (i) sets forth and develops Rules;
- (ii) publishes the Register of Ships;
- (iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various Governments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatement. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
- (i) in the selection of its Surveyors
- (ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of the specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as part of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificate on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaworthiness, structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certification or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, the Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any statutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the right to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorization of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

EXPLANATORY NOTE TO PART B

1. Reference edition

The reference edition for Part B is this edition effective from 1 January 2016.

2. New editions after the reference edition

Except in particular cases, a new edition of the Rules is published annually.

3. Effective date of the requirements

3.1 All requirements in which new or amended provisions with respect to those contained in the reference edition have been introduced are followed by a date shown in brackets.

3.2 The date shown in brackets is the effective date of entry into force of the requirements as amended by the last updating. The effective date of all those requirements not followed by any date shown in brackets is that of the reference edition.

4. Rule Variations and Corrigenda

Until the next edition of the Rules is published, Rule Variations and/or corrigenda, as necessary, will be published on the TASNEEF web site (www.tasneef.ae). Except in particular cases, paper copies of Rule Variations or corrigenda are not issued.

5. Rule subdivision and cross-references

5.1 Rule subdivision

The Rules are subdivided into six parts, from A to F.

Part A: Classification and Surveys

Part B: Hull and Stability

Part C: Machinery, Systems and Fire Protection

Part D: Materials and Welding

Part E: Service Notations

Part F: Additional Class Notations

Each Part consists of:

- Chapters
- Sections and possible Appendices
- Articles
- Sub-articles
- Requirements

Figures (abbr. Fig) and Tables (abbr. Tab) are numbered in ascending order within each Section or Appendix.

5.2 Cross-references

Examples: Pt A, Ch 1, Sec 1, [3.2.1]or Pt A, Ch 1, App 1, [3.2.1]

- Pt A means Part A

The part is indicated when it is different from the part in which the cross-reference appears. Otherwise, it is not indicated.

- Ch 1 means Chapter 1

The Chapter is indicated when it is different from the chapter in which the cross-reference appears. Otherwise, it is not indicated.

- Sec 1 means Section 1 (or App 1 means Appendix 1)

The Section (or Appendix) is indicated when it is different from the Section (or Appendix) in which the cross-reference appears. Otherwise, it is not indicated.

- [3.2.1] refers to requirement 1, within sub-article 2 of article 3.

Cross-references to an entire Part or Chapter are not abbreviated as indicated in the following examples:

- Part A for a cross-reference to Part A
- Part A, Chapter 1 for a cross-reference to Chapter 1 of Part A.

6. Summary of amendments introduced in the edition effective from 1st January 2016.

This edition of the Rules for the classification of Fast Patrol Vessels is considered as a reference edition for future amendments.

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RULES FOR THE CLASSIFICATION OF FAST PATROL VESSELS

Part B
Hull and Stability

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Part B

Hull and Stability

Chapter 1
GENERAL

SECTION 1 GENERAL

1 Preamble

1.1.1 Part B of the this Rules regards the requirements concerning the determination of the minimum hull scantlings built in steel, aluminum alloy or composite material, and the stability requirements, applying on vessels having speed **V**, in knots, greater than $7{,}2 \cdot \nabla^{0{,}1667}$ (where the bottom volume ∇, in m^3, relevant to design displacement).

These requirements are to be integrated with those specified in Part E and F, depending on the service and on the additional class notations assigned to the vessel.

2 Measurements rounding off

2.1 Plates thicknesses

Plates thicknesses calculated in accordance with the rule requirements are to be rounded off to the nearest half-millimetre.

2.2 Stiffener section modulus

Stiffener section modulus calculated in accordance with the rule requirements are to be rounded off to the nearest standard value; however, no reduction may exceed 3%.

3 Protection against corrosion

3.1.1 Scantlings provided in Part B, assume that the material used is to be chosen and protected so that the loss of strength due to corrosion may be negligible.

3.1.2 The shipyard is to prepare and place a documentation at the parties concerned, specifying all the treatments executed to protect the material against corrosion in the constructional: kind of paint, coats number and thickness, the surface preparation, us e conditions, subsequent monitoring, the anodic protection, etc.

3.1.3 This documentation is to be submitted to the Administration together with the vessel documents and is to be completed by the list of all the operations to do during service so that restoring and keeping the thickness of such protection, in any deterioration causes, casual or not.

SECTION 2 SYMBOLS AND DEFINITION

1 Units

1.1.1 Unless otherwise specified, the units used in the Rules are those defined in Tab1.

Table 1: Units

Designation	Usual symbol	Units
Vessel's dimensions	See [2]	m
Hull girder section modulus	Z	m^3
Density	r	t/m^3
Concentrated loads	P	kN
Linearly distributed loads	q	kN/m
Surface distributed loads (pressures)	p	kN/m^2
Thicknesses	t	mm
Span of ordinary stiffeners and primary supporting members	l	m
Spacing of ordinary stiffeners and primary supporting members	s	m
Bending moment	M	kN·m
Shear force	Q	kN
Stresses	s, t	N/mm^2
Section modulus of ordinary stiffeners and primary supporting members	w	cm^3
Sectional area of ordinary stiffeners and primary supporting members	A	cm^2

2 Definitions and symbols

2.1.1 The definitions of the following terms and symbols are applicable throughout this Chapter and its Appendices and are not, as a rule, repeated in the different paragraphs. Definitions applicable only to certain paragraphs are specified therein.

- **"Moulded base line"**: The line parallel to the summer load waterline, crossing the upper side of keel plate or the top of skeg at the middle of length **L**.
- **"Hull"**: The hull is the outer boundary of the enclosed spaces of the craft, except for the deckhouses, as defined below.
- **"Chine"**: For hulls that do not have a clearly identified chine, the chine is the hull point at which the tangent to the hull is inclined 50° to the horizontal.
- **"Bottom"**: The bottom is the part of the hull between the keel and the chines.
- **"Main deck"**: The main deck is the uppermost complete deck of the hull. It may be stepped.
- **"Side"**: The side is the part of the hull between the chine and the main deck.
- **"Castle"**: A castle is a superstructure extending from side to side of the vessel or with the side plating not being inboard of the shell plating more than 4% of the local breadth. In general, such a superstructure fitted on the weather deck of the vessel is considered as "constituting a step of the strength deck" when it extends within 0,4 **L** amidships for at least 0,15 **L**. Other castles are considered as "not constituting a step of the strength deck".
- **"Deckhouse"**: The deckhouse is a decked structure located above the main deck, with lateral walls inboard of the side of more than 4 per cent of the local breadth. Structure located on the main deck and whose walls are not in the same longitudinal plane as the under side shell may be regarded as a deckhouse.
- **"Cross-deck"**: For twin-hull craft, the cross-deck is the structure connecting the two hulls.
- **"Fore end"**: Hull region forward of 0,9 **L** from the aft perpendicular.
- **"Deadrise angle a_d"**: For hulls that do not have a clearly identified deadrise angle, a_d is the angle between the horizontal and a straight line joining the keel and the chine. For catamarans with non-symmetrical hulls (where inner and outer deadrise angles are different), a_d is the lesser angle.
- **"Aft end"**: Hull region abaft of 0,1 **L** from the aft perpendicular.
- **"Midship area"**: Hull region between 0,3 **L** and 0,7 **L** from the aft perpendicular.
- **L:** Rule length, in m, equal to $\mathbf{L}_{WL}$ where $\mathbf{L}_{WL}$ is the waterline measured with the craft at rest in calm water and, for SESS, in the off-cushion condition
- **FP:** forward perpendicular, i.e. the perpendicular at the intersection of the waterline at draught **T** and the foreside of the stem

- **AP**: aft perpendicular, i.e. the perpendicular located at a distance **L** abaft of the forward perpendicular
- **B**: the greatest moulded breadth, in m, of the craft
- $\mathbf{B_w}$: the greatest moulded breadth, in m, measured on the waterline at draught **T**; for catamarans, $\mathbf{B_w}$ is the breadth of each hull
- **D**: depth, in m, measured vertically in the transverse section at the middle of length L from the moulded base line of the hull(s) to the top of the deck beam at one side of the main deck (if the main deck is stepped, **D** will be defined in each separate case at the discretion of Tasneef)
- **T**: draught of the craft, in m, measured vertically on the transverse section at the middle of length **L**, from the moulded base line of the hull(s) to the full load waterline, with the craft at rest in calm water and, for SESS, in the off-cushion condition
- D: moulded displacement at draught **T**, in sea water (mass density = 1,025 t/m^3), in tonnes
- $\mathbf{C_B}$: total block coefficient, defined as follows:
- $$\mathbf{C_B} = \frac{\Delta}{(1,025 \cdot \mathbf{L} \cdot \mathbf{B_W} \cdot \mathbf{T})}$$
- For catamarans, $\mathbf{C_B}$ is to be calculated for a single hull, assuming D equal to one half of the craft's displacement
- **V**: maximum service speed, in knots
- **g**: acceleration of gravity, equal to 9,81 m/s^2
- **LCG**: longitudinal centre of gravity of the craft.

SECTION 3 DOCUMENTATION TO BE SUBMITTED

1 Documentation to be submitted

1.1 Vessels built under the Tasneef's supervision

1.1.1 Plans and documents to be submitted for approval

The plans and documents to be submitted to the Tasneef for approval are listed in Tab 1. This list is intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

The above plans and documents are to be supplemented by further documentation which depends on the service notation and, possibly, the additional class notation (see Pt A, Ch 1, Sec 2) assigned to the vessel, as specified in [1.1.5].

Structural plans are to show details of connections of the various parts and, in general, are to specify the materials used, including their manufacturing processes, welded procedures and heat treatments.

1.1.2 Plans and documents to be submitted for information

In addition to those in [1.1.1], the following plans and documents are to be submitted to the Tasneef for information:

- general arrangement
- capacity plan, indicating the volume and position of the centre of gravity of all compartments and tanks
- lines plan
- hydrostatic curves
- lightweight distribution.

In addition, when direct calculation analyses are carried out by the Designer according to the rule requirements, they are to be submitted to the Tasneef.

1.1.3 Additional information for fibre-reinforced plastic (FRP) craft

For FRP craft, the drawing and documents to be submitted for examination and listed in Tab.1 are to contain the following additional information:

- arrangement of laminate for the various structural elements: thickness, definition of successive layers of reinforcement, mass per square metre in layers of reinforcement, proportion in mass of reinforcement for each layer, directions of roving layers and unidirectional reinforcements, decreasing in thickness between layers,
- direction of laminate in relation to craft structure,
- structure of oil tanks or other liquid tanks which are integrated into the hull,
- details of connection among various structural elements and details of attachment to the hull of supplementary reinforcing elements,
- pillars.

Suppliers' technical specifications with indication of types, trademarks and references of resins and gel-coats, reinforcements and core materials are to be supplied. These specifications are to give the following information:

- resins: type (orthophthalic or isophthalic), specific gravity, Young's modulus, Poisson's ratio, breaking strength and elongation at break,
- reinforcements (mats, woven rovings, unidirectional reinforcements): quality (glass or other material, with specific gravity, breaking strength of the elementary fibre, Young's modulus and Poisson's ratio), mass per square metre, thickness and possibly weft-warp distribution,
- core materials: type and quality; specific gravity; tensile, compressive and shear strength and elasticity modulus.

1.1.4 Number of copies

The number of copies to be submitted for each plan or document is to be agreed with the Tasneef on a case by case basis depending on the specific conditions under which plan approval and supervision during construction are organised. However, it is generally equal to:

- 3 for plans and documents submitted for approval
- 2 for plans and documents submitted for information.

1.1.5 Documentation to be submitted for Additional Class Notation

The documentation to be submitted regarding Additional Class Notation is shown in Part F.

Table 1

Plan	Containing information relevant to:
Midship section Main sections	moulded dimensions, maximum service speed V, design acceleration a_{CG} materials typical structural details
Longitudinal sections	
Decks	openings deck loads, if different from Rule loads
Shell expansion	openings
Machinery space structure (transversal and longitudinal section)	
Watertight bulkheads (Subdivision and tanks)	Openings (in subdivision bulkheads) position of air vents (for tanks)
Deckhouses	details of connections between different materials
Rudder	rudder stock material
Propeller shaft brackets	material
Equipment	
Testing plan	position of air vents
Windows plan	glass thickness

Part B

Hull and Stability

Chapter 2
GENERAL ARRANGEMENTS

SECTION 1 SUBDIVISION ARRANGEMENTS

1 Number and arrangement of transverse watertight bulkheads

1.1 Number of watertight bulkheads

1.1.1 General

All vessels, in addition to complying with the requirements of [1.1.2], are to present at least the following transverse watertight bulkheads:

- one collision bulkhead
- one after peak bulkhead
- two bulkheads forming the boundaries of the machinery space in vessels with machinery amidships, and a bulkhead forward of the machinery space in vessels with machinery aft. In the case of vessels with an electrical propulsion plant, both the generator room and the engine room are to be enclosed by watertight bulkheads.

1.1.2 Additional bulkheads

Additional bulkheads may be required for vessels having to comply with subdivision or damage stability criteria as Ch.3.

2 Collision bulkhead

2.1 Arrangement of collision bulkhead

2.1.1 A collision bulkhead is to be fitted which is to be watertight up to the freeboard deck. This bulkhead is to be located at a distance from the forward perpendicular FP_{LL} between 0,05L and 0,05L+3.

2.1.2 Where any part of the vessel below the waterline extends forward of the forward perpendicular, e.g. a bulbous bow, the distances, in metres, stipulated in [2.1.1] are to be measured from a point either:

- at the midlength of such extension, or
- at a distance 1,5 per cent of the length L_{LL} of the vessel forward of the forward perpendicular, or
- at a distance 3 metres forward of the forward perpendicular; whichever gives the smallest measurement.

2.1.3 The bulkhead may have steps or recesses provided they are within the limits prescribed in [2.1.1] or [2.1.2].
No door, manhole, ventilation duct or any other opening is to be fitted in this bulkhead.

In vessels with Length **L** < 15 m, where impossible to access to the fore peak if not through such bulkhead, or where necessary to realize a second emergency escape from the astern rooms of bulkhead collision, the arrangements will be given a special consideration.

The opening shall be scantlings as limited as possible, and shall be located with the inferior edge over the waterline of full load.

The closing is to be watertight, extendable towards the leading peak and presenting a strength similar to the bulkhead one.

The Tasneef may, on a case by case basis, accept a distance from the collision bulkhead to the forward perpendicular FP_{LL} greater than the maximum specified in [2.1.1] and [2.1.2], provided that subdivision and stability calculations show that, when the vessel is in upright condition on full load summer waterline, flooding of the space forward of the collision bulkhead will not result in any part of the freeboard deck becoming submerged, or in any unacceptable loss of stability.

2.1.4 Where a long forward superstructure is fitted, the collision bulkhead is to be extended weathertight to the next deck above the freeboard deck. The extension need not be fitted directly above the bulkhead below provided it is located within the limits prescribed in [2.1.1] or [2.1.2] with the exemption permitted by [2.1.6] and the part of the deck which forms the step is made effectively weathertight.

3 After peak, machinery space bulkheads and stern tubes

3.1 General

An after peak bulkhead, and bulkheads dividing the machinery space from the cargo and passenger spaces forward and aft, are also to be fitted and made watertight up to the bulkhead deck for passenger vessels and to the freeboard deck for other vessels. The after peak bulkhead may, however, be stepped below the bulkhead deck, provided the degree of safety of the vessel as regards subdivision is not thereby diminished.

4 Height of transverse watertight bulkheads

4.1.1 Transverse watertight bulkheads other than the collision bulkhead and the after peak bulkhead are to extend watertight up to the freeboard deck. In exceptional cases at the request of the Owner, the Tasneef may allow transverse watertight bulkheads to terminate at a deck below that from which freeboard is measured, provided that this deck is at an adequate distance above the full load waterline.

4.1.2 Where it is not practicable to arrange a watertight bulkhead in one plane, a stepped bulkhead may be fitted. In this case, the part of the deck which forms the step is to be watertight and equivalent in strength to the bulkhead.

5 Openings in watertight bulkheads and decks

5.1 General

5.1.1 The number of openings in watertight subdivisions is to be kept to a minimum compatible with the design and proper working of the vessel. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Tasneef may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the vessel is not impaired.

5.1.2 No door, manhole ventilation duct or any other opening is permitted in the collision bulkhead below the subdivision deck.

5.1.3 Lead or other heat sensitive materials may not be used in systems which penetrate watertight subdivision bulkheads, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkheads.

5.1.4 Valves not forming part of a piping system are not permitted in watertight subdivision bulkheads.

5.2 Openings in the watertight bulkheads below the freeboard deck

5.2.1 Doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors capable of being remotely closed from the bridge and are also to be operable locally from each side of the bulkhead. Indicators are to be provided at the control position showing whether the doors are open or closed, and an audible alarm is to be provided at the door closure. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to be paid to minimise the effect of control system failure. Each power-operated sliding watertight door is to be provided with an individual hand-operated mechanism.

5.2.2 The possibility of opening and closing the door by hand at the door itself from both sides is to be assured.

SECTION 2 COMPARTMENT ARRANGEMENT

1 Definitions

1.1 Cofferdam

1.1.1 A cofferdam means an empty space arranged so that compartments on each side have no common boundary; a cofferdam may be located vertically or horizontally. As a rule, a cofferdam is to be properly ventilated and of sufficient size to allow for inspection.

2 Cofferdams

2.1 Cofferdam arrangement

2.1.1 Cofferdams are to be provided between compartments intended for liquid hydrocarbons (fuel oil, lubricating oil) and those intended for fresh water (drinking water, water for propelling machinery and boilers) as well as tanks intended for the carriage of liquid foam for fire extinguishing.

2.1.2 Cofferdams separating fuel oil tanks from lubricating oil tanks and the latter from those intended for the carriage of liquid foam for fire extinguishing or fresh water or boiler feed water may not be required when deemed impracticable or unreasonable by the Tasneef in relation to the characteristics and dimensions of the spaces containing such tanks, provided that:

- the thickness of common boundary plates of adjacent tanks is increased, with respect to the thickness obtained according to Ch 7, Sec 1, by 2 mm in the case of tanks carrying fresh water or boiler feed water, and by 1 mm in all other cases
- the sum of the throats of the weld fillets at the edges of these plates is not less than the thickness of the plates themselves

  the structural test is carried out with a head increased by 1 m with respect to Ch 12, Sec 3, [2].

2.1.3 Spaces intended for the carriage of flammable liquids are to be separated from accommodation and service spaces by means of a cofferdam. Where accommodation and service spaces are arranged immediately above such spaces, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognized as suitable by the Tasneef. The cofferdam may also be omitted where such spaces are adjacent to a passageway, subject to the conditions stated in [2.1.2] for fuel oil or lubricating oil tanks.

2.1.4 Cofferdams are only required between fuel oil double bottoms and tanks immediately above where the inner bottom plating is subjected to the head of fuel oil contained therein, as in the case of a double bottom with its top raised at the sides. Where a corner to corner situation occurs, tanks are not be considered to be adjacent. Adjacent tanks not separated by cofferdams are to have adequate dimensions to ensure easy inspection.

SECTION 3 ACCESS ARRANGEMENTS

1 General

1.1.1 The number and size of small hatchways for trimming and access openings to tanks or other enclosed spaces, are to be kept to the minimum consistent with the satisfactory operation of the vessel.

2 Double bottom

2.1 Inner bottom manholes

2.1.1 Inner bottom manholes are to be not less than 400 mm x 400 mm. Their number and location are to be so arranged as to provide convenient access to any part of the double bottom.

2.1.2 Inner bottom manholes are to be closed by watertight plate covers. Doubling plates are to be fitted on the covers, where secured by bolts.

Where no ceiling is fitted, covers are to be adequately protected from damage by the cargo.

2.2 Floor and girder manholes

2.2.1 Manholes are to be provided in floors and girders so as to provide convenient access to all parts of the double bottom.

2.2.2 The size of manholes and lightening holes in floors and girders is, in general, to be less than 50 per cent of the local height of the double bottom.

Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

2.2.3 Manholes may not be cut into the continuous centreline girder or floors and girders below pillars, except where allowed by the Tasneef on a case by case basis.

3 Access to steering gear compartment

3.1.1 The steering gear compartment is to be readily accessible and, as far as practicable, separated from machinery spaces.

3.1.2 Suitable arrangements to ensure working access to steering gear machinery and controls are to be provided.

These arrangements are to include handrails and gratings or other non-slip surfaces to ensure suitable working conditions in the event of hydraulic fluid leakage.

Part B

Hull and Stability

Chapter 3

STABILITY

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 General

All vessels equal to or greater than 24 m in length may be assigned class only after it has been demonstrated that their intact stability is adequate for the service intended. Adequate intact stability means compliance with standards laid down by the relevant Administration or with the requirements specified in this Chapter taking into account the vessel’s size and type. In any case, the level of intact stability is not to be less than that provided by the Rules.

2 Examination procedure

2.1 Documents to be submitted

2.1.1 List of documents

For the purpose of the examination of the stability, the documentation listed in Ch 1, Sec 3, [1.1.2] is to be submitted for information.

The stability documentation to be submitted for approval, as indicated in Ch 1, Sec 3, [1.2.1], is as follows:

a) Inclining test report for the vessel, as required in [2.2] or:
   - where the stability data is based on a sister ship, the inclining test report of that sister ship along with the lightship measurement report for the vessel in question;

b) trim and stability booklet, as required in Sec 2, [1.1.1]

c) damage stability calculations, as required in Sec 3, [1.1]

A copy of the trim and stability booklet and, if applicable, the grain stability booklet, the damage control documentation or the loading computer documentation is to be available on board for the attention of the Master.

2.1.2 Provisional documentation

Tasneef reserves the right to accept or demand the submission of provisional stability documentation for examination. Provisional stability documentation includes loading conditions based on estimated lightship values.

2.1.3 Final documentation

Final stability documentation based on the results of the inclining test or the lightweight check is to be submitted for examination.

When provisional stability documentation has already been submitted and the difference between the estimated values of the lightship and those obtained after completion of the test is less than:

- 2% for the displacement, and,
- 1% of the length between perpendiculars for the longitudinal position of the centre of gravity, and the determined vertical position of the centre of gravity is not greater than the estimated vertical position of the centre of gravity, the provisional stability documentation may be accepted as the final stability documentation.

2.2 Inclining test/lightweight check

2.2.1 Definitions

a) Lightship

   The lightship is a vessel complete in all respects, but without consumables, stores, cargo, and crew and effects, and without any liquids on board except for machinery and piping fluids, such as lubricants and hydraulics, which are at operating levels.

b) Inclining test

   The inclining test is a procedure which involves moving a series of known weights, normally in the transverse direction, and then measuring the resulting change in the equilibrium heel angle of the vessel. By using this information and applying basic naval architecture principles, the vessel's vertical centre of gravity (VCG or KG) is determined.

c) Lightweight check

   The lightweight check is a procedure which involves auditing all items which are to be added, deducted or relocated on the vessel at the time of the inclining test so that the observed condition of the vessel can be adjusted to the lightship condition. The weight and longitudinal, transverse and vertical location of each item are to be accurately determined and recorded. The lightship displacement and longitudinal centre of gravity (LCG) can be obtained using this information, as well as the static waterline of the vessel at the time of the inclining test as determined by measuring the freeboard or verified draught marks of the vessel, the vessel's hydrostatic data and the sea water density.

2.2.2 General

Any vessel for which a stability investigation is requested in order to comply with class requirements is to be initially subjected to an inclining test permitting the evaluation of the position of the lightship centre of gravity, or a lightweight check of the lightship displacement, so that the stability data can be determined. Cases for which the inclining test is required and those for which the lightweight check is accepted in its place are listed in [2.2.4] and [2.2.5].

The inclining test or lightweight check is to be attended by a Tasneef Surveyor.

The inclining test is adaptable to vessels less than 24 m in length, provided that precautions are taken, on a case by case basis, to ensure the accuracy of the test procedure.

For RHIB and, in general, for vessels without deck, Tasneef or Owner, during inclining test, may require one or more practical test relevant to the worst condition expected in the vessel life.

In such cases a report is to be prepared relevant to the tested loading conditions containing restrictions in the loading conditions and/or in ballasting, if any, which, duly approved by Tasneef, is to replace the prescribed stability booklet.

2.2.3 Inclining test

The inclining test is required in the following cases:

- Any new vessel, after its completion, except for the cases specified in [2.2.4]
- Any vessel, if deemed necessary by Tasneef, where any alterations are made so as to materially affect the stability.

2.2.4 Lightweight check

Tasneef may allow a lightweight check to be carried out in lieu of an inclining test in the case of: an individual vessel, provided basic stability data are available from the inclining test of a sister ship and a lightweight check is performed in order to prove that the sister ship corresponds to the prototype vessel. In such case the Tasneef is satisfied when the result of the lightweight check shows a deviation from the displacement of the prototype vessel not greater than 1%. The final stability data to be considered for the sister ship in terms of displacement and position of the centre of gravity are those of the prototype.

2.2.5 Detailed procedure

A detailed procedure for conducting an inclining test is included in App 1. For the lightweight check, the same procedure applies except as provided for in App 1, [1.1.8].

SECTION 2 INTACT STABILITY

1 General

1.1 Information for the Master

1.1.1 Stability booklet

Each vessel is to be provided with a stability booklet, approved by Tasneef, which contains sufficient information to enable the Master to operate the vessel in compliance with the applicable requirements contained in this Section.

Where any alterations are made to a vessel so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the vessel is to be re-inclined.

1.1.2 Operating booklets for certain vessels

Vessels with innovative design are to be provided with additional information in the stability booklet such as design limitations, maximum speed, worst intended weather conditions or other information regarding the handling of the craft that the Master needs to operate the vessel.

1.2 Permanent ballast

1.2.1 If used, permanent ballast is to be located in accordance with a plan approved by Tasneef and in a manner that prevents shifting of position. Permanent ballast is not to be removed from the vessel or relocated within the vessel without the approval of Tasneef. Permanent ballast particulars are to be noted in the vessel's stability booklet.

1.2.2 Permanent solid ballast is to be installed under the supervision of Tasneef.

2 Design criteria

2.1 General intact stability criteria

2.1.1 General

The standard of stability to be achieved by a new vessel should be dependent on the maximum number of persons permitted to be carried and the intended area of operation (navigation notation).

The following vessels are required to meet the intact stability criteria specified in [2.1.2], [2.1.3], [2.1.4] and [2.1.5]:

d) vessels that may carry 16 or more persons, including the crew and the rescuable persons; or

e) vessels with unrestricted navigation notation assigned; or

f) vessels fitted with a lifting device

The required criteria are to be complied with for the loading conditions mentioned in App 2, [1.2].

However, the lightship condition not being an operational loading case, Tasneef may accept that part of the above-mentioned criteria are not fulfilled.

These criteria set minimum values, but no maximum values are recommended. It is advisable to avoid excessive values of metacentric height, since these might lead to acceleration forces which could be prejudicial to the vessel, its equipment and crew.

2.1.2 GZ curve area

The area under the righting lever curve (GZ curve) is to be not less than 0,055 m·rad up to θ = 30° angle of heel and not less than 0,09 m·rad up to θ = 40° or the angle of down flooding θ_f if this angle is less than 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30°and θ_f, if this angle is less than 40°, is to be not less than 0,03 m·rad.

Note 1: θ_f is an angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight submerge. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

2.1.3 Minimum righting lever

The righting lever GZ is to be at least 0,20 m at an angle of heel equal to or greater than 30°.

2.1.4 Angle of maximum righting lever

The maximum righting arm is to occur at an angle of heel preferably exceeding 30° but not less than 25°. When the righting lever curve has a shape with two maximums, the first is to be located at a heel angle not less than 25°. In cases of vessels with a particular design and subject to the prior agreement of the flag Administration, Tasneef may accept an angle of heel θ_{max} less than 25° but in no case less than 15°, provided that the area "A" below the righting lever curve is not less than the value obtained, in m.rad, from the following formula:

$$\mathbf{A} = 0,055 + 0,002\ (30° - \boldsymbol{\theta}_{\mathbf{max}})$$

where θ_{max} is the angle of heel in degrees at which the righting lever curve reaches its maximum.

2.1.5 Initial metacentric height

The initial metacentric height $\mathbf{GM_0}$ is not to be less than 0,35 m.

2.1.6 Crowding of personnel

The crowding of all personnel, including the crew, towards one side shall be considered.

The static inclining angle due to crowding shall not be more than 10°.

For vessels having length L < 24 m, is sufficient that the static inclining angle due to crowding is no more than the angle corresponding to a residual freeboard of 0,1 m on the side.

For vessels having the service notation **rescue** assigned, Part E, Ch 1, Sec 2, [2.2] apply.

2.1.7 Alternative stability criteria

The intact stability criteria indicated in [2.1.1] may be waived if ISO 12217 Part 1 *'Small craft – Stability and buoyancy assessment and categorisation - Non-sailing boats of hull length greater than or equal to 6 metres'* is assessed by Tasneef using Options 1 or 2 of Section 5.3 - `*Test and calculations to be applied'*, in respect of the Design Category indicated in the following Tab 1 depending on the navigation notation assigned to the vessel.

Table 1 : Design Category

Navigation notation	ISO 12217 Design Category
unrestricted navigation	A
offshore navigation	B
inshore navigation	C

2.1.8 Elements affecting stability

A number of influences such as beam wind on vessels with large windage area, icing of topsides, water trapped on deck, rolling characteristics, following seas, etc., which adversely affect stability, are to be taken into account.

2.1.9 Elements reducing stability

Provisions are to be made for a safe margin of stability at all stages of the voyage, regard being given to additions of weight, such as those due to absorption of water and icing and to losses of weight such as those due to consumption of fuel and stores.

2.1.10 Vessels fitted with lifting appliances

A vessel fitted with a deck crane or other lifting device should be a decked vessel and comply with the general requirements of [2.1.1], which are appropriate to it.

In addition, with the vessel in the worst anticipated service condition for lifting operations, compliance with the following criteria should be demonstrated by a practical test or by calculations.

a) With the crane or other lifting device operating at its maximum load moment, with respect to the vessel, the angle of heel generally should not exceed 7 degrees or that angle of heel which results in a freeboard to deck edge anywhere on the periphery of the vessel of 250 mm, whichever is the lesser angle. (Consideration should be given to the operating performance of cranes or other lifting devices of the variable load-radius type and the load moment with respect to the vessel for lifting devices situated off centreline).

b) When an angle of heel greater than 7 degrees but not exceeding 10 degrees occurs, Tasneef may accept the lifting condition providing that all the following criteria are satisfied when the crane or other lifting device is operating at its maximum load moment:-

- the range of stability from the angle of static equilibrium to downflooding or angle of vanishing stability, whichever is the lesser, is equal to or greater than 20 degrees;
- the area under the curve of residual righting lever, up to 40 degrees from the angle of static equilibrium or the downflooding angle, if this is less than 40 degrees, is equal to or greater than 0.1 metre-radians; and
- the minimum freeboard to deck edge fore and aft throughout the lifting operations should not be less than 500 mm;
- the freeboard to deck edge anywhere on the periphery of the vessel is at least 250 mm.

2.2 Particular intact stability criteria

2.2.1 General

Vessels that carry less than 16 persons, not assigned with unrestricted navigation notation and not provided with lifting appliances may be subjected to a simplified assessment of stability as described in [2.2.2] and are not required to be provided with approved stability booklet (report of practical stability assessment is considered as sufficient to provide necessary information to the Master).

2.2.2 Practical stability assessment

The vessel should be tested in the fully loaded conditions to ascertain the angle of heel and the position of the waterline which results when all persons which the vessel is to be certificated to carry are assembled along one side of the vessel. Each person may be substituted by a mass of 75 kg for the purpose of the test.

The vessel will be judged to have an acceptable standard of stability if the test shows that:

- the angle of heel does not exceed 7 degrees; and
- in the case of a vessel with a watertight weather deck extending from stem to stern the freeboard to deck is not less than 75 mm at any point.
- The angle of heel may exceed 7 degrees, but should not exceed 10 degrees, if the freeboard in the heeled condition is not less than 0,1 m.

Additionally, for vessels over 15 metres in length, the heeling moment applied during the test above described should be calculated. Using the formula below, the vessel should attain a value of initial GM not less than 0.5 m if using an estimated displacement, or 0.35 m if the displacement of the vessel is known by means of direct weighting with dynamometer or by the availability of hydrostatic curves:

$$GM = (57.3 \times HM)/(\theta \times \Delta)$$

where:

HM = Heeling moment in kg·m

θ = angle of heel in degrees obtained from the test

Δ = the displacement of the vessel in kg, either estimated, or measured and verified by Tasneef surveyor

3 Severe wind and rolling criterion

3.1 Application field

3.1.1 For vessels with length **L**>24 m, based on the superstructure's length, Tasneef on its opinion may require the stability test under combined effect of side wind and roll.

In such case the criteria listed in TASNEEFMIL Part B, Ch.3, Sec.2 are to be applied; in special cases, taking into account the operating area of the vessel, the wind speed can be reduced at Tasneef discretion but not less than the value stated in the IMO Res. A.749(18).

SECTION 3 DAMAGE STABILITY

1 Application

1.1.1 The damage stability calculation is requested for all vessels classified according present Rules excluding RIBs and undecked vessels.

1.1.2 Self-righting vessels with **SELF-RIGHT** additional class notation assigned shall comply with relevant requirements stated in Part F.

2 Buoyancy and stability in the displacement mode following damage

2.1.1 The requirements of this section apply to all permitted conditions of loading.

2.1.2 For the purpose of making damage stability calculations, the volume and surface permeabilities shall be, in general, as given in Table 1.

Table 1

Spaces	Permeability
Appropriated to cargo or stores	60
Occupied by accommodation	95
Occupied by machinery	85
Intended for liquids	0 or 95 **(1)**
Void spaces	95
(1) whichever results in the more severe requirements	

2.1.3 Notwithstanding [2.1.2], permeability determined by direct calculation shall be used where a more onerous condition results, and may be used where a less onerous condition results from that provided according to [2.1.2].

2.1.4 The Administration may permit the use of low-density foam or other media to provide buoyancy in void spaces, provided that satisfactory evidence is provided that any such proposed medium is the most suitable alternative and is:

- of closed-cell form if foam, or otherwise impervious to water absorption;
- structurally stable under service conditions;
- chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact; and
- properly secured in place and easily removable for inspection of the void spaces.

2.1 Vessel with L ≤ 24 m

2.1.1 The full load vessel is to present a residual positive metacentric height and limit line not submerged at the final phase of overflowing with any flooded compartment.

2.2 Vessel with L > 24 m

2.2.1 Extent of side damage

The side damage shall be assumed anywhere on length and shall present the following scantlings:

a) the longitudinal extent of damage shall be the less among these three values:

- 0,1 L
- 3 m + 0,03 L
- 11 m

b) the transversal extent of damage shall be the less among these three values:

- 0,2 B
- 0,05 L
- 5 m.

However where the vessel is provided with side structures which do not contribute to buoyancy, the transversal extent of damage shall be assumed at least equivalent to 0,12 for the width of the main buoyancy structure or the pushing tanks structure.

c) the vertical extent of damage shall be equal to the full vertical extent of the craft.

2.2.2 Extent of bottom damage

The bottom damage shall be assumed anywhere on the length and shall present the following scantlings:

a) the longitudinal extent of damage shall be the less among these three values:

- 0,1 L
- 3 m + 0,03 L
- 11 m

b) the transversal extent of damage shall be the less between the whole breadth of bottom and 7 m.

c) the vertical extent of damage shall be the less between 0,02 B e 0,5 m.

2.2.3 Buoyancy and stability in damage

Following any of the postulated damages detailed in [2.2.1] and [2.2.2] the vessel, in still water, shall have sufficient buoyancy and positive stability to ensure simultaneously that:

1. after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 50% of the significant wave height corresponding to the worst intended conditions. Downflooding openings shall include doors and hatches which are used for damage control or evacuation procedures, but may exclude those which are closed by means of weathertight doors and hatch covers and not used for damage control or evacuation procedures.
2. there is a positive freeboard from the damage waterline to survival craft embarkation positions;
3. essential emergency equipment, emergency radios, power supplies and public address systems needed for organizing the evacuation remain accessible and operational;
4. the residual stability of craft meets the appropriate criteria as laid out in [2.2.4]. Within the range of positive stability governed by the criteria of [2.2.4], no unprotected opening shall be submerged.
5. the angle of inclination of the vessel from the horizontal does not exceed 15° in any direction. However, where this is clearly impractical, angles of inclination up to 20°, immediately after damage but reducing to 15° within 15 minutes, shall be permitted provided that efficient non-slip deck surfaces and suitable holding points, e.g., holes, bars, etc., are provided.

2.2.4 Criteria for residual stability after damage

a) The positive residual righting lever curve shall have a minimum range of 15° beyond the angle of equilibrium. This range may be reduced to a minimum of 10°, in the case where the area under the righting lever curve is that specified in b), increased by the ratio:

$$15 / \text{range}$$

where the range is expressed in degrees.

b) The area under the righting lever curve shall be at least 0.015 m·rad, measured from the angle of equilibrium to the lesser of:

- the angle at which progressive flooding occurs; and
- 27° measured from the upright.

c) A residual righting lever shall be obtained within the range of positive stability, taking into account the greatest of the following heeling moments:

- the crowding of all personnel towards one side;
- the launching of all fully loaded davit launched survival craft on one side; and
- due to wind pressure, as calculated by the formula:

  GZ = heeling moment / (displacement) + 0.04 (m)

However, in no case, this righting lever shall be less than 0.1 m.

d) For the purpose of calculating the heeling moments referred to in c), the following assumptions shall be made:

- Moments due to crowding of personnel. This should be calculated in accordance with Section 2, [2.1.6];
- Moments due to launching of all fully loaded davit-launched survival craft on one side:

  1. all lifeboats and rescue boats fitted on the side to which the ship has heeled after having sustained damage shall be assumed to be swung out fully loaded and ready for lowering;

  2. for lifeboats which are arranged to be launched fully loaded from the stowed position, the maximum heeling moment during launching shall be taken;

  3. a fully loaded davit-launched liferaft attached to each davit on the side to which the ship has heeled after having sustained damage shall be assumed to be swung out ready for lowering;

  4. persons not in the life-saving appliances which are swung out shall not provide either additional heeling or righting moment; and

  5. life-saving appliances on the side of the ship opposite to the side to which the ship has heeled shall be assumed to be in a stowed position.

