# Rules for the Classification of Electric Harbour Craft

*Effective from 1 February 2024*

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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 authorised 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 G overnments.

**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 reinstatemen t. 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 th e 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 p art 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 certificati 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 seaw orthiness, 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 righ t 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 authorisation 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 cl ass, 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 c lients 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 propert y 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, certificat es, 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 t o 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.

# RULES FOR THE CLASSIFICATION OF ELECTRIC HARBOUR CRAFT

## Parts **A B C**

Part A **CLASSIFICATION AND SURVEYS**

Part B **HULL AND STABILITY**

Part C **MACHINERY, SYSTEMS AND FIRE PROTECTION**

# CHAPTER 1
# REQUIREMENTS

Part A
# Classification and Surveys

Chapter 1
# REQUIREMENTS

# SECTION 1 FIELD OF APPLICATION OF THE RULES, SERVICE NOTATION AND GENERAL

## 1 Field of application of the Rules

### 1.1

**1.1.1** These Rules are for the purpose of classification of electric harbour craft ("craft") with steel, reinforced plastic or aluminium alloy hull - including catamarans - in commercial use, other than those in use for recreational, sport and pleasure, having a load line length between 4 m and 24 m, with a maximum speed of 45 knots and carrying no more than 12 passengers, whereby the electric power is assumed to be solely supplied by shore-charged batteries (Electrical Storage Systems) or fuel cells.

The application of these Rules to craft with reinforced plastic hull or aluminium alloy hull having different load line length or speed may be considered by the Society on a case-by-case basis, depending on their specific operation and construction characteristics.

Classification and Survey requirement in Part A of the Rules for the Classification of Ships are applicable in general including steel hull, with specific consideration for reinforced plastic hull in Sec 2 and for aluminium hull in Sec 3.

Where necessary, in the various parts of these Rules, specific conditions relevant to the field of application of the requirements are given.

The requirements for assignment of special service notations will be established by Tasneef on a case by case basis, taking into account the specifics of a project and the requirements of Part E of the Rules for the Classification of Ships.

For the purpose of the assignment of special class notations, the requirements of Part F of the Rules for the Classification of Ships are to be complied with, as far as practicable, at Tasneef's discretion, in relation to the navigation and service notations, craft size and hull material.

## 2 Service Notation

### 2.1

**2.1.1** Craft complying with the classification requirements of these Rules are assigned with the service notation **ELECTRIC HARBOUR CRAFT** (the name/area of port or harbour), that may be completed by the following additional service features:

- **Crew Transfer**: when designed to transport crew and other personnel to and from ships within the named port or harbour or area.
- **Cargo**: when designed to transport deck cargo to and from ships within the named port or harbour or area.

## 3 General

### 3.1 Compliance with statutory rules and regulations

**3.1.1** With regard to what is not expressly stated or modified in these Rules, for the purpose of classification, the requirements of the Rules for the Classification of Ships, as far as applicable, are to be complied with.

The classification of a craft, and more in general, Tasneef's decisions and acts, do not absolve the Interested Party from compliance with any additional and/or more stringent rules and requirements, issued by the Administration of the state whose flag the craft is entitled to fly, and/or of the State of the base port from which the craft operates, and with any other specific provisions issued to this end.

### 3.2 Abbreviations

#### 3.2.1 Rules

In these Rules, the wording "Rules" is intended to mean the effective Tasneef "Rules for the Classification of Ships"; i. e., when in the text, reference is made to Part A of the Rules, reference is to be made to Part A of the Rules for the Classification of Ships.

### 3.3 Technical documentation

**3.3.1** Technical Documentation is to enable understanding of the design and construction of the craft and is to confirm compliance with the requirements given in these Rules.

Requirements for documentation are found in the beginning of each section.

# SECTION 2 FIELD OF APPLICATION AND SURVEYS OF CRAFT WITH REINFORCED PLASTIC HULL

## 1 Field of application

### 1.1

**1.1.1** The requirements of this Chapter apply to craft with reinforced plastic hull.

For the purpose of classification and surveys, the requirements of Part A of the Rules ("Rules for the Classification of Ships") are to be complied with, taking account of the modifications and additions specified in [2], [3] and [4], as far as the frequency and the technical requirements relevant to surveys are concerned.

## 2 Periodical surveys and relevant frequency, anticipations and postponements

### 2.1 Surveys in general

**2.1.1** For all periodical surveys, the requirements of Part A, Chapter 2, Section 2 of the Rules ("Rules for the Classification of Ships") are to be fulfilled. However, in the case of craft more than 15 years old, the frequency of the Bottom survey is subject to special consideration.

## 3 First Classification Surveys

### 3.1 First Classification Surveys of craft built under Tasneef supervision

**3.1.1** Special inspections are required at the following stages:

a) when the hull lamination starts with the application of gel-coat;

b) before starting the arrangement of internal stiffeners;

c) when the hull is extracted from the mould;

d) when the connection of the hull to the deck starts;

e) before the installation of the dolly, if any;

f) when the core of sandwich structure is arranged.

In addition, during the supervision of the first hull, an inspection of the shipyard is performed in order to verify that it is provided with adequate equipment in relation to the materials used and to the type of manufacture and that the quality of the laminates is ensured.

### 3.2 First Classification Surveys of craft built without Tasneef supervision

**3.2.1** The eligibility for class is evaluated on the basis of the substantial compliance with the applicable Tasneef Rules, with the examination of main drawings and documents and following the outcome of a First Classification Survey specifically carried out with an extension adequate to the individual cases.

Where appropriate, within reasonable limits, a proven service record of satisfactory performance may be used as criterion of equivalence. Special consideration will be given to craft of recent construction.

For the purpose of classification, it may be required that adequate data for the evaluation of materials, machinery and arrangements in general are made available; such adequate data may consist of the details of specific rules and requirements originally applied but, where appropriate, tests and checks, to be established in the individual cases, may also be required.

## 4 Periodical hull surveys

### 4.1 Annual surveys

**4.1.1** In the case of hulls made of sandwich type structures, it is to be carefully checked that the parts are not detached from the core. The check is to be performed by hammering the shell and evaluating the differences in the sound heard or by means of checks with non-destructive methods recognized by Tasneef.

**4.1.2** The connection between hull and deck is to be carefully checked, in particular when hull and deck are made of different materials.

### 4.2 Class renewal survey (hull) and bottom survey in dry condition

**4.2.1** In addition to the requirements for the Annual surveys given in [4.1], the presence of "osmosis" phenomena in the laminates of the underwater body and/or of cracks in the gel-coat is to be verified.

To this end, the craft is to be made available for the bottom survey in dry condition before the application of any paint, so as to allow a careful visual inspection.

# SECTION 3 FIELD OF APPLICATION AND SURVEYS OF CRAFT WITH ALUMINIUM ALLOY HULL

## 1 Field of application

### 1.1

**1.1.1** The requirements of this Chapter apply to craft with aluminium alloy hull.

The applicable requirements of Part A of the Rules ("Rules for the Classification of Ships") are generally to be complied with, taking account of the modifications and additions specified in [2] and [3], as far as the frequency and the technical requirements relevant to surveys are concerned.

## 2 Periodical surveys and relevant frequency, anticipations and postponements

### 2.1 Surveys in general

**2.1.1** For all periodical surveys, the requirements of Part A, Chapter 2, Section 2 of the Rules ("Rules for the Classification of Ships") are to be fulfilled. However, in the case of craft more than 15 years old, the frequency of the Bottom survey is subject to special consideration.

## 3 First Classification Surveys

### 3.1 First Classification Surveys of craft built without Tasneef supervision

**3.1.1** The eligibility for class is evaluated on the basis of the substantial compliance with the applicable Tasneef Rules, with the examination of main drawings and documents and following the outcome of a First Classification Survey specifically carried out with an extension adequate to the individual cases.

Where appropriate, within reasonable limits, a proven service record of satisfactory performance may be used as criterion of equivalence. Special consideration will be given to craft of recent construction.

For the purpose of classification, it may be required that adequate data for the evaluation of materials, machinery and arrangements in general are made available; such adequate data may consist of the details of specific rules and requirements originally applied but, where appropriate, tests and checks, to be established in the individual cases, may also be required.

# CHAPTER 1
# HULL GENERAL

## Section 1 Design Principles

# CHAPTER 2
# STABILITY

## Section 1 General Requirements

# CHAPTER 3
# HULL SCANTLINGS

# CHAPTER 4
# HULL OUTFITTING

## Section 1 Rudders

## Section 2 Propeller Shaft Brackets



## Section 3 Waterjets



## Section 4 Equipment

Part B
# Hull and Stability

CHAPTER 1
# HULL GENERAL

## SECTION 1 DESIGN PRINCIPLES

# SECTION 1 DESIGN PRINCIPLES

## 1 General

### 1.1 Applications

**1.1.1** Part B of these Rules regards the requirements concerning the determination of the minimum hull scantlings built in steel, reinforced plastic or aluminum alloy and the stability requirements.

**1.1.2 Direct calculations**

Tasneef may require direct calculations to be carried out, if deemed necessary.

Such calculations are to be carried out based on structural modelling, loading and checking criteria accepted by Tasneef.

## 2 Units

### 2.1

**2.1.1** Unless otherwise specified, the following units are used in the Rules:

- thickness of plating, in mm,
- section modulus of stiffeners, in $cm^3$,
- shear area of stiffeners, in $cm^2$,
- span and spacing of stiffeners, in m,
- stresses, in $N/mm^2$,
- concentrated loads, in kN,
- distributed loads, in kN/m or $kN/m^2$.

## 3 Definitions and symbols

### 3.1

**3.1.1** 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 craft 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 craft 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 $\alpha_d$"**: For hulls that do not have a clearly identified deadrise angle, $\alpha_d$ 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), $\alpha_d$ 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

$\Delta$ : moulded displacement at draught **T**, in sea water (mass density = 1,025 t/m³), in tonnes

$C_B$ : total block coefficient, defined as follows:

$$C_B = \frac{\Delta}{(1,025 \cdot \mathbf{L} \cdot \mathbf{B_W} \cdot \mathbf{T})}$$

For catamarans, $C_B$ 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/s²

**LCG** : longitudinal centre of gravity of the craft.

## 4 Documentation

### 4.1

#### 4.1.1 Plans and documents to be submitted

The documentation to be submitted to the Society is to be in accordance with the requirements in Tab 1 and Tab 2.

Additional documentation which may be required are listed in the appropriate sections.

Additional documentation may be required by the Tasneef for appraisal according to Flag State requirements.

**Table 1 : Documentation to be submitted for approval, as applicable**

| No. | Item |
|---|---|
| 1 | Midship section including:<br>• main particulars ($L_{wl}$, $B_{wl}$, D, L) and maximum speed V<br>• materials and associated mechanical properties |
| 2 | Profile and decks |
| 3 | Plan of the decks including:<br>• openings<br>• loads acting, if different from Rule loads |
| 4 | Longitudinal and transverse section |
| 5 | Longitudinal and transversal stiffening members |
| 6 | Shell expansion and framing including openings |
| 7 | Watertight bulkheads, deep tanks and transom including:<br>• openings and their closing appliances<br>• location of overflow |
| 8 | Structure of stern/side doors their closing appliances |
| 9 | Tank structure |
| 10 | Foundation for heavy components |
| 11 | Aft peak structures |
| 12 | Forepeak structures |
| 13 | Superstructures and deckhouses including openings with sill heights and their closing appliances |
| 14 | Support structure for crane including the design loads and connections to the hull structures |
| 15 | Hatchways, hatch covers and ports including securing and tightening appliances |
| 16 | Propeller shaft brackets with their attachments to the hull |
| 17 | Appendages with their attachments to the hull |
| 18 | Rudder and rudder stock including:<br>• details of bearings and seals<br>• materials of all components<br>• calculation speed |
| 19 | Arrangement and particulars of anchoring and mooring equipment. |

**Table 2 : Documentation to be submitted for information, as applicable**

| No. | Item |
|---|---|
| 1 | General arrangement |
| 2 | Tank arrangements |
| 3 | Capacity plan |
| 4 | Body plan |
| 5 | Arrangement of cathodic protection. |

# 5 Arrangement of Bulkheads

## 5.1

### 5.1.1 General

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

- 1 watertight bulkhead if L<6 m
- 2 watertight bulkheads if 6<L<15 m
- 3 watertight bulkheads if L≥15 m

  (one should be the collision bulkhead) in this case craft are to be provided with a collision bulkhead located between 0,05$L_{wl}$ and 0,1$L_{wl}$ aft from FP.

# 6 Accommodation

## 6.1

**6.1.1** Accommodation areas have to be arranged so that they are not dangerous for the users (i.e. not having sharp corners, flammable materials, close to high temperature surfaces, craft under pressure, or moving mechanical parts).

Control and items to be operated in emergency have to be located in accommodation area.

**6.1.2** Enclosed accommodation spaces are to have dedicated ventilation in accordance with an international standard.

Heating, cooking and spaces containing flammable liquids are to be vented independently from other spaces. All compartments are to be provided at least with natural ventilation.

Ventilation Inlets and outlets are to be far from machinery space exhaust.

**6.1.3** Craft are to be arranged with basic sanitary facilities (toilet and wash basin) with suitable ventilation as required by the Administration. This requirement may be waived for craft for limited operation/area.

**6.1.4** An ergonomic seat with the following minimum size have to be provided for every person onboard:

- width 500 mm
- depth 750 mm, free space for legs measured from persons back
- height 900 mm, from seat to free height of head.

The shapes of the seats are to be not dangerous (no sharp corner or fragile material).

Different dimensions if in accordance with the Administration may be accepted.

The strength of a seat is to be in accordance with an international standard accepted by Tasneef and the accelerations of the craft. A minimum static load of 1 kN at the top of the backrest and a vertical load at the center of the seat equal to 2 kN are to be considered for the scantling.

Different scantling criteria if in accordance with the Administration may be accepted.

For craft with speed exceeding 15 knots, the seats on open decks are to be minimum 380 mm lower than top of bulwark/railing unless they are provided with means for protecting persons from falling overboard when seated (such as seat belts).

In craft with speed exceeding 45 knots all the seats are to be equipped with seat belts.

# 7 Steering Position

## 7.1

**7.1.1** The design and layout of the steering position is to be suitable for the intended use and not used for other purposes.

The headroom in a wheelhouse is to be minimal 2m.

Every personnel is to have a seat in the steering position.

The steering position is to be equipped with the instrument and the equipment required by the Administration

**7.1.2** For the field of vision from the steering position reference has to be done to EN ISO 11591. The requirements of the Administration may be used as an alternative.