- Moments due to wind pressure:

  1. the wind pressure shall be taken as

  $(120 \{V_w / 26\}^2)$ (N/m^2),

  where V_w = wind speed (m/s), as defined in Section 2, [3.1.1];

  2. the area applicable shall be the projected lateral area of the ship above the waterline corresponding to the intact condition; and

  3. the moment arm shall be the vertical distance from a point at one half of the mean draught corresponding to the intact condition to the centre of gravity of the lateral area.

e) In intermediate stages of flooding, the maximum righting lever shall be at least 0.05 m and the range of positive righting levers shall be at least 7°. In all cases, only one breach in the hull and only one free surface need be assumed.

APPENDIX 1 INCLINING TEST AND LIGHTWEIGHT CHECK

1 General

1.1 General conditions of the vessel

Prior to the test, Tasneef's Surveyor is to be satisfied of the following:

- the weather conditions are to be favourable
- the vessel is to be moored in a quiet, sheltered area free from extraneous forces, such as to allow unrestricted heeling. The vessel is to be positioned in order to minimise the effects of possible wind, stream and tide
- the vessel is to be transversely upright and the trim is to be taken not more than 1% of the length between perpendiculars. Otherwise, hydrostatic data and sounding tables are to be available for the actual trim
- cranes, derrick, lifeboats and life-rafts capable of inducing oscillations are to be secured
- main and auxiliary boilers, pipes and any other system containing liquids are to be filled
- the bilge and the decks are to be thoroughly dried
- preferably, all tanks are to be empty and clean, or completely full. The number of tanks containing liquids is to be reduced to a minimum taking into account the above-mentioned trim. The shape of the tank is to be such that the free surface effect can be accurately determined and remain almost constant during the test. All cross connections are to be closed
- the weights necessary for the inclination are to be already on board, located in the correct place
- all work on board is to be suspended and crew or personnel not directly involved in the inclining test are to leave the vessel
- the vessel is to be as complete as possible at the time of the test. The number of weights to be removed, added or shifted is to be limited to a minimum. Temporary material, tool boxes, staging, sand, debris, etc., on board is to be reduced to an absolute minimum.

1.2 Inclining weights

The total weight used is preferably to be sufficient to provide a minimum inclination of one degree and a maximum of four degrees of heel to each side. Test weights are to be compact and of such a configuration that the VCG (vertical centre of gravity) of the weights can be accurately determined. Each weight is to be marked with an identification number and its weight. Re-certification of the test weights is to be carried out prior to the incline. A crane of sufficient capacity and reach, or some other means, is to be available during the inclining test to shift weights on the deck in an expeditious and safe manner.

1.3 Pendulums

The use of three pendulums is recommended but a minimum of two are to be used to allow identification of bad readings at any one pendulum station. However, for vessels of a length equal to or less than 30 m, only one pendulum can be accepted. They are each to be located in an area protected from the wind. The pendulums are to be long enough to give a measured deflection, to each side of upright, of at least 10 cm. To ensure recordings from individual instruments are kept separate, it is suggested that the pendulums be physically located as far apart as practical.

The use of an inclinometer or U-tube is to be considered in each separate case. It is recommended that inclinometers or other measuring devices only be used in conjunction with at least one pendulum.

1.4 Determination of the displacement

Tasneef's Surveyor is to carry out all the operations necessary for the accurate evaluation of the displacement of the vessel at the time of the inclining test, as listed below:

- draught mark readings are to be taken at aft, midship and forward, at starboard and port sides

  the mean draught (average of port and starboard reading) is to be calculated for each of the locations where draught readings are taken and plotted on the vessel's lines drawing or outboard profile to ensure that all readings are consistent and together define the correct waterline. The resulting plot is to yield either a straight line or a waterline which is either hogged or sagged. If inconsistent readings are obtained, the freeboards/draughts are to be retaken the specific gravity of the sea water is to be determined. Samples are to be taken from a sufficient depth of the water to ensure a true representation of the sea water and not merely surface water, which could contain fresh water from run off of rain. A hydrometer is to be placed in a water sample and the specific gravity read and recorded. For large vessels, it is recommended that samples of the sea water be taken forward, midship and aft, and the readings averaged. For small vessels, one sample taken from midship is sufficient. The temperature of the water is to be taken and the measured specific gravity corrected for deviation from the standard, if necessary. A correction to water specific gravity is not necessary if the specific gravity is determined at the inclining experiment site. Correction is necessary if specific gravity is measured when the sample temperature differs from the temperature at the time of the inclining (e.g., if the check of specific gravity is performed at the office). Where the value of the average calculated specific gravity is different from that reported in the hydrostatic curves, adequate corrections are to be made to the displacement curve

- all double bottoms, as well as all tanks and compartments which can contain liquids, are to be checked, paying particular attention to air pockets which may accumulate due to the vessel's trim and the position of air pipes, and also taking into account the provisions of [1.1.1]
- it is to be checked that the bilge is dry, and an evaluation of the liquids which cannot be pumped, remaining in the pipes, boilers, condenser, etc., is to be carried out
- the entire vessel is to be surveyed in order to identify all items which need to be added, removed or relocated to bring the vessel to the lightship condition. Each item is to be clearly identified by weight and location of the centre of gravity
- the possible solid permanent ballast is to be clearly identified and listed in the report.

1.5 The incline

The standard test generally employs eight distinct weight movements as shown in Fig 1.

The weights are to be transversally shifted, so as not to modify the vessel's trim and vertical position of the centre of gravity.

After each weight shifting, the new position of the transverse centre of gravity of the weights is to be accurately determined.

After each weight movement, the distance the weight was moved (centre to centre) is to be measured and the heeling moment calculated by multiplying the distance by the amount of weight moved. The tangent is calculated for each pendulum by dividing the deflection by the length of the pendulum. The resultant tangents are plotted on the graph as shown in Fig 2.

The pendulum deflection is to be read when the vessel has reached a final position after each weight shifting.

During the reading, no movements of personnel are allowed.

For vessels with a length equal to or less than 30 m, six distinct weight movements may be accepted.

Figure 1 : Weight shift procedure

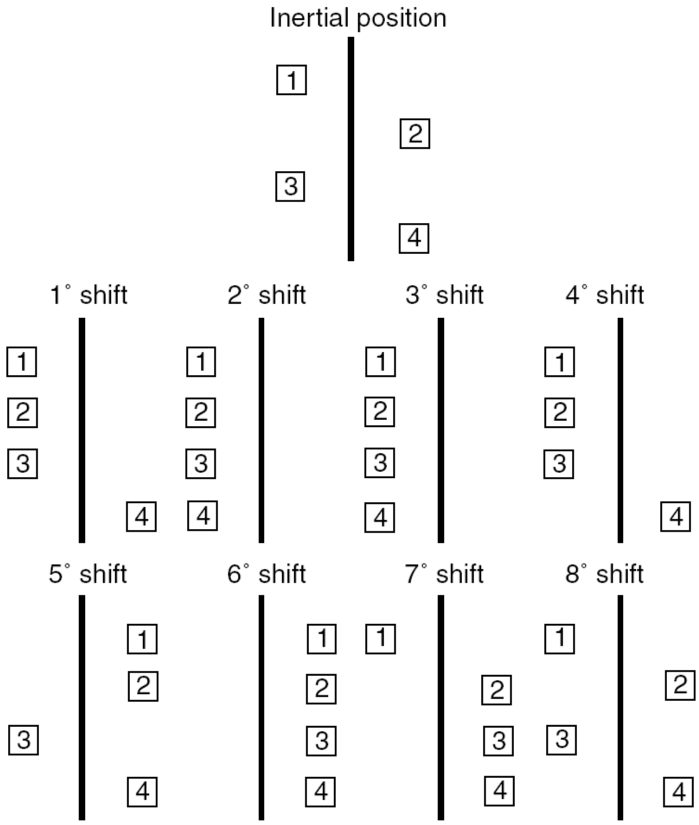
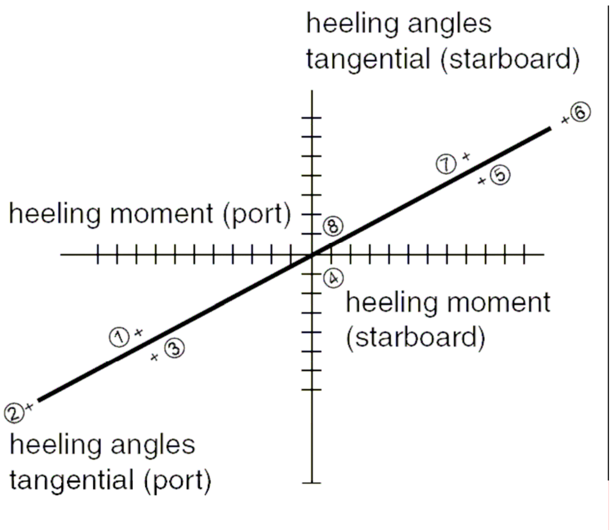


Figure 2 : Graph of resultant tangents



APPENDIX 2 TRIM AND STABILITY BOOKLET

1 Trim and stability booklet

1.1 Information to be included in the trim and stability booklet

1.1.1 General

A trim and stability booklet is a stability manual, to be approved by Tasneef, which is to contain sufficient information to enable the Master to operate the vessel in compliance with the applicable requirements contained in the Rules.

The format of the stability booklet and the information included vary depending on the vessel type and operation.

1.1.2 List of information

The following information is to be included in the trim and stability booklet:

- a general description of the vessel, including:
  - the vessel's name and Tasneef classification number
  - the vessel type and service notation
  - the class notations
  - the yard, the hull number and the year of delivery
  - the Flag, the port of registry, the international call sign and the IMO number
  - the moulded dimensions
  - the draught corresponding to the maximum assigned load line,
  - the displacement corresponding to the above-mentioned draughts
- clear instructions on the use of the booklet
- general arrangement and capacity plans indicating the assigned use of compartments and spaces (cargo, passenger, stores, accommodation, etc.)
- a sketch indicating the position of the draught marks referred to the vessel's perpendiculars
- hydrostatic curves or tables corresponding to the design trim, and, if significant trim angles are foreseen during the normal operation of the vessel, curves or tables corresponding to such range of trim are to be introduced. A clear reference relevant to the sea density, in t/m^3, is to be included as well as the draught measure (from keel or under keel).
- cross curves (or tables) of stability calculated on a free trimming basis, for the ranges of displacement and trim anticipated in normal operating conditions, with indication of the volumes which have been considered in the computation of these curves
- tank sounding tables or curves showing capacities, centres of gravity, and free surface data for each tank
- lightship data from the inclining test, as indicated in Sec 1, [2.2], including lightship displacement, centre of gravity co-ordinates, place and date of the inclining test, as well as Tasneef approval details specified in the inclining test report. It is suggested that a copy of the approved test report be included.
- Where the above-mentioned information is derived from a sister ship, the reference to this sister ship is to be clearly indicated, and a copy of the approved inclining test report relevant to this sister ship is to be included.
- standard loading conditions as indicated in [1.2] and examples for developing other acceptable loading conditions using the information contained in the booklet
- intact stability results (total displacement and its centre of gravity co-ordinates, draughts at perpendiculars, GM, GM corrected for free surfaces effect, GZ values and curve, criteria as indicated in Sec 2, [2] and Sec 2, [3] as well as possible additional criteria specified in Part E when applicable, reporting a comparison between the actual and the required values) are to be available for each of the above-mentioned operating conditions. The method and assumptions to be followed in the stability curve calculation are specified in [1.3].
- information on loading restrictions (maximum allowable load on double bottom, maximum specific gravity allowed in liquid cargo tanks, maximum filling level or percentage in liquid cargo tanks, maximum KG or minimum GM curve or table which can be used to determine compliance with the applicable intact and damage stability criteria) when applicable
- information about openings (location, tightness, means of closure), pipes or other progressive flooding sources
- information concerning the use of any special cross-flooding fittings with descriptions of damage conditions which may require cross-flooding, when applicable
- any other necessary guidance for the safe operation of the vessel
- a table of contents and index for each booklet.

1.2 Loading conditions

1.2.1 General

The standard loading conditions to be included in the trim and stability booklet are:

- lightship condition
- vessel in ballast in the departure condition, without cargo but with full stores and fuel
- vessel in ballast in the arrival condition, without cargo and with 10% stores and fuel remaining.

Additional loading conditions are required depending on the vessel type and kind of cargo carried as specified in the following paragraphs, such loading cases being considered as a minimum requirement. Therefore, further loading cases may be included when deemed necessary or useful.

When a tropical freeboard is to be assigned to the vessel, the corresponding loading conditions are also to be included.

1.3 Stability curve calculation

1.3.1 General

Hydrostatic and stability curves are normally prepared on a designed trim basis. However, where the operating trim or the form and arrangement of the vessel are such that change in trim has an appreciable effect on righting arms, such change in trim is to be taken into account.

The calculations are to take into account the volume to the upper surface of the deck sheathing.

1.3.2 Superstructures, deckhouses, etc. which may be taken into account

The second tier of similarly enclosed superstructures may also be taken into account, except for vessels of length less than 20 m, for which only the first tier of enclosed superstructures may be taken into account and, in the event of doors on both sides of a deckhouse, access from the top is not required.

Deckhouses on the freeboard deck may be taken into account, provided that they comply with the conditions for enclosed superstructures laid down in Ch 1, Sec 2, [3.12].

Where deckhouses comply with the above conditions, except that no additional exit is provided to a deck above, such deckhouses are not to be taken into account; however, any deck openings inside such deckhouses are to be considered as closed even where no means of closure are provided.

Deckhouses, the doors of which do not comply with the requirements of Ch 9, Sec 4, [1.5.4], are not to be taken into account; however, any deck openings inside the deckhouse are regarded as closed where their means of closure comply with the requirements of Ch 9, Sec 7, [7.3].

Deckhouses on decks above the freeboard deck are not to be taken into account, but openings within them may be regarded as closed.

Superstructures and deckhouses not regarded as enclosed may, however, be taken into account in stability calculations up to the angle at which their openings are flooded (at this angle, the static stability curve is to show one or more steps, and in subsequent computations the flooded space are to be considered non-existent).

Trunks may be taken into account. Hatchways may also be taken into account having regard to the effectiveness of their closures.

1.3.3 Angle of flooding

In cases where the vessel would sink due to flooding through any openings, the stability curve is to be cut short at the corresponding angle of flooding and the vessel is to be considered to have entirely lost its stability.

Small openings such as those for passing wires or chains, tackle and anchors, and also holes of scuppers, discharge and sanitary pipes are not to be considered as open if they submerge at an angle of inclination more than 30°. If they submerge at an angle of 30° or less, these openings are to be assumed open if Tasneef considers this to be a source of significant progressive flooding; therefore such openings are to be considered on a case by case basis.

Part B

Hull and Stability

Chapter 4
STRUCTURE DESIGN PRINCIPLES

SECTION 1 MATERIALS

1 General

1.1 Characteristics of materials

1.1.1 The characteristics of the materials to be used in the construction of vessels are to comply with the applicable requirements of TASNEEFMIL Part D.

1.1.2 Materials with different characteristics may be accepted, provided their specification (manufacture, chemical composition, mechanical properties, welding, etc.) is submitted to Tasneef for approval.

1.2 Testing of materials

1.2.1 Materials are to be tested in compliance with the applicable requirements of TASNEEFMIL Part D.

1.3 Manufacturing processes

1.3.1 The requirements of this Section presume that welding and other cold or hot manufacturing processes are carried out in compliance with current sound working practice and the applicable requirements of TASNEEFMIL Part D. In particular:

- parent material and welding processes are to be approved within the limits stated for the specified type of material for which they are intended
- specific preheating may be required before welding
- welding or other cold or hot manufacturing processes may need to be followed by an adequate heat treatment.

2 Steels for hull structure

2.1 Application

2.1.1 Tab 1 gives the mechanical characteristics of steels currently used in the construction of vessels.

2.1.2 Higher strength steels other than those indicated in Tab 1 are considered by Tasneef on a case by case basis.

2.1.3 When steels with a minimum guaranteed yield stress R_{eH} other than 235 N/mm^2 are used on a vessel, hull scantlings are to be determined by taking into account the material factor **k** defined in [2.3].

2.1.4 Characteristics of steels with specified through thickness properties are given in TASNEEFMIL Pt D, Ch 2, Sec 1, [9].

Table 1 : Mechanical properties of hull steels

Steel grades	Minimum yield stress R_{eH}, in N/mm^2	Ultimate minimum tensile strength R_m, in N/mm^2
A-B-D-E t ≤ 100mm	235	400 - 520
AH32-DH32-EH32 t ≤ 100mm FH32 t ≤ 50mm	315	440 - 590
AH36-DH36-EH36 t ≤ 100mm FH36 t ≤ 50mm	355	490 - 620
AH40-DH40-EH40 FH40 t ≤ 50mm	390	510 - 650
Note 1: Reference in TASNEEFMIL Part D		

2.2 Information to be kept on board

2.2.1 A plan is to be kept on board indicating the steel types and grades adopted for the hull structures. Where steels other than those indicated in Tab 1 are used, their mechanical and chemical properties, as well as any workmanship requirements or recommendations, are to be available on board together with the above plan.

2.2.2 It is also recommended that a plan is kept on board indicating the hull structures built in normal strength steel of grades D or E.

2.3 Material factor k

2.3.1 General

Unless otherwise specified, the material factor k has the values defined in Tab 2, as a function of the minimum guaranteed yield stress R_{eH}.

For intermediate values of R_{eH} , k may be obtained by linear interpolation.

Steels with a yield stress lower than 235 N/mm^2 or greater than 390 N/mm^2 are considered by Tasneef on a case by case basis.

Table 2: Material factor k

R_{eH} , in N/mm^2	k
235	1
315	0,78
355	0,72
390	0,70

3 Aluminium alloy structures

3.1 General

3.1.1 The characteristics of aluminium alloys to be used in the construction of aluminium craft are to comply with the relevant requirements of Tasneef Rules.

As a rule, series 5000 aluminium-magnesium alloys or series 6000 aluminium-magnesium-silicon alloys (see Table 3 shall be used.
The list of aluminium alloys given in Table 3 is not exhaustive. Other aluminium alloys may be considered, provided the specification (manufacture, chemical composition, temper, mechanical properties, welding, etc.) and the scope of application be submitted to Tasneef for review.

3.1.2 The use of series 6000 alloys or extruded platings, for parts which are exposed to sea water atmosphere, will be considered in each separate case by Tasneef, also taking into account the protective coating applied.

3.1.3 For forgings or castings, requirements for chemical composition and mechanical properties are to be defined in each separate case by Tasneef.

3.1.4 Unless otherwise specified, the Young's modulus for aluminium alloys is equal to 70000 N/mm^2 and the Poisson's ratio equal to 0,33.

3.2 Extruded plantings

3.2.1 Extrusions with built-in plating and stiffeners, referred to as extruded plating, may be used.

3.2.2 In general, the application is limited to decks and deckhouses. Other uses may be permitted at the discretion of Tasneef.

3.2.3 Extruded plating is preferably to be oriented so that the stiffeners be parallel to the direction of main stresses.

3.2.4 Connections between extruded plating and primary members are to be given special attention.

3.3 Influence of welding on mechanical characteristics

3.3.1 Welding heat input lowers locally the mechanical strength of aluminium alloys hardened by work hardening (series 5000 other than condition 0 or H111) or by heat treatment (series 6000).

3.3.2 Consequently, where necessary, a drop in mechanical characteristics of welded structures is to be considered in the heat-affected zone, with respect to the mechanical characteristics of the parent material. The heat-affected zone may be taken to extend 25 mm on each side of the weld axis.

3.3.3 Aluminium alloys of series 5000 in 0 condition (annealed) or in H111 condition (annealed flattened) are not subject to a drop in mechanical strength in the welded areas.

3.3.4 Aluminium alloys of series 5000 other than condition 0 or H111 are subjected to a drop in mechanical strength in the welded areas. The mechanical characteristics to consider in welded condition are, normally, those of condition 0 or H111, except otherwise indicated in Table 3. Higher mechanical characteristics may be taken into account, provided they are duly justified.

3.3.5 Aluminium alloys of series 6000 are subject to a drop in mechanical strength in the vicinity of the welded areas. The mechanical characteristics to be considered in welded condition are, normally, to be indicated by the supplier.

Table 3 - Aluminium alloys for welded construction

Guaranteed mechanical characteristics **(1)**							
Aluminium alloy				Unwelded condition		Welded condition	
Alloy **(2)**	Temper **(4)**	Products	Thickness (mm)	$R_{p\,0,2}$ (N/mm²)	R_m (N/mm²)	$R_{p\,0,2}$' (N/mm²)	R_m' (N/mm²)
5083	0 / H111	rolled	t ≤ 50	125	275	125	275
	H 321	rolled	t ≤ 40	215	305	125	275
	0	extruded	all	110	270	110	270
5086	0 / H111	rolled	all	100	240	100	240
	H 321	rolled	all	185	275	100	240
	0	extruded	all	95	240	95	240
5383	0 / H111	rolled	t≤ 40	145	290	145	290
	H 321	rolled	t ≤ 40	220	305	145	290
5059	0 / H111	rolled	t ≤ 40	155	300	155	300
	H 321	rolled	t ≤ 20	270	370	155	300
		rolled	20 < t ≤ 40	260	360	155	300
5454	0 / H111	rolled	all	85	215	85	215
	F	rolled	all	100	210	100	210
5754	0 / H111	rolled	t ≤ 6	80	190	80	190
			t > 6	70	190	70	190
6005	T5 / T6	closed extrusions	T ≤ 6	215	255	105	165
			6 < t ≤ 25	200	250	100	165
		open extrusions	t ≤ 10	215	260	95	165
			10 < t ≤ 25	200	250	80	165
6060 **(3)**	T5	extruded	t ≤ 6	150	190	65	115
			6 < t ≤ 25	130	180	65	110
6061	T6	extruded	t ≤25	240	260	115	155
6082	T6	extruded	t ≤15	255	310	115	170
6106	T5	extruded	t ≤6	195	240	65	130
6351	T5	extruded	t ≤25	240	260	140	165

(1) The guaranteed mechanical characteristics in this Table correspond to general standard values. For more information, refer to the minimum values guaranteed by the product supplier. Higher values may be accepted on the basis of welding tests including recurrent workmanship test at the shipyard only.

(2) Other grades or tempers may be considered, subject to Tasneef's agreement.

(3) 6060 alloy is not to be used for structural members sustaining impact loads (e.g. bottom longitudinals). The use of alloy 6106 is recommended in that case.

(4) $R_{p\,0,2}$ and $R_{p\,0,2}$' are the minimum guaranteed yield stresses at 0,2% in unwelded and welded condition respectively.

(5) R_m and R_m' are the minimum guaranteed tensile strengths in unwelded and welded condition respectively.

3.4 Material factor K for scantlings of aluminium alloy

3.4.1 The value of the material factor K to be introduced into formulae for checking scantlings of structural members, given in this Chapter and the various Appendices, is determined by the following equation:

$$\mathbf{k} = 100/\mathbf{R}_{p0,2}$$

where:

R'_{lim}: minimum guaranteed yield stress of the parent metal in welded condition $R'_{p0,2}$, in N/mm^2, but not to be taken greater than 70% of the minimum guaranteed tensile strength of the parent metal in welded condition R'_m, in N/mm^2 (see Table 3).

3.4.2 In case of welding of two different aluminium alloys, the material factor K to be considered for the scantlings of welds is to be the greater material factor of the aluminium alloys of the assembly.

4 Composite Structure

4.1 Reinforced Components

4.1.1 General

The main raw materials are to be type approved by Tasneef.

It may be accepted as equivalent that main raw materials are individually inspected by Tasneef. In such a case, each batch being used is submitted to tests, the conditions and scope of which are stipulated by the Tasneef Surveyor.

4.1.2 Reinforcement fibres

Fibres for reinforcement may be textile glass or aramid or carbon fibres or other fibres.

Products laid on a surface, such as size, binder and coupling finish, are to ensure cohesion between fibres and resins.

During manufacturing, the shipyard is to ensure that reinforcement materials are free from scrap matter and without defects, detrimental to their use.

4.1.3 Resins

Resins are to be capable of withstanding ageing in marine environments and industrial atmospheres.

Resins are to be used within the limits fixed by the Manufacturer. In this respect, the Surveyor may ask for any relevant proof.

4.1.4 Core materials for sandwich laminates

Expanded foams contributing to sandwich laminate strength are to be of the closed cell type and compatible with the resins used.

Expanded polystyrenes may be used only as filling or buoyancy materials.

4.1.5 Additives

Fillers and pigments are to affect neither the conditions of polymerisation of the impregnation resin nor its mechanical characteristics. The percentage of both of them is not to exceed, as a rule, 10% of the mass of resin, with a maximum of 2% for thixotropic agents and 5% for flame retarders.

The use of microspheres is subject to special examination.

The type and proportions of catalyst and accelerator are to be adjusted in any case to the conditions of work (production rate) and ambient atmosphere (temperature).

In order to ensure complete curing, the builder is to respect the indications of the resin Manufacturer, particularly for the ratio of catalyst.

4.1.6 Materials for integrated structures

These are elements entirely covered with laminate, and used for reinforcement, moulding, or as lamination support for stiffeners, for example.

The metals used are to withstand seawater and fuel corrosion; they are to be of good quality and are not to have any influence on resin curing.

They are to undergo appropriate preparation to improve bonding with the resin.

As a rule, wood reinforcements are to be of a plywood type with good seawater resistance. The use of timber is subject to a special examination.

4.2 Tests on laminates

4.2.1 General

a) The shipyard is to make samples representative of shell materials and if possible of other parts of the structure, taking into account the type and size of vessel.

b) If sister ships are built at the same shipyard, and provided that raw materials are not changed, the frequency of samples for testing is determined by Tasneef.

c) These test samples are to be submitted to a laboratory approved by Tasneef to undergo mechanical and physicochemical tests, as defined below.

d) In general, tests are to be carried out according to the standards indicated below, or other recognized standards previously agreed upon with Tasneef.

e) These tests are to show that laminate characteristics are at least equivalent to the theoretical values given by direct calculation following the method given in [4.3]. Otherwise, supplementary tests may be required.

f) Tasneef reserves the right to require tests different from those defined below, if particular materials or unusual manufacturing process are used.

g) Tests are to be carried out on a panel, the composition of which is to be the same as that of a shell plating area, without gel-coat.

h) Identification of the panel is given by the following elements:

- exact name of the resin, with its specific gravity, elasticity modulus, and breaking stress in curing state,
- description of elementary layers,
- characteristics of the laminate (e.g. layer type, direction),
- direction of the panel in respect of longitudinal axis of the vessel and indication of direction for warp and weft for the rovings in respect of the same axis.

i) Conditioning of laminate panels, preparation of test pieces, dimensional scantling of test pieces and the tests defined below are to be carried out according to recognized standards.

j) Tests are to be carried out on test pieces taken out of the panel in two perpendicular directions. The number of test pieces for each direction is given by the standard used for the particular test.

k) For each group of test pieces and for each result, the value to consider is the average obtained from the number of tested pieces, provided that the minimum value is not less than 0,9 times the mean value. Otherwise, the value to consider is determined by Tasneef, taking testing conditions and dispersion of results into account.

l) Mechanical characteristics are to be obtained from dry test pieces, i.e. not conditioned in water.

m) In general, the following tests are to be carried out:

- single skin laminates: tensile tests, bending tests (three-point method), scantling of specific gravity and percentage of reinforcement in mass,
- sandwich laminates: bending tests (four-point method), and, for each skin, tensile tests, scantling of specific gravity and percentage of reinforcement in mass.

n) Bending tests are to be carried out with the load applied either on the gel-coat side or on the opposite side. The choice of the side is to be decided in accordance with Tasneef, so that the failure mode of the test piece is representative of the case of scantlings of the plating.

o) Test results are to be shown in a test report, mentioning the tests in 4.2.1 to 4.2.4.

4.2.2 Tensile tests

a) In general, these tests are to be carried out for single skin laminates and the skins of sandwich laminates.

b) The applicable standard is: ISO 3268.

c) For each test piece, the test report is to provide the following information:

- reference of the standard used for the test,
- widths and thicknesses of the test piece, in mm,
- length between fixed ends, in mm,
- load (in N),
- elongation curve (in mm),
- breaking load, in N,
- tensile breaking stress, in N/mm^2,
- tangential initial elasticity modulus, in N/mm^2,
- other items of information required by the standard, if necessary.

d) If breaking occurs in several steps, the value taken into account is the first break obtained from the load-elongation curve.

e) The test report is also to indicate the mean value of the breaking load, breaking tensile strength and tangential initial elasticity modulus.

4.2.3 Bending tests

a) In general, bending tests using the three-point method are to be carried out only for the single skin laminates.
The applicable standard is:

- ISO 178.

b) In general, bending tests using the four-point method are to be carried out only for sandwich laminates.
The applicable standard is:

- ASTM C 393.

c) For each test piece, the test report is to provide the following information:

- reference of the standard used for the test,
- widths and thicknesses of the test piece, in mm,
- length of the span between supports, in mm,
- for the four-point method: location of the points where the load is applied,
- load (in N),
- deflection (in mm) curve,
- breaking load, in N, and failure mode,
- bending breaking strength, in N/mm^2, for single skin laminate tests,

- bending breaking strength of skin and shear breaking strength of core for sandwich laminate tests, both in N/mm^2,
- other items of information required by the standard, if necessary.

d) If breaking occurs in several steps, the value taken into account is the first break obtained from the load-deflection curve.

e) The test report is also to indicate the mean value of the breaking load and breaking strength.

4.2.4 Mass density and percentage of reinforcement

a) In general, these tests are to be carried out for single skin laminates and the skins of sandwich laminates.

b) The applicable standards are:

- ASTM D 792,
- ASTM D 3171.

c) For each test piece, the test report is to provide the following information:

- reference of the standard used for the test,
- dimensions, in mm, of the test piece,
- mass of the test-piece, in g,
- mass by unit of area of the test piece, in g/m^2,
- specific density, in g/m^3,
- mass of reinforcement of the test piece, in g,
- mass of reinforcement by unit of area, in g/m^2,
- percentage of reinforcement in mass,
- other items of information required by the standard, if necessary.

d) The test report is also to indicate the mean value of the mass by unit of area, in g/m^2, specific gravity, in g/m^3, mass of reinforcement by unit of area, in g/m^2, and percentage of reinforcement in mass.

4.3 Estimation of mechanical characteristics of materials

4.3.1 Symbols

The meanings of the symbols used below are as follows:

Ψ: content in mass of reinforcement in a layer,

ϕ: content in volume of reinforcement in a layer, defined in [4.3.2] below,

μ_0: vacuum content, equal to 0, if there is no available information,

$\mathbf{E}_1$: Young's modulus of a layer with unidirectional fibres, parallel to fibres, in N/mm^2, defined in [4.3.2] below,

$\mathbf{E}_2$: Young's modulus of a layer with unidirectional fibres, perpendicular to fibres, in N/mm^2, defined in [4.3.2] below,

ν_{12},ν_{21} Poisson's ratios of a layer with unidirectional fibres, defined in [4.3.2] below,

$\mathbf{G}_{12}$: Coulomb's modulus of a layer with unidirectional fibres, in N/mm^2, defined in [4.3.2] below,

ρ_v specific gravity of reinforcement, in g/cm^3,

ρ_r specific gravity of resin, in g/cm^3,

$\mathbf{E}_{1v}$ Young's modulus of reinforcement in the direction parallel to fibres, in N/mm^2,

$\mathbf{E}_{2v}$ Young's modulus of reinforcement in the direction perpendicular to fibres, in N/mm^2,

$\mathbf{E}_r$ Young's modulus of resin, in N/mm^2,

ν_v Poisson's ratio of reinforcement,

ν_r Poisson's ratio of resin,

$\mathbf{G}_r$ Coulomb's modulus of resin, in N/mm^2, defined in [4.3.2] below,

$\mathbf{G}_v$ Coulomb's modulus of the reinforcement, in N/mm^2, as given in Tab 4.

When there is no available information, the values given in Tab 4 may be considered.

Table 4

		Fibres				Resins	
		E Glass	Aramid	HS Carbon	HM Carbon	Polyester	Epoxy
Mass density in g/cm³		2,54	1,45	1,80	1,90	1,20	1,20
Young's modulus, in N/mm²	Parallel to fibres	73000	130000	230000	370000	3000	2600
	Perpendicular to fibres	73000	5400	15000	6000	-	-
Coulomb's modulus, in N/mm²		30000	12000	50000	20000	-	-
Poisson's ratio		0,25	0,35	0,35	0,35	0,316	0,40

4.3.2 Elementary layer

a) The content in volume j of reinforcement in the layer is given by the formula:

$$\varphi = \frac{\psi \cdot (1-\mu_0)}{\psi + (1-\psi) \cdot \frac{\rho_v}{\rho_r}}$$

b) Whatever the type of reinforcement used in a particular layer, the elastic characteristics of a layer with unidirectional fibres having the same content of reinforcement as that layer are to be calculated first:

- Young's modulus:
- parallel to fibres

$$E_1 = \varphi \cdot E_{1v} + (1-\varphi) \cdot E_r$$

- perpendicular to fibres

$$E_2 = \frac{E_r}{1-\nu_r^2} \cdot \frac{1 + 0,85 \cdot \varphi^2}{(1-\varphi)^{1,25} + \varphi \frac{E_r}{E_{2v}(1-\nu_r^2)}}$$

- Poisson's ratios::

$$\nu_{12} = \varphi \cdot \nu_v + (1-\varphi) \cdot \nu_r$$

$$\nu_{21} = \nu_{12} \cdot \frac{E_2}{E_1}$$

- Coulomb's modulus:

$$G_{12} = G_r \cdot \frac{1 + 0,6 \cdot \varphi^{0,5}}{(1-\varphi)^{1,25} + \frac{G_r}{G_v} \cdot \varphi}$$

where:

$$G_r = \frac{E_r}{2 \cdot (1+\nu_r)}$$

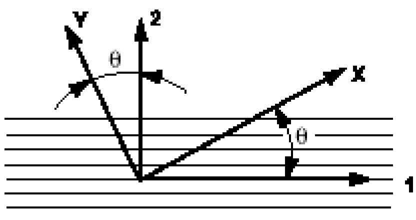
c) Following any direction that forms an angle q with the direction of fibres, Young's modulus of the elementary layer become:

$$\frac{1}{E_x} = \frac{1}{E_1} \cdot \cos^4\theta + \left(\frac{1}{G_{12}} - \frac{2\nu_{12}}{E_1}\right) \cdot \sin^2\theta \cdot \cos^2\theta + \frac{1}{E_2} \cdot \sin^4\theta$$

$$\frac{1}{E_y} = \frac{1}{E_1} \cdot \sin^4\theta + \left(\frac{1}{G_{12}} - \frac{2\nu_{12}}{E_1}\right) \cdot \sin^2\theta \cdot \cos^2\theta + \frac{1}{E_2} \cdot \cos^4\theta$$

The values of E1, E2, n12 and G12 are calculated as above; directions x and y are defined in Fig 1.

Figure 1



d) In general, the content in mass of reinforcement in a layer of mat is between 0,25 and 0,35. Young's modulus of a layer of mat may be estimated from:

$$E_M = \frac{3}{8} \cdot E_1 + \frac{5}{8} \cdot E_2$$

e) Woven rovings may be taffeta, cotton serge, satin, etc., warp and weft balanced or not.

f) In general, the content in mass of reinforcement in a woven roving reinforced layer is between 0,4 and 0,6, and the content in mass of reinforcement in a unidirectional reinforced layer is between 0,6 and

0,7. The direction of the warp (direction 1) is to be distinguished from that of the weft (direction 2); the elastic characteristics are:

$$E_{1R} = k \cdot E_1 + (1-k) \cdot E_2$$

$$E_{2R} = (1-k) \cdot E_1 + k \cdot E_2$$

where k is the woven balance coefficient equal to the ratio of warp tensile strength to the sum of tensile strengths in warp and weft, E1 and E2 being defined above.

Generally, a layer reinforced with woven rovings may be considered as made of two perpendicular unidirectional layers, and it is possible to apply directly to them the formulae laid down above, taking into account the actual content of reinforcement in the layer.

4.3.3 Single skin laminates

a) A laminate is made of n layers. The characteristics of layer i of the laminate are:

t_i : thickness, in mm, regardless of direction, given by

$$t_i = \frac{P_{vi}}{(1-\mu_0)} \cdot \left(\frac{1}{\rho_v} + \frac{1-\psi_i}{\psi_i \cdot \rho_r}\right) \cdot 10^{-3}$$

where P_{vi} is the mass of reinforcement by unit of area in layer i in g/m2, and Yi is the content in mass of reinforcement in layer i.

z_i : distance, in mm, from the neutral fibre of layer i to an edge (regardless of direction):

$$z_i = z_{i-1} + \frac{t_{i-1} + t_i}{2}$$

E_i : Young's modulus of layer i, in N/mm^2, assumed to be known and experimentally verified. Ei is the lowest of the values in tension and compression.

b) The equivalent tensile elasticity modulus EL, in N/mm^2, of the multi-layer laminate may be calculated by:

$$E_L = \frac{\sum E_i \cdot t_i}{\sum t_i}$$

c) The distance of the neutral fibre of the multi-layer laminate is, in mm:

- with regard to the edge of reference,

$$V = \frac{\sum E_i \cdot t_i \cdot z_i}{\sum E_i \cdot t_i}$$

- with regard to the other edge.

$$V' = \sum t_i - V$$

Distances d_i from the neutral fibre of each layer to the neutral fibre of the laminate are, in mm:

$$d_i = z_i - V$$

d) The flexural rigidity of the multi-layer laminate [EI], by millimetre of width, in N.mm^2/mm

$$(EI) = \sum E_i \cdot \left(\frac{t_i^3}{12} + t_i \cdot d_i^2\right)$$

e) The inertia of the multi-layer laminate, by millimetre of width, in mm^4/mm, is:

$$(I) = \sum \left(\frac{t_i^3}{12} + t_i \cdot d_i^2\right)$$

f) The theoretical bending breaking strength of the multi-layer laminate σ_{br}, is, in N/mm2:

$$\sigma_{br} = k \cdot \frac{(EI)}{(I)}((1-\mu_0)^2 \cdot 10^{-3})$$

where

k :

- 17,0 for laminates using polyester resin,
- 25,0 for laminates using epoxy resin.
- 12,5 for laminates using carbon fibre and epoxy resin

When the breaking strength of the laminate, given by mechanical tests as stipulated in [1.2.2], is greater than the theoretical calculated value σ_{br} the breaking strength obtained from tests can be taken into account to increase the preceding value of σ_{br}.

4.3.4 Sandwich laminates

a) The inertia and flexural rigidity of sandwich laminates are to be calculated according to (d) and (e) above, taking into account the core as an elementary layer with its own characteristics (thickness and Young's modulus of the core material).

b) The theoretical bending breaking strength by bending of skins of the sandwich laminate is, in N/mm

$$\sigma_{br} = k \cdot \frac{(EI)}{(I)}((1-\mu_0)^2 \cdot 10^{-3})$$

where:

(EI) : flexural rigidity of the sandwich laminate, in N·mm^2/mm

(I) : inertia of the sandwich laminate, in mm^4/mm,

μ_0 : vacuum content of skins,

k : coefficient equal to:

- 17,0 for laminates using polyester resin,
- 25,0 for laminates using epoxy resin.

- 12,5 for laminates using carbon fibre and epoxy resin

When the breaking strength of the laminate by bending of skins, given by mechanical tests as required in [4.2], is greater than the theoretical calculated value σ_{br}, the breaking strength obtained from tests can be taken into account to increase the preceding value of σ_{br}.

c) The shear breaking of a sandwich laminate is to be considered in each individual case, considering the thickness and the shear breaking strength of the core material.

4.3.5 Stiffeners

a) In general, the characteristics of the member considered as support only for the lamination of the stiffener are not to be taken into account for estimation of the mechanical characteristics of the stiffener.

b) Symbols are shown in Tab 2, where:

l_b : is the width of the associated plating, equal to stiffener's spacing s for ordinary stiffeners, and the less between primary stiffener's spacing or 0,2 ℓ for primary stiffeners where ℓ stiffener's span.

c) To supplement the symbols defined in Tab.5, the following elements are needed:

z_i : distance from the neutral fibres of the three elements, i.e. core, flange and associated plating (index i refers to each one of them), to the outer face of the associated plating, in mm

V : distance from the stiffener neutral fibre to the outer face of the associated plating, in mm:

$$V = \frac{\sum E_i \cdot S_i \cdot z_i}{\sum E_i \cdot S_i}$$

V' : distance from the stiffener neutral fibre to the outer face of the flange, in mm:

$$V' = H - V + t_s + t_b$$

d_i : distances from the neutral fibre of each element to the stiffener neutral fibre, in mm:

$$di = z_i . V$$

I_i : specific inertia of each element, in mm^4.

d) The rigidity of a stiffener [EI], in N/mm^2, is:

$$(EI) = \sum E_i \cdot (I_i + S_i \cdot d_i^2)$$

e) The inertia of a stiffener [I], in mm^4, is:

$$(I) = \sum (I_i + S_i \cdot d_i^2)$$

f) The theoretical bending breaking strength of the stiffener σ_{br}, in N/mm^2, is:

$$\sigma_{br} = k \cdot \frac{(EI)}{(I)} \cdot 10^{-3}$$

where k is equal to:

- 17,0 for laminates using polyester resin,
- 25,0 for laminates using epoxy resin.
- 12,5 for laminates using carbon fibre and epoxy resin

Table 5

Element	Width or height in mm	Thickness in mm	Young's modulus in N/mm^2	Cross-Sectional area mm^2
Flange	$\mathbf{l_s}$	$\mathbf{t_s}$	$\mathbf{E_S}$	$\mathbf{S_s = t_s \cdot l_s}$
Core	**H**	$\mathbf{t_a}$	$\mathbf{E_a}$	$\mathbf{S_a = t_a \cdot H}$
Associated plating	$\mathbf{l_b}$	$\mathbf{t_b}$	$\mathbf{E_b}$	$\mathbf{S_b = t_b \cdot l_b}$

5 Shipyard and construction establishment

5.1.1 Shipyards qualified as vessels in composite material shall present an internal organisation, tools, layout and building process referring with rules for non-steel vessel.

SECTION 2 STRENGTH PRINCIPLES

1 Symbols

E : Young's modulus, in N/mm^2,to be taken equal to:

- for steels in general:

  $E = 2,06 \cdot 10^5$ N/mm^2

- for stainless steels:

  $E = 1,95 \cdot 10^5$ N/mm^2

- for aluminium alloys:

  $E = 7,0 \cdot 10^4$ N/mm^2

s : Spacing, in m, of ordinary stiffeners or primary supporting members, as the case may be

ℓ : Span, in m, of an ordinary stiffener or a primary supporting member, as the case may be, measured between the supporting members (see from Fig 1 to Fig 4)

ℓ_b : Length, in m, of brackets, (see Fig 3 and Fig 4)

h_w : Web height, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

t_w : Net web thickness, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

b_f : Face plate width, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

t_f : Net face plate thickness, in mm, of an ordinary stiffener or a primary supporting member, as the case may be

t_p : Net thickness, in mm, of the plating attached to an ordinary stiffener or a primary supporting member, as the case may be

w : Net section modulus, in cm^3, of an ordinary stiffener or a primary supporting member, as the case may be, with attached plating of width b_P

I : Net moment of inertia, in cm^4, of an ordinary stiffener or a primary supporting member, as the case may be, without attached plating, around its neutral axis parallel to the plating (see Fig 3 and Fig 4)

I_B : Net moment of inertia, in cm^4, of an ordinary stiffener or a primary supporting member, as the case may be, with bracket and without attached plating, around its neutral axis parallel to the plating, calculated at mid-length of the bracket (see Fig 3 and Fig 4).

2 General principles

2.1 Structural continuity

2.1.1 The variation in scantlings between the midship region and the fore and aft parts is to be gradual.

2.1.2 Attention is to be paid to the structural continuity:

- in way of changes in the framing system
- at the connections of primary or ordinary stiffeners
- in way of the ends of the fore and aft parts and machinery space.
- in way of ends of superstructures.

2.1.3 Longitudinal members contributing to the hull girder longitudinal strength, according to Ch 6, Sec 1, [2], are to extend continuously for a sufficient distance towards the ends of the vessel.

Ordinary stiffeners contributing to the hull girder longitudinal strength are generally to be continuous when crossing primary supporting members. Otherwise, the detail of connections is considered by Tasneef on a case by case basis.

Longitudinals of the bottom, bilge, sheerstrake, deck, upper and lower longitudinal bulkhead and inner side strakes, as well as the latter strakes themselves, the lower strake of the centreline bottom girder and the upper strake of the centreline deck girder, where fitted, are to be continuous through the transverse bulkheads of the cargo area and cofferdams. Alternative solutions may be examined by Tasneef on a case by case basis, provided they are equally effective.

2.1.4 Where stress concentrations may occur in way of structural discontinuities, adequate compensation and reinforcements are to be provided.

2.1.5 Openings are to be avoided, as far as practicable, in way of highly stressed areas.

Where necessary, the shape of openings is to be specially designed to reduce the stress concentration factors. Openings are to be generally well rounded with smooth edges.

2.1.6 Primary supporting members are to be arranged in such a way that they ensure adequate continuity of strength. Abrupt changes in height or in cross-section are to be avoided.

2.2 Connections between steel and aluminium

2.2.1 Any direct contact between steel and aluminium alloy is to be avoided (e.g. by means of zinc or cadmium plating of the steel parts and application of a suitable coating on the corresponding light alloy parts).

2.2.2 Any heterogeneous jointing system is considered by Tasneef on a case by case basis.

2.2.3 The use of transition joints made of aluminium/steel-clad plates or profiles is considered by Tasneef on a case by case basis (see TASNEEFMIL Pt D, Ch 3, Sec 2, [4]).

3 Plating

3.1 Insert plates and doublers

3.1.1 A local increase in plating thickness is generally to be achieved through insert plates. Local doublers, which are normally only allowed for temporary repair, may however be accepted by Tasneef on a case by case basis.

3.1.2 In any case, doublers and insert plates are to be made of materials of a quality at least equal to that of the plates on which they are welded.

3.1.3 Doublers having width, in mm, greater than:

- 20 times their thickness, for thicknesses equal to or less than 15 mm
- 25 times their thickness, for thicknesses greater than 15 mm

are to be fitted with slot welds.

3.1.4 When doublers fitted on the outer shell and strength deck within 0,6L amidships are accepted by Tasneef, their width and thickness are to be such that slot welds are not necessary according to the requirements in [3.1.2]. Outside this area, the possibility of fitting doublers requiring slot welds will be considered by Tasneef on a case by case basis.

4 Ordinary stiffeners

4.1 General

4.1.1 Stiffener not perpendicular to the attached plating

Where the stiffener is not perpendicular to the attached plating, the actual net section modulus may be obtained, in cm^3, from the following formula:

$$w = w_o \sin \alpha$$

where:

w_o : Actual net section modulus, in cm^3, of the stiffener assumed to be perpendicular to the plating

α : Angle between the stiffener web and the attached plating.

4.2 Span of ordinary stiffeners

4.2.1 General

The span ℓ of ordinary stiffeners is to be measured as shown in Fig 1 to Fig 4.

Figure 1 : Ordinary stiffener without brackets

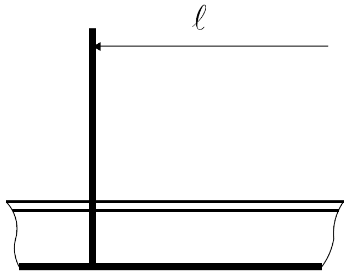


Figure 2 : Ordinary stiffener with a stiffener at one end

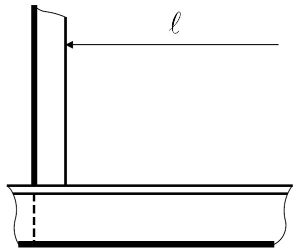


Figure 3 : Ordinary stiffener with end bracket

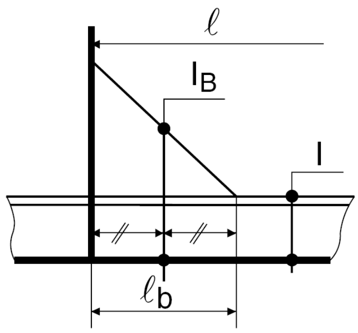
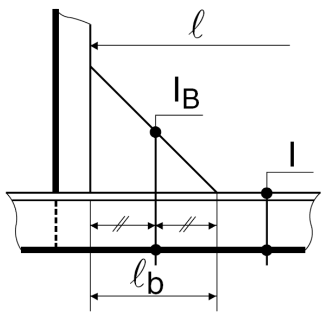


Figure 4 : Ordinary stiffener with a bracket and a stiffener at one end



4.3 Width of attached plating

4.3.1 Yielding check

The width of the attached plating to be considered for the yielding check of ordinary stiffeners is to be obtained, in m, from the following formulae:

- where the plating extends on both sides of the ordinary stiffener:

$$b_P = s$$

- where the plating extends on one side of the ordinary stiffener (i.e. ordinary stiffeners bounding openings):

$$b_P = 0{,}5s.$$

4.4 End connections

4.4.1 Where ordinary stiffeners are continuous through primary supporting members, they are to be connected to the web plating so as to ensure proper transmission of loads, e.g. by means of one of the connection details shown in Fig 5 to Fig 8.

Connection details other than those shown in Fig 5 to Fig 8 may be considered by Tasneef on a case by case basis. In some cases, Tasneef may require the details to be supported by direct calculations submitted for review.

4.4.2 Where ordinary stiffeners are cut at primary supporting members, brackets are to be fitted to ensure the structural continuity. Their net section modulus and their net sectional area are to be not less than those of the ordinary stiffeners.

The net thickness of brackets is to be not less than that of ordinary stiffeners. Brackets with net thickness, in mm, less than $15L_b$, where L_b is the length, in m, of the free edge of the end bracket, are to be flanged or stiffened by a welded face plate. The net sectional area, in cm^2, of the flanged edge or face plate is to be at least equal to L_b

Figure 5 : End connection of ordinary stiffener Without collar plate

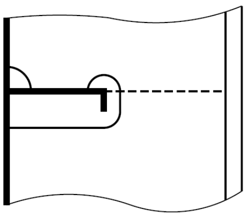


Figure 6 : End connection of ordinary stiffener Collar plate

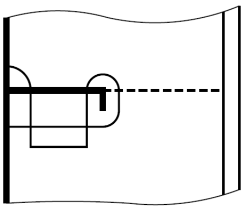


Figure 7 : End connection of ordinary stiffener One large collar plate

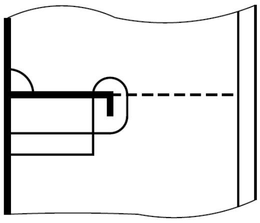
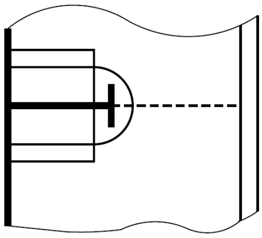


Figure 8 : End connection of ordinary stiffener Two large collar plates



5 Primary supporting members

5.1 Span of primary supporting members

5.1.1 The span of primary supporting members is to be determined in accordance with [5.2].

5.2 Width of attached plating

5.2.1 General

The width of the attached plating to be considered for the yielding check of primary supporting members analysed through beam structural models is to be obtained, in m, from the following formulae:

- where the plating extends on both sides of the primary supporting member:

$$b_P = \min(s; 0{,}2\ell)$$

- where the plating extends on both sides of the primary supporting member:

$$b_P = 0{,}5 \min(s; 0{,}2\ell)$$

5.3 Bracketed end connections

5.3.1 Arm lengths of end brackets are to be equal, as far as practicable.

With the exception of primary supporting members of transversely framed single sides, the height of end brackets is to be not less than that of the primary supporting member.

5.3.2 The net thickness of the end bracket web is generally to be not less than that of the primary supporting member web.

5.3.3 The net scantlings of end brackets are generally to be such that the net section modulus of the primary supporting member with end brackets is not less than that of the primary supporting member at mid-span.

5.3.4 Flange's breadth of end brackets, in mm, shall be greater than 50 (L_b+1)

where L_b is the length, in m, of the bracket's free edge

Moreover, the flange net thickness shall be greater or equal to web thickness.

5.3.5 Stiffening of end brackets is to be designed such that it provides adequate buckling web stability.

As guidance, the following prescriptions may be applied:

- where the length L_b is greater than 1,5 m, the web of the bracket is to be stiffened
- the net sectional area, in cm^2, of web stiffeners is to be not less than 16,5ℓ, where ℓ is the span, in m, of the stiffener
- tripping flat bars are to be fitted to prevent lateral buckling of web stiffeners. Where the width of the symmetrical face plate is greater than 400 mm, additional backing brackets are to be fitted.

5.4 Bracketless end connections

5.4.1 In the case of bracketless crossing between primary supporting members (see Fig 9), the net thickness of the common part of the web is to be not less than the value obtained, in mm, from the following formula:

$$t = 15{,}75\ w / \Omega$$

where:

w : the lesser of w_1 e $w_{2,MAX}$

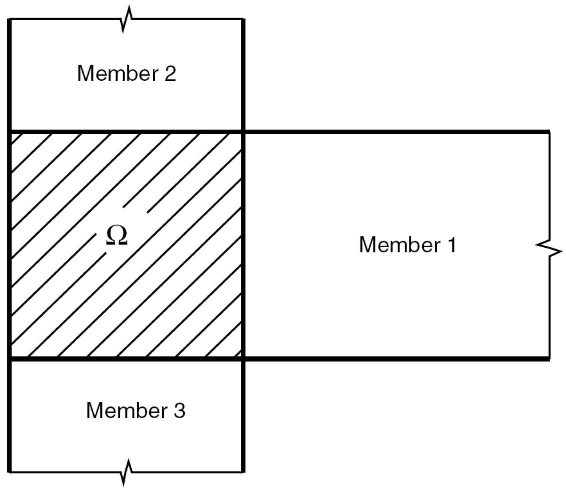
w_1 : gross section modulus, in cm^3, of member 1,

$w_{2,MAX}$: the greater value, in cm^3, of the gross section modulus of members 2 and 3

Ω: Area, in cm^2, of the common part of members 1, 2 and 3.

In the absence of one of members 2 and 3 shown in Fig 9, the value of the relevant gross section modulus is to be taken equal to zero.

Figure 9 : Bracketless end connections of primary supporting members



6 Composite Principles of building

6.1 General provisions

6.1.1 The purpose of this item is to give some structural details which may be recommended. However, they do not constitute a requirement; different details may be proposed by builders and agreed upon by Tasneef, provided that builders give justifications, to be defined in each special case.

6.1.2 Arrangements are to be made to ensure the continuity of longitudinal strength:

- in areas with change of stiffener framing,
- in areas with large change of strength,
- at connections of ordinary and primary stiffeners.

6.1.3 Arrangements are to be made to ensure the continuity of transverse strength in way of connections between hulls of catamarans and axial structure.

6.1.4 Structure discontinuities and rigid points are to be avoided; when the strength of a structure element is reduced by the presence of an attachment or an opening, proper compensation is to be provided.

6.1.5 Openings are to be avoided in highly stressed areas, in particular at ends of primary stiffeners, and for webs of primary stiffeners in way of pillars. If necessary, the shape of openings is to be designed to reduce stress concentration. In any case, the corners of openings are to be rounded.

6.1.6 Connections of the various parts of a hull, as well as attachment of reinforcing parts or hull accessories, can be made by moulding on the spot, by bonding separately moulded, or by mechanical connections.

6.1.7 Bulkheads and other important reinforcing elements are to be connected to the adjacent structure by corner joints (see Fig 16) on both sides, or equivalent joint. The mass per m^2 of the corner joints is to be at least 50% of the mass of the lighter of the two elements to be fitted, and at least 900 g/m^2 of mat or its equivalent. The width of the layers of the corner joints is to be worked out according to the principle given in Fig 10.

6.1.8 The connection of the various parts of the hull, as well as connection of reinforcing members to the hull, can be made by adhesives, subject to special examination by Tasneef.

6.2 Plates

6.2.1 General

a) The edges of the reinforcements of one layer are not to be juxtaposed but to overlap by at least 50 mm; these overlaps are to be offset between various successive layers.

b) Prefabricated laminates are fitted by overlapping the layers, preferably with chamfering of edges to be connected.

The thickness at the joint is to be at least 15% higher than the usual thickness.

c) Changes of thickness for a single-skin laminate are to be made as gradually as possible and over a width which is, in general, not to be less than thirty times the difference in thickness, as shown in Fig 11.

d) The connection between a single-skin laminate and a sandwich laminate is to be carried out as gradually as possible over a width which is, in general, not to be less than three times the thickness of the sandwich core, as shown in Fig 12.

Figure 10

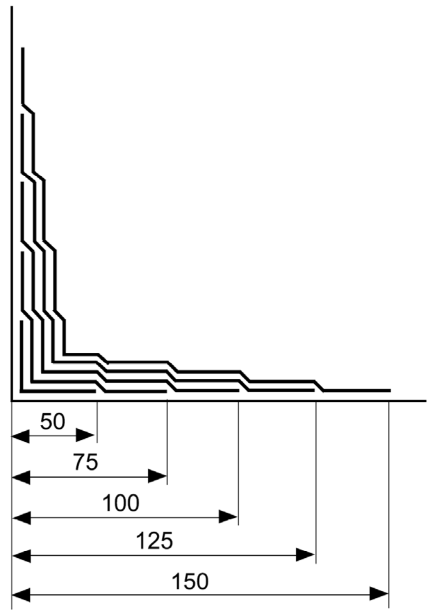


Figure 11

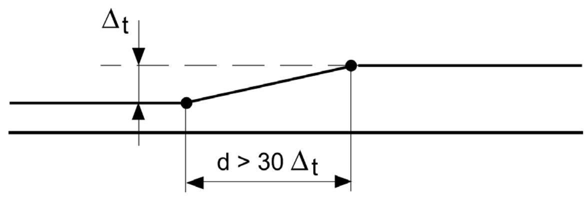


Figure 12

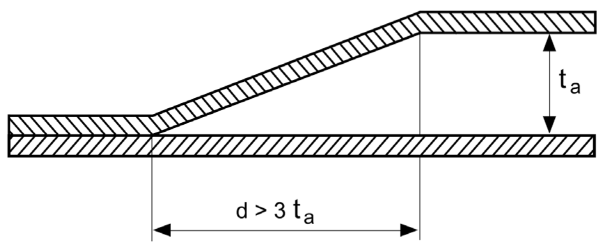
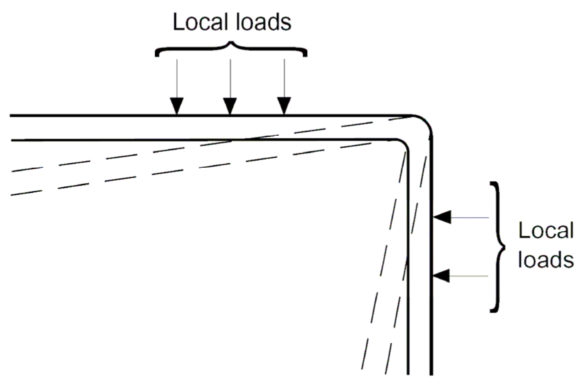


Figure 13



6.2.2 Deck-side shell connection

a) This connection is to be designed both for the bending stress shown in Fig 13, caused by vertical loads on deck and horizontal loads of seawater, and for the shear stress caused by the longitudinal bending.

b) In general, the connection is to avoid possible loosening due to local bending, and ensure longitudinal continuity. Its thickness is to be sufficient to keep shear stresses acceptable.

c) Fig 14 to Fig 17 give examples of deck-side shell connections.

6.2.3 Bulkhead-hull connection

a) In some cases, this connection is needed to distribute the local load due to the bulkhead over a sufficient length of hull. Fig 18 and Fig 19 give possible solutions. The scantlings of bonding angles are determined according to the loads acting upon the connections.

b) The builder is to pay special attention to connections between bulkheads of integrated tanks and structural members.

Figure 14

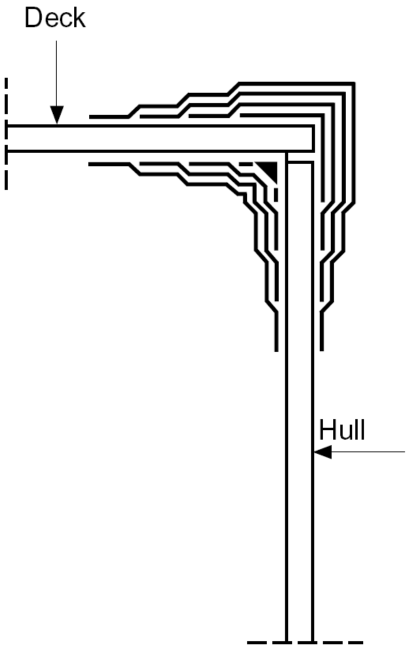


Figure 15

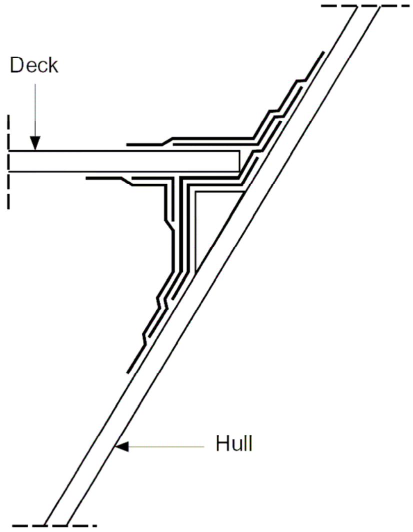


Figure 16

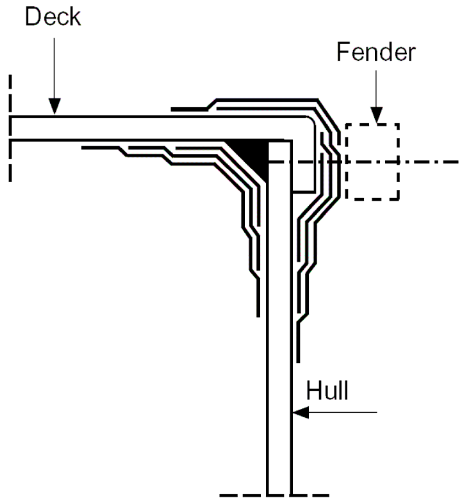


Figure17

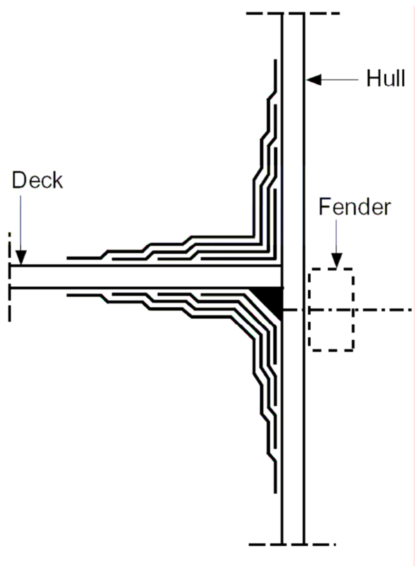


Figure 18

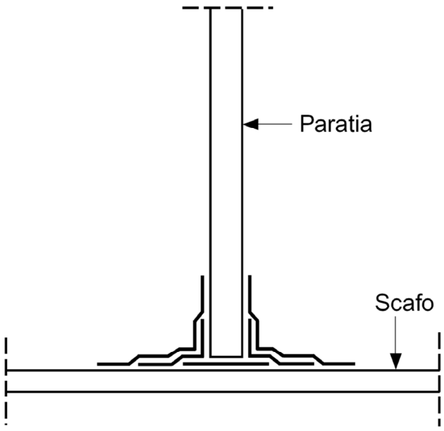
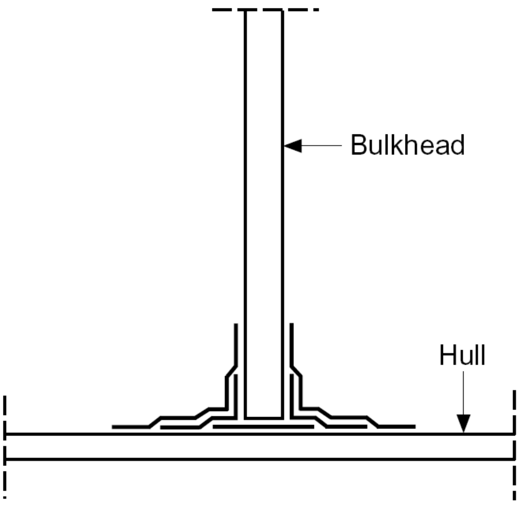


Figure 19



6.2.4 Passages through hull

a) Passages of metal elements through the hull, especially at the level of the rudder stock, shaft brackets, shaft-line, etc., are to be strongly built, in particular when subjected to alternating loads.

b) Passages through hull should be reinforced by means of a plate and counterplate connected to each other.

6.2.5 Passages through watertight bulkheads

The continuous omega or rectangle stiffeners at a passage through a watertight bulkhead are to be watertight in way of the bulkhead.

6.2.6 Openings in deck

The corners of deck openings are to be rounded in order to reduce local stress concentrations as much as possible, and the thickness of the deck is to be increased to maintain the stress at a level similar to the mean stress on the deck.

The reinforcement is to be made from a material identical to that of the deck.

6.3 Stiffeners

6.3.1 Primary stiffeners are to ensure structural continuity.

6.3.2 Abrupt changes in web height, flange breadth and cross-sectional area of web and flange are to be avoided.

6.3.3 In general, at the intersection of two stiffeners of unequal sizes (longitudinals with web-frames, floors, beams or frames with stringers, girders or keelsons), the smallest stiffeners (longitudinals or frames) are to be continuous, and the connection between the elements is to be made by corner joints according to the principles defined in [5.1].

6.3.4 Fig 20 to Fig 22 give various examples of stiffeners.

6.3.5 Connections between stiffeners are to ensure good structural continuity. In particular, the connection between deck beam and frame is to be ensured by means of a flanged bracket. However, some types of connections without bracket may be accepted, provided that loads are light enough. In this case, stiffeners are to be considered as supported at their ends.

Figure 20

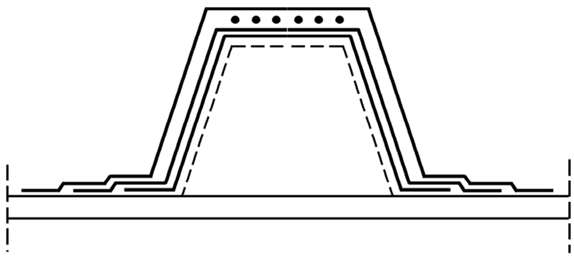


Figure 21

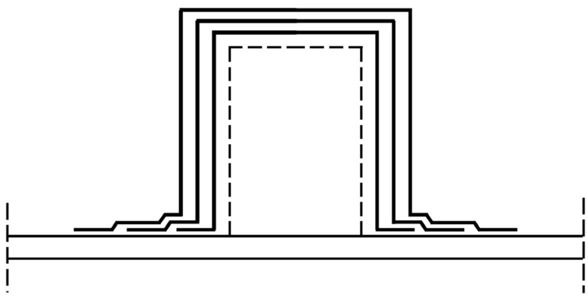
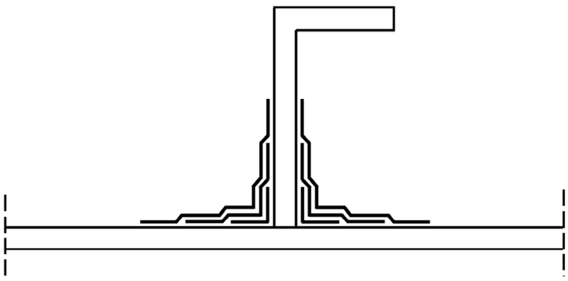


Figure 22



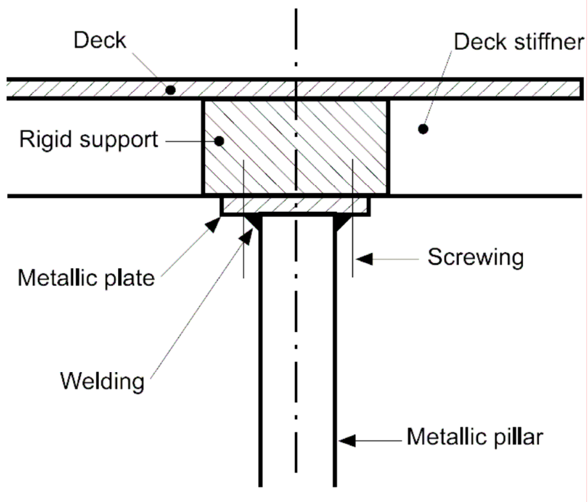
6.4 Pillars

6.4.1 Connections between metal pillars subject to tensile loads and the laminate structure are to be designed to avoid tearing between laminate and pillars.

6.4.2 Connections between metal pillars subject to compressive loads and the laminate structure are to be carried out by mean of intermediate metal plates. The welding of the pillar to the metal plate is to be carried out before fitting of the plate on board vessel.

Fig 23 gives the principle for connection between the structure and pillars subject to compressive loads.

Figure 23

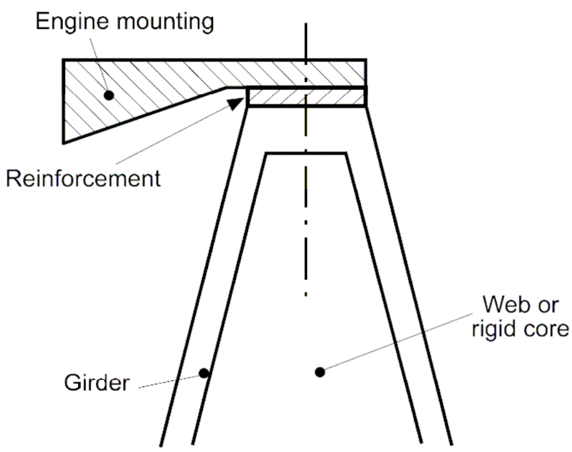


6.5 Engine seating

6.5.1 The engine seating is to be fitted on special girders suitably positioned between floors, which locally ensure sufficient strength in relation to pressure and weight loads.

6.5.2 Fig 24 gives an example of possible seating.

Figure 24



Part B
Hull and Stability

Chapter 5
HULL SCANTLINGS

SECTION 1 GENERAL

1 General

1.1 Introduction

1.1.1 The present chapter describes the hull and superstructures structural scantling standards. Scantlings indicated in the following paragraph are referred to vessels in steel, aluminium alloy or reinforced plastic, of the types listed in Ch 4, Sec 1 of this Rules.

1.1.2 Direct calculation

Tasneef may request the execution of direct calculation, if necessary, likewise shall accept scantlings verified through direct calculation, which assure the same structures' safety level.

Such calculation are to be executed n the grounds of the structural modelling, load and verification criteria, indicated in HSC Rules [C3.6.]

Calculation based on other criteria shall be accepted by Tasneef if considered equivalent to the ones required.

SECTION 2 LOADS AND ACCELERATION

1 Design acceleration

1.1 Vertical acceleration at LCG

1.1.1 The design vertical acceleration at LCG, aCG (expressed in g), is defined by the designer and corresponds to the average of the 1 per cent highest accelerations in the most severe sea conditions expected, in addition to the gravity acceleration. Generally, it is to be not less than::

$$\mathbf{a_{CG} = foc\ Soc\ V/L^{0,5}}$$

where foc and Soc values are indicated in Table 1 AND Table 2.

Table 1

Service Type	Maritime police	Rescue
foc	**1,333**	**1,666**

Table 2

Sea Zone	Unrestricted navigation	offshore navigation	inshore navigation
Soc	**C_F**	**0,30**	**0,23**

where $\mathbf{C_F}$ is given by :

$$C_F = 0,2 + \frac{0,6}{V/(\sqrt{L})} \geq 0,32$$

1.1.2 The sea areas referred to in Table 2 are defined with reference to significant wave heights $\mathbf{H_s}$ which are exceeded for an average of not more than 10 % of the year:

- Open-sea service (**unrestricted navigation**, see Part A, Ch 1, Sec 4 [5.2]) :
  $\mathbf{H_s} \geq 4,0$ m;
- Restricted open-sea service (**offshore navigation**, see Part A, Ch 1, Sec 4 [5.2]):
  $2,0 \text{ m} \leq \mathbf{H_s} < 4,0$ m
- Moderate environment service (**inshore navigation**, see Part A, Ch 1, Sec 4 [5.2]):
  $\mathbf{H_s} < 2,0$ m

inshore navigation is assigned for units without main deck.

1.1.3 If the design acceleration cannot be defined by the designer, the a_{CG} value corresponding to the appropriate values of **foc** and **Soc** reported in Table 1 and Table 2 will be assumed.

1.1.4 The longitudinal distribution of vertical acceleration along the hull is given by

$$\mathbf{a_v = k_v\ a_{CG}}$$

where:

k_v longitudinal distribution factor, not to be less than (see Figure 1):

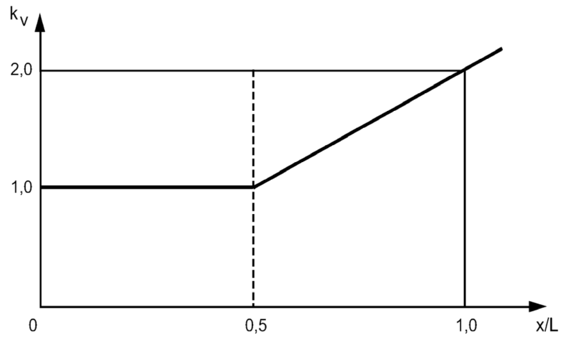
k_v = 1, for x/L .≤ 0,5

k_v = 2·x/L, for x/L > 0,5

Higher values may be requested based on pitch consideration.

a_{CG} design acceleration at L_{CG}.