# 8 Safety of Personnel

## 8.1

**8.1.1** All areas above and below deck intended accessible to persons is to be equipped with either railings, bulwark, hand-holds of substantial design or other means of safe grip.

External decks is normally be surrounded by railing or bulwark with the following characteristics:

- minimum 750 mm height
- distance between vertical stanchions not more than 1.5m.
- vertical distance between bars in rails normally is not to exceed 230 mm from deck level and 330 mm elsewhere
- the top rail is to have ergonomic shape.

Part of the railing may be dismountable.

**8.1.2** All the areas where person has access are to be provided with non-skid surface and decks are to have a toe-rail of minimum 25 mm height at the outboard edge or gunwale.

**8.1.3** For craft with length L exceeding 6 m, or craft with freeboard F exceeding 500 mm, an outboard rescue ladder or steps is to be fitted. The arrangement is to be suitable for a person in the water to enter the craft. The lower step, or any suitable safe part of hull structure to step on, is to be arranged minimum 500 mm below waterline in light condition of the craft. A foldable ladder, or other equivalent system, may be accepted when a safe release system is arranged for access from a position in the water.

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

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

Winches, cranes and other deck-gear are to be arranged to facility safe working.

Winches with open lines, lifting platforms and all types of movable deck gear, is to be shielded and provided with an automatic emergency stop activated by a single person.

Winch barrel, and similar gears are to have protection against line end etc. hitting the person operating the winch or gear.

Operation instructions are to be provided where the gear may be operated.

# 9 Freeing ports and recesses

## 9.1 Freeing ports

**9.1.1** Freeing ports on decked craft have to be provided along the deck, with lower edge preferably flush with deck level in any case of not more than 150mm from the deck.

On craft with bulwark, forecastle, deckhouse or open structures forming wells or recesses, the total freeing port area on each side of the deck is to be minimum A = 0.02 V m2 where the volume is the net volume up to the top the bulwark.

Means to block the flaps or reducing the effective area are not allowed.

If the freeing port has a height of more than 330mm horizontal interruption have to be fitted, the maximum distance from the flush deck and the horizontal interruption is to be not more than 230mm.

## 9.2 Drainage

**9.2.1** On open craft drainage of deck have to be provided on each side of the craft to the bilge or directly overboard with a non-return valve.

The area of drainage is to be minimum $A = 0.01\ V\ m^2$, where V is the volume as defined in [4.1.1].

# 10 Weathertight integrity

## 10.1

**10.1.1** Watertight closing appliances have to provided on paced below the freeboard deck or contributing to the reserve of buoyancy.

Closing appliances are to have the same strength of the surrounding structure.

Other openings giving access to the interior have to be provided with weathertight means of closure.

Weather tight appliances is to be tested with a water jet test.

Hatches which may be opened at sea have to be hinged or attached and being capable of being secured in open position.

Hatch coamings are to be at least 380 mm. For hatches located at least 380 mm above freeboard deck the coaming height may be reduced to 150mm.

Flush hatches on the deck may be accepted if watertight and normally closed when at sea.

Flush hatches located at the top of the superstructure or the deckhouse can be opened during the operation at sea and need to be only weathertight.

The hatches that are required to be weathertight has to be subject to a water jet test, and those that have to be watertight to hydrostatic test.

**10.1.2** Doors have to be operable from either side of the bulkhead without keys or other tools if they are in the way of escape.

The sill height of door openings to spaces below freeboard deck is to be at least 380 mm. For doors located at least 380 mm above freeboard deck, a reduced height of sill may be accepted, but normally not less than minimum 150 mm.

**10.1.3** Arrangement for removable washboard replacing a sill may be accepted based on special consideration.

Port and ramps have to be watertight, the arrangement for safety of operation, stop arrangement and any indicators etc. are to be submitted for approval and the lower edge of openings are not to be less than 200 mm above deepest waterline.

**10.1.4** Ventilation openings have to be arranged so that they have minimum height 600 mm above freeboard deck and have not be immersed at heel angle smaller than 50°.

**10.1.5** Air pipes have not to exceed diameter of 50 mm, they have to be provided with non-return valve or goose necks to prevent water ingress.

The height of air pipes is normally not to be smaller than 600 mm above the freeboard deck and have to be protected from damage from work on deck.

**10.1.6** For windows on deckhouses and portlights in the hull alternatively ISO 12216 or ISO 11336-1 may be applied.

# 11 Testing

## 11.1 Application

**11.1.1** The requirement in Pt B, Ch 12, Sec 3 of the Rules for Classification of Ships as far it is practicable and reasonable apply.

Part B
# Hull and Stability

Chapter 2
# STABILITY

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## SECTION 1 GENERAL REQUIREMENTS

## Symbols used in chapter 2

$FP_{LL}$ : "forward freeboard perpendicular". The forward freeboard perpendicular is to be taken at the forward end the length $L_{LL}$ and is to coincide with the foreside of the stem on the waterline on which the length $L_{LL}$ is measured.

$AP_{LL}$ : "after freeboard perpendicular". The after freeboard perpendicular is to be taken at the after end the length $L_{LL}$.

# SECTION 1 GENERAL REQUIREMENTS

## 1 Documentation to be submitted and general requirements

### 1.1 Documentation to be submitted

**1.1.1** The following documentation is to be submitted for approval:

- stability manual
- inclining test report (when required)
- weathertight integrity plan
- freeboard calculation

The following documentation is assumed for information:

- general arrangement
- body/lines plan

In general the requirements of Pt B, Ch 3 of Rules for the Classification of Ships apply with the relaxations/alternatives reported in this section.

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

Buoyancy elements may consist of foam, prefabricated or formed in position (in-situ), or tanks and double hull filled with air or buoyancy elements. Buoyancy elements must be fixed or permanently fitted and protected against mechanical damage and degradation from the environment; drainage is to be arranged for enclosed spaces used for buoyancy element. Such spaces are normally not to be used for storage or other scopes.

For craft with fenders along the sides of the hull the fenders may be included when calculating the stability of the craft subject to agreement with the Society. This applies to fenders that are secured or bonded to the hull such that they will not be dislodged when submerged. Fenders are to be solid or may be of foam filled construction in which case the foam is to be bonded to the hull such that it will not be dislodged when submerged.

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

For craft with length L less than 6 m, and craft arranged with buoyancy, the ordinary inclining test may be replaced by a full scale stability test.

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

Ballast is generally acceptable provided that it is documented and installed as prescribed by Tasneef Rules and good practice.

### 1.2 General Requirements

**1.2.1** No damage stability calculation is required. Anyway Flag Administration may requires for damage stability calculation or similar cases.

**1.2.2** For intact stability in general the requirements of Pt B, Ch 3 of Rules for the Classification of Ships apply with the relaxations/alternatives reported in this section.

**1.2.3** In case of craft where buoyancy elements are required, it is to be verified with a practical full scale test the stability with the buoyant element flooded.

If of adequate strength and watertight means of closure enclosed superstructure, trunks, deckhouses or similar structures may be considered elements of buoyancy.

Buoyancy elements may consist of foam, prefabricated or not or may be tanks, void spaces or double hull filled with air or buoyancy elements.

Buoyancy elements must be strongly fixed or permanently fitted and protected against damages and degradation from the environment.

Systems to drain enclosed spaces used for buoyancy element have to be provided and nothing is to be stored in such spaces.

**1.2.4** Fenders located on the sides may be considered elements of buoyancy if agreed with Tasneef.

Such fenders are to be solid, filled with foam and fixed to the hull so that they remain in place when the craft is flooded.

**1.2.5** For craft with L < 6 m and craft arranged with buoyancy, the ordinary inclining test may be replaced by a full scale stability test.

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

**1.2.7** Ballast is generally acceptable provided that it is documented and installed as prescribed by Tasneef Rules and good practice.

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

## 2 Freeboard

### 2.1 Decked craft

**2.1.1** For decked craft the minimum freeboard is to be at least 0.2m. The platform height at stem normally is to be nowhere less than 0.12 L above deepest waterline. Such height may be reduced up to the level of freeboard deck at 0.25 L from the stem and afterwards.

Tasneef may evaluate reduction at stem.

## 2.2 Open craft

**2.2.1** The mean freeboard, F, in mm, is to be not less than:

$$\mathbf{F} = \frac{4,5\Delta}{1000\mathbf{LB}}$$

or $F_{min}$ = 500 mm

If what above is not satisfied in the craft buoyancy elements have to be installed.

**2.2.2** For craft arranged with buoyancy elements, the mean freeboard, F, is to be not less than:

F = 200 B mm

or

$F_{min}$ = 200 mm

**2.2.3** On craft the freeboard aft is to be not less than:

$F_{aft}$ = 0.8 F

# 3 Stability Requirements

## 3.1 Decked craft

**3.1.1** In general the requirements of Part B, Chapter 3 of the Rules apply. As alternative what follows may be applied:

The following conditions are to be considered:

a) Lightship with minimum equipment and cargo. Combined loads are not to exceed 10% of maximum load capacity.
b) Loaded with maximum equipment and cargo in holds and on deck. Combined loads are not to be less than 90% of maximum load capacity in the mode of departure and arrival.
c) Deck load with maximum equipment and cargo on deck and empty holds in the mode of departure and arrival.
d) Other relevant conditions , where necessary.

**3.1.2** Crowding of persons at one side: In maximum load condition the craft is not to capsize or be flooded if all persons moves to the same side, the angle of heel is not to exceed 10°, caused by a heeling weight of at least:

P = 82.5 n (kg)

where n = total number of persons.

with the weight located 1 m above deck along the gunwale.

**3.1.3** For the calculation of the heeling moment due to operation of lifting gear and similar appliances it is to be considered a dynamic factor of 1.4. The angle of heel is to be less than 10° for maximum moment in the most unfavourable condition.

In the condition stated in [3.1.1] the followings criteria have to be satisfied:

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

## 3.2 Open craft

**3.2.1** One of the following criteria may be applied:

a) An inclining test is to be carried out to define the metacentric height GM in lightship condition. GM is to be more than 0.50 m, or
b) The inclining test may be omitted if it for the load condition can be demonstrated that the period of roll in seconds (from one side and back to the same side) is less or equal to the craft beam in meters, or
c) The GZ curves satisfy the requirements for Decked craft up to an angel of heel of at least 30°, and
d) Crowding of persons at one side as described for decked craft.

## 3.3 Open craft with buoyancy

### 3.3.1 Stability in intact condition

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

P = 22 × n (kg) (n = number of persons),

or

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

with the weight placed at the gunwale at the maximum beam of the craft, and not less than $B_{max}/2$ from the centreline.

The requirements in case of the crowding of person at one side is to be satisfied with the weight be located on the floor as near to the gunwale as possible, but minimum $B_{max}/4$ from centreline and with longitudinal position corresponding to the arrangement of the accommodation. Weights representing equipment are to be located at their locations.

### 3.3.2 Buoyancy in flooded condition

In maximum load condition including any outboard propulsion machinery the flooded craft is to float reasonably horizontally and not sink when loaded with additional weight:

P = 27.5 × n (kg) (n = total number of persons),

but not less than:

P = 55 + 55 (L - 2.5) (kg),

or

$P_{min}$ = 82.5 (kg).

Weights are to be located at their locations on board.

### 3.3.3 Stability in flooded condition

In maximum load condition including any outboard propulsion machinery the flooded craft is to have a positive stability up to at least 50° of heel when loaded with an additional weight located anywhere along the gunwale:

$P_K$ = 11 + 5.5 × n (kg) (n = total number of persons),

or

$P_{Kmin}$ = 27.5 (kg).

Part B
# Hull and Stability

Chapter 3
# HULL SCANTLINGS

# SECTION 1 GENERAL REQUIREMENTS

## 1 General

### 1.1 Introduction

**1.1.1** The present chapter describes the hull and superstructures structural scantling standards.

#### 1.1.2 Direct calculation

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

Such calculation are to be executed on the grounds of the structural modelling, load and verification criteria, accepted by Tasneef.

# SECTION 2 DESIGN LOADS AND ACCELERATION

## 1 Application

### 1.1 Application

**1.1.1** In general, the requirements from [2] to [5] apply.

**1.1.2** On the basis of the craft's characteristics and the navigation notation required, Tasneef may require structural strength checks based also on direct calculations.

## 2 Design acceleration

### 2.1 Vertical acceleration at LCG

**2.1.1** The design vertical acceleration at **LCG**, $a_{CG}$ (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:

$$a_{CG} = S \cdot \frac{V}{L^{0,5}}$$

where **S** is a parameter with values as indicated in Tab 1.

Other **S** values may be accepted, if justified, at Tasneef's discretion considering the service type and the operating area.

**Table 1**

| Service | S |
|---|---|
| Moderate environment | 0,30 |
| Smooth sea | 0,23 |

**2.1.2** The sea areas referred to in Tab 1 are defined with reference to significant wave heights $H_s$ which are exceeded for an average of not more than 10 percent of the year:

- Moderate environment service: 0,5 m < $H_s$ < 2,5 m
- Smooth sea service: $H_s \leq 0,5$ m.

**2.1.3** If the design acceleration cannot be defined by the Designer, the $a_{CG}$ value corresponding to the appropriate **S** value reported in Tab 1 will be assumed.

**2.1.4** For limit operating conditions allowed for by design parameters, see [2.4].

### 2.2 Longitudinal distribution of vertical acceleration

**2.2.1** The longitudinal distribution of vertical acceleration along the hull is given by:

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

where:

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

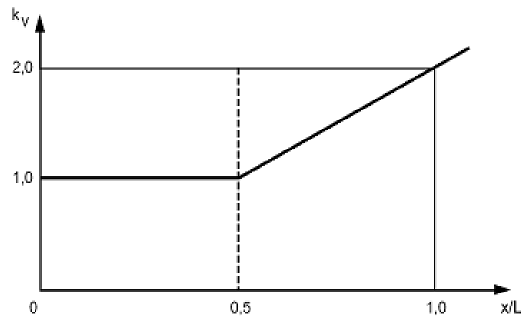
$K_V = 1$ for $x/L \leq 0,5$

$K_V = 2 \cdot x/L$ for $x/L > 0,5$

Higher values may be requested based on pitch consideration.

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

**Figure 1**




**2.2.2** Variation of $a_v$ in the transverse direction may generally be disregarded.

### 2.3 Transverse acceleration

**2.3.1** Transverse acceleration is defined on the basis of results of model tests and full-scale measurements, considering their characteristic value as specified in [2.4.1].