Figure 1



1.1.5 Variation of a_v in the transverse direction may generally be disregarded.

1.1.6 Transverse acceleration

Transverse acceleration is defined on the basis of results of model tests and full-scale scantlings, considering their characteristic value as specified in:

$$a_t = 2,5 \cdot \frac{H_{sl}}{L} \cdot \left(1 + 5 \cdot \left(1 + \frac{V/(\sqrt{L})}{6}\right)^2 \cdot \frac{r}{L}\right)$$

where:

H_{sl} permissible significant wave height at maximum service speed V

r distance of the point from 0,5D

1.2 Assessment of limit operating conditions

1.2.1 "Limit operating conditions" in this paragraph are to be taken to mean sea states (characterized only by their significant wave heights) compatible with the structural design parameters of the craft, i.e. the sea states in which the craft may operate depending on its actual speed.

1.2.2 It is the designer's responsibility to specify the format and the values of the limit operating conditions. Their format may be for example a relation between speed and significant wave height which ascertains actual loads less than the one used for structural design. They must include the maximum allowed significant wave height H_{sm} consistent with the structural strength. H_{sm} is not to be greater than the value calculated according to [1.2.4] below.

1.2.3 The limit operating conditions, taken as a basis for classification, are indicated in the Classification Certificate and are to be considered in defining the worst intended conditions and the critical design conditions.

1.2.4 It is assumed that, on the basis of weather forecast, the craft does not encounter, within the time interval required for the voyage, sea states with significant heights, in m, greater than the following:

$$H_{sm} = 5 \cdot \frac{a_{CG}}{V/(\sqrt{L})} \cdot \frac{L}{6 + 0,14 \cdot L}$$

where vertical acceleration $\mathbf{a}_{CG}$ is defined in [1.1.1].

1.2.5 The significant wave height is related to the craft's geometric and motion characteristics and to the vertical acceleration $\mathbf{a}_{CG}$ by the following formula:

$$a_{CG} = \frac{(50 - \alpha_{dCG}) \cdot \left(\frac{\tau}{16} + 0,75\right)}{3555 \cdot C_B} \cdot \left(\frac{H_S}{T} + 0,084 \cdot \frac{B_W}{T}\right) \cdot K_{FR} \cdot K_{HS}$$

for units for which $V/L^{0,5} \geq 3$ and $\Delta. / (0,01 \cdot L)^3 < 3500$

$$K_{FR} = \left(\frac{V_X}{\sqrt{L}}\right)^2$$

and

$$K_{HS} = 1$$

for units for which $V/L^{0,5} < 3$ or $\Delta/(0,01 \cdot L)^3 < 3500$

$$K_{FR} = 0,8 + 1,6 \cdot \frac{V_X}{\sqrt{L}}$$

and

$$K_{HS} = \frac{H_S}{T}$$

where:

H_s significant wave height, in m,,

α_{dCG} deadrise angle, in degrees, at LCG, to be taken between 10° and 30°,

τ trim angle during navigation, in degrees, to be taken not less than 4°,

V maximum service speed, in knots.

V_x actual craft speed, in knots.

If V_x x is replaced by the maximum service speed V of the craft, the previous formula yields the significant height of the limit sea state, H_{sl}. This formula may also be used to specify the permissible speed in a sea state characterised by a significant wave height equal to or greater than H_{sl}.

1.2.6 On the basis of the formula indicated in [1.2.5], the limit sea state may be defined (characterised by its significant wave height H_{sl}), i.e. the sea state in which the craft may operate at its maximum service speed. During its voyage, whenever the craft encounters waves having a significant height greater than H_{sl}, it has to reduce its speed.

1.2.7 The reduction of vertical acceleration $\mathbf{a}_{CG}$ induced by stabilisation system if any is to be disregarded for the purpose of limit operating conditions imposed by bottom impact loads.

2 Overall loads

2.1 General

2.1.1 The structural scantlings of this Rules are intended suitable for the hull longitudinal strength purposes for vessels with Length not more than 50 m if in steel, 45 m if in aluminium alloy, 40 m if in composite material (see also the HSC Rules, Ch 3 [C3.8]) and openings in the strength deck of limited width.

2.1.2 For vessel with length superior than the above mentioned one and/or openings having elevated width B of the hull and large for the most part of the 0,4 L amidships the longitudinal strength verification to execute, in general, next to the main section or other transversal sections in the central zone of the vessel as considered necessary by is required.
Tasneef

2.2 Overall loads verification

2.2.1 Where required the overall loads verification is to be executed considering only the values concerning the longitudinal bending and shearing strength moments in accordance with what provided in the HSC Rules[C3.4]

3 Local Loads

3.1 General

3.1.1 Design loads defined in this Article are to be used for the resistance checks to obtain scantlings of structural elements of hull and deckhouses.

Such loads may be integrated or modified on the basis of the results of model tests or full-scale scantlings. Model tests are to be carried out in irregular sea conditions with significant wave heights corresponding to the operating conditions of the craft. The scale effect is to be accounted for by an appropriate margin of safety.

The characteristic value to be assumed is defined as the average of the 1 per cent highest values obtained during testing. The length of the test is, as far as practicable, to be sufficient to guarantee that statistical results are stationary.

3.2 Loads

3.2.1 The following loads are to be considered in determining scantlings of hull structures:

- impact pressures due to slamming, if expected to occur,
- sea pressures due to hydrostatic heads and wave loads,
- internal loads.

External pressure generally determines scantlings of side and bottom structures; internal loads generally determine scantlings of deck structures.

Where internal loads are caused by concentrated masses of significant magnitude (e.g. tanks, machinery), the capacity of the side and bottom structures to withstand such loads is to be verified according to criteria stipulated by Tasneef. In such cases, the inertial effects due to acceleration of the craft are to be taken into account.

Such verification is to disregard the simultaneous presence of any external wave loads acting in the opposite direction to internal loads.

3.2.2 Load points

Pressure on panels and strength members may be considered uniform and equal to the pressure at the following load points:

- for panels:
  - lower edge of the plate, for pressure due to hydrostatic head and wave load
  - geometrical centre of the panel, for impact pressure
- for strength members:
  - centre of the area supported by the element.

3.3 Impact pressure on the bottom of hull

3.3.1 If slamming is expected to occur, the impact pressure, in kN/m^2, considered as acting on the bottom of hull is not less than:

$$p_{sl} = 70 \cdot \frac{\Delta}{S_r} \cdot K_1 \cdot K_2 \cdot K_3 \cdot a_{CG}$$

where:

Δ displacement, in tonnes

S_r reference area, m^2, equal to:

$$S_r = 0,7 \cdot \frac{\Delta}{T}$$

K_1 longitudinal bottom impact pressure distribution factor (see Figure 2), equal to:

for x/L < 0,5 :	$K_1 = 0,5 + x/L$
for 0,5 ≤ x/L ≤0,8 :	$K_1 = 1,0$
for x/L > 0,8:	$K_1 = 3,0 - 2,5 \cdot x/L$

where x is the distance, in m, from the aft perpendicular to the load point

K_2 factor accounting for impact area, equal to:

$$K_2 = 0,455 - 0,35 \cdot \frac{u^{0,75} - 1,7}{u^{0,75} + 1,7}$$

with:

- $K_2 \geq$ 0,50 for plating,
- $K_2 \geq$ 0,45 for stiffeners,
- $K_2 \geq$ 0,35 for girders and floors,

$u = 100\ s/S_r$

where s is the area, in m^2, supported by the element (plating, stiffener, floor or girder). For plating, the supported area is the spacing between the stiffeners multiplied by their span, without taking for the latter more than three times the spacing between the stiffeners

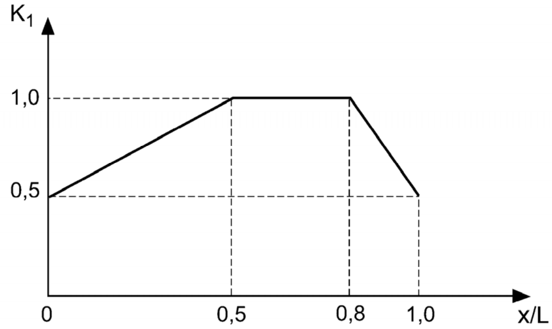
K_3 factor accounting for shape and deadrise of the hull, equal to:

$$K_3 = (70 - \alpha_d)/(70 - \alpha_{dCG})$$

where **α_{dCG}** is the deadrise angle, in degrees, measured at LCG and **α_d** is the deadrise angle, in degrees, between horizontal line and straight line joining the edges of respective area measured at the longitudinal position of the load point; values taken for ad and **α_{dCG}** are to be between 10° and 30°

a_{CG} design vertical acceleration at LCG, defined in [1.1.1].

Figure 2



4 Sea pressures

4.1 Sea pressure on bottom and side shell

4.1.1 The sea pressure, in kN/m^2, considered as acting on the bottom and side shell is not less than p_{smin}, defined in Table 3, nor less than:

for z ≤ T:

$$p_s = 10 \cdot \left(T + 0,75 \cdot S - \left(1 - 0,25 \cdot \frac{S}{T}\right) \cdot z\right)$$

for z > T:

$$p_s = 10 \cdot (T + S - z)$$

where:

z vertical distance, in m, from the moulded base line to load point. z is to be taken positively upwards,

S as given, in m, in Table 3 with C_B taken not greater than 0,5.

Table 3

	S	p_{smin}
$x/L \geq 0,9$	$T \leq 0,36 \cdot a_{CG} \cdot \frac{\sqrt{L}}{C_B} \leq 3,5 \cdot T$	$20 \leq \frac{L+75}{5} \leq 35$
$x/L \leq 0,5$	$T \leq 0,60 \cdot a_{CG} \cdot \sqrt{L} \leq 2,5 \cdot T$	$10 \leq \frac{L+75}{10} \leq 20$

Between midship area and fore end (0,5 < x/L < 0,9), p_s varies in a linear way as follows:

$$p_s = p_{sFP} - (2,25 - 2,5 \cdot x/L) \cdot (p_{sFP} - p_{sM}))$$

where p_{sFP} is the sea pressure at fore end and p_{sM} in midship area.

4.1.2 Stern doors and side shell doors

The sea pressures on stern doors and side shell doors is to be taken according to [4.4.1] for scantlings of plating and secondary members.

The design forces, in kN, considered for the scantlings of primary members are to be not less than:

- external force: $F_e = A \cdot p_s$
- internal force: $F_i = F_o + 10 \cdot W$

where:

A area, in m², of the door opening,

W mass of the door, in t,

F_p total packing force in kN. Packing line pressure is normally not to be taken less than 5 N/mm,

F_o the greater of F_c and $5 \cdot A$ (kN),

F_c accidental force, in kN, due to loose of cargo etc., to be uniformly distributed over the area A and not to be taken less than 300 kN. For small doors, such as bunker doors and pilot doors, the value of F_c may be appropriately reduced. However, the value of F_c may be taken as zero, provided an additional structure such as an inner ramp is fitted, which is capable of protecting the door from accidental forces due to loose cargoes,

p_s sea pressure as defined in [4.1.1].

The design forces, in kN, considered for the scantlings of securing or supporting devices of doors opening outwards are to be not less than:

- external force: $F_e = A \cdot p_s$
- internal force: $F_i = F_o + 10 \cdot W + F_p$

where the parameters are defined above.

The design forces, in kN, considered for the scantlings of securing or supporting devices of doors opening inwards are to be not less than:

- external force: $F_e = A \cdot p_s + F_p$
- internal force: $F_i = F_o + 10 \cdot W$

where the parameters are defined above.

4.2 Sea pressures on front walls of the hull

4.2.1 The pressure, kN/m², considered as acting on front walls of the hull (in case of stepped main deck), not located at the fore end, is not less than:

$$p_{sf} = 6 \cdot \left(1 + \frac{x_1}{2 \cdot L(C_B + 0,1)}\right)(1 + 0,045 \cdot L - 0,38 \cdot z_1)$$

where:

x_1 distance, in m, from front walls to the midship perpendicular (for front walls aft of the midship perpendicular, x_1 is equal to 0),

z_1 distance, in m, from load point to waterline at draught T.

Where front walls are inclined backwards, the pressure calculated above can be reduced to (p_{sF} sen α), where a is the angle in degree between front wall and deck.

$\mathbf{p_{sf}}$ is not less than the greater of:

$3 + (6,5 + 0,06 \cdot L) \cdot \text{sen } \alpha$

$3 + 2,4 \cdot a_{CG}$

For front walls located at the fore end, the pressure $\mathbf{p_{sf}}$ will be individually considered by Tasneef.

4.3 Sea pressures on deckhouses

4.3.1 The pressure, kN/m², considered as acting on walls of deckhouses is not less than:

$$p_{su} = K_{su} \cdot \left(1 + \frac{x_1}{2 \cdot L(C_B + 0,1)}\right)(1 + 0,045 \cdot L - 0,38 \cdot z_1)$$

where:

K_{su} coefficient equal to:

- 6,0, for front walls of a deckhouse located directly on the main deck not at the fore end:
- 5,0, for unprotected front walls of the second tier, not located at the fore end:
- 1,5 + 3,5 b/B (with $3 \leq K_{su} < 5$), ¥ for sides of deckhouses, b being the breadth, in m, of the considered deckhouse:
- 3, for the other walls:

x_1 distance, in m, from front walls or from wall elements to the midship perpendicular (for front walls or side walls aft of the midship perpendicular, x1 is equal to 0),

z_1 distance, in m, from load point to waterline at draught T.

The minimum values of $\mathbf{p_{su}}$, in kN/m^2, to be considered are:

- for the front wall of the lower tier:

  $p_{su} = 6{,}5 + 0{,}06 \cdot \mathbf{L}$

- for the sides and aft walls of the lower tier:

  $p_{su} = 4{,}0$

- for the other walls or sides:

  $p_{su} = 3{,}0$

For unprotected front walls located at the fore end, the pressure $\mathbf{p_{su}}$ will be individually considered by Tasneef.

4.4 Deck loads

4.4.1 General

The pressure $\mathbf{p_d}$, in kN/m^2, considered as acting on decks is given by the formula:

$p_d = p\,(1 + 0{,}4a_v)$

where:

p uniform pressure due to the load carried, kN/m2. Minimum values are given below

a_v design vertical acceleration, defined in [1.1]

Where decks are intended to carry masses of significant magnitude, including vehicles, the concentrated loads transmitted to structures are given by the corresponding static loads multiplied by (1+0,4 a_v).

4.4.2 Weather decks and exposed areas

For weather decks and exposed areas without deck cargo:

- if $z_d \leq 2$:

  $p = 6{,}0$ kN/m^2

- if $2 < z_d < 3$:

  $p = (12 - 3 \cdot z_d)$ kN/m^2

- if $z_d \geq 3$:

  $p = 3{,}0$ kN/m^2

where z_d is the vertical distance, in m, from deck to waterline at draught T.

p can be reduced by 20% for primary supporting members and pillars under decks located at least 4 m above the waterline at draught T, excluding embarkation areas.

For weather decks and exposed areas with deck cargo:

- if $z_d \leq 2$:

  $p = (p_c + 2)$ kN/m^2,

  with pc ≥ 4,0 kN/m2

- if $2 < z_d < 3$:

  $p = (p_c + 4 - z_d)$ kN/m^2,

  with $p_c \geq (8{,}0 - 2 \cdot z_d)$ kN/m^2

- if $z_d \geq 3$:

  $p = (p_c + 1)$ kN/m^2,

  with $p_c \geq 2{,}0$ kN/m^2

where:

z_d distance defined in [4.4.2],

p_c uniform pressure due to deck cargo load, in kN/m^2, to be defined by the designer with the limitations indicated above.

4.4.3 Sheltered decks

They are decks which are not subjected to the sea pressures. Crew can access such deck with care and taking account of the admissible load, which is to be clearly indicated.

Deckhouses protected by such decks may not have direct access to between-deck below.

For shelter decks:

$p = 1{,}3$ kN/m^2

A lower value may be accepted, at the discretion of Tasneef, provided that such a value as well as the way of access to the deck are clearly specified by and agreed upon with the Owner.

4.4.4 Enclosed accommodation decks

For enclosed accommodation decks not carrying goods:

$p = 3{,}0$ kN/m^2

p can be reduced by 20 per cent for primary supporting members and pillars under such decks.

For enclosed accommodation decks carrying goods:

$p = p_c$

l The value of p_c is to be defined by the designer, but taken as not less than 3,0 kN/m^2.

4.4.5 Enclosed cargo decks

For enclosed cargo decks other than decks carrying vehicles:

$p = p_c$

where p_c is to be defined by the designer, but taken as not less than 3,0 kN/m^2.

4.4.6 Platforms of machinery spaces

For platforms of machinery spaces:

$p = 15{,}0$ kN/m^2

4.5 Pressures on tank structures

4.5.1 The pressure, in kN/m^2, considered as acting on tank structures is not less than the greater of:

$$p_{t1} = 9,81 \cdot h_1 \cdot \rho \cdot (1 + 0,4 \cdot a_v) + 100 \cdot p_v$$

$$p_{t2} = 9,81 \cdot h_2$$

where:

h_1 distance, in m, from load point to tank top,

h_2 distance, in m, from load point to top of overflow or to a point located 1,5 m above the tank top, whichever is greater,

ρ liquid density, in t/m3 (1,0 t/m3 for water),

p_v setting pressure, in bars, of pressure relief valve, when fitted.

4.6 Pressures on subdivision bulkheads

4.6.1 The pressure, in kN/m^2, considered as acting on subdivision bulkheads is not less than:

$$p_{sb} = 9,81 \cdot h_3$$

where:

h_3 distance, in m, from load point to bulkhead top.

SECTION 3 PLATING AND STIFFENERS SCANTLING

1 General

Plating, hull, deck, bulkhead and superstructure stiffeners scantlings shall comply with formulae as shown below referring to relevant Tasneef Rules, using loads (pressures) calculated on Sec.2 of this Chapter.

1.1 Plating

1.1.1 General

The thicknesses of plating are to be not less than the minimum values given in Table 1.

Lesser thicknesses than the one given in Table 1 may be accepted provided that their adequacy in relation to strength against buckling and collapse is demonstrated to the satisfaction of Tasneef. Adequate provision is also to be made to limit corrosion.

Table 1

Element	Minimum thickness (mm)
Shell plating:	
• Bottom shell plating	$1,35 \cdot L^{1/3} \geq 2,5$
• Side shell plating and wet deck plating	$1,15 \cdot L^{1/3} \geq 2,5$
Deck plating	2,5
Bulkhead plating	2,5
Deckhouse side shell plating	2,5

The thickness of keel plating is to be not less than that required for adjacent bottom plating.

The thickness of bilge plating is not, in any case, to be less than that of the bottom and side adjacent, whichever is greater.

The thickness of plates connected to the stern frame, or in way of propeller shaft brackets, is to be at least 1,5 times the thickness of the adjacent plating.

Sea intakes and other openings are to be well rounded at the corners and located, as far as practicable, well clear of sharp edges.

Sea chests are to have scantlings as for watertight tank bulkheads , taking a design pressure p_t, in kN/m^2, equal to:

$$p_t = p_s + 0,5 \cdot p_{sl}$$

where p_s and p_{sl} are defined in Section 2.

The gunwale thickness is not be less than the side or stringer ones. Next to the deckhouses extremities the gunwale thickness is to be adequately increased.

In case of portholes, windings and other openings arranged in the gunwale course, thickness is to be increased as to compensate the openings itself.

1.1.2 Scantlings

Plating, hull, deck, bulkhead and superstructure stiffeners scantlings, for steel, aluminum alloy and composite material shall comply with relevant formulae as shown below referring to HSC Rules Ch 3 [C3.7.7] for steel, or aluminium alloy vessels and [C3.8] for e vessels in composite.

Non structural tanks plating assigned to diesel oil or lube oil, for vessels built in composite material, shall comply to Rules for non-steel ship Part B, Ch 1, Sec 3).

Plantings scantlings in composite material of RHIB (Rigid Hull Inflatable Boat) vessels are to be verified referring with The Rules for non-steel vessels Pt B, Ch 1, Sec 3, [7.2], while the inflating pipes are to be achieved in accordance with ISO 6185 standard.

1.2 Ordinary stiffeners

1.2.1 General

The thicknesses of web stiffeners are to be not less than the minimum values given in Tab.1 for plating

These formulae are valid for stiffeners whose web is perpendicular to the plating, or forms an angle to the plating of less than 15°.

In the case of stiffeners whose web forms an angle a > 15° to the perpendicular to the plating, the required modulus and shear area may be obtained from the same formulae, dividing the values of Z and A_t by cos (α).

The section modulus of ordinary stiffeners is to be calculated in association with an effective width of plating equal to the spacing of the stiffeners, without exceeding 20 per cent of the span.

For steel stiffeners, the web thickness is to be not less than:

- 1/18 of the depth, for flat bars,
- 1/50 of the depth, for other sections,

and the thickness of the face plate is to be not less than:

- 1/15 of its width.

For aluminium alloy stiffeners, the web thickness is to be not less than:

- 1/15 of the depth, for flat bars,

- 1/35 of the depth, for other sections,

and the thickness of the face plate is to be not less than:

- 1/20 of its width.

The ends of ordinary stiffeners are, in general, to be connected by means of rule brackets to effective supporting structures.

Ends without brackets are accepted at the penetrations of primary supporting members or bulkheads by continuous stiffeners, provided that there is sufficient effective welding section between the two elements. Where this condition does not occur, bars may be accepted instead of the brackets, at the discretion of Tasneef.

Both single and double bottoms are generally to be longitudinally framed. Bottom longitudinals are preferably continuous through the transverse elements.

Where they are interrupted at a transverse watertight bulkhead, continuous brackets are to be positioned through the bulkhead so as to connect the ends of longitudinals.

Where there are concentrated loads of significant magnitude, deck stiffeners are to be adequately strengthened

The ordinary stiffeners of decks or flats constituting the top or bottom of tanks are also to comply with the requirements of tank stiffeners. Hollow profiles are not allowed inside tanks assigned to flammable liquid.

Where longitudinals are interrupted in way of watertight bulkheads or reinforced transverse structures, the continuity of the structure is to be maintained by means of brackets penetrating the transverse element. Tasneef may allow double brackets welded to the transverse element, provided that special provision is made for the alignment of longitudinals, and full penetration welding is used.

Any front or side wall vertical stiffeners of first tier deckhouses are to be connected, by means of brackets at the ends, to strengthening structures for decks or adjacent sides.

Longitudinal stiffeners are to be fitted on the upper and lower edges of large openings in the plating. The openings for doors are, in general, to be stiffened all the way round.

Where there is no access from inside deckhouses to between-decks below, or where a deckhouse boundary wall is in a particularly sheltered location, reduced scantlings with respect to those stipulated above may be accepted, in the opinion of Tasneef.

1.3 Scantling

Plating, hull, deck, bulkhead and superstructure ordinary stiffeners scantlings, for steel, aluminium alloy and composite material shall comply with relevant formulae as shown below referring to HSC Rules Ch 3 [C3.7.8] for steel, or aluminium alloy vessels and [C3.8] for composite vessels.

Non structural tanks ordinary stiffeners, assigned to diesel oil or lube oil, for vessels built in composite material, shall comply to Rules for non-steel vessel Part B, Ch 1, Sec 3).

Ordinary reinforcements scantlings in composite material of RHIB (Rigid Hull Inflatable Boat) vessels are to be verified through the Rules for non-steel vessels Pt B, Ch 1, Sec 3, [7.2].

1.4 Primary supporting members

1.4.1 General

The primary supporting members (floors, frames, beams) are to form continuous transverse frames. In general, the stiffened frame spacing, in mm, is not to exceed:

$$1200 + 10 \cdot \mathbf{L} \text{ without being greater than 2 m.}$$

Primary supporting members with spacing other than that defined above may be required for specific parts of the hull (e.g. machinery space, under pillars), as stipulated in the provisions below.

The above formulae are applicable where reinforced structures are not of the grillage type. Otherwise, the scantlings of reinforced structures are to be stipulated by means of direct calculations performed on the basis of criteria agreed upon with Tasneef.

The section modulus of primary supporting members is to be calculated in association with an attached plating, according to criteria specified by Tasneef.

For steel stiffeners, the following geometric ratios are to be satisfied:

- the web thickness is to be not less than 1/80 of web depth,
- the face plate thickness is to be not less than 1/30 of face plate breadth (1/15 for face plates which are not symmetrical with respect to the web).

For aluminium stiffeners, the following geometric ratios are to be satisfied, where the compressive stress is not known:

- the web thickness is to be not less than 1/35 of web depth,
- the face plate thickness is to be not less than 1/20 of face plate breadth (1/10 for face plates which are not symmetrical with respect to the web).

Particular attention is to be paid to compressive buckling strength of associated plating of transverse primary members

In case of primary structure made of floating frames and extruded panels, the flexural contribution of the extruded plating may generally be disregarded.

Floors are to be positioned in way of side and deck transverses. Intermediate floors may also be fitted provided that they are adequately connected at the ends.

Manholes and other openings are not to be located at the ends of floor or girder spans, unless shear stress checks are carried out in such areas.

Floors are to be fitted in machinery spaces, generally at every frame, and additional stiffeners are to be provided at bottom in way of machinery and pillars.

A girder is, generally, to be fitted centreline for dry-docking. The height of such a girder is to be not less than that of floors amidships and its scantling according to HSC Ch 3 [C3.7.9]

In hulls with a longitudinally framed bottom and width B > 8 m, side girders are also to be positioned in such a way as to divide the floor span into approximately equal parts. In catamaran, B is to be taken as the width of a single-hull. The thickness of the web may be assumed to be equal to that of the centre girder less 1 mm, and the area of the face plate may be reduced to 60% of that of the centre girder. Where side girders are intended to support floors, a structural check of their scantlings is to be carried out as deemed necessary by Tasneef.

Reinforced elements in decks forming top or bottom of liquid tanks are to be verified also with the formulae concerning liquid tanks.

In the presence of concentrated loads of considerable importance (e.g. transmitted by props or other primary element), deck girders are to be adequately reinforced. In this case the deck's verification is to be in general executed adopting the static model of a girder with partial joints at the extremities (extremities coefficient equal to a 0,30). Admissible stresses indicated in the HSC Rules are to be considered. The girder's section is to be assumed constant along its whole length.

Calculations based on different static models may be accepted at Tasneef's discretion, on the basis of the structural typology adopted.

Where there is no access from inside deckhouses to between-decks below, or where a deckhouse boundary wall is in a particularly sheltered location, reduced scantlings with respect to those stipulated above may be accepted, in the opinion of Tasneef.

For exposed frontal bulkheads at the bow, pressure p_{su}, as to the admissible stresses, will be considered by Tasneef case by case basis.

1.4.2 Scantling

Reinforced girders, hull, deck, bulkhead and super structures scantlings, in steel or aluminium alloy or in composite material, are to be verified through the formulae relevant the material, given in the HSC Rules Ch 3 [C3.7.9] for vessels in steel or aluminium alloy and [C3.8] for vessels in composite material].

1.5 Pillars

1.5.1 Dimensional verifications concerning steel or aluminium alloy props, their arrangement and integration with decks are to be in accordance with the requirements given in the HSC Rules Ch 3 [C3.7.10].

Part B

Hull and Stability

Chapter 6
OTHER STRUCTURES

SECTION 1 MACHINERY SPACE

1 Application

1.1.1 The requirements of this Section apply for the arrangement and scantling of machinery space structures as regards general strength. It is no substitute to machinery manufacturer's requirements which have to be dealt with at Shipyard diligence.

1.2 Scantlings

1.2.1 General

Unless otherwise specified in this Section, the scantlings of plating, ordinary stiffeners and primary supporting members in the machinery space are to be determined according to the relevant criteria in Chapter 5.

1.2.2 Primary supporting members

The Designer may propose arrangements and scantlings alternative to the requirements of this Section, on the basis of direct calculations which are to be submitted to Tasneef for examination on a case by case basis. Tasneef may also require such direct calculations to be carried out whenever deemed necessary.

1.3 Connections of the machinery space with structures located aft and forward

1.3.1 Tapering

Adequate tapering is to be ensured between the scantlings in the machinery space and those aft and forward. The tapering is to be such that the scantling requirements for all areas are fulfilled.

1.3.2 Deck discontinuities

Decks which are interrupted in the machinery space are to be tapered on the side by means of horizontal brackets.

2 Double bottom

2.1 Arrangement

2.1.1 General

Where the machinery space is immediately forward of the after peak, the double bottom is to be transversely framed. In all other cases it may be transversely or longitudinally framed.

2.1.2 Double bottom height

The double bottom height at the centerline, irrespective of the location of the machinery space, is to be not less than 700 mm. This depth may need to be considerably increased in relation to the type and depth of main machinery settings.

The above height is to be increased by the Shipyard where the machinery space is very large and where there is a considerable variation in draught between light ballast and full load conditions.

Where the double bottom height in the machinery space differs from that in adjacent spaces, structural continuity of longitudinal members is to be ensured by sloping the inner bottom over an adequate longitudinal extent.

The knuckles in the sloped inner bottom are to be located in way of floors.

2.1.3 Center bottom girder

In general, the center bottom girder may not be provided with holes. In any case, in way of any openings for manholes on the center girder, permitted only where absolutely necessary for double bottom access and maintenance, local strengthening is to be arranged.

2.1.4 Side bottom girders

In the machinery space the number of side bottom girders is to be adequately increased, with respect to the adjacent areas, to ensure adequate rigidity of the structure.

The side bottom girders are to be a continuation of any bottom longitudinal in the areas adjacent to the machinery space and are generally to have a spacing not greater than 3 times that of longitudinal and in no case greater than 3 m.

2.1.5 Side bottom girders in way of machinery seatings

Additional side bottom girders are to be fitted in way of machinery seatings.

Side bottom girders arranged in way of main machinery seatings are to extend for the full length of the machinery space.

Where the machinery space is situated amidships, the bottom girders are to extend aft of the after bulkhead of such space for at least three frame spaces, and beyond to be connected to the hull structure by tapering.

Where the machinery space is situated aft, the bottom girders are to extend as far aft as practicable in relation to the shape of the bottom and to be supported by floors and side primary supporting members at the ends.

Forward of the machinery space forward bulkhead, the bottom girders are to be tapered for at least three frame spaces and are to be effectively connected to the hull structure.

2.1.6 Floors in longitudinally framed double bottom

Where the double bottom is longitudinally framed, the floor spacing is to be not greater than:

- 1 frame spacing in way of the main engine and thrust bearing
- 2 frame spacings in other areas of the machinery space.

Additional floors are to be fitted in way of other important machinery.

2.1.7 Floors in transversely framed double bottom

Where the double bottom in the machinery space is transversely framed, floors are to be arranged at every frame.

Furthermore, additional floors are to be fitted in way of boiler foundations or other important machinery.

2.1.8 Floors stiffeners

Floors are to have web stiffeners sniped at the ends and spaced not more than approximately 1 m apart.

2.1.9 Manholes and wells

The number and size of manholes in floors located in way of seatings and adjacent areas are to be kept to the minimum necessary for double bottom access and maintenance.

The depth of manholes is generally to be not greater than 40% of the floor local depth, and in no case greater than 750 mm, and their width is to be equal to approximately 400 mm.

In general, manhole edges are to be stiffened with flanges; failing this, the floor plate is to be adequately stiffened with flat bars at manhole sides.

Manholes with perforated portable plates are to be fitted in the inner bottom in the vicinity of wells arranged close to the aft bulkhead of the engine room.

Drainage of the tunnel is to be arranged through a well located at the aft end of the tunnel.

3 Single bottom

3.1 Arrangement

3.1.1 Bottom girder

For single bottom girder arrangement, the requirements of Ch 4, Sec 4, [4.1] and Ch 4, Sec 4, [4.4] for double bottom apply.

3.1.2 Floors in longitudinally framed single bottom

Where the single bottom is longitudinally framed, the floor spacing is to be not greater than:

- 1 frame spacing in way of the main engine and thrust bearing
- 2 frame spacings in other areas of the machinery spaces.

Additional floors are to be fitted in way of other important machinery.

3.1.3 Floors in transversely framed single bottom

Where the single bottom is transversely framed, the floors are to be arranged at every frame.

Furthermore, additional floors are to be fitted in way of boiler foundations or other important machinery.

3.1.4 Floor height

The height of floors in way of machinery spaces located amidships is to be not less than B/14,5. Where the top of the floors is recessed in way of main machinery, the height of the floors in way of this recess is generally to be not less than B/16. Lower values will be considered by Tasneef on a case by case basis.

Where the machinery space is situated aft or where there is considerable rise of floor, the depth of the floors wll be considered by Tasneef on a case by case basis.

3.1.5 Floor flanging

Floors are to be fitted with welded face plates in way of:

- engine bed plates
- thrust blocks
- auxiliary seatings.

4 Side

4.1 Arrangement

4.1.1 General

The type of side framing in machinery spaces is generally to be the same as that adopted in the adjacent areas.

4.1.2 Extension of the hull longitudinal structure within the machinery space

In vessels where the machinery space is located aft and where the side is longitudinally framed, the longitudinal structure is preferably to extend for the full length of the machinery space.

In any event, the longitudinal structure is to be maintained for at least 0,3 times the length of the machinery space, calculated from the forward bulkhead of the latter, and abrupt structural discontinuities between longitudinally and transversely framed structures are to be avoided.

4.1.3 Side transverses

Side transverses are to be aligned with floors. One is preferably to be located in way of the forward end and another in way of the after end of the machinery casing.

For a longitudinally framed side, the side transverse spacing is to be not greater than 4 frame spacings.

For a transversely framed side, the side transverse spacing is to be not greater than 5 frame spaces. The web height is to be not less than twice that of adjacent frames and the section modulus is to be not less than four times that of adjacent frames.

Side transverse spacing greater than that above may be accepted provided that the scantlings of ordinary frames are increased, according to Tasneef's requirements to be defined on a case by case basis.

5 Platforms

5.1 Arrangement

5.1.1 General

The location and extension of platforms in machinery spaces are to be arranged so as to be a continuation of the structure of side longitudinals, as well as of platforms and side girders located in the adjacent hull areas.

5.1.2 Platform transverses

In general, platform transverses are to be arranged in way of side or longitudinal bulkhead transverses.

For longitudinally framed platforms, the spacing of platform transverses is to be not greater than 4 frame spacings.

5.2 Minimum thicknesses

5.2.1 The thickness of platforms is to be not less than that obtained, in mm, from the following formula:

$$t = (0{,}018 \cdot L + 4{,}5) K^{1/2}$$

6 Pillaring

6.1 Arrangement

6.1.1 General

The pillaring arrangement in machinery spaces is to account both for the concentrated loads transmitted by machinery and superstructures and for the position of main machinery and auxiliary engines.

6.1.2 Pillars

Pillars are generally to be arranged in the following positions:

- in way of machinery casing corners and corners of large openings on platforms; alternatively, two pillars may be fitted on the centerline (one at each end of the opening)
- in way of the intersection of platform transverses and girders
- in way of transverse and longitudinal bulkheads of the superstructure.

In general, pillars are to be fitted with brackets at their ends.

6.1.3 Pillar bulkheads

In general, pillar bulkheads, fitted tweendecks below the upper deck, are to be located in way of load-bearing bulkheads in the superstructures.

Longitudinal pillar bulkheads are to be a continuation of main longitudinal hull structures in the adjacent spaces forward and aft of the machinery space.

Pillar bulkhead scantlings are to be not less than those required in [7.3] for machinery casing bulkheads.

7 Machinery casing

7.1 Arrangement

7.1.1 Ordinary stiffener spacing

Ordinary stiffeners are to be located:

- at each frame, in longitudinal bulkheads
- at a distance of about 750 mm, in transverse bulkheads.

The ordinary stiffener spacing in portions of casings which are particularly exposed to wave action is considered by Tasneef on a case by case basis.

7.2 Openings

7.2.1 General

All machinery space openings, which are to comply with the requirements in Sec 3, [6.1.2], are to be enclosed in a steel casing leading to the highest open deck. Casings are to be reinforced at the ends by deck beams and girders associated to pillars.

In the case of large openings, the arrangement of cross-ties as a continuation of deck beams may be required.

Skylights, where fitted with openings for light and air, are to have coamings of a height not less than:

900 mm, if in position 1

760 mm, if in position 2.

7.2.2 Access doors

Access doors to casings are to comply with Sec 3, [6.1.2].

7.3 Scantlings

7.3.1 Plating and ordinary stiffeners

The net scantlings of plating and ordinary stiffeners are to be not less than those obtained according to the applicable requirements in Ch 5, Sec 3.

8 Main machinery seatings

8.1 Arrangement

8.1.1 General

The scantlings of main machinery seatings and thrust bearings are to be adequate in relation to the weight and power of engines and the static and dynamic forces transmitted by the propulsive installation.

8.1.2 Seating supporting structure

Transverse and longitudinal members supporting the seatings are to be located in line with floors and double or single bottom girders, respectively.

They are to be so arranged as to avoid discontinuity and ensure sufficient accessibility for welding of joints and for surveys and maintenance.

8.1.3 Seatings included in the double bottom structure

Girders supporting the bedplates in way of seatings are to be aligned with double bottom girders and are to be extended aft in order to form girders for thrust blocks.

The girders in way of seatings are to be continuous from the bedplates to the bottom shell.

8.1.4 Seatings above the double bottom plating

Where the seatings are situated above the double bottom plating, the girders in way of seatings are to be fitted with flanged brackets, generally located at each frame and extending towards both the centre of the vessel and the sides.

The extension of the seatings above the double bottom plating is to be limited as far as practicable while ensuring adequate spaces for the fitting of bedplate bolts. Bolt holes are to be located such that they do not interfere with seating structures.

8.1.5 Seatings in a single bottom structure

For vessels having a single bottom structure within the machinery space, seatings are to be located above the floors and to be adequately connected to the latter and to the girders located below.

8.2 Minimum scantlings

As a guidance, the net scantlings of the structural elements in way of the internal combustion engine seatings may be obtained from the formulae in TASNEEFMIL - Part B, Ch 8, Sec 3.