In the absence of such results, transverse acceleration, in g, at the calculation point of the craft may be obtained from:

$$a_t = 2,5 \cdot \frac{H_{sl}}{L} \cdot \left[1 + 5 \cdot \left(1 + \frac{V/L^{0,5}}{6}\right)^2 \cdot \frac{r}{L}\right]$$

where:

$H_{sl}$ : permissible significant wave height, defined in [2.4].

**r** : distance of the point from:

- 0,5 **D**, for monohull craft
- waterline at draught **T**, for twin-hull craft.

### 2.4 Assessment of limit operating conditions

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

**2.4.2** 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 [2.4.4] below.

**2.4.3** 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.

**2.4.4** 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:

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

where vertical acceleration $a_{CG}$ is defined in [1.1.1].

**2.4.5** The significant wave height is related to the craft's geometric and motion characteristics and to the vertical acceleration aCG 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 $\Delta / (0,01 \cdot L)^3 \geq 3500$

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

  and

  $K_{HS} = 1$

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

  $$= 0,8 + 1,6 \cdot \frac{V_x}{\sqrt{L}}$$

  and

  $K_{HS} = H_S/T$

where:

- **Hs** : significant wave height, in m;
- $\alpha_{dCG}$ : deadrise angle, in degrees, at **LCG**, taken to be between 10° and 30°;
- $\tau$ : trim angle during navigation, in degrees, taken to be not less than 4°;
- **V** : maximum service speed, in knots.
- $V_x$ : actual craft speed, in knots.

If $V_x$ 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 $H_{sl}$.

# 3 Overall loads

## 3.1 Twin-hull craft transverse loads

### 3.1.1 General

For twin-hull craft, the hull connecting structures are to be checked for load conditions specified in [3.1.2] and [3.1.3] below. These load conditions are to be considered as acting separately. Design moments and forces given in the following paragraphs are to be used unless other values are verified by model tests, full-scale measurements or any other information provided by the Designer.

For craftraft with structural arrangements that do not permit a realistic assessment of stress conditions based on simple models, the transverse loads are to be evaluated by means of direct calculations carried out in accordance with criteria specified in [5] or other criteria considered equivalent by Tasneef.

### 3.1.2 Transverse bending moment and shear force

The transverse bending moment $M_{bt}$, in KN ·m, and shear force $T_{bt}$, in KN ·m, are given by:

$$M_{bt} = \frac{\Delta \cdot b \cdot a_{CG} \cdot g}{5}$$

$$T_{bt} = \frac{\Delta \cdot a_{CG} \cdot g}{4}$$

where:

- **b** : transverse distance, in m, between the centres of the two hulls;
- $a_{CG}$ : vertical acceleration at LCG, defined in [2.1].

### 3.1.3 Transverse torsional connecting moment

The twin-hull transverse torsional connecting moment, in kN · m, about a transverse axis is given by:

$$M_{tt} = 0,125 \cdot \Delta \cdot L \cdot a_{CG} \cdot g$$

where $a_{CG}$ is the vertical acceleration at LCG, defined in [2.1], which need not to be taken greater than 1,0 g for this calculation.

## 3.2 Small waterplane area twin-hull (SWATH) craft-Forces

### 3.2.1 Side beam force

The design beam side force, in kN, (see Fig 2) is given by:

$$F_Q = 12,5 \cdot T \cdot \Delta^{2/3} \cdot d \cdot L_S$$

where:

- **d** : $1,55 - 0,75 \cdot \tanh\left(\frac{\Delta}{11000}\right)$
- $L_S$ : $2,99 \cdot \tanh\lambda - 0,725$
- $\lambda$ : $\frac{0,137 \cdot A_{lat}}{T \cdot \Delta^{1/3}}$

$\mathbf{A_{lat}}$ : lateral area, in m², projected on a vertical plane, of one hull with that part of strut or struts below waterline at draught T.

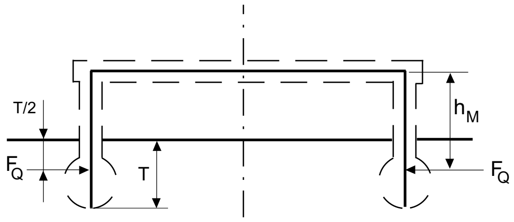
The lateral pressure, in kN/m², acting on one hull is given by:

$$\mathbf{p_Q} = \frac{\mathbf{F_Q}}{\mathbf{A_{lat}}}$$

The distribution of the lateral force $\mathbf{F}_Q$ can be taken as constant over the effective length $\mathbf{L}_e = \mathbf{A}_{lat} / \mathbf{T}$, in m. The constant lateral force per unit length, in kN/m, is thus given by:

$$\mathbf{q_Q} = \frac{\mathbf{F_Q}}{\mathbf{L_e}}$$

**Figure 2**



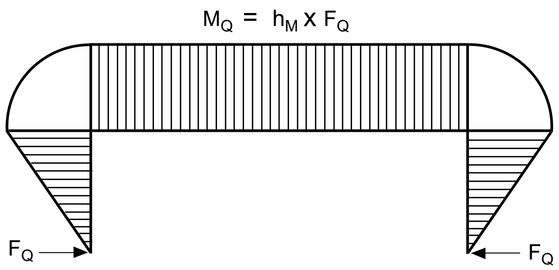

#### 3.2.2 Bending moment

The corresponding design bending moment, in KN · m, is given by:

$$\mathbf{M_Q} = \mathbf{h_M} \cdot \mathbf{F_Q}$$

$\mathbf{h}_M$ : half the draught T plus the distance from the waterline at draught T to the midpoint of the cross-deck structure (see Fig 3), in m.

**Figure 3**




## 4 Local loads

### 4.1 General

**4.1.1** Design loads defined in this Article are to be used for the resistance checks provided for in Sec 3 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 fullscale measurements. 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.

### 4.2 Loads

**4.2.1** 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.

#### 4.2.2 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.

### 4.3 Impact pressure on the bottom

**4.3.1** If slamming is expected to occur, the impact pressure, kN/m², considered as acting on the bottom is not less than:

$$\mathbf{p_{sl}} = 70 \cdot \frac{\Delta}{\mathbf{S_r}} \cdot \mathbf{K}_1 \cdot \mathbf{K}_2 \cdot \mathbf{K}_3 \cdot \mathbf{a_{CG}}$$

where:

$\Delta$ : displacement, in tonnes

$\mathbf{S}_r$ : reference area, m²:

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

$\mathbf{K}_1$ : longitudinal bottom impact pressure distribution factor (see Fig 4), equal to:

0,5 + **x/L**, for **x/L** < 0,5

1,0, for 0,5 ≤ **x/L** ≤ 0,8

3,0 -2,5 · **x/L**, for **x/L** > 0,8

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

**$K_2$** : factor accounting for impact area

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

where

**u** : $100 \cdot \frac{s}{S_r}$

**s** : area, m², 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.

where:

$K_2 \geq 0{,}50$ , for plating

$K_2 \geq 0{,}45$ , for stiffeners

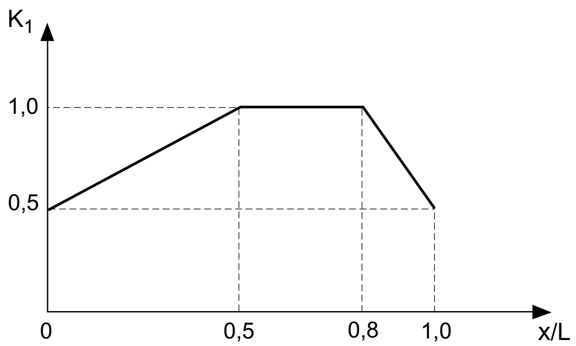
$K_2 \geq 0{,}35$ , for girders and floors.

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

factor accounting for shape and deadrise of the hull, where $\alpha_{dCG}$ is the deadrise angle, in degrees, measured at **LCG** and $\alpha_d$ 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 $\alpha_d$ and $\alpha_{dCG}$ are to be between 10° and 30°.

**$a_{CG}$** : design vertical acceleration at LCG, defined in [2].

**Figure 4**




### 4.4 Impact pressure on bottom of cross-deck and internal sides (for twin-hull craft)

**4.4.1** Slamming on bottom of the cross-deck (wet deck) is assumed to occur if the distance, in m, between the waterline at draught **T** and the wet deck is less than $Z_{wd}$, where:

**$Z_{wd}$** : $0{,}05 \cdot L$ , if $L \leq 65$ m

**$Z_{wd}$** : $3{,}25 + 0{,}0214 \cdot (L - 65)$, if $L > 65$ m

In such a case, the impact pressure, in kN/m², considered as acting on the wet deck is not less than:

$$p_{sl} = 3 \cdot K_2 \cdot K_{CD} \cdot V \cdot V_{sl} \cdot \left(1 - 0{,}85 \frac{H_A}{H_S}\right)$$

where:

**$K_2$** : as defined in [4.3]

**$K_{CD}$** : longitudinal wet deck impact pressure distribution factor ( Fig 5):

$0{,}5 \cdot (1{,}0 - x/L)$ for $x/L < 0{,}2$

$0{,}4$ for $0{,}2 \leq x/L \leq 0{,}7$

$6{,}0 \cdot x/L - 3{,}8$ for $0{,}7 < x/L \leq 0{,}8$

$1{,}0$ for $x/L > 0{,}8$

**x** : distance, in m, from aft perpendicular to load point.

**V** : craft's speed, in knots,

**$H_a$** : air gap, in m

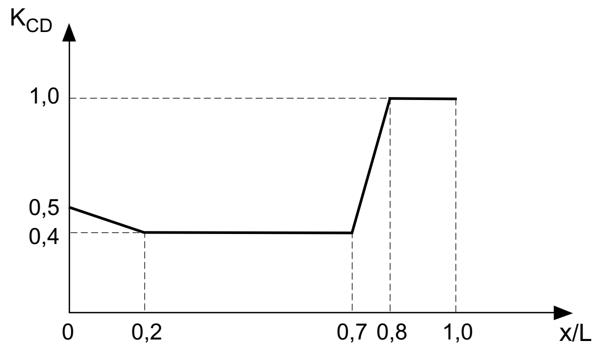
**$V_{SL}$** : relative impact velocity, in m/s, given by:

$$V_{SL} = \frac{4 \cdot H_S}{L^{0{,}5}} + 1$$

**$H_S$** : significant wave height, in m.

If slamming is considered to occur on the wet deck, the impact pressure on the internal sides is obtained by interpolation between the pressure considered as acting on the bottom and the pressure $P_{SL}$ at wet deck.

**Figure 5**




If the wet deck at a transverse section considered is not parallel to the design waterline the impact pressure $P_{SL}$ will be considered in each separate case by Tasneef.

### 4.5 Sea pressures

**4.5.1** The sea pressure, in kN/m², considered as acting on the bottom and side shell is not less than $p_{smin}$, defined in Tab 3, or less than:

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

$$p_s = 10 \cdot (T + S - z), \text{ for } z > T$$

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 Tab 2 with $C_B$ taken not greater than 0,5

**Table 2**

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

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 $p_{sM}$ the sea pressure in the midship area.

## 4.6 Sea pressures on front walls of the hull

**4.6.1** The pressure, kN/m², considered as acting on front walls of the hull (in the case of a 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, $x_1 = 0$)

$z_1$ : 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

$$p_{sF} \cdot \sin^2\alpha$$

where $\alpha$ is the angle in degrees between front wall and deck.

$p_{sF}$ is not less than the greater of:

$3 + (6,5 + 0,06 \cdot L) \cdot \sin\alpha$

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

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

## 4.7 Sea pressures on deckhouses

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

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

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
- $1,5 + 3,5 \cdot \frac{b}{B}$ (with $3 \leq K_{su} < 5$)

  for sides of deckhouses b = breadth, in m, of 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, $x_1 = 0$)

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

The minimum values of $p_{su}$, in kN/m², to be considered are:

- for the front wall of the lower tier:

  $p_{su} = 6,5 + 0,06 \cdot L$
- for the sides and aft walls of the lower tier:

  $p_{su} = 4$
- for the other walls or sides:

  $p_{su} = 3$

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

## 4.8 Deck loads

### 4.8.1 General

The pressure, in kN/m², considered as acting on decks is given by the formula

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

where:

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

$a_v$ : design vertical acceleration, defined in [2.2].

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

### 4.8.2 Weather decks and exposed areas

a) For weather decks and exposed areas without deck cargo if:

- $z_d \leq 2$ m $\quad p = 6,0$ kN/m²
- $2\text{ m} < z_d < 3$ m $\quad p = 12 - 3 \cdot z_d$ kN/m²
- $z_d \geq 3$ m $\quad p = 3,0$ kN/m²

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.

b) For weather decks and exposed areas with deck cargo if:

- $z_d \leq 2$ m, $p = p_c + 2$ kN/m², with $p_c \geq 4$ kN/m²
- $2\text{ m} < z_d < 3$ m, $\quad p = p_c + 4 - z_d$ kN/m²

  with $p_c \geq 8 - 2 \cdot z_d$ kN/m²
- $z_d \geq 3$ m, $\quad p = p_c + 1$ kN/m²

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

$\mathbf{p_c}$ : uniform pressure due to deck cargo load, in kN/m², to be defined by the Designer with the limitations indicated above.

#### 4.8.3 Shelter decks

They are decks which are not accessible to the passengers and which are not subjected to the sea pressures. Crew can access such decks 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 'tween-deck below.

For shelter decks:

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

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.

#### 4.8.4 Enclosed accommodation decks

a) For enclosed accommodation decks not carrying goods:

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

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

b) For enclosed accommodation decks carrying goods:

$\mathbf{p} = \mathbf{p_c}$

The value of $\mathbf{p_c}$ is to be defined by the Designer, but taken as not less than 3,0 kN/m².

#### 4.8.5 Enclosed cargo decks

For enclosed cargo decks other than decks carrying vehicles

$\mathbf{p} = \mathbf{p_c}$

where $\mathbf{p_c}$ is to be defined by the Designer, but taken as not less than 3,0 kN/m².

For enclosed cargo decks carrying vehicles, the loads are defined in [4.8.7].

#### 4.8.6 Platforms of machinery spaces

For platforms of machinery spaces

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

#### 4.8.7 Enclosed decks carrying vehicles

The scantlings of the structure of enclosed decks carrying vehicles are to be determined by taking into account only the concentrated loads transmitted by the wheels of vehicles, except in the event of supplementary requirements from the Designer.