SECTION 2 SUPERSTRUCTURES AND DECKHOUSES

1 Connections of superstructures and deckhouses with the hull structure

1.1.1 Superstructure and deckhouse frames are to be fitted as far as practicable as extensions of those underlying and are to be effectively connected to both the latter and the deck beams above.

Ends of superstructures and deckhouses are to be efficiently supported by bulkheads, diaphragms, webs or pillars.

Where hatchways are fitted close to the ends of superstructures, additional strengthening may be required.

1.1.2 Connection to the deck of corners of superstructures and deckhouses is considered by Tasneef on a case by case basis. Where necessary, doublers or reinforced welding may be required.

1.1.3 As a rule, the frames of sides of superstructures and deckhouses are to have the same spacing as the beams of the supporting deck.

1.1.4 The side plating at ends of superstructures is to be tapered into the bulwark or sheerstrake of the strength deck.

Where a raised deck is fitted, this arrangement is to extend over at least 3 frame spacings.

2 Structural arrangement of superstructures and deckhouses

2.1 Strengthening in way of superstructures and deckhouses

2.1.1 Web frames, transverse partial bulkheads or other equivalent strengthening are to be fitted inside deckhouses of at least 0,5B in breadth extending more than 0,15L in length within 0,4L amidships. These transverse strengthening reinforcements are to be spaced approximately 9 m apart and are to be arranged, where practicable, in line with the transverse bulkheads below.

Web frames are also to be arranged in way of large openings, boats davits and other areas subjected to point loads.

Web frames, pillars, partial bulkheads and similar strengthening are to be arranged, in conjunction with deck transverses, at ends of superstructures and deckhouses.

2.2 Access and doors

Access openings cut in sides of enclosed superstructures are to be fitted with doors made of steel or other equivalent material, and permanently attached.

Special consideration is to be given to the connection of doors to the surrounding structure.

Securing devices which ensure watertightness are to include tight gaskets, clamping dogs or other similar appliances, and are to be permanently attached to the bulkheads and doors. These doors are to be operable from both sides.

Doors are to open outwards, to provide additional security against the impact of the sea, unless otherwise permitted by RINA.

Doors are to be provided with coming high not less than 380 mm, if settled on the bulkhead deck and 100 mm if settled on decks over bulkhead deck.

Where the door is the access to a watertight room without any openings for the rooms below, the coaming height shall be reduced to the omission if considered necessary for the efficacy of the room itself.

For vessels with Length **L**≤ 30 m, the co aming height shall be reduced in Tasneef's opinion.

2.3 Strengthening of deckhouses in way of lifeboats and rescue boats

2.3.1 Sides of deckhouses are to be strengthened in way of lifeboats and rescue boats and the top plating is to be reinforced in way of their lifting appliances.

2.4 Constructional details

2.4.1 Lower tier stiffeners are to be welded to the decks at their ends.

Brackets are to be fitted at the upper and preferably also the lower ends of vertical stiffeners of exposed front bulkheads of engine casings and superstructures or deckhouses protecting pump room openings.

3 Scantlings

3.1.1 Plantings, frontal, side and astern bulkheads and decks strengthening scantlings are to be verified through the formulae indicated in the HSC Rules in Ch 3 using load index listed in Ch 5 Sec 2 of Pt B of this Rules.

SECTION 3 ARRANGEMENTS OF HULL AND SUPERSTRUCTURE OPENINGS

1 General

1.1 Application

1.1.1 The requirements of this Section apply to the arrangement of hull and superstructure openings.

1.2 Definitions

1.2.1 Exposed zones

Exposed zones are the boundaries of superstructures or deckhouses set in from the vessel's side at a distance less than or equal to 0,04 B.

1.2.2 Unexposed zones

Unexposed zones are the boundaries of deckhouses set in from the vessel's side at a distance greater than 0,04 B.

2 External openings

2.1 General

2.1.1 All external openings leading to compartments assumed intact in the damage analysis, which are below the final damage waterline, are required to be watertight.

2.1.2 External openings required to be watertight in accordance with [2.1.1] are to be of sufficient strength and, except for cargo hatch covers, are to be fitted with indicators on the bridge.

3 Sidescuttles, windows and skylights

3.1 General

3.1.1 Application

The requirements in [3.1] to [3.4] apply to sidescuttles and rectangular windows providing light and air, located in positions which are exposed to the action of sea and/or bad weather.

3.1.2 Sidescuttle definition

Sidescuttles are round or oval openings with an area not exceeding 0,16 m^2. Round or oval openings having areas exceeding 0,16 m^2 are to be treated as windows.

3.1.3 Window definition

Windows are rectangular openings generally, having a radius at each corner relative to the window size in accordance with recognized national or international standards, and round or oval openings with an area exceeding 0,16 m^2.

3.1.4 Number of openings in the shell plating

The number of openings in the shell plating are to be reduced to the minimum compatible with the design and proper working of the vessel.

3.1.5 Material and scantlings

Sidescuttles and windows together with their glasses, deadlights and storm covers, if fitted, are to be of approved design and substantial construction in accordance with, or equivalent to, recognized national or international standards.

Non-metallic frames are not acceptable. The use of ordinary cast iron is prohibited for sidescuttles below the freeboard deck.

For vessels with length L < 15 m, Tasneef may contemplate to fit glued glass on the basis of practical tests carried out on simulacrum according to ISO-12216 standard.

3.1.6 Means of closing and opening

The arrangement and efficiency of the means for closing any opening in the shell plating are to be consistent with its intended purpose and the position in which it is fitted is to be generally to the satisfaction of Tasneef.

3.1.7 Non-opening type sidescuttles

Sidescuttles are to be of the non-opening type where they become immersed by any intermediate stage of flooding or the final equilibrium waterplane in any required damage case for vessels subject to damage stability regulations

3.1.8 Skylights

Fixed or opening skylights are to have glass thickness appropriate to their size and position as required for sidescuttles and windows. Skylight glasses in any position are to be protected from mechanical damage and, where fitted in every positions, to be provided with permanently attached robust deadlights or storm covers.

3.2 Glasses

3.2.1 General

In general, toughened glasses with frames of special type are to be used in compliance with, or equivalent to, recognised national or international standards.

The use of clear plate glasses is considered by Tasneef on a case by case basis.

3.2.2 Thickness of toughened glasses in sidescuttles

The thickness of toughened glasses in sidescuttles is to be not less than that obtained, in mm, from Tab 1.

Type A, B or C sidescuttles are to be adopted according to the requirements of Tab 2, where:

- Zone 1 is the zone comprised between a line, parallel to the sheer profile, with its lowest points at a distance above the summer load waterline equal to 0,025B m, or 0,5 m, whichever is the greater, and a line parallel to the previous one and located 1,4 m above it
- Zone 2 is the zone located above Zone A and bounded at the top by the freeboard deck
- Zone 3 is the first tier of superstructures or deckhouses
- Zone 4 is the second tier of deckhouses
- Zone 5 is the third and higher tiers of deckhouses.

Table 1 : Thickness of toughened glasses in sidescuttles

Clear light	Thickness, in mm		
	Type A Heavy series	Type B Medium series	Type C Light series
200	10	8	6
250	12	8	6
300	15	10	8
350	15	12	8
400	19	12	10
450	Not applicable	15	10

Table 2 : Types of sidescuttles

<table>
<tr><th>Zone</th><th colspan="2">Aft of 0,875 L from the aft end</th><th>Fwd of 0,875 L from the aft end</th></tr>
<tr><td>5</td><td colspan="2">Type C</td><td>Type B</td></tr>
<tr><td rowspan="2">4</td><td colspan="2">Protecting openings giving direct access to spaces below the freeboard deck: Type B</td><td rowspan="2">Type B</td></tr>
<tr><td colspan="2">Not protecting openings giving direct access to spaces below the freeboard deck: Type C</td></tr>
<tr><td rowspan="3">3</td><td colspan="2">Exposed zones: Type B</td><td rowspan="3">Type B</td></tr>
<tr><td rowspan="2">Unexposed zones</td><td>Protecting openings giving direct access to spaces below the freeboard deck: Type B</td></tr>
<tr><td>Not protecting openings giving direct access to spaces below the freeboard deck: Type C</td></tr>
<tr><td>2</td><td colspan="2">Type B</td><td>Type A</td></tr>
<tr><td>1</td><td colspan="2">Type A</td><td>Type A</td></tr>
</table>

3.2.3 Tempered glass thickness for rectangular windows

Tempered glass thickness for rectangular windows is given by the following formula:

$$\mathbf{t} = 0{,}005\ (\beta\ \mathbf{p})^{0{,}5}$$

where:

p design pressure in kN/m^2 for superstructure side with a window

b window's lower side, in mm

β $= 0{,}54\ \mathbf{A} - 0{,}078\ \mathbf{A}^2 - 0{,}17$

$= 0{,}75$ per $\mathbf{A} > 3$

where:

A = a/b

a = window's grater side in mm.

3.2.4 Non-hardened crystal material

Non-hardened crystal material shall be used for windows and portholes arranged on superstructures' walls except for the steerage windows.

Plates thicknesses shall be obtained multiplying the regulation hardened crystal thickness by 1,3 in case of polycarbonate plates and by 1,5 for acrylic plates.

In alternative thickness shall be determined by an hydraulic pressing test on simulacrum, showing that the provided thickness is capable to assure the watertight at a pressure not less than four times the calculation pressure.

4 Discharges

4.1 Arrangement of discharges

4.1.1 Inlets and discharges

All inlets and discharges in the shell plating are to be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the vessel.

Normally every single discharge shall present an automatic non-return valve, with an active closing system over the bulkhead deck. Where the inboard end of the garbage chute exceeds 0,01 L above the summer load waterline, valve control from the freeboard deck is not required, provided the inboard gate valve is always accessible under service conditions. Where this vertical distance is more than 02 L, only one automatic non-return valve without the active closing system may be accepted. Means for the active manoeuvre of valves are to be easily accessible and provided with a device indicating the valve open or shut.

5 Freeing ports

5.1 General provisions

5.1.1 General

Where bulwarks on the weather portions of freeboard or superstructure decks form wells, ample provision is to be made for rapidly freeing the decks of water and for draining them.

A well is any area on the deck exposed to the weather, where water may be entrapped. Wells are considered to be deck areas bounded on four sides by deck structures; however, depending on their configuration, deck areas bounded on three or even two sides by deck structures may be deemed wells.

5.1.2 Freeing port areas

The overall section **A**, in m^2, of openings required for every side is not to be less than the one indicated in Tab 3 where **a** is the bulwark length, which is to assume not more than 0,7 **L**.

Table 3

Position	a ≤20 m	a> 20 m
Bulkhead deck	**0,7 + 0,035 a**	**0,07 a**
Superstructure deck	**0,35 + 0,0175 a**	**0.035 a**

For bulwarks higher than 1,2 m, the values indicated in Tab 3 are to be increased of 004 m^2 for each length meter and for every 0,1 m of greater height as regards 1,2 m. A similar reduction shall be apply for bulwarks high less than 0,90 m.

5.1.3 Freeing port arrangement

Where a sheer is provided, two thirds of the freeing port area required is to be provided in the half of the well nearer the lowest point of the sheer curve.

One third of the freeing port area required is to be evenly spread along the remaining length of the well.

Where the exposed freeboard deck or an exposed superstructure deck has little or no sheer, the freeing port area is to be evenly spread along the length of the well.

However, bulwarks may not have substantial openings or accesses near the breaks of superstructures, unless they are effectively detached from the superstructure sides.

5.1.4 Freeing port positioning

The lower edge of freeing ports is to be as near the deck as practicable, at not more than 100 mm above the deck.

All the openings in the bulwark are to be protected by rails or bars spaced approximately 230 mm apart.

5.1.5 Discharge from cockpits in vessels with Length L < 15 m

The possible cockpit is to be watertight and self empting, the bottom is to be settled at a full load waterline height such to assure the self empting of the cockpit itself with the full load waterline vessel.

Cockpit is to be provided with scuppers having an overall surface in accordance with ISO DIS 11812 standard for Design Category A.

Possible openings for rooms under the cockpit are to be provided with strong closings, arranged in permanent way, watertight to bad weather and presenting a coaming not less than a 100 mm.

6 Machinery space openings

6.1.1 Engine room skylights are to be properly framed, securely attached to the deck and efficiently enclosed by steel casings of suitable strength. Where the casings are not protected by other structures, their strength will be considered by Tasneef on a case by case basis.

6.1.2 Height of coamings and thresholds are to be in general not less than 380 mm, for the admissions to rooms watertight to bad weather over the bulkhead deck, and 100 mm, if arranged on decks over the bulkhead deck. For vessels with Length less or equal to 30 m, such heights shall be reduced till a value compatible with the vessel's safety, in Tasneef's opinion.

6.1.3 Fiddly openings are to be fitted with strong covers of steel or other equivalent material permanently attached in their proper positions and capable of being secured weathertight.

6.1.4 Admissions to companions are to comply in general with the requirements given in Sec 2 [2.2] of the present Chapter.

6.1.5 Fiddly openings in machinery space are to satisfy the requirements given in [7].

7 Ventilation pumps

7.1.1 Wind scoops in rooms under bulkheads and closed superstructures decks are to be provided with strong coamings efficaciously connected to the deck. The coamings height shall be in general not less than 100 mm, for wind scoops in rooms watertight to bad weather over the bulkhead deck and less than 380 mm, elsewhere.

For vessels with Length less or equal to 30 m, height shall be reduced till a minimum value compatible with the vessel's safety.

7.1.2 Wind scoops with coamings bigger than 1 m on the deck, or arranged on decks over the bulkhead deck, are not required to be provided with closings, except where trimmed before or that such closings are specifically required by the Administration.

7.1.3 Except for what provided in 7.1.2, fiddly openings are to be provided of efficient closings watertight to bad weather.

7.1.4 Wind scoops openings, where possible shall be overlooked astern or towards the vessels sides.

SECTION 4 HELICOPTER DECKS

1 Application

1.1 General

1.1.1 The design of areas used for landing or take-off, located above deck or platform connected to the vessel, are to comply, in scantling and arrangements, to TASNEEFMIL Part B, Ch 8, Sec 10.

Part B

Hull and Stability

Chapter 7
HULL OUTFITTING

SECTION 1 RUDDERS

1 General

1.1 Symbols

V_{AV} : :maximum ahead service speed, in knots, with the vessel on summer load waterline

V_{AD} : : maximum astern speed, in knots, to be taken not less than 0,5 V_{AV}

A : total area of the rudder blade, in m^2, bounded by the blade external contour, including the mainpiece and the part forward of the centreline of the rudder pintles,

k_1 : material factor, defined in [1.4.3]

k : material factor, defined in Ch. 4, Sec 1, [2.3.1]

C_R : rudder force, in N, acting on the rudder blade, defined in [2.2]

M_{TR} : rudder torque, in N·m, acting on the rudder blade, defined in [2.1.3]

M_B : :bending moment, in N·m, in the rudder stock, defined in [4.1].

1.2 Application

1.2.1 Spade rudders

In general rudders treated in this section and arranged in the vessels considered in this Rules are spade rudders type. Different rudders are to be measured in accordance with the provisions of TASNEEFMIL - Pt B, Ch 9, Sec 1.

1.2.2 Ordinary profile rudders

The requirements of this Section apply to ordinary profile rudders, without any special arrangement for increasing the rudder force, whose maximum orientation at maximum vessel speed is limited to 35° on each side.

In general, an orientation greater than 35° is accepted for manoeuvres or navigation at very low speed.

1.2.3 High lift profiles

The requirements of this Section also apply to rudders fitted with flaps to increase rudder efficiency. For these rudder types, an orientation at maximum speed less than 35° may be accepted. In these cases, the rudder forces are to be calculated by the Designer for the most severe combinations between orientation angle and vessel speed. These calculations are to be considered by Tasneef on a case-by-case basis.

The rudder scantlings are to be designed so as to be able to sustain possible failures of the orientation control system, or, alternatively, redundancy of the system itself may be required.

1.2.4 Special rudder types

Rudders others than those in this section or in TASNEEFMIL will be considered by Tasneef on a direct calculation basis.

In general the stock and blade equivalent stress shall result not more than 120/$\mathbf{k_1}$ N/mm^2

1.3 Arrangements

1.3.1 Effective means are to be provided for supporting the weight of the rudder without excessive bearing pressure, e.g. by means of a rudder carrier attached to the upper part of the rudder stock. The hull structure in way of the rudder carrier is to be suitably strengthened.

1.3.2 Suitable arrangements are to be provided to prevent the rudder from lifting.

1.3.3 In addition, structural rudder stops of suitable strength are to be provided, except where the steering gear is provided with its own rudder stopping devices, as detailed in Pt C, Ch 1, Sec 10.

1.3.4 In rudder trunks which are open to the sea, a seal or stuffing box is to be fitted above the deepest load waterline, to prevent water from entering the steering gear compartment and the lubricant from being washed away from the rudder carrier. If the top of the rudder trunk is below the deepest waterline two separate stuffing boxes are to be provided.

1.4 Materials

1.4.1 Rudder stocks, pintles, coupling bolts, keys and cast parts of rudders are to be made of rolled steel, steel forgings or steel castings according to the applicable requirements in TASNEEFMIL Pt D, Ch 2. Composite rudder parts are not allowed.

1.4.2 The material used for rudder stocks, pintles, keys and bolts is to have a minimum yield stress not less than 200 N/mm^2.

1.4.3 The requirements relevant to the determination of scantlings contained in this Section apply to steels having a minimum yield stress equal to 235 N/mm^2.

Where the material used for rudder stocks, pintles, coupling bolts, keys and cast parts of rudders has a yield stress different from 235 N/mm^2, the scantlings calculated with the formulae contained in the requirements of this Section are to be modified, as indicated, depending on the material factor $\mathbf{k_1}$, to be obtained from the following formula:

$$\mathbf{k}_1 = (235/\mathbf{R}_{eH})^n$$

where:

$\mathbf{R_{eH}}$: yield stress, in N/mm2, of the steel used, and not exceeding the lower of 0,7 $\mathbf{R}_m$

$\mathbf{R_m}$: : minimum ultimate tensile strength, in N/mm^2, of the steel used,

n : :coefficient to be taken equal to:

n = 0,75 for $\mathbf{R_{eH}}$ > 235 N/mm^2

n = 1,00 for $\mathbf{R_{eH}}$ $\leq$. 235 N/mm^2.

1.4.4 Significant reductions in rudder stock diameter due to the application of steels with yield stresses greater than 235 N/mm^2 may be accepted by Tasneef subject to the results of a check calculation of the rudder stock deformations.

1.4.5 Large rudder stock deformations are to be avoided in order to avoid excessive edge pressures in way of bearings.

1.4.6 Welded parts of rudders are to be made of approved rolled hull materials.

For these members, the material factor k defined in Ch 4, Sec 1, [2.3.1] is to be used.

2 Force and torque acting on the rudder

2.1 Rudder blade description

A rudder blade without cut-outs may have trapezoidal or rectangular contour.

2.2 Rudder force

The rudder force $\mathbf{C_R}$ is to be obtained, in N, from the following formula:

$$\mathbf{C_R} = 132\ \mathbf{A}\ \mathbf{V}^2\ \mathbf{r_1}\ \mathbf{r_2}\ \mathbf{r_3}$$

where:

V : $\mathbf{V_{AV}}$, o $\mathbf{V_{AD}}$, depending on the condition under consideration (for high lift profiles see [1.1.3])

$\mathbf{r_1}$: shape factor, to be taken equal to:

$\mathbf{r_1} = (\lambda + 2)/3$

with $\lambda = \mathbf{h}^2/\mathbf{A_T}$ and not greater than 2,

h : mean height, in m, of the rudder area to be taken equal to (see Fig 1):

where ; $\mathbf{h} = (z_3 + z_4 - z_2)/2$

$\mathbf{A}_T$: area, in m^2, of rudder blade

$\mathbf{r}_2$: coefficient to be obtained from Tab 1

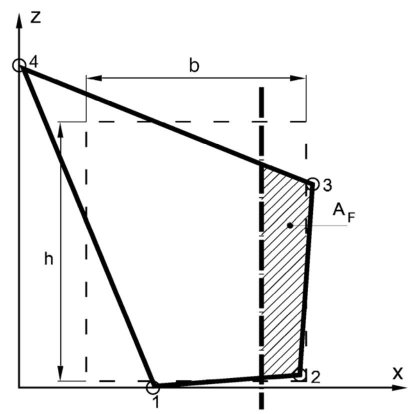
$\mathbf{r}_3$: coefficient to be taken equal to:

$\mathbf{r}_3$ = 0,8 for rudders outside the propeller jet (centre rudders on twin screw vessels, or similar cases),

$\mathbf{r}_3$ = 1,15 for rudders behind a fixed propeller nozzle,

$\mathbf{r}_3$ = 1,0 in other cases

Figure 1 : Geometry of rudder blade without cut-outs



2.3 Rudder torque

The rudder torque , for both ahead and astern conditions, is to be obtained, in N·m, from the following formula:

$$\mathbf{M}_{TR} = \mathbf{C}_R\ r$$

where:

r : lever of the force $\mathbf{C}_R$, in m, equal to:

$\mathbf{r} = b[\alpha - (\mathbf{A}_T/\mathbf{A})]$ and to be taken not less than 0,1 b for the ahead condition,

b : mean breadth, in m, of rudder area to be taken equal to (see Fig 1):

$\mathbf{b} = (x_2 + x_3 - x_1)/2$

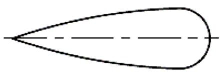
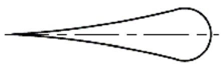
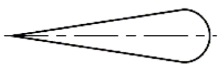
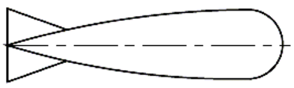
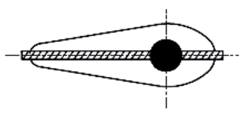
α : coefficient to be taken equal to:

α = 0,33 for ahead condition

α = 0.66 for astern condition

$\mathbf{A}_F$: area, in m^2, of the rudder blade portion afore the centerline of rudder stock (see Fig 1)

Table 1: Values of coefficient r_2

Rudder profile type	r_2 for ahead condi-tion	r_2 for astern condi-tion
NACA 00 - Goettingen 	1,10	0,80
Hollow 	1,35	0,90
Flat side 	1,10	0,90
High lift 	1,70	1,30
Fish tail 	1,40	0,80
Single plate 	1,00	1,00

3 Loads acting on the rudder structure

3.1 General

3.1.1 Loads

The force and torque acting on the rudder, defined in [2], induce in the rudder structure the following loads:

- bending moment and torque in the rudder stock,
- support forces,
- bending moment, shear force and torque in the rudder body,
- bending moment, shear force and torque in rudder horns and solepieces.

3.1.2 Direct load calculations

The bending moment in the rudder stock, the support forces, and the bending moment and shear force in the rudder body are to be determined through direct calculations to be performed in accordance to the static schemes and the load conditions specified in TASNEEFMIL Pt B ,Ch 9,Sec 1, App 1.

For rudders with solepiece or rudder horns these structures are to be included in the calculation model in order to account for the elastic support of the rudder body.

The other loads (i.e. the torque in the rudder stock and in the rudder body and the loads in rudder horns and solepieces) are to be calculated as indicated in the relevant requirements of this Section.

3.1.3 Simplified methods for load calculation

For ordinary rudder types, the bending moment in the rudder stock, the support forces, and the bending moment and shear force in the rudder body may be determined through approximate methods specified in the relevant requirements of this Section.

The other loads (i.e. the torque in the rudder stock and in the rudder body and the loads in rudder horns and solepieces) are to be calculated as indicated in the relevant requirements of this Section.

4 Rudder stock scantlings

4.1 Bending moment

4.1.1 The bending moment M_B in the rudder stock is to be obtained as follows:

$M_B = 0{,}866\ (H \cdot C_R) / A$

where H, in m^3, is given by:

$H = A \cdot (H_C + h/2)$

where:

A : rudder area, in m^2

H_C : distance, in m, from the junction between rudder stock and blade to the lower face of the rudder stock bearing;

h : defined in [2.2].

4.2 Scantlings

4.2.1 Rudder stock subjected to torque only

For rudder stocks subjected to torque only.

It is to be checked that the torsional shear stress τ, in N/mm^2, induced by the torque $\mathbf{M}_{TR}$ is in compliance with the following formula:

$$\tau . \leq \tau_{ALL}$$

where:

τ_{ALL} : : allowable torsional shear stress, in N/mm^2 not grater than $68/k_1$

For this purpose, the rudder stock diameter is to be not less than the value obtained, in mm, from the following formula:

$$d_T = 4{,}2\ (M_{TR} \cdot k_1)^{1/3}$$

4.2.2 Rudder stock subjected to combined torque and bending

For rudder stocks subjected to combined torque and bending , it is to be checked that the equivalent stress σ_E induced by the bending moment M_B and the torque M_{TR} is in compliance with the following formula:

$$\sigma_E \leq \sigma_{E,ALL}$$

where:

σ_E : equivalent stress to be obtained, in N/mm^2, from the following formula,:

$$\sigma_E = \sqrt{\sigma_B^2 + 3\tau_T^2}$$

σ_B : bending stress to be obtained, in N/mm^2, from the following formula:

$$\sigma_B = 10^3 \frac{10{,}2 M_B}{d_{TF}^3}$$

τ_T : torsional stress to be obtained, in N/mm^2, from the following formula:

$$\tau_T = 10^3 \frac{5{,}1 M_{TR}}{d_{TF}^3}$$

For this purpose the rudder stock diameter shall be not less than the value d_{TF} obtained with the following formulae:

$$d_{TF} = 4,2(M_{TR}k_1)^{1/3}\left(1 + \frac{4}{3}\left(\frac{M_B}{M_{TR}}\right)^2\right)^{1/6}$$

In general, the diameter of a rudder stock subjected to torque and bending may be gradually tapered above the upper stock bearing so as to reach the value of d_T in way of the quadrant or tiller.

5 Rudder stock couplings

5.1 Horizontal flange couplings

5.1.1 General

I In general, the coupling flange and the rudder stock are to be forged from a solid piece. A shoulder radius as large as practicable is to be provided for between the rudder stock and the coupling flange. This radius is to be not less than 0,13 d_1, where d_1 is the greater of the rudder stock diameters d_T and d_{TF}, in mm, to be calculated in compliance with the requirements in [4.2.1] and [4.2.2], respectively.

Where the rudder stock diameter does not exceed 350 mm, the coupling flange may be welded onto the stock provided that its thickness is increased by 10%, and that the weld extends through the full thickness of the coupling flange and that the assembly obtained is subjected to heat treatment. This heat treatment is not required if the diameter of the rudder stock is less than 75 mm.

Where the coupling flange is welded, the grade of the steel used is to be of weldable quality, particularly with a carbon content not greater than 0,25% and the welding conditions (preparation before welding, choice of electrodes, pre and post heating, inspection after welding) are to be defined to the satisfaction of Tasneef. The throat weld at the top of the flange is to be concave shaped to give a fillet shoulder radius as large as practicable. This radius is to be not less than 0,13 d_1, where d_1 is defined above.

5.1.2 Bolts

Horizontal flange couplings are to be connected by fitted bolts having a diameter not less than the value obtained, in mm, from the following formula:

$$d_B = 0{,}62 \sqrt{\frac{d_1^3 k_{1B}}{n_B e_M k_{1S}}}$$

where:

d_1 : rudder stock diameter, in mm, defined in [5.1.1],

k_{1S} : material factor k_1 for the steel used for the rudder stock,

k_{1B} : material factor k_1 for the steel used for the bolts,

e_M : mean distance, in mm, from the bolt axes to the longitudinal axis through the coupling center (i.e. the center of the bolt system),

n_B : total number of bolts, which is to be not less than 6.

Non-fitted bolts may be used provided that, in way of the mating plane of the coupling flanges, a key is fitted having a section of (0,25 d_T x 0,10 d_T) mm^2 and keyways in both the coupling flanges, and provided that at least two of the coupling bolts are fitted bolts.

The distance from the bolt axes to the external edge of the coupling flange is to be not less than 1,2 d_B.

5.1.3 Coupling flange

The thickness of the coupling flange is to be not less than the value obtained, in mm, from the following formula:

$$t_P = d_B \sqrt{\frac{k_{1F}}{k_{1B}}}$$

where:

d_B : bolt diameter, in mm, calculated in accordance with [5.1.2], where the number of bolts n_B is to be taken not greater than 8,

k$_{1F}$: material factor **k**$_1$ for the steel used for the flange

k$_{1B}$: material factor **k**$_1$ for the steel used for the bolts.

In any case, the thickness **t**$_P$ is to be not less than 0,9 **d**$_B$.

5.1.4 Locking device

A suitable locking device is to be provided to prevent the accidental loosening of nuts.

5.2 Cone couplings between rudder stocks and tillers

5.2.1 Application

Requirements given in Pt C, Ch 1, Sec 10 apply.

5.2.2 General

The entrance edge of the tiller bore and that of the rudder stock cone are to be rounded or beveled.

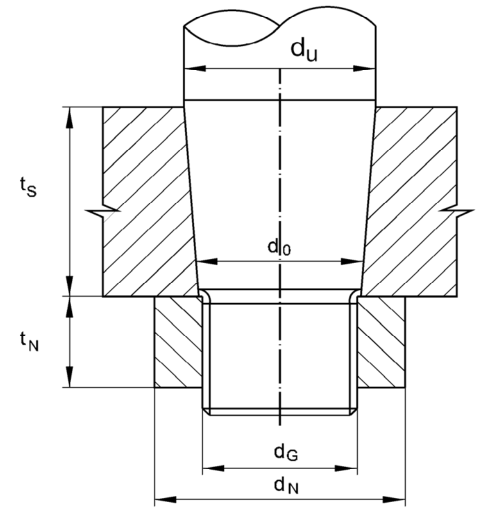
The right fit of the tapered bearing is to be checked before final fit up, to ascertain that the actual bearing is evenly distributed and at least equal to 80% of the theoretical bearing area; push-up length is measured from the relative positioning of the two parts corresponding to this case.

The required push-up length is to be checked after releasing of hydraulic pressures applied in the hydraulic nut and in the assembly

5.2.3 Keyless couplings through special devices

- The use of special devices for frictional connections, such as expansible rings, may be accepted by Tasneef on a case-by-case basis provided that the following conditions are complied with:
- evidence that the device is efficient (theoretical calculations and results of experimental tests, references of behaviour during service, etc.) are to be submitted to Tasneef
- the torque transmissible by friction is to be not less than 2 **M**$_{TR}$
- design conditions and strength criteria are to comply with [5.2.1]
- instructions provided by the manufacturer are to be complied with, notably concerning the pre-stressing of the tightening screws.

Figure 2: Geometry of cone coupling



5.3 Cone couplings between rudder stocks and rudder blades

5.3.1 Taper on diameter of the cone couplings

The taper on diameter of the cone couplings is to be in compliance with the following formulae:

- for cone couplings without hydraulic arrangements for assembling and disassembling the coupling:

$$\frac{1}{12} \le \frac{d_U - d_0}{t_S} \le \frac{1}{8}$$

- for cone couplings with hydraulic arrangements for assembling and disassembling the coupling (assembling with oil injection and hydraulic nut):

$$\frac{1}{20} \le \frac{d_U - d_0}{t_S} \le \frac{1}{12}$$

where:

d$_U$, **t**$_S$, **d**$_0$,: geometrical parameters of the coupling, defined in Fig 2.

5.3.2 Push up length of cone coupling with hydraulic arrangements for assembling and disassembling the coupling

Requirements given in Pt B, Ch 9, Sec 1 [5.3.2] of TASNEEFMIL apply.

5.3.3 Slogging nut

The coupling is to be secured by a slugging nut, whose dimensions are to be in accordance with the following formulae:

$t_S \geq 1{,}5\ d_1$

$d_G \geq 0{,}65\ d_1$

$t_N \geq 0{,}60\ d_G$

$d_N \geq 1{,}2\ d_0$

and, in any case

$\mathbf{d}_N \geqslant 1{,}5\,\mathbf{d}_G$

where:

$\mathbf{t}_S$, $\mathbf{d}_G$, $\mathbf{t}_N$, $\mathbf{d}_N$, $\mathbf{d}_1$, $\mathbf{d}_0$: geometrical parameters of the coupling, defined in Fig 2.

The above minimum dimensions of the locking nut are only given for guidance, the determination of adequate scantlings being left to the Designer.

5.3.4 Washer

For cone couplings with hydraulic arrangements for assembling and disassembling the coupling, a washer is to be fitted between the nut and the rudder gudgeon, having a thickness not less than 0,13 $\mathbf{d}_G$ and an outer diameter not less than 0,13 $\mathbf{d}_0$ or 1,6 $\mathbf{d}_G$, whichever is the greater.

5.3.5 Key

For cone couplings without hydraulic arrangements for assembling and disassembling the coupling, a key is to be fitted having a section of (0,25 $\mathbf{d}_T$ x 0,10 $\mathbf{d}_T$) mm^2 and keyways in both the tapered part and the rudder gudgeon.

The key is to be machined and located on the fore or aft part of the rudder. The key is to be inserted at half-thickness into stock and into the solid part of the rudder.

For cone couplings with hydraulic arrangements for assembling and disassembling the coupling, the key may be omitted. In this case the designer is to submit to Tasneef shrinkage calculations supplying all data necessary for the relevant check.

5.3.6 Instructions

All necessary instructions for hydraulic assembly and disassembly of the nut, including indication of the values of all relevant parameters, are to be available on board.

5.4 Vertical flange couplings

5.4.1 Vertical flange couplings are to be achieved in accordance with the requirements given in Pt B, Ch 9, Sec 1 [5.4] of TASNEEFMIL.

5.5 Couplings by continuous rudder stock welded to the rudder blade

5.5.1 When the rudder stock extends through the upper plate of the rudder blade and is welded to it, the thickness of this plate in the vicinity of the rudder stock is to be not less than 0,20 d_1 where d_1 is defined in [5.1.1].

5.5.2 The welding of the upper plate of the rudder blade with the rudder stock is to be made with a full penetration weld and is to be subjected to non-destructive inspection through dye penetrant or magnetic particle test and ultrasonic testing.

The throat weld at the top of the rudder upper plate is to be concave shaped to give a fillet shoulder radius as large as practicable. This radius is to be not less than 0,20 d_1, where d_1 is defined in [5.1.1].

5.6 Skeg connected with rudder trunk

5.6.1 In case of a rudder trunk connected with the bottom of a skeg, the throat weld is to be concave shaped to give a fillet shoulder radius as large as practicable. This radius is considered by Tasneef on a case by case basis.

6 Rudder stock and pintle bearings

6.1 Forces on rudder stock and pintle bearings

6.1.1 Where a direct calculation according to the static schemes and the load conditions specified in TASNEEFMIL Part B, Ch 9, Sec 1 is carried out, the support forces are to be obtained as specified in above-mentioned App 1.

Where such a direct calculation is not carried out, the support forces F_{A1} acting on the rudder stock bearing and on the pintle bearing, are to be obtained, in N, from the following formulae:

$$F_{A1} = (1 + 0{,}87\, h_o/H_o)\, C_R$$

where:

$\mathbf{h}_0$ = 1,15·λ, where λ distance, in m, between spade gravity center and lower edge of rudder trunk.

$\mathbf{H}_0$: distance, in m, between the points at mid-height of the upper and lower rudder stock bearings.

6.2 Rudder stock bearing

6.2.1 The mean bearing pressure acting on the rudder stock bearing is to be in compliance with the following formula:

$$\mathbf{p}_F \leq . \mathbf{p}_{F,ALL}$$

where:

$\mathbf{p}_F$: mean bearing pressure acting on the rudder stock bearings, in N/mm^2, equal to:

$$p_F = \frac{F_{A1}}{d_m h_m}$$

$\mathbf{F}_{A1}$: force acting on the rudder stock bearing, in N, calculated as specified in [6.1.1],

$\mathbf{d}_m$: actual inner diameter, in mm, of the rudder stock bearings,

$\mathbf{h}_m$: bearing length, in mm.

$\mathbf{p}_{F,ALL}$: allowable bearing pressure, in N/mm^2, defined in Tab 2. Values greater than those given in Tab 2 may be accepted by Tasneef in accordance with the Manufacturer's specifications if they are verified by tests.

6.2.2 An adequate lubrication of the bearing surface is to be ensured.

6.2.3 For the purpose of this calculation the bearing contact length, in mm, it is to be taken not greater than 1,2 d_m, for spade rudder.

Table 2: Allowable bearing pressure

Bearing material	$p_{F,ALL}$, in N/mm²
Lignum vitae	2,5
White metal, oil lubricated	4,5
Synthetic material with hardness between 60 and 70 Shore D (1)	5,5
Steel, bronze and hot-pressed bronze-graphite materials (2)	7,0
(1) Indentation hardness test at 23°C and with 50% moisture to be performed according to a recognised standard. Type of synthetic bearing materials is to be approved by Tasneef. **(2)** Stainless and wear-resistant steel in combination with stock liner approved by Tasneef.	

7 Rudder blade scantlings

7.1 General

7.1.1 Application

The requirements in [7.1] to [7.6] apply to streamlined rudders and, when applicable, to rudder blades of single plate rudders.

7.1.2 Rudder blade structure

The structure of the rudder blade is to be such that stresses are correctly transmitted to the rudder stock and pintles. To this end, horizontal and vertical web plates are to be provided.

Horizontal and vertical webs acting as main bending girders of the rudder blade are to be suitably reinforced.

Streamlined rudders, including those filled with pitch, cork or foam, are to be fitted with plug-holes and the necessary devices to allow their mounting and dismounting.