The scantlings under racking effects of the primary structure of decks carrying vehicles are to be the greater of the following cases:

- scantlings determined under concentrated loads transmitted by the wheels of vehicles,
- scantlings determined under a uniform load $\mathbf{p_c}$ taken not less than 2,5 kN/m². This value of $\mathbf{p_c}$ may be increased if the structural weight cannot be considered as negligible, in the opinion of Tasneef.

### 4.9 Pressures on tank structures

**4.9.1** The pressure, in kN/m², considered as acting on tank structures is not less than the greater of:

$$\mathbf{p_{t1}} = 9,81 \cdot \mathbf{h_1} \cdot \rho \cdot (1 + 0,4 \cdot \mathbf{a_v}) + 100 \cdot \mathbf{p_v}$$
$$\mathbf{p_{t2}} = 9,81 \cdot \mathbf{h_2}$$

where:

$\mathbf{h_1}$ : distance, in m, from load point to tank top

$\mathbf{h_2}$ : 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

$\rho$ : liquid density, in t/m³ (1,0 t/m³ for water)

$\mathbf{p_v}$ : setting pressure, in bars, of pressure relief valve, when fitted.

### 4.10 Pressures on subdivision bulkheads

**4.10.1** The pressure, in kN/m², considered as acting on subdivision bulkheads is not less than:

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

where:

$\mathbf{h_3}$ : distance, in m, from load point to bulkhead top.

## 5 Direct calculations

### 5.1 General

**5.1.1** When deemed necessary by Tasneef, direct calculations of the hull structural scantlings are to be carried out, on the basis of the most advanced calculation techniques.

When performing direct calculations, the loads specified in [2] to [4] are generally to be applied. Where, in the case of craft of special design for which, in the opinion of Tasneef, these requirements are deemed inappropriate, loads calcu-lated according to other criteria are to be adopted.

# SECTION 3 HULL SCANTLING

## 1 General

### 1.1 General

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

## 2 Steel hull

### 2.1 Scantling

**2.1.1** For steel hull, the requirements in Chapter 3 of the Rules for the Classification of High Speed Craft apply.

## 3 Reinforced plastic hull

### 3.1 Scantling

**3.1.1** For reinforced plastic hull, the requirements in Chapter 1 of the Rules for the Classification of Ships with reinforced plastic, aluminium alloy or wooden hulls apply.

## 4 Aluminium alloy hull

### 4.1 Scantling

**4.1.1** For reinforced plastic hull, the requirements in Chapter 2 of the Rules for the Classification of Ships with reinforced plastic, aluminium alloy or wooden hulls apply.

Part B
# Hull and Stability

Chapter 4
# HULL OUTFITTING

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# SECTION 1 RUDDERS

## Symbols

$V_{AV}$ : maximum ahead service speed, in knots, with the craft on summer load waterline; if $V_{AV}$ is less than 10 knots, the maximum service speed is to be taken not less than the value obtained from the following formula:

$$V_{MIN} = \frac{V_{AV} + 20}{3}$$

$V_{AD}$ : 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, if any

$k_1$ : material factor, defined in [1.4.4]

k : material factor as defined below, as a function of the minimum guaranteed yield stress $R_{eH}$ in $N/mm^2$. 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 the Society on a case by case basis:

- k = 1 for $R_{eH}$ = 235 $N/mm^2$
- k = 0,78 for $R_{eH}$ = 315 $N/mm^2$
- k = 0,72 for $R_{eH}$ = 355 $N/mm^2$
- k = 0,68 for $R_{eH}$ = 390 $N/mm^2$

$C_R$ : rudder force, in N, acting on the rudder blade, defined in [2.1.2]

$M_{TR}$ : 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 [3.1.6].

## 1 General

### 1.1 General

**1.1.1** In general rudders treated in this section and arranged in the craft considered in this Rules are spade rudders type.

**1.1.2** In general rudders treated in this section and arranged in the craft considered in this Rules are spade rudders type.

These requirements apply to ordinary profile rudders without any special arrangement for increasing the rudder force, such as fins or flaps, steering propellers, etc. Unconventional rudders of unusual type or shape and those with speeds exceeding 45 knots will be the subject of special consideration by Tasneef.

In such cases, the scantlings of the rudder and the rudder stock will be determined by means of direct calculations to be agreed with Tasneef as regards the load and schematisation.

#### 1.1.3 Ordinary profile spade rudders

The requirements of this Section apply to ordinary profile spade rudders made of steel, without any special arrangement for increasing the rudder force, whose maximum orientation at maximum craft 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.

#### 1.1.4 High lift profiles

The requirements of this Section also apply to rudders made of steel 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 craft speed. These calculations are to be considered by the Society 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.

#### 1.1.5 Steering nozzles

The requirements for steering nozzles are given in [10].

#### 1.1.6 Special rudder types

Rudders others than those mentioned above will be considered by the Society on a case-by- case basis.

### 1.2 Gross scantlings

**1.2.1** All scantlings and dimensions referred to in this Section are gross, i.e. they include the margins for corrosion.

### 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.

**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** Rudders made of materials others than steel will be considered by the Society on a case-by-case basis.

**1.4.2** 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 Part D, Ch 2 of the Rules.

**1.4.3** The material used for rudder stocks, pintles, keys and bolts is to have a minimum yield stress not less than 200 $N/mm^2$.

**1.4.4** The requirements relevant to the determination of scantlings contained in this Section apply to steels having a minimum yield stress equal to 235 N/mm2.

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 $k_1$, to be obtained from the following formula:

$$k_1 = \left(\frac{235}{R_{eH}}\right)^n$$

where:

- $R_{eH}$ : yield stress, in $N/mm^2$, of the steel used, and not exceeding the lower of 0,7 $R_m$ and 450 $N/mm^2$,
- $R_m$ : minimum ultimate tensile strength, in $N/mm^2$, of the steel used,
- n : coefficient to be taken equal to:
  - n = 0,75 for $R_{eH} > 235$ $N/mm^2$,
  - n = 1,00 for $R_{eH} \le 235$ $N/mm^2$.

**1.4.5** Significant reductions in rudder stock diameter due to the application of steels with yield stresses greater than 235 N/mm2 may be accepted by the Society subject to the results of a check calculation of the rudder stock deformations.

**1.4.6** Large rudder stock deformations are to be avoided in order to avoid excessive edge pressures in way of bearings.

**1.4.7**

Welded parts of rudders are to be made of approved rolled hull materials.

## 2 Force and torque acting on the rudder

### 2.1 Rudder blade description

**2.1.1** A rudder blade without cut-outs may have trapezoidal or rectangular contour.

### 2.2 Rudder force

**2.2.1** The rudder force CR is to be obtained, in N, from the following formula:

$C_R = 132\ n_t\ A\ V^2\ r_1\ r_2\ r_3$

where:

- $n_t$ : craft's type coefficient, to be taken equal to 0,25,
- V : $V_{AV}$, or $V_{AD}$, depending on the condition under consideration (for high lift profiles see [1.1.4]),
- $r_1$ : shape factor, to be taken equal to:

$$r_1 = \frac{\lambda + 2}{3}$$

- $\lambda$ : coefficient, to be taken equal to:

$$\lambda = \frac{h^2}{A_T}$$

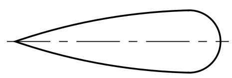
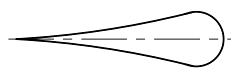
and not greater than 2,

- $A_T$ : area, in $m^2$, to be calculated by adding the rudder blade area A to the area of the rudder post or rudder horn, if any, up to the height h,
- h : mean height, in m, of the rudder area to be taken equal to (see Fig 1):

$$h = \frac{z_3 + z_4 - z_2}{2}$$

- $r_2$ : coefficient to be obtained from Tab 1,
- $r_3$ : coefficient to be taken equal to:
  - $r_3 = 0,8$ for rudders outside the propeller jet (centre rudders on twin screw craft, or similar cases),
  - $r_3 = 1,15$ for rudders behind a fixed propeller nozzle,
  - $r_3 = 1,0$ in other cases.

**Table 1 : Values of coefficient $r_2$**

| Rudder profile type | $r_2$ for ahead condition | $r_2$ for astern condition |
|---|---|---|
| **NACA 00 - Goettingen**  | 1,10 | 0,80 |
| **Hollow**  | 1,35 | 0,90 |

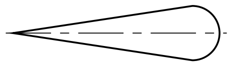
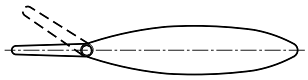
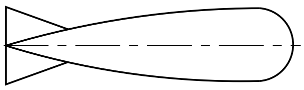
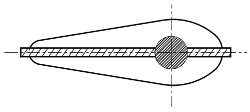
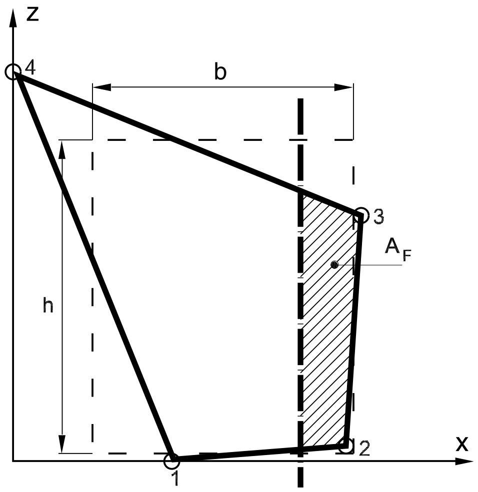
| Rudder profile type | $r_2$ for ahead condition | $r_2$ for astern condition |
|---|---|---|
| **Flat side**  | 1,10 | 0,90 |
| **High lift**  | 1,70 | 1,30 |
| **Fish tail**  | 1,40 | 0,80 |
| **Single plate**  | 1,00 | 1,00 |

**Figure 1 : Geometry of rudder blade without cut-outs**




## 2.3 Rudder torque

**2.3.1** The rudder torque $M_{TR}$, for both ahead and astern conditions, is to be obtained, in N.m, from the following formula:

$M_{TR} = C_R\ r$

where:

r : lever of the force $C_R$, in m, equal to:

$$\mathbf{r} = \mathbf{b}\left(\alpha - \frac{\mathbf{A_F}}{\mathbf{A}}\right)$$

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):

$$\mathbf{b} = \frac{\mathbf{x}_2 + \mathbf{x}_3 - \mathbf{x}_1}{2}$$

α : coefficient to be taken equal to:

- $\alpha = 0{,}33$ for ahead condition,
- $\alpha = 0{,}66$ for astern condition,

$A_F$ : area, in $m^2$, of the rudder blade portion afore the centreline of rudder stock (see Fig 1).

# 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.

### 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 and the loads in the rudder horn are to be determined through direct calculations to be performed in accordance to the static schemes and the load conditions specified in [3.1.3].

The other loads (i.e. the torque in the rudder stock and in the rudder body and the loads in the solepieces) are to be calculated as indicated in the relevant requirements of this Section.

### 3.1.3 Criteria for direct calculation of the loads acting on the rudder structure

These requirements provide the criteria for calculating the following loads:

- bending moment $M_B$ in the rudder stock,
- support forces $F_A$,
- bending moment $M_R$ and shear force $Q_R$ in the rudder body.

### 3.1.4 Load calculation

The loads in 3.1.3 are to be calculated through direct calculations depending on the type of rudder.

They are to be used for the stress analysis required in:

- [4], for the rudder stock,
- [7] for the rudder blade
- [8] for the rudder trunk.

### 3.1.5 Forces per unit length

The force per unit length $p_R$ (see Fig 2) acting on the rudder body is to be obtained in N/m, from the following formula:

$$\mathbf{p_R} = \frac{\mathbf{C_R}}{\ell_{10}}$$

#### 3.1.6 Moments and forces

The loads in [3.1.3] may therefore be obtained from the following formulae (See Fig 2):

- maximum bending moment $M_B$ in the rudder stock, in N.m:

$$\mathbf{M_B} = \mathbf{C_R}\left(\ell_{20} + \frac{\ell_{10}(2\mathbf{C_1} + \mathbf{C_2})}{3(\mathbf{C_1} + \mathbf{C_2})}\right)$$

where $C_1$ and $C_2$ are the lengths, in m, defined in Fig 2,

- support forces, in N:

$$\mathbf{F_{A3}} = \frac{\mathbf{M_B}}{\ell_{30}}$$

$$\mathbf{F_{A1}} = \mathbf{C_R} + \mathbf{F_{A3}}$$

- maximum shear force in the rudder body, in N:

$Q_R = C_R$

# 4 Rudder stock scantlings

## 4.1 Bending moment

#### 4.1.1 General

The bending moment $M_B$ in the rudder stock for spade rudders is to be determined according to [3.1.2] through a direct calculation.

## 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 $\tau$, in $N/mm^2$, induced by the torque $M_{TR}$ is in compliance with the following formula:

$\tau \leq \tau_{ALL}$

where:

$\tau_{ALL}$ : allowable torsional shear stress, in N/mm2 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:

$d_T = 4{,}2\ (M_{TR}\ k_1)^{1/3}$

#### 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 $\sigma_E$ 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:

$\sigma_E$ : equivalent stress to be obtained, in $N/mm^2$, from the following formula:

$$\sigma_E = \sqrt{\sigma_B^2 + 3\tau_T^2}$$

$\sigma_B$ : bending stress to be obtained, in $N/mm^2$, from the following formula:

$$\sigma_B = 10^3 \frac{10{,}2\mathbf{M_B}}{\mathbf{d_{TF}^3}}$$

$\tau_T$ : torsional stress to be obtained, in $N/mm^2$, from the following formula:

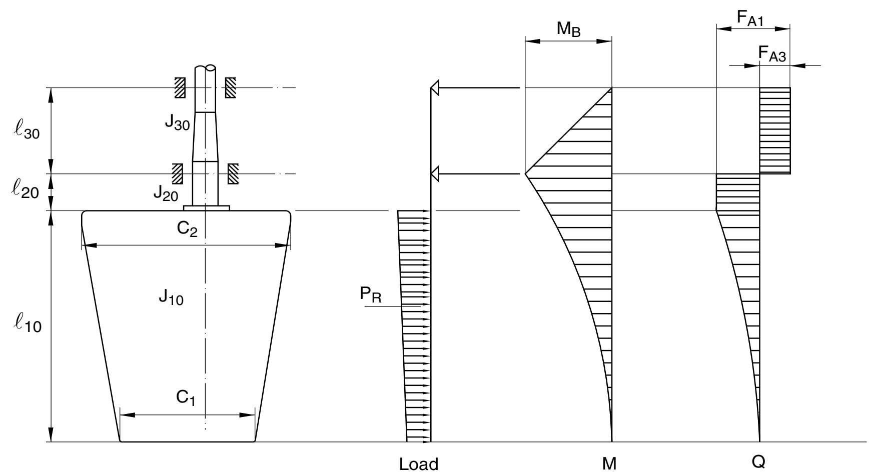
$$\tau_T = 10^3 \frac{5{,}1\mathbf{M_{TR}}}{\mathbf{d_{TF}^3}}$$

For this purpose, the rudder stock diameter is to be not less than the value obtained, in mm, from the following formula:

$$\mathbf{d_{TF}} = 4,2(\mathbf{M_{TR}k_1})^{1/3}\left(1 + \frac{4}{3}\left(\frac{\mathbf{M_B}}{\mathbf{M_{TR}}}\right)^2\right)^{1/6}$$

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.

Figure 2 : Spade rudders




# 5 Rudder stock couplings

## 5.1 Horizontal flange couplings

#### 5.1.1 General

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..

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 the Society. 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 45 mm.

#### 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:

$$\mathbf{d_B} = 0{,}62\sqrt{\frac{\mathbf{d_1^3 k_{1B}}}{\mathbf{n_B e_M k_{1S}}}}$$

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 centre (i.e. the centre 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 ($0{,}25d_T$ x $0{,}10d_T$) $mm^2$ 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:

$$\mathbf{t_P} = \mathbf{d_B}\sqrt{\frac{\mathbf{k_{1F}}}{\mathbf{k_{1B}}}}$$

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 Couplings between rudder stocks and tillers

#### 5.2.1 Application

The requirements in Pt C, Ch 1, Sec 10 of the Rules apply.

#### 5.2.2 General

The entrance edge of the tiller bore and that of the rudder stock cone are to be rounded or bevelled.

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 the Society 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 the Society
- 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.

### 5.3 Cone couplings between rudder stocks and rudder blades

#### 5.3.1 General

For cone couplings without hydraulic arrangements for assembling and disassembling the coupling, a key is to be fitted having 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.

#### 5.3.2 Tapering on diameter of the cone couplings

The taper on diameter of the cone couplings is to be in compliance with the following formula valid for cone couplings without hydraulic arrangements for assembling and disassembling the coupling:

$$\frac{1}{12} \leq \frac{d_U - d_0}{t_S} \leq \frac{1}{8}$$

where:

$d_U$, $t_S$, $d_0$,: geometrical parameters of the coupling, defined in Fig 3.

The cone shapes are to fit exactly. The coupling length $t_S$ is to be, in general, not less than $1,5d_U$.

#### 5.3.3 Dimensions of key

The shear area of the key, in cm², is not to be less than:

$$a_S = \frac{17,55 Q_F}{d_k R_{eH1}}$$

where:

$Q_F$ : design yield moment of rudder stock, from the following formula:

$$Q_F = 0,02664 \frac{d_T^3}{k_1}$$

Where the actual diameter $d_{Ta}$ is greater than the calculated $d_T$, the diameter $d_{Ta}$ is to be used. However $d_{Ta}$ applied to the above formula need not be taken greater than $1.145d_T$:

$d_T$ : rudder stock diameter, in mm, subject to torque only (see 4.2.1)

$d_k$ : mean diameter of the conical part of the rudder stock, in mm, at the key

$R_{eH1}$ : minimum yield stress of the key material, in N/mm²

The effective surface area, in cm², of the key (without rounded edges) between key and rudder stock or cone coupling is not to be less than:

$$a_k = \frac{5 Q_F}{d_k R_{eH2}}$$

where:

$R_{eH2}$ : minimum yield stress of the key, stock or coupling material, in N/m², whichever is the less.

#### 5.3.4 Slugging nut

The cone coupling is to be secured by a slugging nut, whose dimensions are to be in accordance with the following formulae:

$d_G \geq 0,65\ d_u$

$t_N \geq 0,60\ d_G$

$d_N \geq 1,2\ d_0$ and, in any case, $d_N \geq 1,5\ d_G$

where:

$d_G$, $t_N$, $d_N$, $d_1$, $d_0$:geometrical parameters of the coupling, defined in Fig 3.

The above minimum dimensions of the locking nut are only given for guidance, the determination of adequate scantlings being left to the Designer.

The nut is to be secured, e.g. by a securing plate as shown in Fig 3.

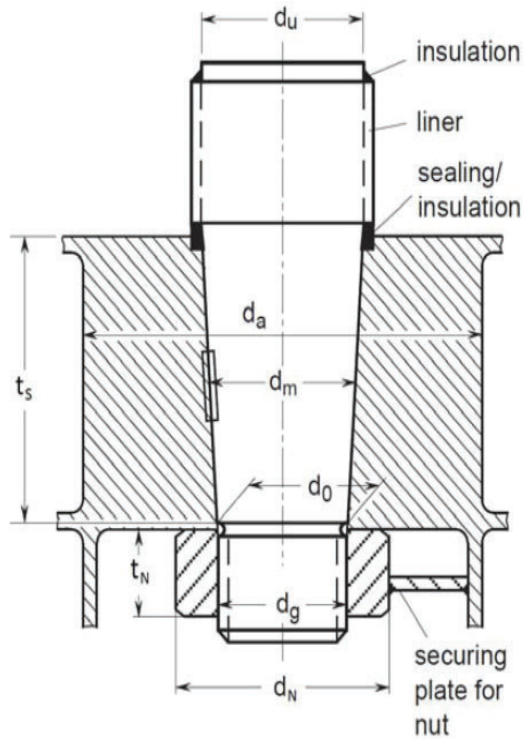
#### 5.3.5 Slugging nut

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 $d_G$ and an outer diameter not less than 0,13 $d_0$ or 1,6 $d_G$, whichever is the greater.

#### 5.3.6 Push-up

It is to be proved that 50% of the design yield moment is solely transmitted by friction in the cone couplings. This can be done by calculating the required push-up pressure and push-up length according to Pt B, Ch 10, Sec 1, [5.4.3] and [5.4.4] of the Rules for a torsional moment $Q'_F = 0,5Q_F$.

**Figure 3 : Geometry of cone coupling with key**




#### 5.3.7 Rudder torque transmitted entirely by the key

Notwithstanding the requirements in [5.3.3] and [5.3.5], where a key is fitted to the coupling between stock and rudder and it is considered that the entire rudder torque is transmitted by the key at the couplings, the scantlings of the key as well as the push-up force and push-up length are to be evaluated on a case by case basis. The general criteria for the scantlings of the key are given by the following formulae.

The shear area of the key, in cm², is not to be less than:

$$a_S = \frac{35,1 Q_F}{d_k R_{eH1}}$$

The effective surface area, in cm², of the key (without rounded edges) between key and rudder stock or cone coupling is not to be less than:

$$a_k = \frac{10Q_F}{d_k R_{eH2}}$$

### 5.4 Cone couplings between rudder stocks and rudder blades with special arrangements for mounting and dismounting the couplings

#### 5.4.1 General

See Pt B, Ch 10, Sec 1, [5.4] of the Rules for Classification of Ships.

### 5.5 Vertical flange couplings

#### 5.5.1

See Pt B, Ch 10, Sec 1, [5.5] of the Rules for Classification of Ships.

### 5.6 Couplings by continuous rudder stock welded to the rudder blade

#### 5.6.1

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].

#### 5.6.2

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].

### 5.7 Skeg connected with rudder trunk

#### 5.7.1

See Pt B, Ch 10, Sec 1, [5.7] of the Rules for Classification of Ships.

## 6 Rudder stock bearings

### 6.1 General

#### 6.1.1

The mean bearing pressure acting on the rudder stock bearing is to be in compliance with the following formula:

$p_F \leq p_{F,ALL}$

where:

$p_F$ : mean bearing pressure acting on the rudder stock bearings, in N/mm², equal to:

$$p_F = \frac{F_{A1}}{d_m h_m}$$

$F_{A1}$ : force acting on the rudder stock bearing, in N, calculated as specified in [3.1.1],

$d_m$ : actual inner diameter, in mm, of the rudder stock bearings,

$h_m$ : bearing length, in mm.

$p_{F,ALL}$ : allowable bearing pressure, in N/mm², defined in Tab 2.

**6.1.2** For the purposes of this calculation it is to be taken not greater than 1,2 $d_m$, for spade rudders

**6.1.3** Values greater than those given in Tab 2 may be accepted by the Society in accordance with the Manufacturer's specifications if they are verified by tests, but in no case more than 10 N/mm².

**6.1.4** The minimum thickness of the lower bearing is to be 0,2$d_{TF}$ and the minimum height is to be at least $d_m$.

**6.1.5** An adequate lubrication of the bearing surface is to be ensured.

**6.1.6** The manufacturing tolerance $t_0$ on the diameter of metallic supports is to be not less than the value obtained, in mm, from the following formula:

$$t_0 = \frac{d_m}{1000} + 1$$

In the case of non-metallic supports, the tolerances are to be carefully evaluated on the basis of the thermal and distortion properties of the materials employed.

The tolerance on support diameter is to be not less than 1,5 mm, unless a smaller tolerance is supported by the manufacturer's recommendation and there is documented evidence of satisfactory service history with a reduced clearance.

**6.1.7** Liners and bushes are to be fitted in way of bearings. The minimum thickness of liners and bushes is to be equal to:

- $t_{min}$ = 8 mm for metallic materials and
- $t_{min}$ = 22 mm for lignum material.

**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 the Society.
**(2)** Stainless and wear-resistant steel in combination with stock liner approved by the Society.

# 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.

### 7.1.3 Access openings

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.

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 $\sigma$, in N/mm², induced by the loads defined in [3.1], is in compliance with the following formula:

$\sigma \le \sigma_{ALL}$

where:

$\sigma_{ALL}$ : allowable bending stress, in N/mm², specified in Tab 3.

**Table 3 : Allowable stresses for rudder blade scantlings**

| Allowable bending stress $\sigma_{ALL}$ in N/mm² | Allowable shear stress $\tau_{ALL}$ in N/mm² | Allowable equivalent stress $\sigma_{E,ALL}$ in N/mm² |
|---|---|---|
| 110/k | 50/k | 120/k |

### 7.2.2 Shear stresses

For the generic horizontal section of the rudder blade it is to be checked that the shear stress $\tau$, in N/mm², induced by the loads defined in [3.1], is in compliance with the following formula:

$\tau \le \tau_{ALL}$

where:

$\tau_{ALL}$ : 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 $\sigma_E$ is in compliance with the following formula:

$\sigma_E \le \sigma_{E,ALL}$

where:

$\sigma_E$ : 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 $\sigma_E$ 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,

$\sigma$ : bending stress, in N/mm²,

$\tau$ : shear stress, in N/mm²,

$\sigma_{E,ALL}$ : allowable equivalent stress, in N/mm², specified in Tab 3.

## 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:

$$t_f = \left(5{,}5 s \beta \sqrt{T + \frac{C_R 10^{-4}}{A}}\right)\sqrt{k} + 2{,}5$$

where:

$\beta$ : coefficient equal to:

$$\beta = \sqrt{1{,}1 - 0{,}5\left(\frac{s}{b_L}\right)^2}$$

to be taken not greater than 1,0 if $b_L/s > 2{,}5$

s : length, in m, of the shorter side of the plate panel,

$b_L$ : length, in m, of the longer side of the plate panel

T : moulded draught, in m.

### 7.3.2 Thickness of the top and bottom plates of the rudder blade

The thickness of the top and bottom plates of the rudder blade is to be not less than the thickness $t_F$ 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:

- 8 mm for craft ≥ 500GT
- 6 mm for craft < 500GT
- 5 mm for craft of less than 24m in $L_{LL}$ or $L_H$

except for the upper and lower horizontal webs, for which the requirements in [7.3.2] apply.

When the design of the rudder does not incorporate a mainpiece, this is to be replaced by two vertical webs closely spaced, having thickness not less than 1,4 $t_f$ and the thickness of rudder plating to be at least 1,3 $t_f$. One vertical web only may be accepted provided its thickness is at least twice that of normal webs.

#### 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 obtained, in mm, from [7.3.4].

#### 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 Part D of the Rules.

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.

### 7.4 Connections of rudder blade structure with solid parts in forged or cast steel

#### 7.4.1 General

See Pt B, Ch 10, Sec 1, [7.4] of the Rules for Classification of Ships.

### 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:

$w_S = 1,3\ d_{1TF}^3\ 10^{-4}$

where $d_{1TF}$, in mm, is to be calculated in compliance with the requirements in [4.2], 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 $t_f$ and 1,3 $t_f$ 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:

$$t_B = (1{,}5 s V_{AV} + 2{,}5) \cdot \sqrt{k}$$

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:

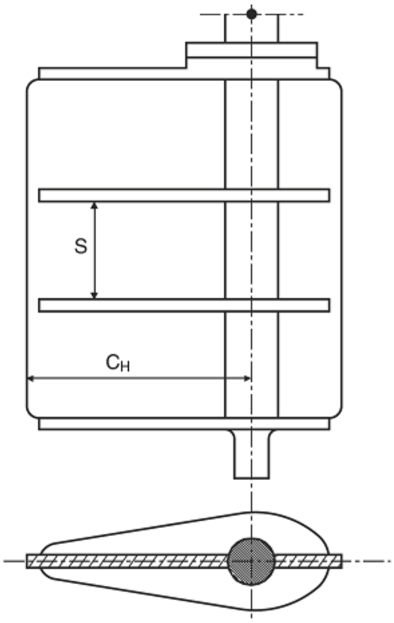
$$Z_A = 0{,}5\, s\, C_H^2\, V_{AV}^2\, k$$

where:

$C_H$ : horizontal distance, in m, from the aft edge of the rudder to the centreline of the rudder stock (see Fig 4),

s : defined in [7.6.2].

**Figure 4 : Single plate rudder**




# 8 Rudder trunk

## 8.1 General

**8.1.1** See Pt B, Ch 10, Sec 1, [8.4] of the Rules for Classification of Ships.

# 9 Simplex rudder shaft

## 9.1 General

**9.1.1** See Pt B, Ch 10, Sec 1, [9] of the Rules for Classification of Ships.

# 10 Steering nozzles

## 10.1 General

**10.1.1** See Pt B, Ch 10, Sec 1, [10] of the Rules for Classification of Ships.

# 11 Azimuth propulsion system

## 11.1 General

**11.1.1** See Pt B, Ch 10, Sec 1, [11] of the Rules for Classification of Ships.

# SECTION 2 PROPELLER SHAFT BRACKETS

## 1 Propeller shaft brackets

### 1.1 General

**1.1.1** For certain craft, 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

**1.2.1** The scantlings of bracket arms are to be calculated as indicated below. For high-powered craft, 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 $\mathbf{d}_S$, where:

$\mathbf{d}_S$ : Rule diameter, in mm, of the propeller shaft, calculated with the actual mechanical characteristics.