Access openings to the pintles are to be provided. If necessary, the rudder blade plating is to be strengthened in way of these openings.

The corners of openings intended for the passage of the rudder horn heel and for the dismantling of pintle or stock nuts are to be rounded off with a radius as large as practicable.

Where the access to the rudder stock nut is closed with a welded plate, a full penetration weld is to be provided.

7.2 Strength checks

7.2.1 Bending stresses

For the generic horizontal section of the rudder blade it is to be checked that the bending stress s, in N/mm², induced by the loads defined in [2.1], is in compliance with the following formula:

$$\sigma \leq \sigma_{ALL}$$

where:

σ_{ALL} : allowable bending stress, in N/mm², specified in Tab 3.

7.2.2 Shear stresses

For the generic horizontal section of the rudder blade it is to be checked that the shear stress t, in N/mm², induced by the loads defined in [2.1], is in compliance with the following formula:

$$\tau \leq \tau_{ALL}$$

where:

τ_{ALL} : allowable shear stress, in N/mm², specified in Tab 3.

7.2.3 Combined bending and shear stresses

For the generic horizontal section of the rudder blade it is to be checked that the equivalent stress σ_E in N/mm², is in compliance with the following formula:

$$\sigma_E \leq \sigma_{E,ALL}$$

where:

σ_E : equivalent stress induced by the loads defined in [3.1], to be obtained, in N/mm², from the following formula:

$$\sigma_E = \sqrt{\sigma^2 + 3\tau^2}$$

Where unusual rudder blade geometries make it practically impossible to adopt ample corner radiuses or generous tapering between the various structural elements, the equivalent stress σ_E is to be obtained by means of direct calculations aiming at assessing the rudder blade areas where the maximum stresses, induced by the loads defined in [3.1], occur,

σ : bending stress, in N/mm²

τ : shear stress, in N/mm²

$\sigma_{E,ALL}$: allowable equivalent stress, in N/mm², as specified in Tab 3.

Table 3 :Allowable stresses for rudder blade scantlings

Allowable bending stress σ_{ALL} in N/mm²	Allowable shear stress τ_{ALL} in N/mm²	Allowable equivalent stress $\sigma_{E,ALL}$ in N/mm²
110/k	50/k	120/k

7.3 Rudder blade plating

7.3.1 Plate thickness

The thickness of each rudder blade plate panel is to be not less than the value obtained, in mm, from the following formula:

$$t_F = \left(5{,}5 s \beta \sqrt{T + \frac{C_R 10^{-4}}{A}} + 2{,}5\right)\sqrt{k}$$

where:

β : coefficient equal to:

$$\beta = \sqrt{1{,}1 - 0{,}5\left(\frac{s}{b_L}\right)^2}$$

to be taken not greater than 1,0 se $\mathbf{b_L/s}$ >2,5

s : length, in m, of the shorter side of the plate panel,

$\mathbf{b_L}$: length, in m, of the longer side of the plate panel.

7.3.2 Thickness of the top and bottom plates of the rudder blade

L The thickness of the top and bottom plates of the rudder blade is to be not less than the thickness $\mathbf{t_F}$ defined in [7.3.1], without being less than 1,2 times the thickness obtained from [7.3.1] for the attached side plating.

Where the rudder is connected to the rudder stock with a coupling flange, the thickness of the top plate which is welded in extension of the rudder flange is to be not less than 1,1 times the thickness calculated above.

7.3.3 Web spacing

The spacing between horizontal web plates is to be not greater than 1,20 m.

Vertical webs are to have spacing not greater than twice that of horizontal webs.

7.3.4 Web thickness

Web thickness is to be at least 70% of that required for rudder plating and in no case is it to be less than 7 $k^{0,5}$ mm, except for the upper and lower horizontal webs. The thickness of each web is to be uniform and in no case is it to be less then the greatest thickness t_F , calculated as specified in [7.3.1]. In every case a thickness increasing superior 20% is not required as regards the one of ordinary diaphragm. In rudders without the shaft incorporated, a vertical diaphragm with thickness not less than 1,8 t_F is to be arranged instead of the shaft itself.

7.3.5 Thickness of side plating and vertical web plates welded to solid part or to rudder flange

The thickness, in mm, of the vertical web plates welded to the solid part where the rudder stock is housed, or welded to the rudder flange, as well as the thickness of the rudder side plating under this solid part, or under the rudder coupling flange, is to be not less than the value 1,3 t_F .

7.3.6 Welding

The welded connections of blade plating to vertical and horizontal webs are to be in compliance with the applicable requirements of TASNEEFMIL Part D.

Where the welds of the rudder blade are accessible only from outside of the rudder, slots on a flat bar welded to the webs are to be provided to support the weld root, to be cut on one side of the rudder only.

7.3.7 Rudder nose plate thickness

Rudder nose plates are to have a thickness not less than 1,25 t_F, where t_F is defined in [7.3.1].

In general this thickness need not exceed 15 mm, unless otherwise required in special cases to be considered individually by Tasneef.

7.4 Connections of rudder blade structure with solid parts in forged or cast steel

7.4.1 General

Solid parts in forged or cast steel which ensure the housing of the rudder stock or of the pintle are in general to be connected to the rudder structure by means of two horizontal web plates and two vertical web plates.

7.4.2 Minimum section modulus of the connection with the rudder stock housing

The section modulus of the cross-section of the structure of the rudder blade which is connected with the solid part where the rudder stock is housed, which is made by vertical web plates and rudder plating, is to be not less than that obtained, on cm^3, from the following formula:

$$w_S = d_1^3\left(\frac{H_E - H_X}{H_E}\right)^2 \frac{k}{k_1} 10^{-4}$$

where:

$\mathbf{d_1}$: rudder stock diameter, in mm, defined in [5.1.1]

$\mathbf{H_E}$: vertical distance, in m, between the lower edge of the rudder blade and the upper edge of the solid part,

$\mathbf{H_X}$: vertical distance, in m, between the considered cross-section and the upper edge of the solid part,

k, $\mathbf{k_1}$: material factors, defined in [1.3], for the rudder blade plating and the rudder stock, respectively.

7.4.3 Calculation of the actual section modulus of the connection with the rudder stock housing

The actual section modulus of the cross-section of the structure of the rudder blade which is connected with the solid part where the rudder stock is housed is to be calculated with respect to the symmetrical axis of the rudder.

The breadth of the rudder plating to be considered for the calculation of this actual section modulus is to be not greater than that obtained, in m, from the following formula:

$$b = s_V + 2\frac{H_X}{m}$$

where:

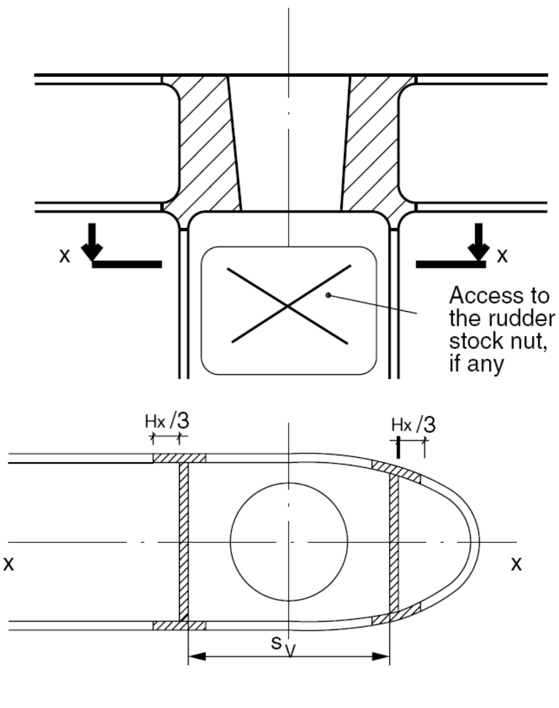
s_V : spacing, in m, between the two vertical webs (see Fig 3)

H_X : Defined in [7.4.2]

m : coefficient to be taken, in general, equal to 3.

Where openings for access to the rudder stock nut are not closed by a full penetration welded plate according to [7.1.3], they are to be deducted (see Fig 3).

Figure 3 : Cross-section of the connection between rudder blade structure and rudder stock housing



7.4.4 Thickness of horizontal web plates

In the vicinity of the solid parts, the thickness of the horizontal web plates, as well as that of the rudder blade plating between these webs, is to be not less than the greater of the values obtained, in mm, from the following formulae:

- $t_H = 1,2\ t_F$
- $t_H = 0,045\ d_S^2/s_H$

where:

t_F : defined in [7.3.1]

d_S : diameter, in mm, to be taken equal to d_1 for the solid part connected to the rudder stock, where d_1 is the rudder stock diameter, defined in [5.1.1]

s_H : spacing, in mm, between the two horizontal web plates.

Different thickness may be accepted when justified on he basis of direct calculations submitted to Tasneef for approval.

7.4.5 Thickness of side plating and vertical web plates welded to the solid part

The thickness of the vertical web plates welded to the solid part where the rudder stock is housed as well as the thickness of the rudder side plating under this solid part is to be not less than 1,4 t_F and 1,3 t_F respectively.

7.4.6 Solid part protrusions

The solid parts are to be provided with protrusions. Vertical and horizontal web plates of the rudder are to be butt welded to these protrusions. These protrusions are not required when the web plate thickness is less than 10 mm.

7.5 Connection of the rudder blade with the rudder stock by means of horizontal flanges

7.5.1 Minimum section modulus of the connection

The section modulus of the cross-section of the structure of the rudder blade which is directly connected with the flange, which is made by vertical web plates and rudder blade plating, is to be not less than the value obtained, in cm^3, from the following formula:

$$w_s = 1,3\ d_1^3\ 10^{-4}$$

where d_1 is the greater of the rudder stock diameters d_T and d_{TF}, in mm, to be calculated in compliance with the requirements in [4.2.1] and [4.2.2], respectively, taken k_1 equal to 1.

7.5.2 Actual section modulus of the connection

The section modulus of the cross-section of the structure of the rudder blade which is directly connected with the flange is to be calculated with respect to the symmetrical axis of the rudder.

For the calculation of this actual section modulus, the length of the rudder cross-section equal to the length of the rudder flange is to be considered.

Where the rudder plating is provided with an opening under the rudder flange, the actual section modulus of the rudder blade is to be calculated in compliance with [7.4.3].

7.5.3 Welding of the rudder blade structure to the rudder blade flange

The welds between the rudder blade structure and the rudder blade flange are to be full penetrated (or of equivalent strength) and are to be 100% inspected by means of non-destructive tests.

Where the full penetration welds of the rudder blade are accessible only from outside of the rudder, a backing flat bar is to be provided to support the weld root.

The external fillet welds between the rudder blade plating and the rudder flange are to be of concave shape and their throat thickness is to be at least equal to 0,5 times the rudder blade thickness.

Moreover, the rudder flange is to be checked before welding by non-destructive inspection for lamination and inclusion detection in order to reduce the risk of lamellar tearing.

7.5.4 Thickness of side plating and vertical web plates welded to the rudder flange

The thickness of the vertical web plates directly welded to the rudder flange as well as the plating thickness of the rudder blade upper strake in the area of the connection with the rudder flange is to be not less than 1,4 $\mathbf{t}_F$ and 1,3 $\mathbf{t}_F$ respectively.

7.6 Single plate rudders

7.6.1 Mainpiece diameter

The mainpiece diameter is to be obtained from the formulae in [4.2].

In any case, the mainpiece diameter is to be not less than the stock diameter.

For spade rudders the lower third may taper down to 0,75 times the stock diameter.

7.6.2 Blade thickness

The blade thickness is to be not less than the value obtained, in mm, from the following formula:

$$t_B = (1{,}5\,sV_{AV} + 2{,}5)\sqrt{k}$$

where:

s : spacing of stiffening arms, in m, to be taken not greater than 1 m (see Fig 4).

7.6.3 Arms

The thickness of the arms is to be not less than the blade thickness.

The section modulus of the generic section is to be not less than the value obtained, in cm3, from the following formula:

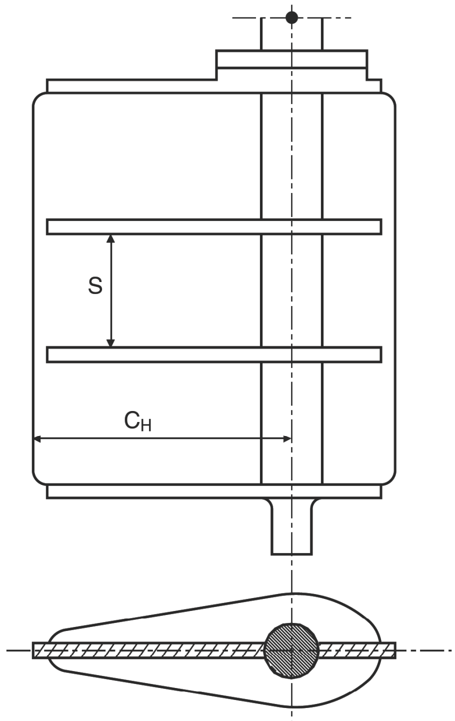
$$Z_A = 0{,}5\,sC_H^2V_{AV}^2k$$

where:

C_H : horizontal distance, in m, from the aft edge of the rudder to the centerline of the rudder stock (see Fig 4)

s : defined in [7.6.2].

Figure 4 : Single plate rudder



7.7 Rudders for vessels with Length L≤15 m

7.7.1 General

Rudders in vessels with Length L ≤ 15 m shall be measured through the formulae of the present article.

Rudders with parts in composite material are not admitted.

7.7.2 Stock measurement

Diameter $\mathbf{d}_{TF}$, in mm, of the rudder stock subject to flexion and torsion is given by the following ratio:

$$\mathbf{d}_{TF} = 14{,}5\,\mathbf{K}\,(\mathbf{A}\,\mathbf{R}\,\mathbf{V}^2\,\mathbf{k}_1)^{1/3}$$

Where:

- **K** = 1,08 + 0,24 (H/R) where H is the vertical distance, in m, of the barycentre in area A from the inferior extremity of the stock bearing next to the rudder trunk;
- **A =** overall rudder area, in m^2,bounded by its external edge including the shaft;
- **R** = horizontal distance, in m, of the barycentre in area A from the rudder rotation axis, to assume not less than 0,12 **b**, where **b** is the rudder width, in m, in rudder with rectangular edges; for rudders with non- rectangular edge, **b = A/h** where **h** is the rudder height, in m, next to the rotation axis ;
- **V =** maximum service speed in AV gear, in knots, in the full load waterline vessel;
- $\mathbf{k}_1$ defined in [1.4.3]

The shaft diameter $\mathbf{d_T}$, required in the zone of the rudder stock bearing, is to be extended on the upper part till at least the 10% of the neck bearing length, or till an height equal to 2 $\mathbf{d_{TF}}$, if such is bigger. The top of the shaft diameter shall be gradually reduced till a value equal to $\mathbf{d_{TF}/K}$ next to the bar or rudder's machinery.

Below the diameter $\mathbf{d_{TF}}$ is to be extended till the coupling between stock and the mainpiece or in its absence, shall be gradually reduced under the superior border of the rudder blade.

7.7.3 Simple plate rudder blade

Standards reported in the following parts refers to ordinary plate rudder blade; plates in other metallic material are admitted, e.g. aluminium alloy or stainless steel which scantlings will be decided in order to the equivalent principle, as regards the material mechanical.

Simple plate rudder are to be provided with:

- section shaft equal or equivalent to the one of the shaft next to the upper edge of blade and gradually reduced to not less than 50% under such edge;
- thickness plate $\mathbf{t}$ = 5 + 0,11 [($\mathbf{d_{TF}}$/$\mathbf{K}$) - 20] mm to increase in linear way where the interval $\mathbf{s}$, in mm, between arms is more than a 750 mm;
- associated strip nozzle, not less than $\mathbf{Z}$ = 7 + 0,8[($\mathbf{d}_{TF}$/ $\mathbf{K}$)-60] cm^3 horizontal arms of rectangular section having strength modulus with not less than 7 cm^3

7.7.4 Double plate rudder blade

Rudders with double planting are to present a shaft as the simple plate rudders, planting thickness t, in mm, and vertical and horizontal diaphragms not less than the following value:

$$\mathbf{t} = (\mathbf{d_{TF}/K})^{0,45} (0,7 + \mathbf{s})$$

where $\mathbf{s}$ is the horizontal diaphragms in m to assume not more than 1 m.

Welded connections are to be achieved in accordance with standards listed in the present Chapter. Internal surfaces are to be protected through paints or filled with light material of expanded type and a draining lightening is to be arranged.

7.7.5 Fused rudders

For rudders and related stocks obtained by fusion, the kind of material and related mechanical are to be approved in advance by Tasneef and tested.

Fusions with non-connected corners and sudden section variations are to be avoided, in particular where stock and blade are fused together.

7.7.6 Connection of the rudder blade with the rudder stock

The connection of the rudder stock with the mainpiece by means of horizontal flanges, when the rudder stock is not a solid part with the mainpiece, is to present:

- Flanges of such scantlings as to the coupling pivots are well settled and the condition listed in the second-last item is satisfy;
- flanges with thickness not less the pivots' diameter d; pivots with diameter $\mathbf{d}$, in mm, not less than 0,65 $\mathbf{d_{TF}}/\mathbf{n}^{0,5}$ where $\mathbf{n}$ is the pivots number in no case is to be less than 4;
- pivots which axis are settled each other at a distance not less 1,2 $\mathbf{d}$ from the flanges external edge;
- pivots nuts provided device.

The rudder shaft is composed by the stock itself inside the blade where coupling is not provided or, at the contrary by a full or piping round or by a double T structure or box structure type, as in double plates rudder cases.

Blade supports arms or diaphragms are to be connected to the shaft.

SECTION 2 PROPELLER SHAFT BRACKETS

1 Propeller shaft brackets

1.1 General

For certain vessels, the propeller shafting is extended to the propeller bearings clear of the main hull.

Propeller shafting is either enclosed in bossing or independent of the main hull and supported by shaft brackets.

1.2 Shaft brackets

The scantlings of bracket arms are to be calculated as indicated below. For high-powered vessels, Tasneef may require direct calculations to be carried out.

Bracket arms are to be attached to deep floors or girders of increased thickness, and the shell plating is to be increased in thickness and suitably stiffened, at the discretion of Tasneef. The thickness of the palm connecting the arms to the hull, if any, is to be not less than 0,2 x $\mathbf{d}_S$, where:

$\mathbf{d}_S$: Rule diameter, in mm, of the propeller shaft, calculated with the actual mechanical characteristics.

In the case of metallic hull and brackets of the same material the junction between the bracket and the shell plate shall be welded. Brackets shall pass through the shell and are to be welded to adequate internal structure (transversal and/or longitudinal). The thickness of the shell plating in the area surrounding the brackets is to be duly increased and the connection shall be made with full-penetration welding.

The arm is to be connected to the hull by means of through bolts, fitted with nut and lock nut, in way of the internal hull structures suitably stiffened at the discretion of Tasneef.

The arms of V-shaft brackets are to be perpendicular, as far as practicable.

The bearing length of the shaft bracket boss, in mm, is to be not less than 3 x $\mathbf{d}_S$.

The thickness, in mm, of the shaft bracket boss after boring operation is to be not less than:

$$\mathbf{t}_b = 0,2 \cdot \mathbf{d}_s \cdot (\mathbf{k}_1 + 0,25)$$

where:

$\mathbf{K}_1$: $\mathbf{R}_{ms}/\mathbf{R}_{mb}$,

$\mathbf{R}_{ms}$: minimum tensile strength, in N/mm^2, of the propeller shaft,

$\mathbf{R}_{mb}$: minimum tensile strength, in N/mm^2, of the shaft bracket boss, with appropriate metallurgical temper.

Each arm of V-shaft brackets is to have a cross-sectional area, in mm^2, of not less than:

$$\mathbf{S} = 87,5 \cdot 10^{-3} \cdot \mathbf{d}_{so}^2 \cdot \left(\frac{1600 + \mathbf{R}_{ma}}{\mathbf{R}_{ma}}\right)$$

where:

$\mathbf{d}_{SO}$: Rule diameter, in mm, of the propeller shaft, for carbon steel material,

$\mathbf{R}_{ma}$: minimum tensile strength, in N/mm^2, of arms, with appropriate metallurgical temper.

Single-arm shaft brackets are to have a section modulus at vessel plating level, in cm^3, of not less than:

$$Z = \frac{30}{R_{ma}} \cdot 10^{-3} \cdot \ell \cdot d_{SO}^2 \cdot (n \cdot d_{SO})^{0,5}$$

where:

ℓ : length of the arm, in m, measured from the shell plating to the centerline of the shaft boss,

n : shaft revolutions per minute.

Moreover, the cross-sectional area of the arm at the boss is not to be less than 60% of the cross-sectional area at shell plating.

SECTION 3 EQUIPMENT

1 General

1.1.1 The anchoring equipment required in this section is intended for temporary occasional mooring of a craft within a harbour or sheltered area when the craft is awaiting berth, tide, etc.

1.1.2 The equipment is therefore not designed to hold a craft off fully exposed coasts in rough weather or to stop a craft which is moving or drifting. In this condition the loads on the anchoring equipment increase to such a degree that its components may be damaged or lost owing to the high energy forces generated, particularly in large craft.

1.1.3 For crafts where frequent anchoring in open sea is expected, the owner's and shipyard's attention is drawn to the fact that anchoring equipment shall be provided in excess of the requirements of these Rules.

1.1.4 For crafts with an Equipment Number greater than 600, two anchors and two relevant chain cables are required. For such vessels engaged in a regular service, the second anchor and its relevant chain cable may be hold readily available in one of the home ports.

1.1.5 The anchoring equipment required in [2] is designed to hold a vessel in good holding ground in conditions such as to avoid dragging of the anchor. In poor holding ground, the holding power of the anchors will be significantly reduced.

1.1.6 The Equipment Numeral (EN) formula for anchoring equipment, as stipulated in [2], is based on an assumed current speed of 2,5 m/s, wind speed of 25 m/s and a scope of chain cable between 6 and 10.

1.1.7 For small craft with a length L ≤ 25 m, some partial exemption from the Rules may be accepted especially for what concerns anchor operation; in particular, where proper and safe anchor operation is assured, hand-operated machinery and/or absence of hawse pipe may be accepted.

1.1.8 In alternative to the provisions given in this Section anchor's and chain's equipment and the related windlass as well as the mooring ropes shall be determined through the Rules for non-steel vessels.

2 Equipment number

2.1 General

Each craft is to be provided with anchors and relevant stud link chain cables according to its equipment number EN, as stipulated in Table 1

2.2 Equipment number calculation

The equipment number EN is to be calculated as follows:

$$EN = \Delta^{2/3} + 2 \cdot \left[a \cdot B + \sum_i (b_i \cdot h_i \cdot \sin\Theta_i)\right] + 0,1 \cdot A$$

where:

Δ Maximum displacement, in t

a : Distance, in m, from summer load waterline amidships to the upper deck at side

$\mathbf{h_i}$: Height, in m, on the centerline of each tier of deck houses having an actual breadth $\mathbf{b_i}$ greater than **B**/4, where **B** is the breadth, in m, as defined in Part B, Ch 1, Sec 1

Θ_i : Angle of inclination aft of each front bulkhead,

A : Area, in m^2, in profile view of the hull, superstructures and deck houses above the summer load waterline, and with a breadth greater than **B**/4.

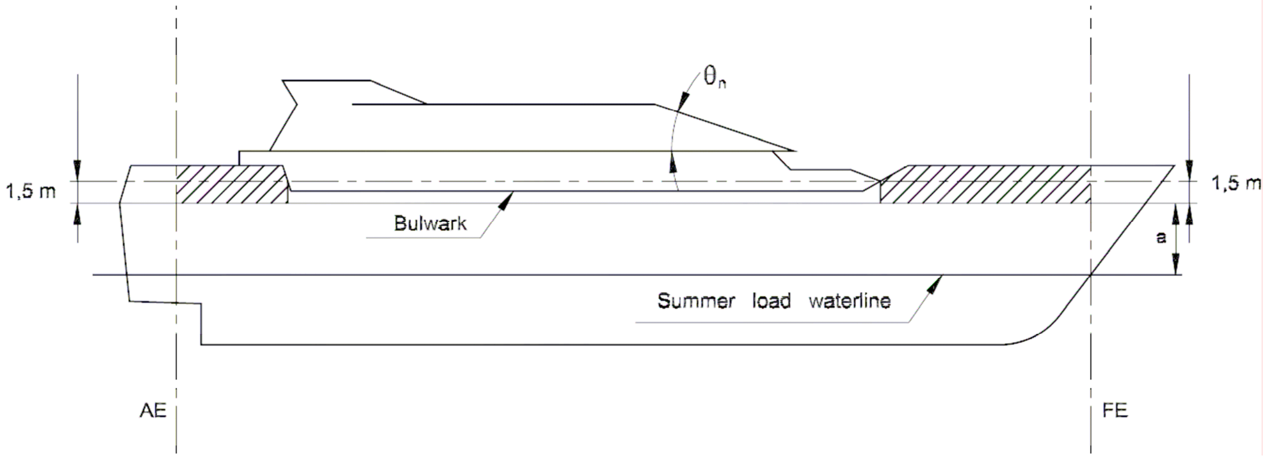
In the scantling of $\mathbf{h_i}$, sheer and trim are to be ignored. $\mathbf{h_i}$,

If a deck house broader than **B**/4 is placed on top of another deck house equal to or less than **B**/4 in breadth, only the widest is to be considered and the narrowest may be ignored.

Windscreens or bulwarks more than 1,5 m in height above the deck at side are to be regarded as parts of superstructures and houses when determining hi and A. The height of hatch coamings may be ignored in the evaluation of $\mathbf{h_i}$ and **A**.

In the calculation of **A**, when a bulwark is more than 1,5 m in height, the cross hatched area of Figure 1 is to be considered.

Figure 1



2.3 Anchors

2.3.1 General

The anchorage arrangements are to be such a s to prevent the damage of cable or chains. Suitable arrangements are to be provided as to erect the anchor in every working conditions.

Anchor scantlings are to be in accordance with Tasneef and other recognized standards.

For the approval and/or as anchor with high or highest anchoring power, comparative tests with ordinary anchors without stock on several sea ambient are to be executed with positive result. Such tests are to be driven as indicated in Pt B, Ch 9, Sec 4 of TASNEEFMIL.

2.3.2 Mass of anchors

Table 1 indicates the mass of a “high holding power anchor” (HHP) i.e. anchor having a holding power greater than that of an ordinary anchor.

“Very high holding power anchors” (VHHP), i.e. anchors having a holding power equal to, at least, four times that of an ordinary anchor, may be used.

The actual mass of each anchor may vary within (+7, -3) per cent of the value shown in the Table.

The mass of a VHHP anchor is to be not less than 2/3 of the mass required for the HHP anchor it replaces.

2.3.3 Anchor design

Anchors are to have appropriate shape and scantlings in compliance with Society requirements and are to be constructed in compliance with Society requirements.

A high or very high holding power anchor is to be suitable for use on board without any prior adjustment or special placement on the ground.

For approval and/or acceptance as a high or very high holding power anchor, the anchor is to have a holding power equal, respectively, to at least twice or four times that of an ordinary stockless anchor of the same mass.

2.4 Chain cables

2.4.1 Bow anchors are to be used in connection with stud link chain cables whose scantlings and steel grades are to be in accordance with the requirements of Tasneef.

Normally grade Q2 or grade Q3 stud link chain cables are to be used with HHP anchors. In case of VHHP anchors, grade Q3 chain cables are to be used.

Proposal for use of grade Q1 chain cables connected to ordinary anchors will be specially considered by Tasneef.

2.4.2 For craft with an Equipment Number **EN** ≤ 205, studless short link chain cables may be used, provided that:

a) steel grade of the studless chain is to be equivalent to the steel grade of the stud chains it replaces, i.e., referring to ISO standard 1834:
   - Class M (4) [grade 400], i.e. grade SL2 as defined in Part D, Ch. 4, Sec 1, [3] of TASNEEFMIL, in lieu of grade Q2
   - Class P (5) [grade 500], i.e. grade SL3 as defined in Part D, Ch. 4, Sec 1, [3] of TASNEEFMIL, in lieu of grade Q3

b) equivalence in strength is to be based on proof load (not on breaking load)

c) the studless chain cable meets the requirements of Tasneef.

2.4.3 The proof loads **PL** and breaking loads **BL**, in kN, required for the studless link chain cables are given by the following formulae, where d, in mm, is the required diameter of grade Q2 and grade Q3 stud chain cables taken from Table 1.

- grade Q2:

$$PL_2 = 9{,}807 \cdot d^2 \cdot (44 - 0{,}08 \cdot d) \cdot 10^{-3}$$

$$BL_2 = 2 \cdot PL_2$$

- grade Q3:

$$PL_3 = 13,73 \cdot d^2 \cdot (44 - 0,08 \cdot d) \cdot 10^{-3}$$
$$BL_3 = 2 \cdot PL_3$$

2.4.4 The method of manufacture of chain cables and the characteristics of the steel used are to be approved by Tasneef for each manufacturer. The material from which chain cables are manufactured and the completed chain cables themselves are to be tested in accordance with the appropriate requirements.

2.4.5 Chain cables are to be made of unit lengths ("shots") of 27 m minimum joined together by Dee or lugless shackles.

2.5 Pennants

2.5.1 Both pennants and chains' joint elements are to be such to present a strength equivalent to the chains one and are to be tested in accordance with Tasneef standards (Pt D of TASNEEFMIL).

2.6 Synthetic fiber ropes for anchors

2.6.1 In alternative to synthetic fiber ropes studding link chain cables required in Tab 1 for vessels with Length **L**≤25 m, synthetic fiber cables may be used, unless different stated by the Administration, and provided that the following requirements are complied with:

- Fiber ropes are to be made of polyamide or other equivalent synthetic fibers, excluding polypropylene.
- The length L_{sfr}, in m, of the synthetic fiber rope is to be not less than the chain length required in Table 1
- The effective breaking load $\mathbf{P_s}$, in kN, of the synthetic fiber rope is to be not less than the following value:

  $\mathbf{P_s} = 2,2\ \mathbf{BL}^{8/9}$

  where **BL**, in kN, is the required breaking load of the chain cable replaced by the synthetic fiber rope (**BL** can be determined by the formulae given in [2.4.3]).
- A short length of chain cable complying with [2.4] is to be fitted between the synthetic fiber rope and the bow anchor.

2.7 Arrangement of anchors and chain cables

2.7.1 The bow anchors, connected to their own chain cables, are to be so stowed as to always be ready for use.

2.7.2 Hawse pipes are to be of a suitable size and so arranged as to create, as far as possible, an easy lead for the chain cables and efficient housing for the anchors.

2.7.3 For this purpose, chafing lips of suitable form with ample lay-up and radius adequate for the size of the chain cable are to be provided at the shell and deck. The shell plating at the hawse pipes is to be reinforced as necessary.

2.8 Windlass

2.8.1 The windlass is to be power driven and suitable for the size of chain cable, and is to have the characteristics stated below.

2.8.2 The windlass is to be fitted in a suitable position in order to ensure an easy lead of the chain cable to and through the hawse pipe; the deck, at the windlass, is to be suitably reinforced.

2.8.3 The windlass is to be able to supply, for at least 30 minutes, a continuous duty pull $\mathbf{P_C}$, in N, corresponding to the grade of the chain cables, given by the following formulae:

- for grade Q2 chain cables:

  $$\mathbf{P_C} = 42,5\ \mathbf{d}^2$$
- for grade Q3 chain cables:

  $$\mathbf{P_C} = 47,5\ \mathbf{d}_2$$

where **d** is the stud link chain cable diameter of the intended steel grade, in mm.

2.8.4 The windlass unit prime mover is to provide the necessary temporary overload capacity for breaking out the anchor.

The temporary overload capacity or "short term pull" is to be not less than 1,5 times the continuous duty pull $\mathbf{P_C}$ for at least two minutes.

The speed in this overload period may be lower than the nominal speed specified in [2.8.5] below.

2.8.5 The nominal speed of the chain cable when hoisting the anchor and cable may be a mean speed only and is to be not less than 0,15 m/s.

The speed is to be measured over two shots of chain cable during the entire trip; the test is to commence with 3 shots (81 m) of chain fully submerged, or with the longest practicable submerged chain length where the chain length does not allow 3 shots to be paid out.

2.8.6 The windlass is to be provided with a brake having sufficient capacity to stop chain cable and anchor when paying out, even in the event of failure of the power supply.

2.8.7 Windlass and brake not combined with a chain stopper have to be designed to withstand a pull of 80% of the breaking load of the chain cable without any permanent deformation of the stressed parts and without brake slip.

Windlass and brake combined with a chain stopper have to be designed to withstand a pull of 45% of the breaking load of the chain cable.

2.8.8 The stresses on the parts of the windlass, its frame and brake are to be below the yield point of the material used.

The windlass, its frame and the brake are to be efficiently anchored to the deck.

2.8.9 Performance criteria and strength of windlasses are to be verified by means of workshop testing according to TASNEEFMIL Rules.

2.9 Chain stopper

2.9.1 A chain stopper is normally to be fitted between the windlass and the hawse pipe in order to relieve the windlass of the pull of the chain cable when the vessel is at anchor.

2.9.2 A chain stopper is to be capable of withstanding a pull of 80% of the breaking load of the chain cable; the deck at the chain stopper is to be suitably reinforced.

However, fitting of a chain stopper is not compulsory.

2.9.3 Chain tensioners or lashing devices supporting the weight of the anchor when housed in the anchor pocket are not to be considered as chain stoppers.

2.9.4 Where the windlass is at a distance from the hawse pipe and no chain stopper is fitted, suitable arrangements are to be provided to lead the chain cable to the windlass.

2.10 Chain locker

2.10.1 The chain locker is to be of a capacity adequate to stow all chain cable equipment and provide an easy direct lead to the windlass.

2.10.2 Where two anchor lines are fitted, the port and starboard chain cables are to be separated by a steel bulkhead in the locker.

2.10.3 The inboard ends of chain cables are to be secured to the structure by a fastening able to withstand a force not less than 15% nor more than 30% of the breaking load of the chain cable.

In an emergency, the attachments are to be easily released from outside the chain locker.

2.10.4 Where the chain locker is arranged aft of the collision bulkhead, its boundary bulkheads are to be watertight and a drainage system provided.

2.11 Anchoring sea trials

2.11.1 The anchoring sea trials are to be carried out on board in the presence of a Society surveyor.

2.11.2 The test is to demonstrate that the windlass complies with the requirements given in [2.8.5].

2.11.3 The brake is to be tested during lowering operations.

Table 1 – Equipment

Equipment Number EN		HHP bow anchor		Stud link chain cable for bow anchor		
A < EN ≤ B		Mass of each anchor (kg)	Number of anchors	Total length (m)	Diameter **(1)**	
A	B				grade Q2 steel (mm)	grade Q3 steel (mm)
19	22	16	1	65,0	(6,0)	(5,5)
22	25	20	1	70,0	(6,5)	(6,0)
25	30	24	1	70,0	(7,0)	(6,5)
30	35	28	1	75,0	(7,5)	(7,0)
35	40	32	1	75,0	(8,0)	(7,5)
40	45	40	1	80,0	(8,5)	(7,5)
45	50	48	1	82,5	(9,0)	(8,0)
50	60	60	1	82,5	(10,0)	(8,5)
60	70	67	1	82,5	11,0	(9,5)
70	80	75	1	110,0	11,0	(10,0)
80	90	90	1	110,0	12,5	11,0
90	100	105	1	110,0	12,5	11,0
100	110	120	1	110,0	14,0	12,5
110	120	135	1	110,0	14,0	12,5
120	130	150	1	110,0	14,0	12,5
130	140	180	1	110,0	16,0	14,0
140	150	195	1	137,5	16,0	14,0
150	175	225	1	137,5	17,5	16,0
175	205	270	1	137,5	17,5	16,0
205	240	315	1	137,5	19,0	17,5
240	280	360	1	137,5	20,5	19,0
280	320	430	1	165,0	22,0	20,5
320	360	495	1	165,0	24,0,	22,0
360	400	525	1	165,0	26,0	22,0
400	450	585	1	165,0	26,0	24,0
450	500	675	1	192,5	28,0	26,0
500	550	765	1	192,5	30,0	26,0
550	600	855	1	192,5	32,0	28,0

SECTION 4 INDEPENDENT FUEL OIL TANKS

1 General

1.1 Application

1.1.1 The provisions of this Appendix apply to fuel oil tanks and bunkers which are not part of the vessel's structure.

1.2 Documents to be submitted

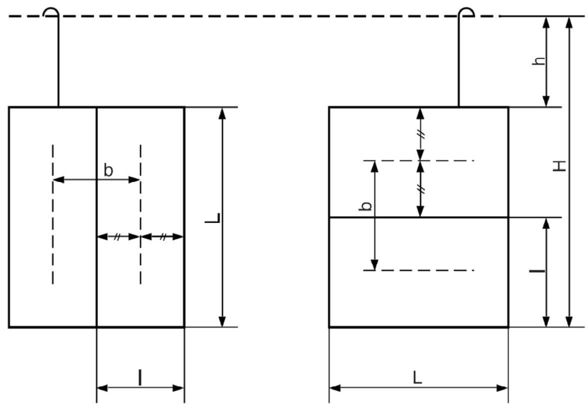
1.2.1 Constructional drawings of the tanks are to be submitted, showing the height of the overflow and air pipe above the top of the tank.

1.3 Symbols and units

1.3.1 Tanks

The meaning of the symbols used for tanks is given in Fig 1.