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 · $\mathbf{d}_S$ .

The thickness, in mm, of the shaft bracket boss after boring operation is to be not less than:

$\mathbf{t_b}$ = ,0 2 ;)($\mathbf{K}_1$ $\mathbf{d}_S$ 10+25

where:

$\mathbf{K}_1$ : $\mathbf{R}_{ms}/\mathbf{R}_{mb}$,

$\mathbf{R}_{ms}$ : minimum tensile strength, in N/mm², of the propeller shaft,

$\mathbf{R}_{mb}$ : minimum tensile strength, in N/mm², of the shaft bracket boss, with appropriate metallurgical temper.

Each arm of V-shaft brackets is to have a cross-sectional area, in mm², 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/mm², of arms, with appropriate metallurgical temper.

Single-arm shaft brackets are to have a section modulus at craft plating level, in cm³, of not less than:

$$\mathbf{Z} = \frac{30}{\mathbf{R}_{ma}} \cdot 10^{-3} \cdot \mathbf{l} \cdot \mathbf{d}_{so}^2 \cdot (\mathbf{n} \cdot \mathbf{d}_{so})^{0,5}$$

where:

$\mathbf{l}$ : length of the arm, in m, measured from the shell plating to the centreline of the shaft boss,

$\mathbf{n}$ : 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.

### 1.3 Plating bossing

**1.3.1** Where the propeller shafting is enclosed within a plated bossing, the aft end of the bossing is to be adequately supported.

**1.3.2** The scantlings of end supports are to be individually considered. Supports are to be designed to transmit loads to the main structure.

**1.3.3** End supports are to be connected to at least two deep floors of increased thickness, or connected to each other within the craft.

**1.3.4** Stiffening of the boss plating is to be individually considered. At the aft end, transverse diaphragms are to be fitted at every frame and connected to floors of increased scantlings. At the fore end, web frames spaced not more than four frames apart are to be fitted.

# SECTION 3 WATERJETS

## 1 Waterjets

### 1.1 General

**1.1.1** The supporting structures of waterjets are to be able to withstand the loads thereby generated in the following conditions:

- maximum ahead thrust;
- maximum thrust at maximum lateral inclination;
- maximum reversed thrust (going astern).

**1.1.2** Information on the above loads is to be given by the waterjet Manufacturer, supported by documents.

**1.1.3** The shell thickness in way of nozzles, as well as the shell thickness of the tunnel, is to be individually considered. In general, such thicknesses are to be not less than 1,5 times the thickness of the adjacent bottom plating.

# SECTION 4 EQUIPMENT

## 1 Equipment Number

### 1.1

**1.1.1** The equipment of the craft is to be as stipulated in Tab 1 based on the Equipment Number EN given in the requirements of Part B, Ch 10, Sec 4 of the Rules for Classification of Ships. Alternatively, Tasneef, taking into account the specific service and operational area for which the craft is classed, may accept arrangements other than those above, following a request with grounds from the Interested Parties.

**1.1.2** In case the craft is normally moored at quay and is thus only exceptionally anchored, the second anchor and attached chain end length (or guy pendant) may be stored ashore and not necessarily onboard.

## 2 Anchors

### 2.1

**2.1.1** The mass per anchor given in Tab 1 applies to normal type anchors and may be reduced to 75% of that shown when high holding power anchors are used.

**2.1.2** Anchors are generally to be arranged in hawse pipes or, in any event, so that the chain cables can be easily and rapidly paid out. The chafing lips, and in any case the zone at the shell and deck, are to have radius adequate to the diameter of the chain cable; in general, this is to be not less than 8 times the diameter of the chain cable.

## 3 Chain cables and ropes

### 3.1

**3.1.1** The chain cable diameters shown in Tab 1 refer to chain cables made of mild steel, grade Q1. The total length of chain cable for the anchor may be provided using a length of at least 10 m, having the required diameter, connected at one end to the anchor and at the other to a wire or natural fibre rope having the required chain cable length and breaking load at least equal to that of the chain cable.

**3.1.2** If synthetic fibre ropes are used to replace both the chain cable and the mooring and/or warping lines, the breaking load is to be calculated as stated in Part B, Ch 10, Sec 4 of the Rules for Classification of Ships.

## 4 Windlass

### 4.1

**4.1.1** The windlass is to be suitable for the size of chain cable and is generally to be power driven.

**Table 1**

| Equipment number EN | Number of anchors | Mass of each anchor (kg) | Chain Cable | | | Lines | | |
|---|---|---|---|---|---|---|---|---|
| | | | Diameter (mm) | | Total length (m) | Breaking load (kN) | | Length (m) |
| | | | studless | with stud | | warping | mooring | |
| 30 | 2 | 28 | 9,5 | - | 110 | 31 | 18 | 60 |
| 40 | 2 | 48 | 11 | - | 110 | 46 | 21 | 65 |
| 50 | 2 | 58 | 11 | - | 165 | 60 | 24 | 70 |
| 60 | 2 | 78 | 12,5 | - | 165 | 71 | 26 | 75 |
| 70 | 2 | 99 | 14 | - | 165 | 80 | 28 | 80 |
| 80 | 2 | 117 | 14 | 12,5 | 190 | 88 | 30 | 85 |
| 90 | 2 | 133 | 16 | 12,5 | 190 | 94 | 33 | 88 |
| 100 | 2 | 149 | 17,5 | 14 | 190 | 99 | 35 | 92 |
| 110 | 2 | 156 | 17,5 | 14 | 220 | 104 | 37 | 97 |
| 120 | 2 | 167 | 19 | 16 | 220 | 108 | 38 | 102 |
| 130 | 2 | 177 | 19 | 16 | 220 | 112 | 39 | 104 |
| 140 | 2 | 187 | 19 | 16 | 220 | 114 | 40 | 107 |
| 150 | 2 | 195 | 20,5 | 17,5 | 220 | 116 | 41 | 110 |
| 160 | 2 | 205 | 20,5 | 17,5 | 220 | 118 | 42 | 113 |

**Note 1:** When the calculated EN is intermediate between two values given in the Table, the masses of the anchors and the breaking loads of the lines may be obtained by linear interpolation; the other elements are to be assumed based on the higher EN.

**Note 2:** Natural or synthetic fibre ropes with diameter under 20 mm are not permitted.

**Note 3:** The breaking loads of the lines refer to steel wires or natural fibre ropes. For synthetic fibre ropes, the breaking load is to be determined in accordance with Part B, Chapter 10, Sec 4 of the Rules.

# CHAPTER 1
# MACHINERY

## Section 1 Machinery

# CHAPTER 2
# ELECTRICAL INSTALLATIONS

## Section 3 System Design

# CHAPTER 3
# AUTOMATION

## Section 6 Testing

# CHAPTER 4
# FIRE PROTECTION

## Section 1 General

# CHAPTER 5
# BATTERY AND FUEL CELL POWER

## Section 1 Battery Power



## Section 2 Fuel Cell Power

# Part C
# **Machinery, Systems and Fire Protection**

## Chapter 1
## MACHINERY

### SECTION 1 MACHINERY

# SECTION 1 MACHINERY

## 1 Application, General Requirements and Documentation to be submitted

### 1.1

#### 1.1.1

For the systems for which this Section does not give requirements the requirements of Part C, Chapter 1 of the Rules as far is it is practicable and reasonably generally apply.

Materials used in piping systems are to be suitable for the liquid conveyed and the external environment to which they are exposed; different materials are not to be combined such that there is a possibility for galvanic corrosion.

All components in the installation are to have sufficient strength and be so mounted that the system including its foundations will withstand the accelerations and vibrations to which it may be exposed as well as the design pressure. They are to be protected against mechanical damage. Expansion joints or equivalent arrangement are to be provided to allow expansion/contraction of pipes.

Corrosion and temperature variation have to be taken into consideration.

Pipes or hoses are not to be installed over switchboard or electrical distribution panels except when they are metallic without junctions.

#### 1.1.2 Documentation to be submitted

The documentation to be submitted to the Society, for approval, is listed in Tab 1.

**Table 1 : Documentation to be submitted for approval, as applicable**

| No. | Item |
|---|---|
| 1 | Diagram of the bilge and ballast system (in and outside machinery spaces) |
| 2 | Diagram of the air, sounding and overflow systems |
| 3 | Diagram of cooling systems (sea water and fresh water) |
| 4 | Diagram of the lubricating oil system (if applicable) |
| 5 | Propeller (for information) |
| 6 | Gearing (for information) |
| 7 | Shaft line arrangement (for information) |
| 8 | Steering gear (for information) |
| 9 | Azimuth thruster (if applicable, for information) |

## 2 Bilge systems

### 2.1

#### 2.1.1

The bilge system is to be permanently installed.

The bilge system is to be able to drain all compartments except tanks.

The bilge system is to be made of steel, or suitable plastic material.

Metallic materials are to be used in the machinery space. If flexible hoses are used they have to be of a type recognized by Tasneef and special attention is to be given to collapse due to suction.

#### 2.1.2

Each watertight compartment is to be drained by a dedicated bilge branch and the branch is to be fitted with a non-return valve between the bilge main and the individual branch. The valve is to be operable from above the working platform. Special considerations may be done for small compartments.

#### 2.1.3

One bilge pump driven directly by the propulsion machinery or by electric motor is to be installed.

The internal diameter d, in mm, of the bilge main and the bilge suction branches leading from the various compartments is to be not less than that calculated according to the following formula:

$d = 0,85\ L + 25$

Where:

L = load line length

However, the actual internal diameter defined above may be rounded off to the nearest standard size acceptable to Tasneef (in any case it is to be not more than 5 mm less than that obtained from the formula).

The capacity of the bilge pump is to be not less than that given by the following formula:

$Q = 0{,}00565d^2$

Where:

Q = capacity of the bilge pump in $m^3/h$

d = rule inner diameter of the bilge main, in mm, calculated with the above formula.

The bilge pump is to be possible to operate from the steering position. In craft larger than 6 m minimum two pumps are to be fitted, each with at least 60% of the capacity given above.

#### 2.1.4

As an alternative separate bilge pumps may be installed for one or more compartments. Pumps are to be possible to operate from the steering position. The capacity of the pump is to be consistent with the length of the compartment to be drained.

#### 2.1.5

For non-open craft all the spaces are to be fitted with bilge alarm.

## 3 Seawater cooling systems

### 3.1 General

#### 3.1.1

In sea water system, flexible hoses may be fitted If satisfying ISO 7840 provided that they are protected against mechanical damage and possibly above the design waterline. Flexible hoses end is to be in accordance with [3.3.2].

#### 3.1.2

Seawater intakes are to have strainers or filters and it is to be possible to carry out maintenance works without stopping the propulsion machinery.

## 4 Fresh water systems and grey water systems

### 4.1 General

#### 4.1.1

Fresh and Grey water tanks may be independent or part of the craft structure and accessible for cleaning and filled/empty from above the deck.

#### 4.1.2

Integral freshwater tanks are not to be located contiguous to grey water tanks.

#### 4.1.3

Grey water is to be collected in dedicated tanks.

## 5 Shell penetrations

### 5.1 General

#### 5.1.1

Overboard suction and discharges with lower end located lower than 200 mm above deepest waterline are to be arranged with a non-return closing valve. This valve is to be made of metallic ductile material and is to be easy accessible. For this valve an open/closed indication or other equivalent means for preventing water from passing inboard is to be provided. Only for structural scuppers coming from the deck a non-return valve is acceptable.

## 6 Testing

### 6.1 General

#### 6.1.1

the requirements of Pt C, Ch 1 of the Rules as far is it is practicable and reasonably generally apply.

## 7 Steering system

### 7.1 General

#### 7.1.1

The steering arrangement is to be suitable to manouvre the craft at the maximum power and it is to be suitable protected from damages.

#### 7.1.2

An emergency means of steering is to be provided in case of failure of the main steering system.

#### 7.1.3

Rudder stops are to be provided.

### 7.2 Hydraulic steering system

#### 7.2.1

The capacity of the steering system is to be verified and is to be tested during sea trials.

#### 7.2.2

The complete installation is to be tested for leaks at a suitable pressure.

#### 7.2.3

Hand operated hydraulic steering systems CE-marked according to RCD Directive may be accepted. The system is to be installed according to the manufacturers instructions.

### 7.3 Cable steering system

#### 7.3.1

Cable steering systems CE-marked according to RCD Directive may be accepted. They are to be installed according to the manufacturers recommendations.

### 7.4 Steering wheel

#### 7.4.1

Steering wheels are to be normally CE-marked according to RCD Directive. Not CE-marked steering wheels on very small craft will be evaluated on a case by case basis.

### 7.5 Waterjet installations

#### 7.5.1

The manufacturer of the water jet installation has to declare the forces acting on the craft from the water jet.

# 8 Shafting

## 8.1 General

### 8.1.1 Propeller, intermediate and thrust shafts

The minimum diameter of intermediate and propeller shafts is not to be less than the value given by the following formula:

$$\mathbf{d} = \mathbf{k} \cdot \left[\frac{\mathbf{P}}{\mathbf{n} \cdot (1 - \mathbf{Q}^4)} \cdot \frac{560}{\mathbf{R_m} + 160}\right]^{1/3}$$

where:

**d** : rule diameter of the intermediate or propeller shaft, in mm

**k** 90, for all types of shafts

**P** : maximum service power, in kW

**n** : shaft rotational speed, in r.p.m., corresponding to **P** power

**Q** : 0, in the case of solid shafts

ratio of the hole diameter to the outer shaft diameter in the concerned section, in the case of a hollow shaft; where **Q** ≤ 0,3, **Q** = 0 is to be taken.

Hollow shafts whose longitudinal axis does not coincide with the longitudinal hole axis will be specially considered by Tasneef in the individual cases.

$\mathbf{R_m}$ : value of the minimum tensile strength of the shaft material, in N/mm$^2$.

Intermediate and propeller shafts having an actual minimum diameter less than above rule diameter may be accepted, provided they are based on documented satisfactory service experience and/or on technical documents submitted by the Manufacturer to Tasneef and deemed suitable by the latter.

# 9 Machinery

## 9.1 Machinery spaces

### 9.1.1

Machinery spaces are not to be used for other purposes. The propulsion machinery control position is to be readily accessible and safe from hot surfaces and dangerous rotating parts and equipped with artificial lighting.

### 9.1.2

Glazed openings in machinery space(s) are to have the same fire rating as surrounding structure.

### 9.1.3

Forced ventilation is to be provided as per the propulsion machinery Manufacturer's instructions.

## 9.2 Propellers

### 9.2.1

Propellers have to be made of metallic material, have to be made by a recognized Manufacturer and installed in accordance with the Manufacturer's instruction.

## 9.3 Pressure vessels

### 9.3.1

Pressure vessels have to be provided with a certification deemed suitable by Tasneef

## 9.4 Gears

### 9.4.1

Gears have to be made by a recognized Manufacturer and installed in accordance with the Manufacturer's instructions.

Part C
# Machinery, Systems and Fire Protection

Chapter 2
# ELECTRICAL INSTALLATIONS

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# SECTION 1 GENERAL

## 1 Application

### 1.1 General

**1.1.1** The requirements of this Chapter apply to electrical installations on craft. In particular, they apply to the components of electrical installations for:

- primary essential services
- secondary essential services
- services for habitability.

The other parts of the installation are to be so designed as not to introduce any risks or malfunctions to the above services.

**1.1.2** The Society may consider to modify the requirements for craft with length L≤20 m or restricted navigation, based on risk analysis and alternative design.

### 1.2 Alternative design

**1.2.1** Alternative design may be proposed based on:

- Formal Safety Assessment (FSA) procedure of IMO Guidelines (MSC-MEPC.2/Circ.12/Rev.2);
- Risk Assessment (RA) and ensuring technical evidence & document according to Tasneef Guide for Risk

Analysis. **1.2.2** Alternative design is to be submitted with:

- the outcome and report of FSA or RA as per [1.2.1]
- the departure of requirements with detailed comparison between the part of Guidelines and the alternative proposal
- the documents (plans, diagrams, specifications and calculations etc.) resulting from the alternative proposal with detailed comparison between the original documents and the ones reflecting alternative design.

### 1.3 References to other regulations and standards

**1.3.1** The Society may refer to other regulations and standards when deemed necessary. These include the IEC publications, notably the IEC 60092 series.

**1.3.2** When referred to by the Society, publications by the International Electrotechnical Commission (IEC) or other internationally recognised standards, are those currently in force at the date of agreement for craft classification.

## 2 Documentation to be submitted

### 2.1

**2.1.1** The documents listed in Tab 1 are to be submitted.

The list of documents requested is to be intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

## 3 Definitions

### 3.1 General

**3.1.1** Unless otherwise stated, the terms used in this Chapter have the definitions laid down by the IEC standards.

The definitions given in the following requirements also apply.

### 3.2 Essential services

**3.2.1** Essential services are those services essential for propulsion and steering, and the safety of the craft, and services to ensure minimum comfortable conditions of habitability.

**Table 1 : Documents to be submitted**

| No. | I/A **(1)** | Documents to be submitted |
|---|---|---|
| 1 | A | Single line diagram of main and emergency power and lighting systems. |
| 2 | A | Electrical power balance. |
| 3 | I | Calculation of short-circuit currents for each installation in which the sum of rated power of the energy sources which may be connected contemporaneously to the network is greater than 500 kVA (KW). |
| 4 | A | List of circuits including, for each supply and distribution circuit, data concerning the nominal current, the cable type, length and cross-section, nominal and setting values of the protective and control devices. |
| 5 | A | Single line diagram and detailed diagram of the main switchboard. |
| 6 | A | Single line diagram and detailed diagram of the emergency switchboard. |
| 7 | A | Diagram of the most important section board and motor control centres (above 100kW). |
| 8 | A | Diagram of the general emergency alarm system, of the public address system and other intercommunication systems. |
| 9 | A | Detailed diagram of the navigation lights switchboard. |
| 10 | A | Diagram of the remote stop system (ventilation, etc.). |
| 11 | A **(2)** | Selectivity and coordination of the electrical protection. |
| 12 | A | Single line diagram of electrical propulsion system. |
| 13 | A | Principles of control system and power supply of electrical propulsion system. |
| 14 | A | Alarm and monitoring system including:<br>• list of alarm and monitoring points<br>• power supply diagram<br>for electrical propulsion system. |
| 15 | A | Safety system including:<br>• list of monitored parameter for safety system<br>• power supply diagram<br>for electrical propulsion system. |

**(1)** A: to be submitted for approval
I: to be submitted for information
**(2)** for high voltage installations

## 3.3 Primary essential services

**3.3.1** Primary essential services are those which need to be in continuous operation to maintain propulsion and steering.

Examples of equipment for primary essential services are the following:

- Steering gear
- Pumps for controllable pitch propellers
- Supplying cooling water pumps for main and auxiliary machinery for propulsion
- Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps
- Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps
- Electric supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Control, monitoring and safety devices/systems for equipment for primary essential services.

The main lighting system for those parts of the craft normally accessible to and used by personnel and passengers is also considered (included as) a primary essential service.

## 3.4 Secondary essential services

**3.4.1** Secondary essential services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the craft's safety.

Examples of equipment for secondary essential services are the following:

- Windlasses
- Sea water pumps
- Bilge, ballast and heeling pumps
- Fire pumps and other fire-extinguishing medium pumps
- Ventilation fans for machinery spaces
- Navigation lights, aids and signals
- Internal safety communication equipment
- Fire detection and alarm systems
- Electrical equipment for watertight closing appliances
- Hydraulic pumps supplying the above equipment

- Control, monitoring and safety devices/systems for equipment for secondary essential services.

**3.4.2** Services for habitability are those which need to be in operation to maintain the craft's minimum comfort conditions for people on board.

Examples of equipment for maintaining conditions of habitability:

- Cooking
- Heating
- Domestic refrigeration
- Mechanical ventilation
- Sanitary and fresh water
- Power sources supplying the above equipment.

## 3.5 Safety voltage

**3.5.1** A voltage which does not exceed 50 V a.c. r.m.s. between conductors, or between any conductor and earth, in a circuit isolated from the supply by means such as a safety isolating transformer.

**3.5.2** A voltage which does not exceed 50 V d.c. between conductors or between any conductor and earth in a circuit isolated from higher voltage circuits.

## 3.6 Low-voltage systems

**3.6.1** Alternating current systems with rated voltages greater than 50 V r.m.s. up to 1000 V r.m.s. inclusive and direct current systems with a maximum instantaneous value of the voltage under rated operating conditions greater than 50 V up to 1500 V inclusive.

## 3.7 High-voltage systems

**3.7.1** Alternating current systems with rated voltages greater than 1000 V r.m.s. and direct current systems with a maximum instantaneous value of the voltage under rated operating conditions greater than 1500 V.

## 3.8 Basic insulation

**3.8.1** Insulation applied to live parts to provide basic protection against electric shock.

Note 1: Basic insulation does not necessarily include insulation used exclusively for functional purposes.

## 3.9 Supplementary insulation

**3.9.1** Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

## 3.10 Double insulation

**3.10.1** Insulation comprising both basic insulation and supplementary insulation.

## 3.11 Reinforced insulation

**3.11.1** A single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation.

Note 1: The term "single insulation system" does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

## 3.12 Earthing

**3.12.1** The earth connection to the general mass of the hull of the craft in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

## 3.13 Normal operational and habitable condition

**3.13.1** *A condition under which the craft as a whole, the machinery, services, means and aids ensuring propulsion, ability to steer, safe navigation, fire and flooding safety, internal and external communications and signals, means of escape, and emergency boat winches, as well as the designed comfortable conditions of habitability are in working order and functioning normally.*

## 3.14 Emergency condition

**3.14.1** *A condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electrical power.*

## 3.15 Main source of electrical power

**3.15.1** *A source intended to supply electrical power to the main switchboard for distribution to all services necessary for maintaining the craft in normal operational and habitable condition.*

## 3.16 "Dead ship" condition

**3.16.1** *The condition under which the main propulsion plant and electrical power supply are not in operation due to the absence of electrical power.*

## 3.17 Main generating station

**3.17.1** *The space or spaces in which the main source of electrical power is situated, i.e. battery room(s).*

## 3.18 Main switchboard

**3.18.1** *A switchboard which is directly supplied by the main source of electrical power and is intended to distribute electrical energy to the craft's services.*

## 3.19 Emergency switchboard

**3.19.1** *A switchboard which in the event of failure of the main electrical power supply system is directly supplied by the emergency source of electrical power or the transitional* *source of emergency and is intended to distribute electrical energy to the emergency services.*

## 3.20 Emergency source of electrical power

**3.20.1** *A source of electrical power, intended to supply the emergency switchboard in the event of failure of the supply from the main source of electrical power.*

## 3.21 Section boards

**3.21.1** A switchgear and controlgear assembly which is supplied by another assembly and arranged for the distribution of electrical energy to other section boards or distribution boards.

## 3.22 Distribution board

**3.22.1** A switchgear and controlgear assembly arranged for the distribution of electrical energy to final sub-circuits.

## 3.23 Hazardous areas

**3.23.1** Areas in which an explosive atmosphere is present, or may be expected to be present due to the presence of vapours, gases, flammable dusts or explosives in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

**3.23.2** Hazardous areas are classified in zones based upon the frequency and the duration of the occurrence of explosive atmosphere.

**3.23.3** Hazardous areas for explosive gas atmosphere are classified in the following zones:

- Zone 0: an area in which an explosive gas atmosphere is present continuously or is present for long periods
- Zone 1: an area in which an explosive gas atmosphere is likely to occur in normal operation
- Zone 2: an area in which an explosive gas atmosphere is not likely to occur in normal operation and if it does occur, is likely to do only infrequently and will exist for a short period only.

## 3.24 Certified safe-type equipment

**3.24.1** Certified safe-type equipment is electrical equipment of a type for which a national or other appropriate authority has carried out the type verifications and tests necessary to certify the safety of the equipment with regard to explosion hazard when used in an explosive gas atmosphere.

## 3.25 Environmental categories

**3.25.1** Electrical equipment is classified into environmental categories according to the temperature range, vibration levels, and resistance to chemically active substances and to humidity.

The designation of the environmental categories is indicated by the EC Code in Tab 2

The first characteristic numeral indicates the temperature range in which the electrical equipment operates satisfactorily, as specified in Tab 3

The second characteristic numeral indicates the vibration level in which the electrical equipment operates satisfactorily, as specified in Tab 4.

**Table 2 : EC Code**

| Code letter | First characteristic numeral | Second characteristic numeral | Additional letter | Supplementary letter |
|---|---|---|---|---|
| EC | (numerals 1 to 4) | (numerals 1 to 3) | (letter S) **(1)** | (letter C) **(2)** |

**(1)** The additional letter S indicates the resistance to salt mist (exposed decks, masts) of the electrical equipment.
**(2)** The supplementary letter C indicates the relative humidity up to 80% (air conditioned areas) in which the electrical equipment operates satisfactorily.

**Table 3 : First characteristic numeral**

| First characteristic numeral | Brief description of location | Temperature range °C | |
|---|---|---|---|
| 1 | Air conditioned areas | + 5 | + 40 |
| 2 | Enclosed spaces | + 5 | + 45 |
| 3 | Inside consoles or close to propulsion machinery and similar | + 5 | + 55 |
| 4 | Exposed decks, masts | - 25 | + 45 |

**Table 4 : Second characteristic numeral**

| Second characteristic numeral | Brief description of location | Frequency range Hz | Displacement amplitude mm | Acceleration amplitude g |
|---|---|---|---|---|
| 1 | Machinery spaces, command and control stations, accommodation spaces, exposed decks, cargo spaces | from 2,0 to 13,2<br>from 13,2 to 100 | 1,0<br>- | -<br>0,7 |
| 2 | Masts | from 2,0 to 13,2<br>from 13,2 to 50 | 3,0<br>- | -<br>2,1 |
| 3 | On air compressors, on propulsion machinery and similar | from 2,0 to 25,0<br>from 25,0 to 100 | 1,6<br>- | -<br>4,0 |

# SECTION 2 GENERAL DESIGN REQUIREMENTS

## 1 Ambient conditions

### 1.1 General

**1.1.1** The electrical components of installations are to be designed and constructed to operate satisfactorily under the environmental conditions on board.

In particular, the conditions shown in the tables in this Article are to be taken into account.

Note 1: The environmental conditions are characterised by:

- one set of variables including climatic conditions (e.g. ambient air temperature and humidity), biological conditions, conditions dependent upon chemically active substances (e.g. salt mist) or mechanically active substances (e.g. dust or oil), mechanical conditions (e.g. vibrations or inclinations) and conditions dependent upon electromagnetic noise and interference, and
- another set of variables dependent mainly upon location on craft, operational patterns and transient conditions.

### 1.2 Ambient air temperatures

**1.2.1** For craft classed for unrestricted navigation, the reference ambient air temperature ranges are shown in Tab 1 in relation to the various locations of installation.

**1.2.2** Where electrical equipment is installed within environmentally controlled spaces, the ambient temperature for which the equipment is to be suitable may be reduced from 45° and maintained at a value not less than 35° provided:

- the equipment is not for use for emergency services and is located outside the machinery space(s)
- temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is (are) capable of satisfactorily maintaining the design temperature.
- the equipment is able to be initially set to work safely up to a 45° ambient temperature until such time as the lower ambient temperature is achieved; the cooling equipment is to be rated for a 45 ° ambient temperature.
- audible and visual alarms are fitted, at a continually manned control station, to indicate any malfunction of the cooling units.

**1.2.3** In accepting an ambient temperature less than 45° it is to be ensured that electrical cables are adequately rated throughout their length for the maximum ambient temperature to which they are exposed.

**1.2.4** The equipment used for cooling and maintaining the lower ambient temperature is to be classified for a secondary essential service.

### 1.3 Humidity

**1.3.1** For craft classed for unrestricted service, the humidity ranges shown in Tab 2 are applicable in relation to the various locations of installation.