Figure 1 : Symbols used for tanks



L : Greater length of the considered plating element, in m

l : Smaller length of the considered plating element, in m

H : Height, in m, of the overflow or air pipe above the lower edge of the considered plating element

h : Height, in m, of overflow or air pipe above the top of the tank, subject to a minimum of:

- 3,60 m for fuel oil having a flash point below 60°C,
- 2,40 m for fuel oil having a flash point grater 60°C
- 1,00 m otherwise

1.3.2 Stiffeners

The following symbols and units are used for the stiffeners:

b : Width of the plating element supported by the stiffener, in m

w : Section modulus of the stiffeners, in cm^3.

2 Design and installation of tanks

2.1 Materials

2.1.1 General

Independent fuel oil tanks are to be made of steel except where permitted in [2.1.2].

2.1.2 Use of materials other than steel

a) On vessel where **L** $\leq$30 m, independent fuel oil tanks may be made of:

- aluminium alloys or equivalent material, provided that the tanks are located outside the propulsion machinery spaces or, when located within such spaces, they are insulated to A-60 class standard
- glass reinforced plastics (GRP), provided: the total volume of tanks located in the same space does not exceed 6 m^3. An overall volume shall be accepted provided that the room is protected with a CO_2 system with fire detections or other system accepted by Tasneef.
- the properties of GRP including fire resistance comply with the relevant provisions in [2.3.2].

b) For vessel with **L**$>$30 m, the use of independent fuel oil tanks made of aluminium alloys or GRP will be given special consideration.

c) For vessels with Length **L**$\leq$15 m the use of flexible tanks arranged in dry rooms will be accepted under Tasneef's conditions , referring technical documentation concerning material a construction.

2.2 Scantling of steel or Aluminium alloy tanks

2.2.1 General

a) The scantling of tanks whose dimensions are outside the range covered by the following provisions will be given special consideration.

b) The scantling of the tanks is to be calculated assuming a minimum height h of the overflow or air pipe above the top of the tank according to [1.3.1].

c) Tanks having length greater than 1 m shall have an internal wall in order to hinder fluid motions.

2.2.2 Thickness of plating

The thickness of the plates is not to be less than the value given in Tab 1 for the various values of **l**, **L/l** and **H**. However, for tanks having a volume of more than 1 m^3, the thickness of the plates is not to be less than 3 mm for steel tank (also for HS steel) and 4 mm for aluminium alloy tank filled with flammable liquid and having a total volume grater 1 m^3.

2.2.3 Scantlings of stiffeners

a) This requirement applies only to stiffeners which are all vertical or all horizontal and attached according to the types shown in Fig 2. Other cases will be given special consideration.

b) The minimum values of the ratio w/b required for stiffeners are given in:

- Tab 2 for vertical stiffeners
- Tab 3 for horizontal stiffeners, for the different types of attachments shown in Fig 2.

2.3 Non-metallic tanks scantling

2.3.1 General

Non metallic tanks' scantling will be considered by Tasneef case by case basis referring to the kind of material and to the results of the strength testing took on a sample.

2.3.2 Tanks in composite material

Simple laminate tanks are to present the strengthening thickness of laminate **t**, in mm, and the one of the modulus **Z**, in cm^3, not less than the values given by the following formulae:

$$\mathbf{t} = 148\ \mathbf{s}\ (\mathbf{H}\ \mathbf{R}_{mf})^{0,5}$$

where $\mathbf{R}_{mf}$ is the breaking stress at bending laminate in N/mm^2, and **s** is the strengthening interval, in mm.

$$\mathbf{Z} = 1955\ \mathbf{s}\ \mathbf{S}^2\ \mathbf{H}\ /\mathbf{R}_t$$

where **S** is the strengthening span, in m, and $\mathbf{R}_t$ the breaking stress at laminate traction, in N/mm^2

The materials composing the composite structure are to be proof to the liquid they must hold.

In combustible and, in general, inflammable liquids tanks, the internal surface is to be covered with resin liquid proof and the external surface is to be covered with self extinguishing resin.

Anyone interested in this matter should present a Manufacturer's declaration attesting such features.

Mechanical testing on laminate samples after one-week submersion in the liquid they will contain at not less than 20°C are to be executed. The values concerning the breaking stresses in traction and flexion are to result not less than 80% of values of samples.

2.4 Installation

2.4.1 Securing

Independent tanks are to be securely fixed to hull structures and are to be so arranged as to permit inspection of adjacent structures.

2.4.2 Protection against spillage

Where permitted, independent fuel oil tanks are to be placed in an oil-tight spill tray of ample size with a suitable drain pipe leading to a suitably sized spill oil tank.

Table 1 : Thickness of plating (mm)

l (m)	L / l	H (m)													
		2,4 - 2,7	2,7 - 3,0	3,0 - 3,3	3,3 - 3,6	3,6 - 4,0	4,0 - 4,4	4,4 - 4,8	4,8 - 5,2	5,2 - 5,8	5,8 - 6,4	6,4 - 7,0	7,0 - 8,0	8,0 - 9,0	9,0 - 10,0
0,40	< 2	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,5	3,5	3,5	4,0	4,0	4,0	4,5
	≥ 2	3,0	3,0	3,0	3,5	3,5	3,5	4,0	4,0	4,0	4,5	4,5	5,0	5,0	5,5
0,45	< 2	3,0	3,0	3,0	3,0	3,0	3,5	3,5	3,5	4,0	4,0	4,0	4,5	4,5	5,0
	≥ 2	3,5	3,5	3,5	4,0	4,0	4,0	4,5	4,5	4,5	5,0	5,0	5,5	6,0	6,0
0,50	< 2	3,0	3,0	3,5	3,5	3,5	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,5	7,0
	≥ 2	3,5	4,0	4,0	4,0	4,5	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,5	7,0
0,55	< 2	3,5	3,5	3,5	4,0	4,0	4,0	4,0	4,5	4,5	5,0	5,0	5,5	5,5	6,0
	≥ 2	4,0	4,5	4,5	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,0	6,5	7,0	7,5
0,60	< 2	3,5	4,0	4,0	4,0	4,0	4,5	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,5
	≥ 2	4,5	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,0	6,5	6,5	7,0	7,5	8,0
0,65	< 2	4,0	4,0	4,0	4,0	4,5	4,5	5,0	5,0	5,5	5,5	6,0	6,0	6,5	7,0
	≥ 2	4,5	5,0	5,0	5,0	5,5	6,0	6,0	6,5	6,5	7,0	7,5	7,5	8,5	8,5
0,70	< 2	4,0	4,0	4,5	4,5	5,0	5,0	5,0	5,5	5,5	6,0	6,5	6,5	7,0	7,5
	≥ 2	5,0	5,0	5,5	5,5	6,0	6,5	6,5	7,0	7,0	7,5	8,0	8,5	9,0	----
0,75	< 2	4,5	4,5	5,0	5,0	5,0	5,5	5,5	6,0	6,0	6,5	6,5	7,0	7,5	8,0
	≥ 2	5,5	5,5	6,0	6,0	6,5	6,5	7,0	7,5	7,5	8,0	8,5	9,0	----	----
0,80	< 2	4,5	5,0	5,0	5,0	5,5	6,0	6,0	6,0	6,5	7,0	7,0	7,5	8,0	8,5
	≥ 2	5,5	6,0	6,0	6,5	6,5	7,0	7,5	7,5	8,0	8,5	9,0	----	----	----
0,85	< 2	5,0	5,0	5,5	5,5	5,5	6,0	6,5	6,5	7,0	7,0	7,5	8,0	8,5	9,0
	≥ 2	6,0	6,5	6,5	7,0	7,0	7,5	8,0	8,0	8,5	9,0	----	----	----	----
0,90	< 2	5,0	5,5	5,5	6,0	6,0	6,5	6,5	7,0	7,0	7,5	8,0	8,5	9,0	----
	≥ 2	6,5	6,5	7,0	7,0	7,5	8,0	8,5	8,5	9,0	----	----	----	----	----
0,95	< 2	5,5	5,5	6,0	6,0	6,5	7,0	7,0	7,5	7,5	8,0	8,5	9,0	----	----
	≥ 2	6,5	7,0	7,0	7,5	8,0	8,5	9,0	9,0	----	----	----	----	----	----
1,00	< 2	5,5	6,0	6,0	6,5	7,0	7,0	7,5	7,5	8,0	8,5	9,0	----	----	----
	≥ 2	7,0	7,5	7,5	8,0	8,5	8,5	9,0	----	----	----	----	----	----	----

Note:

1. Thicknesses given in table are referred to ordinary steel having yield stress equal to 235 N/mm^2. In case high tensile strength steel is used, thickness shall be multiplied by $\mathbf{k^{0,5}}$**.**
2. In case aluminium alloy, thickness shall be multiplied by $(220/\mathbf{R}_{EH})^{0,5}$, where $\mathbf{R}_{EH}$ welded yield stress in N/mm^2.

Figure 2 : Type of stiffener end attachments

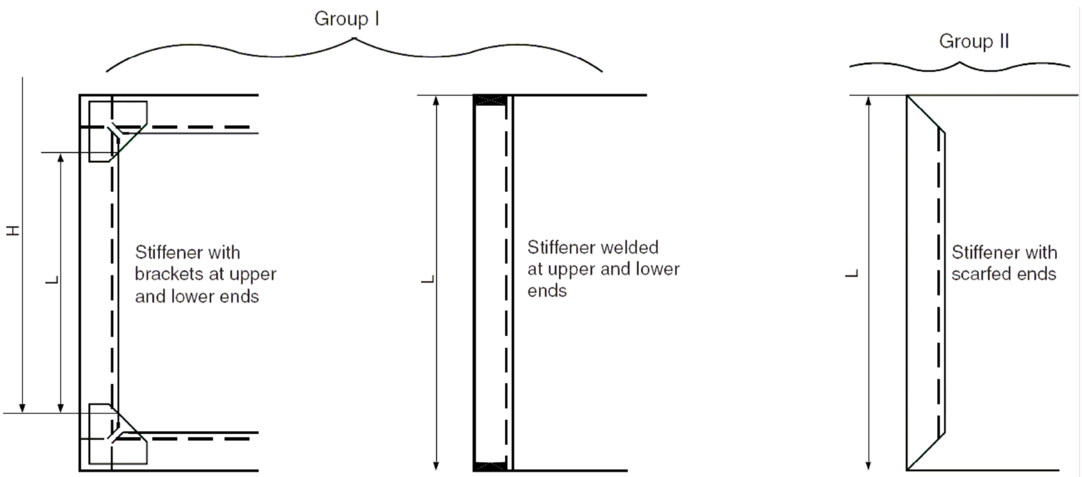


Table 2 : Values of w/b ratio for vertical stiffeners (cm^3/m)

L (m)	end attachment	H, in m (1)												
		3,0	3,3	3,6	3,9	4,3	4,6	5,0	5,5	6,0	7,0	8,0	9,0	10,0
0,6	I II	5,0 8,0	5,5 9,0	6,0 10,0	6,5 11,0	7,5 12,0	8,0 12,5	9,0 13,0	9,5 15,0	10,5 16,0	11,5 19,0	14,0 22,0	16,0 25,0	18,0 28,0
0,8	I II	8,5 13,0	9,5 15,0	10,5 16,0	11,5 18,0	13,0 20,0	14,0 21,5	15,0 24,0	16,5 25,5	18,0 28,5	22,0 34,0	25,0 38,0	28,0 43,0	31,5 48,0
1,0	I II		14,5 22,0	16,0 24,0	17,5 27,0	19,5 30,0	21,0 32,5	23,0 36,0	26,0 39,0	28,5 43,0	34,0 51,0	38,0 58,0	43,0 67,0	49,0 75,0
1,2	I II			22,5 34,0	24,5 30,7	28,0 42,5	30,0 46,0	33,0 50,0	37,0 55,0	40,5 61,0	48,0 73,0	55,0 84,0	63,0 96,0	71,0 107
1,4	I II			30,0 45,0	32,5 49,0	37,0 56,0	40,0 61,0	44,0 67,0	49,0 74,0	55,0 82,0	65,0 98,0	75,0 113,0	85,0 129,0	96,0 144,0
1,6	I II				47,0 71,0	53,0 80,0	57,0 87,0	64,0 96,0	71,0 107,0	79,0 118,0	94,0 141,0	110,0 165,0	125,0 187,0	140,0
1,8	I II				58,0 87,0	65,0 98,0	71,0 107,0	79,0 118,0	88,0 132,0	98,0 147,0	117,0 176,0	136,0 204,0	156,0	175,0
2,0	I II					78,0 118,0	85,0 129,0	95,0 142,0	107,0 160,0	119,0 178,0	142,0	166,0	190,0	
2,2	I II						100,0 151,0	112,0 168,0	126,0 190,0	140,0	170,0	198,0		
2,5	I II						124,0 187,0	139,0	158,0					

(1) H is to be taken equal to the height of the tank top above the lower end of the stiffener, plus h.

Note:

3. Thicknesses given in table are referred to ordinary steel having yield stress equal to 235 N/mm². In case high tensile strength steel is used, thickness shall be multiplied by $\mathbf{k^{0,5}}$.
4. In case aluminium alloy is used, thickness shall be multiplied by $(220/\mathbf{R}_{EH})^{0,5}$, where $\mathbf{R}_{EH}$ welded yield stress in N/mm².

Table 3 : Values of w/b ratio for horizontal and top and bottom stiffeners (cm^3/m)

L (m)	end attachment	H, in m **(1)**															
		2,4	2,6	2,8	3,0	3,3	3,6	3,9	4,3	4,6	5,0	5,5	6,0	7,0	8,0	9,0	10,0
0,6	I	4,5	5,0	5,5	6,0	6,5	7,0	7,5	8,5	9,0	10,0	11,0	12,0	13,5	15,0	17,0	19,0
	II	7,0	8,0	8,5	9,0	10,0	11,0	11,5	12,5	13,5	15,0	16,0	17,5	21,0	24,0	27,0	30,0
0,8	I	8,0	9,0	9,5	10,0	11,0	12,0	13,0	14,5	15,5	17,0	18,5	20,0	23,5	27,0	30,0	33,5
	II	13,0	15,0	15,5	16,5	18,0	19,5	21,5	23,5	25,0	27,0	30,0	34,0	38,0	44,0	49,0	55,0
1,0	I	13,0	15,0	15,5	16,5	18,0	19,5	21,5	23,5	25,0	27,0	30,0	34,0	38,0	44,0	49,0	55,0
	II	20,0	22,0	23,5	25,0	28,0	30,0	33,0	36,0	39,0	42,0	46,0	50,0	59,0	67,0	75,0	84,0
1,2	I	18,0	20,0	21,0	22,5	25,0	26,5	29,5	32,5	34,5	37,5	41,5	45,0	52,5	60,0	67,5	75,0
	II	28,0	31,0	33,0	35,0	39,0	42,0	46,0	51,0	54,0	59,0	65,0	70,0	82,0	93,0	105	117
1,4	I	26,0	28,0	30,5	32,5	36,0	39,0	42,5	46,5	50,0	54,5	59,5	65,0	76,0	87,0	97,0	108
	II	39,0	43,0	45,5	49,0	54,0	58,5	63,5	70,0	75,0	81,0	89,0	97,0	113	130	146	162
1,6	I	36,0	39,0	42,0	45,0	50,0	54,0	59,0	65,0	69,0	75,0	82,0	90,0	105	120	135	150
	II	56,0	61,0	66,0	70,0	77,0	84,0	91,0	100	107	117	128	140	163	186		
1,8	I	46,0	50,0	54,0	58,0	63,0	69,0	75,0	82,0	88,0	95,0	105	115	134	153	172	191
	II	70,0	76,0	82,0	88,0	96,0	105	113	125	134	146	160	175	204			
2,0	I	57,0	62,0	67,0	72,0	78,0	85,0	92,0	102	109	118	130	142	166	190		
	II	87,0	95,0	102	109	120	130	141	155	166	181	198					
2,2	I	70,0	76,0	82,0	88,0	96,0	105	113	125	134	145	160	175	204			
	II	107	116	125	134	147	160	174	192	205							
2,5	I	92,0	100	108	115	127	138	150	165	176	191						
	II	140	152	163	175	192											
(1) For horizontal stiffeners, H is to be measured from the horizontal stiffener immediately below the stiffener considered. For top stiffeners, H = h.																	

Note:

5. Thicknesses given in table are referred to ordinary steel having yield stress equal to 235 N/mm^2. In case high tensile strength steel is used, thickness shall be multiplied by $\mathbf{k^{0,5}}$.
6. In case aluminium alloy is used, thickness shall be multiplied by $(220/\mathbf{R}_{EH})^{0,5}$, where $\mathbf{R}_{EH}$ welded yield stress in N/mm^2.

Part B

Hull and Stability

Chapter 8
CONSTRUCTION AND TESTING

SECTION 1 WELDING AND WELD CONNECTIONS

1 General

1.1 Application

1.1.1 The requirements of this Section apply for the preparation, execution and inspection of welded connections in hull structures.

1.1.2 The general requirements relevant to fabrication by welding and qualification of welding procedures are given in Part D, Chapter 5 of TASNEEFMIL. As guidance see also the indications given in the "Guide for Welding".

1.1.3 The requirements relevant to the non-destructive examination of welded connections are given in the Rules for carrying out non-destructive examination of welding.

1.1.4 Weld connections are to be executed according to the approved plans. Any detail not specifically represented in the plans is, in any event, to comply with the applicable requirements.

1.1.5 It is understood that welding of the various types of steel is to be carried out by means of welding procedures approved for the purpose, even though an explicit indication to this effect may not appear on the approved plans.

1.1.6 The quality standard adopted by the shipyard is to be submitted to Tasneef and applies to all constructions unless otherwise specified on a case-by-case basis.

1.2 Base material

1.2.1 The requirements of this Section apply for the welding of hull structural steels or aluminium alloys of the types considered in Part D of TASNEEFMIL or other type allowed by Tasneef.

1.2.2 The service temperature is intended to be the ambient temperature, unless otherwise stated.

1.3 Welding consumables and procedures

1.3.1 Approval of welding consumables and procedures

Welding consumables and welding procedures adopted are to be approved by Tasneef.

The requirements for the approval of welding consumables are given in Pt D, Ch 5, Sec 2 of TASNEEFMIL.

The requirements for the approval of welding procedures for the individual users are given in Part D, Ch 5, Sec 4 and in Part D, Ch 5, Sec 5 of TASNEEFMIL.

The approval of the welding procedure is not required in the case of manual metal arc welding with approved covered electrodes, except in the case of one side welding on refractory backing (ceramic).

1.3.2 Consumables

For welding of hull structural steels, the minimum consumable grades to be adopted are specified in Tab 1 depending on the steel grade.

For welding of other materials, the consumables indicated in the welding procedures to be approved are considered by Tasneef on a case by case basis.

1.3.3 Electrodes for manual welding

Basic covered electrodes are to be used for the welding of structural members made in higher strength steels and, irrespective of the steel type.

Non-basic covered electrodes are generally allowed for manual fillet welding of structural members of moderate thickness (gross thickness less than 25 mm) made in normal strength steels.

Table 1: Consumable grades

Steel grade	Consumable minimum grade	
	Butt welding, partial and full T penetration welding	Fillet welding
A	1	1
B - D	2	
E	3	
AH32 - AH36 DH32 - DH36	2Y	2Y
EH32 - EH36	3Y	
FH32 - FH36	4Y	
AH40	2Y40	2Y40
DH40 - EH40	3Y40	
FH40	4Y40	

Note 1:
Welding consumables approved for welding higher strength steels (Y) may be used in lieu of those approved for welding normal strength steels having the same or a lower grade; welding consumables approved in grade Y40 may be used in lieu of those approved in grade Y having the same or a lower grade.
Note 2:
In the case of welded connections between two hull structural steels of different grades, as regards strength or notch toughness, welding consumables appropriate to one or the other steel are to be adopted.

1.4 Personnel and equipment

1.4.1 Welders

Manual and semi-automatic welding is to be performed by welders certified by RINA in accordance with recognised standards (Part D, Ch. 5, Sec 1, [2.2.3] e Part D, Ch. 5, Sec 1, [2.2.5] of TASNEEFMIL); the welders are to be employed within the limits of their respective approval.

1.4.2 Automatic welding operators

Personnel manning automatic welding machines and equipment are to be competent and sufficiently trained.

1.4.3 Organisation

The internal organisation of the shipyard is to be such as to ensure compliance in full with the requirements in [1.4.1] and [1.4.2] and to provide for assistance and inspection of welding personnel, as necessary, by means of a suitable number of competent supervisors.

1.4.4 NDE operators

Non-destructive tests are to be carried out by qualified personnel, certified by Tasneef, or by recognised bodies in compliance with appropriate standards.

The qualifications are to be appropriate to the specific applications.

1.4.5 Technical equipment and facilities

The welding equipment is to be appropriate to the adopted welding procedures, of adequate output power and such as to provide for stability of the arc in the different welding positions.

In particular, the welding equipment for special welding procedures is to be provided with adequate and duly calibrated measuring instruments, enabling easy and accurate reading, and adequate devices for easy regulation and regular feed.

Manual electrodes, wires and fluxes are to be stocked in suitable locations so as to ensuring their preservation in good condition.

1.5 Documentation to be submitted

1.5.1 The structural plans to be submitted for approval, according to Ch 1, Sec 3, are to contain the necessary data relevant to the fabrication by welding of the structures and items represented. Any detail not clearly represented in the plans is, in any event, to comply with the applicable Rule requirements.

For important structures, the main sequences of prefabrication, assembly and welding and non-destructive examination planned are also to be represented in the plans.

1.5.2 A plan showing the location of the various steel types is to be submitted at least for outer shell, deck and bulkhead structures.

1.6 Design

1.6.1 General

For the various structural details typical of welded construction in shipbuilding and not dealt with in this Section, the rules of good practice, recognised standards and past experience are to apply as agreed by Tasneef.

1.6.2 Plate orientation

The plates of the shell and strength deck are generally to be arranged with their length in the fore-aft direction. Possible exceptions to the above will be considered by TASNEEF on a case by case basis; tests as deemed necessary (for example, transverse impact tests) may be required by Tasneef.

1.6.3 Overall arrangement

Particular consideration is to be given to the overall arrangement and structural details of highly stressed parts of the hull.

Special attention is to be given to the above details in the plan approval stage; accurate plans relevant to the special detail.

1.6.4 Prefabrication sequences

Prefabrication sequences are to be arranged so as to facilitate positioning and assembling as far as possible.

The amount of welding to be performed on board is to be limited to a minimum and restricted to easily accessible connections.

1.6.5 Distance between welds

Welds located too close to one another are to be avoided. The minimum distance between two adjacent welds is considered on a case by case basis, taking into account the level of stresses acting on the connected elements.

In general, the distance between two adjacent butts in the same strake of shell or deck plating is to be greater than two frame spaces.

2 Type of connections and preparation

2.1 General

2.1.1 The type of connection and the edge preparation are to be appropriate to the welding procedure adopted, the structural elements to be connected and the stresses to which they are subjected.

2.2 Butt welding

2.2.1 General

In general, butt connections of plating are to be full penetration, welded on both sides except where special procedures or specific techniques, considered equivalent by Tasneef, are adopted.

Connections different from the above may be accepted by Tasneef on a case by case basis; in such cases, the relevant detail and workmanship specifications are to be approved.

2.2.2 Welding of plates with different thicknesses

In the case of welding of plates with a difference in gross thickness equal to or greater than:

- 3 mm, if the thinner plate has a gross thickness equal to or less than 10 mm
- 4 mm, if the thinner plate has a gross thickness greater than 10 mm,

a taper having a length of not less than 4 times the difference in gross thickness is to be adopted for connections of plating perpendicular to the direction of main stresses.

For connections of plating parallel to the direction of main stresses, the taper length may be reduced to 3 times the difference in gross thickness.

When the difference in thickness is less than the above values, it may be accommodated in the weld transition between plates.

2.2.3 Edge preparation, root gap

Typical edge preparations and gaps are indicated in the “Guide for welding”.

The acceptable root gap is to be in accordance with the adopted welding procedure and relevant bevel preparation.

2.2.4 Butt welding on permanent backing

Butt welding on permanent backing, i.e. butt welding assembly of two plates backed by the flange or the face plate of a stiffener, may be accepted where back welding is not feasible or in specific cases deemed acceptable by Tasneef.

The type of bevel and the gap between the members to be assembled are to be such as to ensure a proper penetration of the weld on its backing and an adequate connection to the stiffener as required.

2.2.5 Section, bulbs and flat bars

When lengths of longitudinals of the shell plating and strength deck within 0,6 L amidships, or elements in general subject to high stresses, are to be connected together by butt joints, these are to be full penetration. Other solutions may be adopted if deemed acceptable by Tasneef on a case by case basis.

The work is to be done in accordance with an approved procedure; in particular, this requirement applies to work done on board or in conditions of difficult access to the welded connection. Special measures may be required by Tasneef.

Welding of bulbs without a doubler is to be performed by welders specifically certified by Tasneef for such type of welding.

2.3 Fillet welding

2.3.1 General

In general, ordinary fillet welding (without bevel) may be adopted for T connections of the various simple and composite structural elements, where they are subjected to low stresses (in general not exceeding 30 N/mm^2) and adequate precautions are taken to prevent the possibility of local laminations of the element against which the T web is welded.

Where this is not the case, partial or full T penetration welding according to [2.4] is to be adopted.

2.3.2 Fillet welding types

Fillet welding may be of the following types:

- continuous fillet welding, where the weld is constituted by a continuous fillet on each side of the abutting plate (see [2.3.3])
- intermittent fillet welding, which may be subdivided (see [2.3.4]) into:
  - chain welding
  - scallop welding
  - staggered welding.

2.3.3 Continuous fillet welding

Continuous fillet welding is to be adopted:

- for watertight connections
- for connections of brackets, lugs and scallops
- at the ends of connections for a length of at least 75mm
- where intermittent welding is not allowed, according to [2.3.4].

Continuous fillet welding may also be adopted in lieu of intermittent welding wherever deemed suitable, and it is recommended where the spacing p, calculated according to [2.3.4], is low.

2.3.4 Intermittent welding

The spacing p and the length d, in mm, of an intermittent weld, shown in:

- Fig 1, for chain welding
- Fig 2, for scallop welding
- Fig 3, for staggered welding

are to be such that:

$$(\mathbf{p}/\mathbf{d}) \leq \varphi$$

where the coefficient φ. is defined in Tab 2 and Tab 3 for the different types of intermittent welding, depending on the type and location of the connection.

In general, staggered welding is not allowed for connections subjected to high alternate stresses.

In addition, the following limitations are to be complied with:

- chain welding (see Fig 1):

  d ≥ 75 mm

  p-**d** ≤ 200 mm
- scallop welding (see Fig 2):

  d ≥ 75 mm

  p-**d** ≤ 150 mm

  v ≤ 0,25 **b** without being greater than 75 mm

Figure 1 : Intermittent chain welding

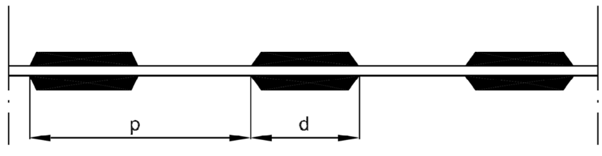


Figure 2: Intermittent scallop welding

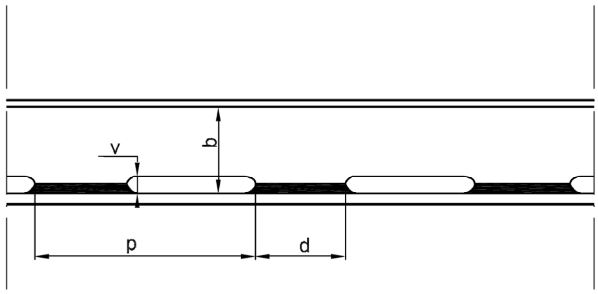
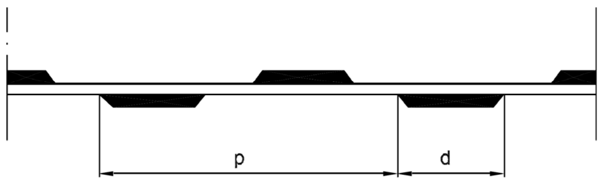


Figure 3: Intermittent staggered welding



- staggered welding (see Fig 3):

  d ≥ 75 mm

  p-**2d** ≤ 300 mm

  p ≤ 2**d** for connections subjected to high alternate stresses.

2.3.5 Throat thickness of fillet weld T connections

The throat thickness of fillet weld T connections is to be obtained, in mm, from the following formula:

$$t_T = w_F t \frac{p}{d}$$

where:

w_F : Welding factor, defined in Tab 2 for the various hull structural connections; for connections of primary supporting members belonging to single skin structures and not mentioned in Tab 2, Tab 3; for some connections of specific vessel types, **t_T** is specified in Tab 3.

t : Actual gross thickness, in mm, of the structural element which constitutes the web of the T connection

p, **d** : Spacing and length, in mm, of an intermittent weld, defined in [2.3.4].

For continuous fillet welds, **p**/**d** is to be taken equal to 1.

In no case may the throat thickness be less than:

- 3,0 mm, where the gross thickness of the thinner plate is less than 8 mm
- 3,5 mm, otherwise.

The throat thickness may be required by Tasneef to be increased, depending on the results of structural analyses.

The leg length of fillet weld T connections is to be not less than 1,4 times the required throat thickness.

Table 2: Welding coefficient w_F and coefficient for different connection type

Hull area	Connection			w_F (1)	φ (2) (3)			p_1, in mm (see [2.3.6])
	of	to			CH	SC	ST	
General, unless otherwise specified in the table	watertight plates	boundaries		0,35				
	webs of ordinary stiffeners	plating		0,13	3,5	3,0	4,6	ST 260
		face plate of fabricated stiffeners	at ends (4)	0,13				
			elsewhere	0,13	3,5	3,0	4,6	ST 260
Bottom and double bottom	longitudinal ordinary stiffeners	bottom and inner bottom plating		0,13	3,5	3,0	4,6	ST 260
	centre girder	keel		0,25	1,8	1,8		CH/SC 130
		inner bottom plating		0,20	2,2	2,2		CH/SC 160
	side girders	bottom and inner bottom plating		0,13	3,5	3,0	4,6	ST 260
		floors (interrupted girders)		0,20	2,2			CH 160
	floors	bottom and inner bottom plating	in general	0,13	3,5	3,0	4,6	ST 260
			at ends (20% of span) for longitudinally framed double bottom	0,25	1,8			CH 130
		inner bottom plating in way of brackets of primary supporting members		0,25	1,8			CH 130
		girders (interrupted floors)		0,20	2,2			CH 160
		side girders in way of hopper tanks		0,35				
	partial side girders	floors		0,25	1,8			CH 130
	web stiffeners	floor and girder webs		0,13	3,5	3,0	4,6	ST 260
Side and inner side	ordinary stiffeners	side and inner side plating		0,13	3,5	3,0	4,6	ST 260
	girders in double side skin ships	side and inner side plating		0,35				
Deck	strength deck	side plating		Partial penetration welding				
	non-watertight decks	side plating		0,20	2,2			CH 160
	ordinary stiffeners and intercostals girders	deck plating		0,13	3,5	3,0	4,6	ST 260
	hatch coamings	deck plating	in general	0,35				
			at corners of hatchways for 15% of the hatch length	0,45				
	web stiffeners	coaming webs		0,13	3,5	3,0	4,6	ST 260

Hull area	Connection of	Connection to		w_F (1)	φ (2) (3) CH	φ (2) (3) SC	φ (2) (3) ST	p_1, in mm (see [2.3.6])
Bulkheads	tank bulkhead structures	tank bottom	plating and ordinary stiffeners (plane bulkheads)	0,45				
			vertical corrugations (corrugated bulkheads)	Full penetration welding				
		boundaries other than tank bottom		0,35				
	watertight bulkhead structures	boundaries		0,35				
	non-watertight bulkhead structures	boundaries	wash bulkheads	0,20	2,2	2,2		CH/SC 160
			others	0,13	3,5	3,0	4,6	ST 260
	ordinary stiffeners	bulkhead plating	in general (5)	0,13	3,5	3,0	4,6	ST 260
			at ends (25% of span), where no end brackets are fitted	0,35				
Structures located forward of 0,75 L from the AE (6)	bottom longitudinal ordinary stiffeners	bottom plating		0,20	2,2			CH 160
	floors and girders	bottom and inner bottom plating		0,25	1,8			CH 130
	side frames in panting area	side plating		0,20	2,2			CH 160
	webs of side girders in single side skin structures	side plating and face plate	$A < 65\ cm^2$ (7)	0,25	1,8	1,8		CH/SC 130
			$A \geq 65\ cm^2$ (7)	See Tab 3				
After peak (6)	internal structures	each other		0,20				
	side ordinary stiffeners	side plating		0,20				
	floors	bottom and inner bottom plating		0,20				
Machinery space (6)	centre girder	keel and inner bottom plating	in way of main engine foundations	0,45				
			in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,25	1,8	1,8		CH/SC 130
	side girders	bottom and inner bottom plating	in way of main engine foundations	0,45				
			in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,20	2,2	2,2		CH/SC 160

Hull area	Connection			w_F (1)	φ (2) (3)			p_1, in mm (see [2.3.6])
	of	to			CH	SC	ST	
	floors (except in way of main engine foundations)	bottom and inner bottom plating	in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,20	2,2	2,2		CH/SC 160
	floors in way of main engine foundations	bottom plating		0,35				
		foundation plates		0,45				
	floors	centre girder	single bottom	0,45				
			double bottom	0,25	1,8	1,8		CH/SC 130
Superstructures and deckhouses	external bulkheads	deck	in general	0,35				
			engine and boiler casings at corners of openings (15% of opening length)	0,45				
	internal bulkheads	deck		0,13	3,5	3,0	4,6	ST 260
	ordinary stiffeners	external and internal bulkhead plating		0,13	3,5	3,0	4,6	ST 260
Hatch covers	ordinary stiffener	plating		0,13	3,5	3,0	4,6	ST 260
Pillars	elements composing the pillar section	each other (fabricated pillars)		0,13				
	pillars	deck	pillars in compression	0,35				
			pillars in tension	Full penetration welding				
Ventilators	coamings	deck		0,35				
Rudders	webs in general	each other		0,20		2,2		SC 160
		plating	in general	0,20		2,2		SC 160
			top and bottom plates of rudder plating	0,35				
		solid parts or rudder stock		According to Ch 10, Sec 1, [7.4] or Ch 10, Sec 1, [7.5]				
	horizontal and vertical webs directly connected to solid parts	each other		0,45				
		plating		0,35				

(1) In connections for which $w_F \geq 0,35$, continuous fillet welding is to be adopted.

(2) For coefficient φ see [2.3.4]. In connections for which no φ value is specified for a certain type of intermittent welding, such type is not permitted and continuous welding is to be adopted.

(3) CH = chain welding, SC = scallop welding, ST = staggered welding.

(4) Ends of ordinary stiffeners means the area extended 75 mm from the span ends. Where end brackets are fitted, ends means the area extended in way of brackets and at least 50 mm beyond the bracket toes.

(5) In tanks intended for the carriage of ballast or fresh water, continuous welding with $w_F = 0,35$ is to be adopted.

(6) For connections not mentioned, the requirements for the central part apply.

(7) A is the face plate sectional area of the side girders, in cm^2.

Table 3 : Required throat thickness

t, in mm	t_T, in mm	t, in mm	t_T, in mm
6	3,0	17	7,0
8	3,5	18	7,0
9	4,0	19	7,5
10	4,5	20	7,5
11	5,0	21	8,5
12	5,5	22	8,5
13	6,0	23	9,0
14	6,0	24	9,0
15	6,5	25	10,0
16	6,5	26	10,0

2.3.6 Weld dimensions in a specific case

Where intermittent fillet welding is adopted with:

- length d = 75 mm
- throat thickness $\mathbf{t_T}$ specified in Tab 3 depending on the thickness **t** defined in [2.3.5] the weld spacing may be taken equal to the value $\mathbf{p_1}$ defined in Tab 2.

The values of $\mathbf{p_1}$ in Tab 2 may be used when $8 \le \mathbf{t} \le 16$mm.

For thicknesses t less than 8 mm, the values of p1 may be increased, with respect to those in Tab 2, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding without exceeding the limits in [2.3.4].

For thicknesses t greater than 16 mm, the values of p1 are to be reduced, with respect to those in Tab 2, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding.

without exceeding the limits in [2.3.4].

2.3.7 Throat thickness of welds between cut-outs

The throat thickness of the welds between the cut-outs in primary supporting member webs for the passage of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$$t_{TC} = t_T \frac{\varepsilon}{\lambda}$$

where:

$\mathbf{t_T}$: Throat thickness defined in [2.3.5]

ε, λ : Dimensions, in mm, to be taken as shown in:

- Fig 4, for continuous welding
- Fig 5, for intermittent scallop welding.

Figure 4: Continuous fillet welding between cut-outs

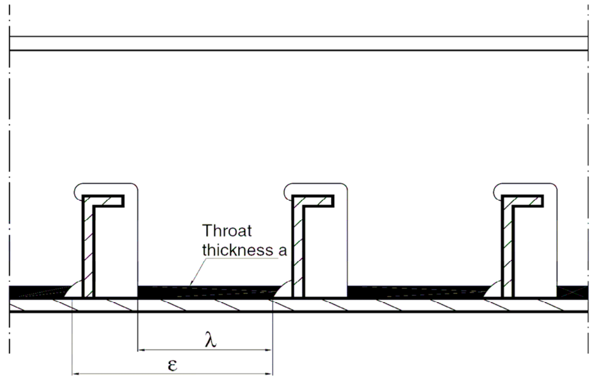
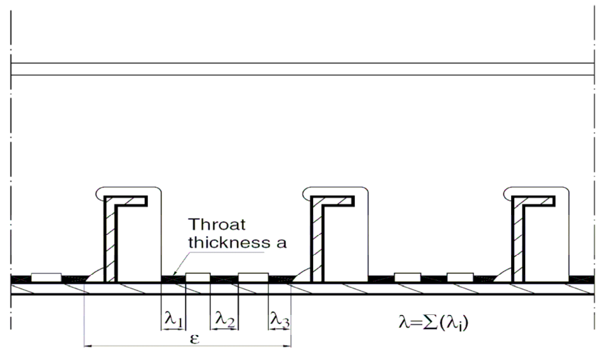


Figure 5: Intermittent scallop fillet welding between cut-outs



2.3.8 Throat thickness of welds connecting ordinary stiffeners with primary supporting members

The throat thickness of fillet welds connecting ordinary stiffeners and collar plates, if any, to the web of primary supporting members is to be not less than 0,35 $\mathbf{t_W}$, where $\mathbf{t_W}$ is the web gross thickness, in mm.

Where primary supporting member web stiffeners are welded to ordinary stiffener face plates, in certain cases Tasneef may require the above throat thickness to be obtained, in mm, from the following formula:

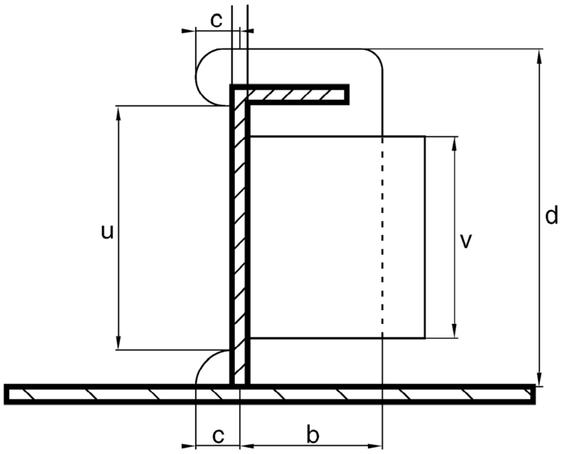
$$t_T = \frac{4(p_S + p_W)s\ell\left(1 - \frac{s}{2\ell}\right)}{u + v\left(\frac{c + 0,2d}{b + 0,2d}\right)}$$

where:

$\mathbf{p_S}$, $\mathbf{p_W}$: Still water and wave pressure, respectively, in kN/m^2, acting on the ordinary stiffener, defined in Ch. 5, Sec 2, [2.3]

b,c,d,u,v: Main dimensions, in mm, of the cut-out shown in Fig 6.

Figure 6: End connection of ordinary stiffener Dimensions of the cut-out



2.3.9 Throat thickness of deep penetration fillet welding

When fillet welding is carried out with automatic welding procedures, the throat thickness required in [2.3.5] may be reduced up to 15%, depending on the properties of the electrodes and consumables.

However, this reduction may not be greater than 1,5 mm.

The same reduction applies also for semi-automatic procedures where the welding is carried out in the down hand position.

2.4 Partial and full T penetration welding

2.4.1 General

Partial or full T penetration welding is to be adopted for connections subjected to high stresses for which fillet welding is considered unacceptable by Tasneef.

Typical edge preparations are indicated in:

- for partial penetration welds: in Fig 7 and Fig 8, in which **f**, in mm, is to be taken between 3 mm and **t**/3, and **α** between 45° and 60°
- for full penetration welds: in Fig 9 and Fig 10, in witch **f**, in mm, is to be taken between 0 and 3 mm, and **α** between 45° and 60°

Back gouging is generally required for full penetration welds.

Figure 7: Partial penetration weld

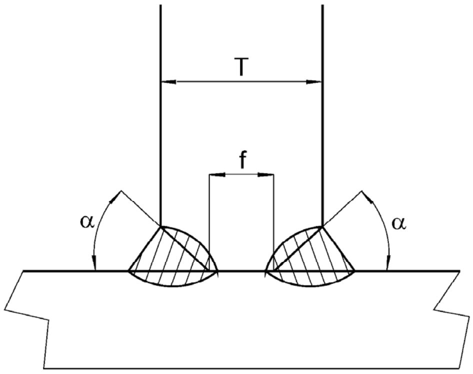


Figure 8: Partial penetration weld

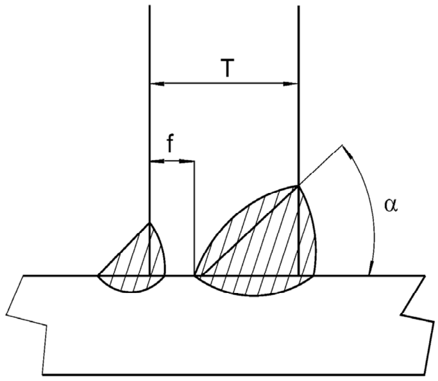


Figure 9: Full penetration weld

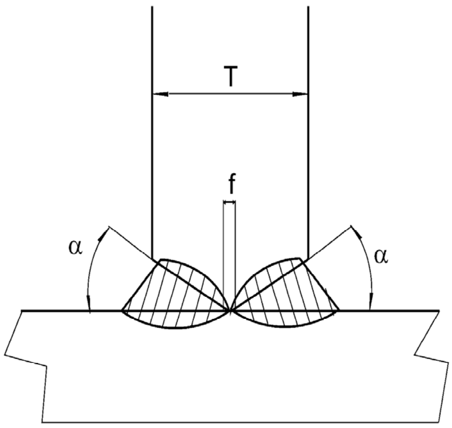
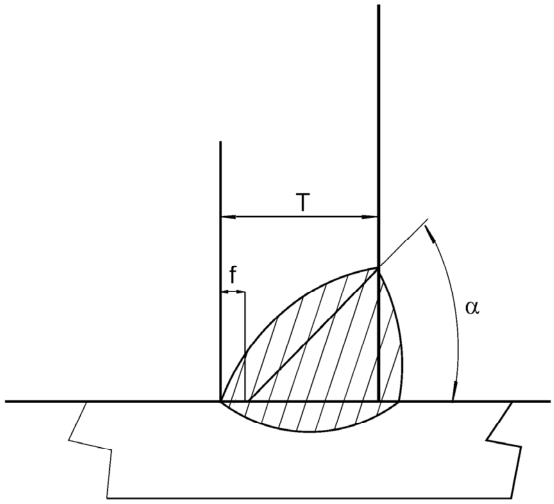


Figure 10: Full penetration weld



2.4.2 Lamellar tearing

Precautions are to be taken in order to avoid lamellar tears, which may be associated with:

- cold cracking when performing T connections between plates of considerable thickness or high restraint
- large fillet welding and full penetration welding on higher strength steels.

2.5 Lap-joint welding

2.5.1 General

Lap-joint welding may be adopted for:

- peripheral connection of doublers
- internal structural elements subjected to very low stresses.

Elsewhere, lap-joint welding may be allowed by Tasneef on a case by case basis, if deemed necessary under specific conditions.

Continuous welding is generally to be adopted.

2.5.2 Gap

The surfaces of lap-joints are to be in sufficiently close contact.

2.6 Slot welding

2.6.1 General

Slot welding may be adopted in very specific cases subject to the special agreement of Tasneef, e.g. doublers according to Ch 4, Sec 3, [2.1].

In general, slot welding of doublers on the outer shell and strength deck is not permitted within 0,6L amidships. Beyond this zone, slot welding may be accepted by Tasneef on a case by case basis.

Slot welding is, in general, permitted only where stresses act in a predominant direction. Slot welds are, as far as possible, to be aligned in this direction.

2.6.2 Dimensions

Slot welds are to be of appropriate shape (in general oval) and dimensions, depending on the plate thickness, and may not be completely filled by the weld.

Typical dimensions of the slot weld and the throat thickness of the fillet weld are given in the “Guide for welding”.

The distance between two consecutive slot welds is to be not greater than a value which is defined on a case by case basis taking into account:

- the transverse spacing between adjacent slot weld lines
- the stresses acting in the connected plates
- the structural arrangement below the connected plates.

2.7 Plug welding

2.7.1 Plug welding may be adopted only when accepted by Tasneef on a case by case basis, according to specifically defined criteria. Typical details are given in the “Guide for welding”.

3 Specific weld connections

3.1 Corner joint welding

3.1.1 Corner joint welding, as adopted in some cases at the corners of tanks, performed with ordinary fillet welds, is permitted provided the welds are continuous and of the required size for the whole length on both sides of the joint.

3.1.2 Alternative solutions to corner joint welding may be considered by Tasneef on a case by case basis.

3.2 Bilge keel connection

The intermediate flat, through which the bilge keel is connected to the shell according to Ch 4, Sec 4, [6], is to be welded as a shell doubler by continuous fillet welds.

The butt welds of the doubler and bilge keel are to be full penetration and shifted from the shell butts.

The butt welds of the bilge plating and those of the doublers are to be flush in way of crossing, respectively, with the doubler and with the bilge keel.

3.3 Connection between propeller post and propeller shaft bossing

3.3.1 Fabricated propeller posts are to be welded with full penetration welding to the propeller shaft bossing.

3.4 Bar stem connections

The bar stem is to be welded to the bar keel generally with butt welding.

The shell plating is also to be welded directly to the bar stem with butt welding.

4 Workmanship

4.1 Forming of plates

4.1.1 Hot or cold forming is to be performed according to the requirements of recognised standards or those accepted by Tasneef on a case by case basis depending on the material grade and rate of deformation.

Recommendations for cold and hot forming are given in the "Guide for welding".

4.2 Welding procedures and consumables

4.2.1 The various welding procedures and consumables are to be used within the limits of their approval and in accordance with the conditions of use specified in the respective approval documents.

4.3 Welding operations

4.3.1 Weather protection

Adequate protection from the weather is to be provided to parts being welded; in any event, such parts are to be dry.

In welding procedures using bare, cored or coated wires with gas shielding, the welding is to be carried out in weather protected conditions, so as to ensure that the gas outflow from the nozzle is not disturbed by winds and draughts.

4.3.2 Butt connection edge preparation

The edge preparation is to be of the required geometry and correctly performed.

In particular, if edge preparation is carried out by flame, it is to be free from cracks or other detrimental notches.

Recommendations for edge preparation are given in the "Guide for welding".

4.3.3 Surface condition

The surfaces to be welded are to be free from rust, moisture and other substances, such as mill scale, slag caused by oxygen cutting, grease or paint, which may produce defects in the welds.

Effective means of cleaning are to be adopted particularly in connections with special welding procedures; flame or mechanical cleaning may be required.

The presence of a shop primer may be accepted, provided it has been approved by Tasneef.

Shop primers are to be approved by Tasneef for a specific type and thickness according to Part D, Ch. 5, Sec 3 of TASNEEFMIL.

4.3.4 Assembling and gap

The setting appliances and system to be used for positioning are to ensure adequate tightening adjustment and an appropriate gap of the parts to be welded, while allowing maximum freedom for shrinkage to prevent cracks or other defects due to excessive restraint.

The gap between the edges is to comply with the required tolerances or, when not specified, it is to be in accordance with normal good practice.

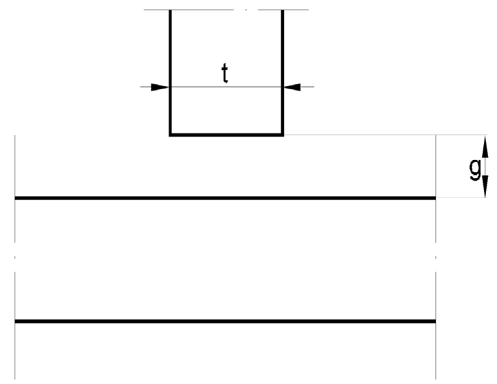
4.3.5 Gap in fillet weld T connections

In fillet weld T connections, a gap g, as shown in Fig 11, not greater than 2 mm may be accepted without increasing the throat thickness calculated according to [2.3.5] to [2.3.9], as applicable.

In the case of a gap greater than 2 mm, the above throat thickness is to be increased accordingly as specified in Sec 2 for some special connections of various vessel types. Recommendations are also given in the "Guide for welding".

In any event, the gap g may not exceed 4 mm.

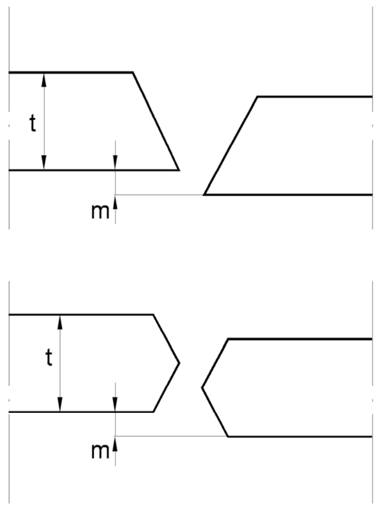
Figure 11: Gap in fillet weld T connections



4.3.6 Plate misalignment in butt connections

The misalignment m, measured as shown in Fig 12, between plates with the same gross thickness t is to be less than 0,15 **t**, without being greater than 3 mm, where **t** is the gross thickness of the thinner abutting plate.

Figure 12: Plate misalignment in butt connections



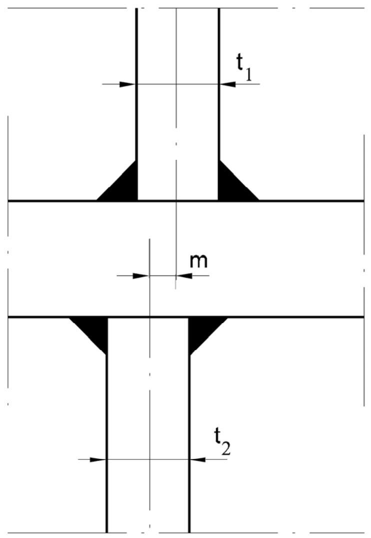
4.3.7 Misalignment in cruciform connections

The misalignment **m** in cruciform connections, measured on the median lines as shown in Fig 13, is to be less than:

- **t**/2, in general, where **t** is the gross thickness of the thinner abutting plate

Tasneef may require lower misalignment to be adopted for cruciform connections subjected to high stresses.

Figure 13: Misalignment in cruciform connections



4.3.8 Assembling of aluminium alloy parts

When welding aluminium alloy parts, particular care is to be taken so as to:

- reduce as far as possible restraint from welding shrinkage, by adopting assembling and tack welding procedures suitable for this purpose
- keep possible deformations within the allowable limits.

4.3.9 Preheating and interpass temperatures

Suitable preheating, to be maintained during welding, and slow cooling may be required by Tasneef on a case by case basis.

4.3.10 Welding sequences

Welding sequences and direction of welding are to be determined so as to minimise deformations and prevent defects in the welded connection.

All main connections are generally to be completed before the vessel is afloat.

Departures from the above provision may be accepted by Tasneef on a case by case basis, taking into account any detailed information on the size and position of welds and the stresses of the zones concerned, both during vessel launching and with the vessel afloat.

4.3.11 Interpass cleaning

After each run, the slag is to be removed by means of a chipping hammer and a metal brush; the same precaution is to be taken when an interrupted weld is resumed or two welds are to be connected.

4.3.12 Stress relieving

It is recommended and in some cases it may be required that special structures subject to high stresses, having complex shapes and involving welding of elements of considerable thickness (such as rudder spades and stern frames), are prefabricated in parts of adequate size and stress-relieved in the furnace, before final assembly, at a temperature within the range 550°C ÷ 620°C, as appropriate for the type of steel.

4.4 Crossing of structural elements

4.4.1 In the case of T crossing of structural elements (one element continuous, the other physically interrupted at the crossing) when it is essential to achieve structural continuity through the continuous element (continuity obtained by means of the welded connections at the crossing), particular care is to be devoted to obtaining the correspondence of the interrupted elements on both sides of the continuous element.

Suitable systems for checking such correspondence are to be adopted.

5 Modifications and repairs during construction

5.1 General

5.1.1 Deviations in the joint preparation and other specified requirements, in excess of the permitted tolerances and found during construction, are to be repaired as agreed with Tasneef on a case by case basis.

5.2 Gap and weld deformations

When the gap exceeds the required values, welding by bu ilding up or repairs are to be authorised by the Surveyor.

Recommendations for repairing gap and weld deformations not complying with the required standards are given in the "Guide for welding".

5.3 Defects

Defects and imperfections on the materials and welded connections found during construction are to be evaluated for possible acceptance on the basis of the applicable requirements of Tasneef.

Where the limits of acceptance are exceeded, the defective material and welds are to be discarded or repaired, as deemed appropriate by the Surveyor on a case by case basis.

When any serious or systematic defect is detected either in the welded connections or in the base material, the manufacturer is required to promptly inform the Surveyor and submit the repair proposal.

The Surveyor may require destructive or non-destructive examinations to be carried out for initial identification of the defects found and, in the event that repairs are undertaken, for verification of their satisfactory completion.

5.4 Repairs on structures already welded

5.4.1 In the case of repairs involving the replacement of material already welded on the hull, the procedures to be adopted are to be agreed with Tasneef on a case by case basis, considering these modifications as repairs of the in-service vessel's hull.

6 Inspections and checks

6.1 Visual and non-destructive examinations

6.1.1 After completion of the welding operation and workshop inspection, the structure is to be presented to the Surveyor for visual examination at a suitable stage of fabrication.

As far as possible, the results on non-destructive examinations are to be submitted.

6.1.2 Non-destructive examinations are to be carried out with appropriate methods and techniques suitable for the individual applications, to be agreed with the Surveyor on a case by case basis.

6.1.3 Radiographic examinations are to be carried out on the welded connections of the hull in accordance with Tasneef requirements ,the approved plans and the Surveyor's instructions.

6.1.4 Tasneef may allow radiographic examinations to be partially replaced by ultrasonic examinations.

6.1.5 When the visual or non-destructive examinations reveal the presence of unacceptable defects, the relevant connection is to be repaired to sound metal for an extent and according to a procedure agreed with the Surveyor.

The repaired zone is then to be submitted to non-destructive examination, using a method at least as effective as that adopted the first time and deemed suitable by the Surveyor to verify that the repair is satisfactory.

Additional examinations may be required by the Surveyor on a case by case basis.

6.1.6 Ultrasonic and magnetic particle examinations may also be required by the Surveyor in specific cases to verify the quality of the base material.

SECTION 2 TESTING

1 Pressure tests

1.1 Application

1.1.1 The following requirements determine the testing conditions for watertight or weathertight structures.

The purpose of these tests is to check the tightness and/or the strength of structural elements.

1.1.2 Tests are to be carried out in the presence of the Surveyor at a stage sufficiently close to completion so that any subsequent work would not impair the strength and tightness of the structure.

In particular, tests are to be carried out after air vents and sounding pipes are fitted.

1.2 Definitions

1.2.1 Shop primer

Shop primer is a thin coating applied after surface preparation and prior to fabrication as a protection against corrosion during fabrication.

1.2.2 Protective coating

Protective coating is a final coating protecting the structure from corrosion.

1.2.3 Structural testing

Structural testing is a hydrostatic test carried out to demonstrate the tightness of the tanks and the structural adequacy of the design. Where practical limitations prevail and hydrostatic testing is not feasible (for example when it is difficult, in practice, to apply the required head at the top of the tank), hydropneumatic testing may be carried out instead.

Structural testing is to be carried out according to [2.2].

1.2.4 Hydropneumatic testing

Hydropneumatic testing is a combination of hydrostatic and air testing, consisting in filling the tank to the top with water and applying an additional air pressure.

Hydro pneumatic testing is to be carried out according to [2.3].

1.2.5 Leak testing

Leak testing is an air or other medium test carried out to demonstrate the tightness of the structure.

Leak testing is to be carried out according to [2.4].

1.2.6 Hose testing

Hose testing is carried out to demonstrate the tightness of structural items not subjected to hydrostatic or leak testing and of other components which contribute to the watertight or weathertight integrity of the hull.

Hose testing is to be carried out according to [2.5].

1.2.7 Margin line

The margin line is a line drawn at least 76 mm below the upper surface of the bulkhead deck at side.

1.2.8 Sister ship

A sister ship is a vessel having the same main dimensions, general arrangement, capacity plan and structural design as those of the first vessel in a series.

2 Watertight compartments

2.1 General

2.1.1 The requirements in [2.1] to [2.6] intend generally to verify the adequacy of the structural design of the tanks, based on the loading conditions which prevailed when determining the tank structure scantlings.

2.1.2 General requirements for testing of watertight compartments are given in Tab 1, in which the types of testing referred to are defined in [1.2].

Table 1: Watertight compartments - General testing requirements

Compartment or structure to be tested	Type of testing	Structural test pressure	Remarks
Double bottom tanks	Structural testing **(1)**	The greater of the following: • head of water up to the top of overflow • head of water up to the margin line	Tank boundaries tested from at least one side
Tank bulkheads, deep tanks	Structural testing	The greater of the following **(2)**: • head of water up to the top of overflow • 2,4 m head of water above highest point of tank **(5)** • setting pressure of the safety relief valves, where relevant	Tank boundaries tested from at least one side
Fore and after peaks used as tank	Structural testing	The greater of the following: • head of water up to the top of overflow • 2,4 m head of water above highest point of tank **(5)**	Test of the after peak carried out after the sterntube has been fitted
Fore peak not used as tank	Structural testing	The greater of the following: • maximum head of water to be sustained in the event of damage • head of water up to the margin line	
After peak not used as tank	Leak testing		
Cofferdams	Structural testing **(3)**	The greater of the following: • head of water up to the top of overflow • 2,4 m head of water above highest point of tank **(5)**	
Watertight bulkheads	Hose testing **(4)**		
Watertight doors below freeboard or bulkhead deck **(6)**	Structural testing	Head of water up to the bulkhead deck	Test to be carried out before the ship is put into service, either before or after the door is fitted on board
Double plate rudders	Leak testing		
Shaft tunnel clear of deep tanks	Hose testing		
Shell doors	Hose testing		
Weathertight hatch covers and closing appliances	Hose testing		
Chain locker (if aft of collision bulkhead)	Structural testing	Head of water up to the top	

Compartment or structure to be tested	Type of testing	Structural test pressure	Remarks
Independent tanks	Structural testing	Head of water up to the top of overflow, but not less than 0,90 m	

(1) Hydropneumatic or leak testing may be accepted under the conditions specified in [2.3] and [2.4], respectively.

(2) Where applicable, the highest point of the tank is to be measured to deck and excluding hatches. In holds for liquid cargo or ballast with large hatch covers, the highest point of tanks is to be taken at the top of the hatch.

(3) Hydropneumatic or leak testing may be accepted under the conditions specified in [2.3] and [2.4], respectively, when,at Tasneef's discretion, it is considered significant also in relation to the construction techniques and the welding procedures adopted.

(4) When a hose test cannot be performed without damaging possible outfitting (machinery, cables, switchboards, insulation, etc..) already installed, it may be replaced, at Tasneef discretion, by a careful visual inspection of all the crossings and welded joints. Where necessary, a dye penetrant test or ultrasonic leak test may be required.

(5) For vessels of less than 40 m in length, 2,4 m may be replaced by 0,3H with $0,9 \le 0,3\,H \le 2,4$, where H is the height of compartment, in m.

(6) The means of closure are to be subjected to a hose test after fitting on board.

2.2 Structural testing

2.2.1 Structural testing may be carried out before or after launching.

2.2.2 Structural testing may be carried out after application of the shop primer.

2.2.3 Structural testing may be carried out after the protective coating has been applied, provided that one of the following two conditions is satisfied:

- all the welds are completed and carefully inspected visually to the satisfaction of the Surveyor prior to the application of the protective coating
- leak testing is carried out prior to the application of the protective coating.

In the absence of leak testing, protective coating is to be applied after the structural testing of:

- all erection welds, both manual and automatic
- all manual fillet weld connections on tank boundaries and manual penetration welds.

2.3 Hydropneumatic testing

2.3.1 When a hydropneumatic testing is performed, the conditions are to simulate, as far as practicable, the actual loading of the tank.

The value of the additional air pressure is at the discretion of Tasneef, but is to be at least as defined in [2.4.2] for leak testing.

The same safety precautions as for leak testing (see [2.4.2]) are to be adopted.

2.4 Leak testing

2.4.1 An efficient indicating liquid, such as a soapy water solution, is to be applied to the welds.

2.4.2 Where leak testing is carried out, in accordance with Tab 1, an air pressure of $0,15 \cdot 10^5$ Pa is to be applied during the test.

Prior to inspection, it is recommended that the air pressure in the tank should be raised to $0,2 \cdot 10^5$ Pa and kept at this level for approximately 1 hour to reach a stabilized state, with a minimum number of personnel in the vicinity of the tank, and then lowered to the test pressure.

The test may be conducted after the pressure has reached a stabilized state at $0,2 \cdot 10^5$ Pa, without lowering the pressure, provided Tasneef is satisfied of the safety of the personnel involved in the test.

2.4.3 A U-tube filled with water up to a height corresponding to the test pressure is to be fitted to avoid overpressure of the compartment tested and verify the test pressure.

The U-tube is to have a cross-section larger than that of the pipe supplying air.

In addition, the test pressure is also to be verified by means of one master pressure gauge.

Alternative means which are considered to be equivalently reliable may be accepted at the discretion of the Surveyor.

2.4.4 Leak testing is to be carried out, prior to the application of a protective coating, on all fillet weld connections on tank boundaries, and penetration and erection welds on tank boundaries excepting welds made by automatic processes.

Selected locations of automatic erection welds and pre-erection manual or automatic welds may be required to be similarly tested to the satisfaction of the Surveyor, taking account of the quality control procedures operating in the shipyard.

For other welds, leak testing may be carried out after the protective coating has been applied, provided that such welds have been carefully inspected visually to the satisfaction of the Surveyor.

2.4.5 Any other recognized method may be accepted to the satisfaction of the Surveyor.

2.5 Hose testing

2.5.1 When hose testing is required to verify the tightness of the structures, as defined in Tab 1, the minimum pressure in the hose, at least equal to $2,0*10^5$ Pa, is to be applied at a maximum distance of 1,5 m.

The nozzle diameter is to be not less than 12 mm.

2.6 Other testing methods

2.6.1 Other testing methods may be accepted, at the discretion of Tasneef, based upon consiequivalency derations.

3 Miscellaneous

3.1 Watertight decks, trunks, etc.

3.1.1 After completion, a hose or flooding test is to be applied to watertight decks and a hose test to watertight trunks, tunnels and ventilators.

3.2 Doors in bulkheads above the bulkhead deck

3.2.1 Doors are to be designed and constructed as weathertight doors and, after installation, subjected to a hose test from each side for weathertightness.

3.3 Semi-watertight doors

3.3.1 Internal openings fitted with semi-watertight means of closure are able to sustain a constant head of water corresponding to the immersion relevant to the highest waterline after damage at the equilibrium of the intermediate stages of flooding.

Semi-watertight openings may lead to progressive flooding if they are located below the final equilibrium waterline after damage.

These means of closure are to be subjected to a structural test at the manufacturer's works. The head of water is to be up to the highest waterline after damage at the equilibrium of the intermediate stages of flooding. The duration of the test is to be at least 30 min.

A leakage quantity of approximately 100 l/hour is considered as being acceptable for a 1,35 m2 opening.

The means of closure are to be subjected to a hose test after fitting on board.

3.4 Steering nozzles

3.4.1 Upon completion of manufacture, the nozzle is to be subjected to a leak test.

4 Working tests

4.1 Working test of windlass

4.1.1 The working test of the windlass is to be carried out on board in the presence of a Surveyor.

4.1.2 The test is to demonstrate that the windlass complies with the requirements of Ch 10, Sec 4, [3.7] and, in particular, that it works adequately and has sufficient power to weigh the bower anchors (excluding the housing of the anchors in the hawse pipe) suspended to 82,5 m of chain cable and verifying that the time required for the weighing (excluding the housing in the hawse pipe) does not exceed 9 min.

APPENDIX 1 REFERENCE SHEETS FOR SPECIAL STRUCTURAL DETAILS

1 Contents

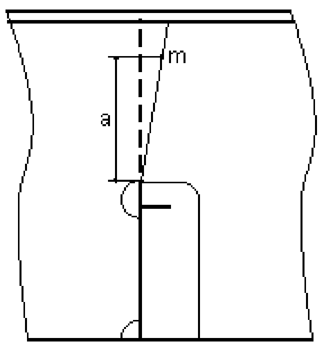
1.1 General

1.1.1 This appendix includes the reference sheets for vessels having longitudinally framed side and specify the requirements to comply with

In general such instructions are required for vessels having length **L**>50 m.

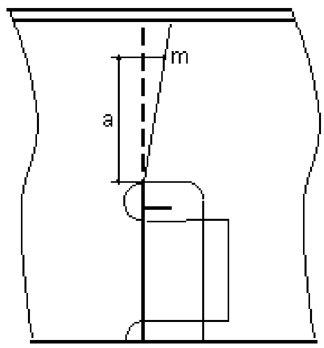
With regard to vessel's type and service performances, Tasneef may require the application also to vessels having lower length L.

ALL LONGITUDINALLY FRAMED SIDE VESSELS

<table>
<tr><td>AREA 1: Side between $0,7T_B$ and 1,15T from the baseline</td><td colspan="2">Connection of side longitudinal ordinary stiffeners with transverse primary supporting members - No collar plate</td><td>Sheet 1.1</td></tr>
<tr><td colspan="4">
t_W = web thickness of transverse primary supporting member</td></tr>
<tr><td colspan="2">SCANTLINGS:</td><td colspan="2">FATIGUE:</td></tr>
<tr><td colspan="2">Net sectional area of the web stiffener according to Ch 4, Sec 3, 4.7.</td><td colspan="2">Fatigue check not required.</td></tr>
<tr><td colspan="2">CONSTRUCTION:</td><td colspan="2">NDE:</td></tr>
<tr><td colspan="2">• Web stiffener not compulsory. When fitted, its misalignment m with the web of the side longitudinal $\leq$ a / 50.
• Cut-outs in the web free of sharps notches.
• Gap between web and side longitudinal to be not greater than 4 mm.</td><td colspan="2">Visual examination 100%.</td></tr>
<tr><td colspan="4">WELDING AND MATERIALS:</td></tr>
<tr><td colspan="4">Welding requirements:
- continuous fillet welding along the connection of web with side longitudinal,
- throat thickness according to Ch 7, Sec 1, [2.3.7], in case of gap g greater than 2 mm increase the throat thickness by 0,7(g-2) mm,
- weld around the cuts in the web at the connection with the longitudinal and the side shell,
- avoid burned notches on web.</td></tr>
</table>

ALL LONGITUDINALLY FRAMED SIDE VESSELS

AREA 1: Side between $0,7T_B$ and 1,15T from the baseline	**Connection of side longitudinal ordinary stiffeners with transverse primary supporting members - One collar plate**	**Sheet 1.2**



t_W = web thickness of transverse primary supporting member

t_{CP} = collar plate thickness

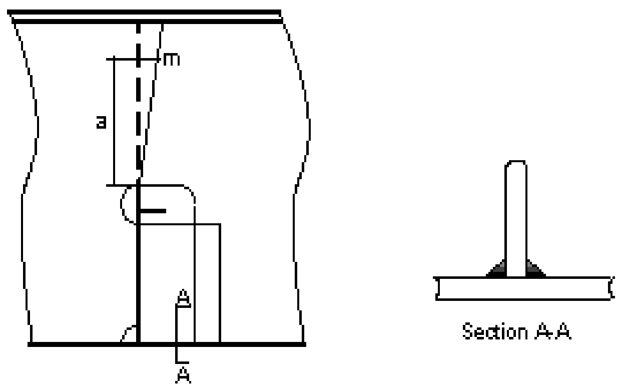
SCANTLINGS:	**FATIGUE:**
Net sectional area of the web stiffener according to Ch 4, Sec 2, [4.5.1].	Fatigue check not required.
CONSTRUCTION:	**NDE:**
• Web stiffener not compulsory. When fitted, its misalignment m with the web of the side longitudinal ≤ a / 50. • Misalignment between web and collar plate ≤ t_{CP}. • *Cut-outs in the web free of sharps notches.* • Gap between web and side longitudinal and between collar plate and side longitudinal to be not greater than 4 mm.	Visual examination 100%.

WELDING AND MATERIALS:

- *Welding requirements:*
  - *continuous fillet welding along the connection of web and collar plate with side longitudinal and at the lap joint between web and collar plate,*
  - *throat thickness according to Ch 7, Sec 1, [2.3.7], in case of gap g greater than 2 mm increase the throat thickness by 0,7(g-2) mm,*
  - *weld around the cuts in the web at the connection with the longitudinal and the side shell,*
  - *avoid burned notches on web.*
- Fillet welding of overlapped joint to be done all around.

ALL LONGITUDINALLY FRAMED SIDE VESSELS

AREA 1: Side between $0,7T_B$ and 1,15T from the baseline	**Connection of side longitudinal ordinary stiffeners with transverse primary supporting members - One large collar plate**	**Sheet 1.3**



t_W = web thickness of transverse primary supporting member

t_{CP} = collar plate thickness

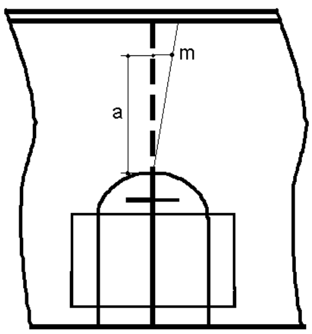
SCANTLINGS:	**FATIGUE:**
Net sectional area of the web stiffener according to Ch 4, Sec 2, [4.5.1].	Fatigue check not required.

CONSTRUCTION:	**NDE:**
• Web stiffener not compulsory. When fitted, its misalignment m with the web of the side longitudinal ≤ a / 50. • Misalignment between web and collar plate ≤ t_{CP}. • *Cut-outs in the web free of sharps notches.* • Gap between web and side longitudinal and between collar plate and side longitudinal to be not greater than 4 mm.	Visual examination 100%.

WELDING AND MATERIALS:
• Welding requirements: - *continuous fillet welding along the connection of web and collar plate with side longitudinal and at the lap joint between web and collar plate,* - *throat thickness according to Ch 7, Sec 1, [2.3.7], in case of gap g greater than 2 mm increase the throat thickness by 0,7(g-2) mm,* - T joint connection of collar plate with side shell: see section A-A, - weld around the cuts in the web at the connection with the longitudinal and the side shell, - *avoid burned notches on web.* • Fillet welding of overlapped joint to be done all around.

ALL LONGITUDINALLY FRAMED SIDE VESSELS

AREA 1: Side between $0,7T_B$ and 1,15T from the baseline	Connection of side longitudinal ordinary stiffeners with transverse primary supporting members - Two collar plates	Sheet 1.4



t_W = web thickness of transverse primary supporting member

t_{CP} = collar plate thickness

SCANTLINGS:	FATIGUE:
Net sectional area of the web stiffener according to Ch 4, Sec 2, [4.5.1].	Fatigue check not required.

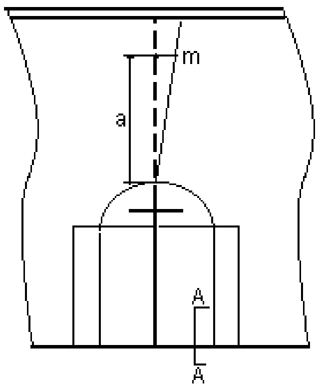
CONSTRUCTION:	NDE:
• Web stiffener not compulsory. When fitted, its misalignment m with the web of the side longitudinal $\leq$ a / 50. • Misalignment between collar plates across the side longitudinal $\leq t_{CP}$ / 2. • *Cut-outs in the web free of sharps notches.* • Gap between collar plates and side longitudinal to be not greater than 4 mm.	Visual examination 100%.

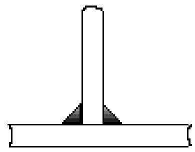
WELDING AND MATERIALS:

- Welding requirements:
  - *continuous fillet welding along the connection of collar plates with side longitudinal and at the lap joint between web and collar plates,*
  - *throat thickness according to Ch 7, Sec 1, [2.3.7], in case of gap g greater than 2 mm increase the throat thickness by 0,7(g-2) mm,*
  - avoid burned notches on web.
- Fillet welding of overlapped joint to be done all around.

ALL LONGITUDINALLY FRAMED SIDE VESSELS

AREA 1: Side between $0,7T_B$ and 1,15T from the baseline	Connection of side longitudinal ordinary stiffeners with transverse primary supporting members - Two large collar plates	Sheet 1.5





Section A-A

t_W = web thickness of transverse primary supporting member

t_{CP} = collar plate thickness

SCANTLINGS:	FATIGUE:
Net sectional area of the web stiffener according to Ch 4, Sec 2, [4.5.1].	Fatigue check not required.

CONSTRUCTION:	NDE:
• Web stiffener not compulsory. When fitted, its misalignment m with the web of the side longitudinal $\leq$ a / 50. • Misalignment between collar plates across the side longitudinal $\leq t_{CP}$ / 2. • *Cut-outs in the web free of sharps notches.* • Gap between collar plates and side longitudinal to be not greater than 4 mm.	Visual examination 100%.

WELDING AND MATERIALS:

- Welding requirements:
  - *continuous fillet welding along the connection of collar plates with side longitudinal and at the lap joint between web and collar plates,*
  - *throat thickness according to Ch 7, Sec 1, [2.3.7], in case of gap g greater than 2 mm increase the throat thickness by 0,7(g-2) mm,*
  - T joint connection of collar plates with side shell: see section A-A,
  - avoid burned notches on web.
- Fillet welding of overlapped joint to be done all around.