**Table 1 : Ambient air temperature**

| Location | Temperature range, in °C | |
|---|---|---|
| Enclosed spaces | + 5 | + 45 |
| Inside consoles or fitted on propulsion machinery and similar | + 5 | + 55 |
| Exposed decks | - 25 | + 45 |

**Table 2 : Humidity**

| Location | Humidity |
|---|---|
| General | 95% at 55 °C |
| Air conditioned areas | Different values may be considered on a case by case basis |

### 1.4 Cooling water temperatures

**1.4.1** The temperatures shown in Tab 3 are applicable to craft classed for unrestricted service.

**Table 3 : Water temperature**

| Coolant | Temperature range, in °C | |
|---|---|---|
| Sea water | 0 | + 32 |

### 1.5 Salt mist

**1.5.1** The applicable salt mist content in the air is to be 1 mg/m$^3$.

### 1.6 Inclinations

**1.6.1** The inclinations applicable are those shown in Tab 4.

The Society may consider deviations from these angles of inclination taking into consideration the type, size and service conditions of the craft.

### 1.7 Vibrations

**1.7.1** In relation to the location of the electrical components, the vibration levels given in Tab 5 are to be assumed.

**1.7.2** The natural frequencies of the equipment, their suspensions and their supports are to be outside the frequency ranges specified.

Where this is not possible using a suitable constructional technique, the equipment vibrations are to be dumped so as to avoid unacceptable amplifications.

## 2 Quality of power supply

### 2.1 General

**2.1.1** All electrical components are to be so designed and manufactured that they are capable of operating satisfactorily under the variations of voltage, frequency and harmonic distortion of the power supply specified from [2.2] to [2.4].

### 2.2 A.C. distribution systems

**2.2.1** For alternating current components the voltage and frequency variations of power supply shown in Tab 6 are to be assumed.

### 2.3 D.C. distribution systems

**2.3.1** For direct current components voltage variations of power supply shown in Tab 7 are to be assumed.

**2.3.2** For direct current components supplied by electrical battery the following voltage variations are to be assumed:

- +30% to -25% for components connected to the battery during charging (see Note 1)
- +20% to -25% for components not connected to the battery during charging.

Note 1: Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.

**2.3.3** Any special system, e.g. electronic circuits, which cannot operate satisfactorily within the limits shown in Tab 6 and Tab 7 is not to be supplied directly from the system but by alternative means, e.g. through stabilised supply.

### 2.4 Harmonic distortions

**2.4.1** For components intended for systems without substantially static converter loads, it is assumed that the total voltage harmonic distortion does not exceed 5%, and the single harmonic does not exceed 3% of the nominal voltage.

**2.4.2** For components intended for systems fed by static converters, and/or systems in which the static converter load predominates, it is assumed that:

- the single harmonics do not exceed 5% of the nominal voltage up to the 15th harmonic of the nominal frequency, decreasing to 1% at the 100th harmonic (see Fig 1), and that
- the total harmonic distortion does not exceed 10%.

**2.4.3** Higher values for the harmonic content (e.g. in electric propulsion plant systems) may be accepted on the basis of correct operation of all electrical devices.

**Figure 1**

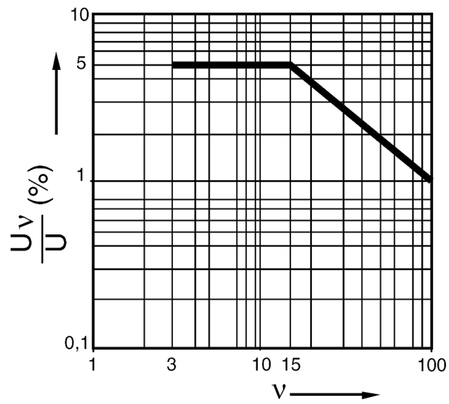



**Table 4 : Inclination of craft**

| Type of machinery, equipment or component | Angles of inclination, in degrees **(1)** | | | |
|---|---|---|---|---|
| | Athwartship | | Fore-and-aft | |
| | static | dynamic **(3)** | static | dynamic **(4)** |
| Machinery and equipment relative to main electrical power installation | 15 | 22,5 | 5 | 7,5 |
| Machinery and equipment relative to the emergency power installation and crew and passenger safety systems of the craft (e.g. emergency source of power, emergency fire pumps, etc.) | 22,5 | 22,5 | 10 | 10 |
| Switchgear and associated electrical and electronic components and remote control systems **(2)** | 22,5 | 22,5 | 10 | 10 |

**(1)** Athwartship and fore-and-aft angles may occur simultaneously in their most unfavourable combination.
**(2)** No undesired switching operations or functional changes may occur up to an angle of inclination of 45°.
**(3)** The period of dynamic inclination may be assumed equal to 10 s.
**(4)** The period of dynamic inclination may be assumed equal to 5 s.

**Table 5 : Vibration levels**

| Location | Frequency range Hz | Displacement amplitude mm | Acceleration amplitude g |
|---|---|---|---|
| Machinery spaces, command and control stations, accommodation spaces, exposed decks, cargo spaces | from 2,0 to 13,2<br>from 13,2 to 100 | 1,0<br>- | -<br>0,7 |
| On air compressors, on propulsion machinery and similar | from 2,0 to 25,0<br>from 25,0 to 100 | 1,6<br>- | -<br>4,0 |
| Masts | from 2,0 to 13,2<br>from 13,2 to 50 | 3,0<br>- | -<br>2,1 |

**Table 6 : Voltage and frequency variations of power supply in A.C.**

| Parameter | Variations | |
|---|---|---|
| | Continuous | Transient |
| Voltage | + 6%  - 10% | ± 20% (recovery time: 1,5 s) |
| Frequency | ± 5% | ± 10% (recovery time: 5 s) |

**Table 7 : Voltage variations of power supply in D.C.**

| Parameters | Variations |
|---|---|
| Voltage tolerance (continuous) | ± 10% |
| Voltage cyclic variation | 5% |
| Voltage ripple (a.c. r.m.s. over steady d.c. voltage) | 10% |

# 3 Electromagnetic susceptibility

## 3.1

**3.1.1** For electronic type components such as sensors, alarm panels, automatic and remote control equipment, protective devices and speed regulators, the conducted and radiated disturbance levels to be assumed are those given in Chapter 3.

Note 1: See also IEC Publication 60533 - "Electromagnetic Compatibility of Electrical and Electronic Installations in ships and of Mobile and Fixed Offshore Units".

# 4 Materials

## 4.1 General

**4.1.1** In general, and unless it is adequately protected, all electrical equipment is to be constructed of durable, flame-retardant, moisture-resistant materials which are not subject to deterioration in the atmosphere and at the temperatures to which they are likely to be exposed. Particular consideration is to be given to sea air and oil vapour contamination.

Note 1: The flame-retardant and moisture-resistant characteristics may be verified by means of the tests cited in IEC Publication 60092-101 or in other recognised standards.

**4.1.2** Where the use of incombustible materials or lining with such materials is required, the incombustibility characteristics may be verified by means of the test cited in IEC Publication 60092-101 or in other recognised standards.

## 4.2 Insulating materials for windings

**4.2.1** Insulated windings are to be resistant to moisture, sea air and oil vapour unless special precautions are taken to protect insulators against such agents.

**4.2.2** The insulation classes given in Tab 8 may be used in accordance with IEC Publication 60085.

**Table 8 : Insulation Classes**

| Class | Maximum continuous operating temperature °C |
|---|---|
| A | 105 |
| E | 120 |
| B | 130 |
| F | 155 |
| H | 180 |

## 4.3 Insulating materials for cables

**4.3.1** See also Sec 9 of this Chapter.

# 5 Construction

## 5.1 General

**5.1.1** All electrical apparatus is to be so constructed as not to cause injury when handled or touched in the normal manner.

**5.1.2** The design of electrical equipment is to allow accessibility to each part that needs inspection or adjustment, also taking into account its arrangement on board.

**5.1.3** Enclosures are to be of adequate mechanical strength and rigidity.

**5.1.4** Enclosures for electrical equipment are generally to be of metal; other materials may be accepted for accessories such as connection boxes, socket-outlets, switches and luminaires. Other exemptions for enclosures or parts of enclosures not made of metal will be specially considered by the Society.

**5.1.5** Cable entrance are not to impair the degree of protection of the relevant enclosure.

**5.1.6** All nuts and screws used in connection with current-carrying parts and working parts are to be effectively locked.

**5.1.7** All equipment is generally to be provided with suitable, fixed terminal connectors in an accessible position for convenient connection of the external cables.

### 5.2 Degree of protection of enclosures

**5.2.1** Electrical equipment is to be protected against the ingress of foreign bodies and water.

The minimum required degree of protection, in relation to the place of installation, is generally that specified in Sec 3, Tab 2.

**5.2.2** The degrees of protection are to be in accordance with:

- IEC Publication No. 60529 for equipment in general
- IEC Publication No. 60034-5 for rotating machines.

**5.2.3** For cable entries see [5.1.5].

## 6 Protection against explosion hazard

### 6.1 Protection against explosive gas or vapour atmosphere hazard

**6.1.1** Electrical equipment intended for use in areas where explosive gas or vapour atmospheres may occur (e.g. oil tankers, liquefied gas carriers, chemical tankers, etc.), is to be of a "safe type" suitable for the relevant flammable atmosphere and for shipboard use.

**6.1.2** The following “certified safe type” equipment is considered:

- intrinsically-safe: Ex(ia) - Ex(ib)
- flameproof: Ex(d)
- increased safety: Ex(e)
- pressurised enclosure: Ex(p)
- encapsulated: Ex(m)
- sand filled: Ex(q)
- special protection: Ex(s)
- oil-immersed apparatus (see Note 1): Ex(o)

Note 1: Only when required by the application.

**6.1.3** Other equipment complying with types of protection other than those in [6.1.2] may be considered by the Society, such as:

- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules
- electrical apparatus specifically designed and certified by the appropriate authority for use in Zone 0 or specially tested for Zone 2 (e.g. type “n” protection)
- equipment the type of which ensures the absence of sparks and arcs and of “hot spots” during its normal operation
- pressurised equipment
- equipment having an enclosure filled with a liquid dielectric, or encapsulated.

### 6.2 Protection against combustible dust hazard

**6.2.1** Electrical appliances intended for use in areas where a combustible dust hazard may be present are to be arranged with enclosures having a degree of protection and maximum surface temperature suitable for the dust to which they may be exposed.

Note 1: Where the characteristics of the dust are unknown, the appliances are to have a degree of protection IP6X. For most dusts a maximum surface temperature of 200°C is considered adequate.

# SECTION 3 SYSTEM DESIGN

## 1 Supply systems and characteristics of the supply

### 1.1 Supply systems

**1.1.1** The following distribution systems may be used:

a) on d.c. installations:
- two-wire insulated
- two-wire with one pole earthed

b) on a.c. installations:
- three-phase three-wire with neutral insulated
- three-phase three-wire with neutral directly earthed or earthed through an impedance
- three-phase four-wire with neutral directly earthed or earthed through an impedance
- single-phase two-wire insulated
- single-phase two-wire with one phase earthed.

**1.1.2** Distribution systems other than those listed in [1.1.1] (e.g. with hull return, three-phase four-wire insulated) will be considered by Tasneef on a case by case basis.

**1.1.3** For craft with composite hull the requirements given in Pt C, Ch 1, Sec 2 of the Rules regarding craft in different material than steel, are also to apply.

### 1.2 Maximum voltages

**1.2.1** The maximum voltages for both alternating current and direct current low-voltage systems of supply for the craft's services are given in Tab 1.

**1.2.2** Voltages exceeding those shown will be specially considered in the case of specific systems.

**Table 1 : Maximum voltages for various craft services**

| Use | | Maximum voltage, in V |
|---|---|---|
| For permanently installed and connected to fixed wiring | Power equipment | 1000 |
| | Heating equipment (except in accommodation spaces) | 500 |
| | Cooking equipment | 500 |
| | Lighting | 250 |
| | Space heaters in accommodation spaces | 250 |
| | Control **(1)**, communication (including signal lamps) and instrumentation equipment | 250 |
| For permanently installed and connected by flexible cable | Power and heating equipment, where such connection is necessary because of the application (e.g. for moveable cranes or other hoisting gear) | 1000 |
| For socket-outlets supplying | Portable appliances which are not hand-held during operation (e.g. refrigerated containers) by flexible cables | 1000 |
| | Portable appliances and other consumers by flexible cables | 250 |
| | Equipment requiring extra precaution against electric shock where an isolating transformer is used to supply one appliance **(2)** | 250 |
| | Equipment requiring extra precaution against electric shock with or without a safety transformer **(2)**. | 50 |

**(1)** For control equipment which is part of a power and heating installation (e.g. pressure or temperature switches for starting/stopping motors), the same maximum voltage as allowed for the power and heating equipment may be used provided that all components are constructed for such voltage. However, the control voltage to external equipment is not to exceed 500 V.
**(2)** Both conductors in such systems are to be insulated from earth.

## 2 Sources of electrical power

### 2.1 General

**2.1.1** Electrical installations are to be such that:

a) All electrical main and auxiliary services necessary for maintaining the craft in normal operational and habitable conditions and for the preservation of the cargo will be assured without recourse to the emergency source of electrical power.

b) Electrical services essential for safety will be assured under various emergency conditions.

## 2.2 Main source of electrical power

**2.2.1** The main source of electrical power is to be of sufficient capability to supply all electrical main and auxiliary services necessary for maintaining the craft in normal operational and habitable conditions and for the preservation of the cargo without recourse to the emergency source of electrical power.

**2.2.2** The main source of electrical power is to consist of at least two independent electrical power storage.

**2.2.3** Those services necessary to provide normal operational conditions of propulsion and safety include primary and secondary essential services.

For the purpose of calculating the capacity necessary for such services, it is essential to consider which of them can be expected to be in use simultaneously.

**2.2.4** Where transformers, converters or similar appliances constitute an essential part of the electrical supply system, the system is to be so arranged as to ensure the same continuity of supply as stated in this sub-article.

This may be achieved by arranging at least two three-phase or three single-phase transformers supplied, protected and installed as indicated in Fig 1, so that with any one transformer not in operation, the remaining transformer(s) is (are) sufficient to ensure the supply to the services stated in [2.2.3].

Each transformer required is to be located as a separate unit with separate enclosure or equivalent, and is to be served by separate circuits on the primary and secondary sides. Each of the primary and secondary circuits is to be provided with switchgears and protection devices in each phase.

Suitable interlocks or a warning label are to be provided in order to prevent maintenance or repair of one single-phase transformer unless both switchgears are opened on their primary and secondary sides.

## 2.3 Emergency source of electrical power

**2.3.1** A self-contained emergency source of electrical power is to be provided.

**2.3.2** Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, electrical emergency power sources may be used, exceptionally, and for short periods, to supply non-emergency circuits.

Exceptionally is understood to mean conditions, while the craft is at sea, such as:

a) blackout situation

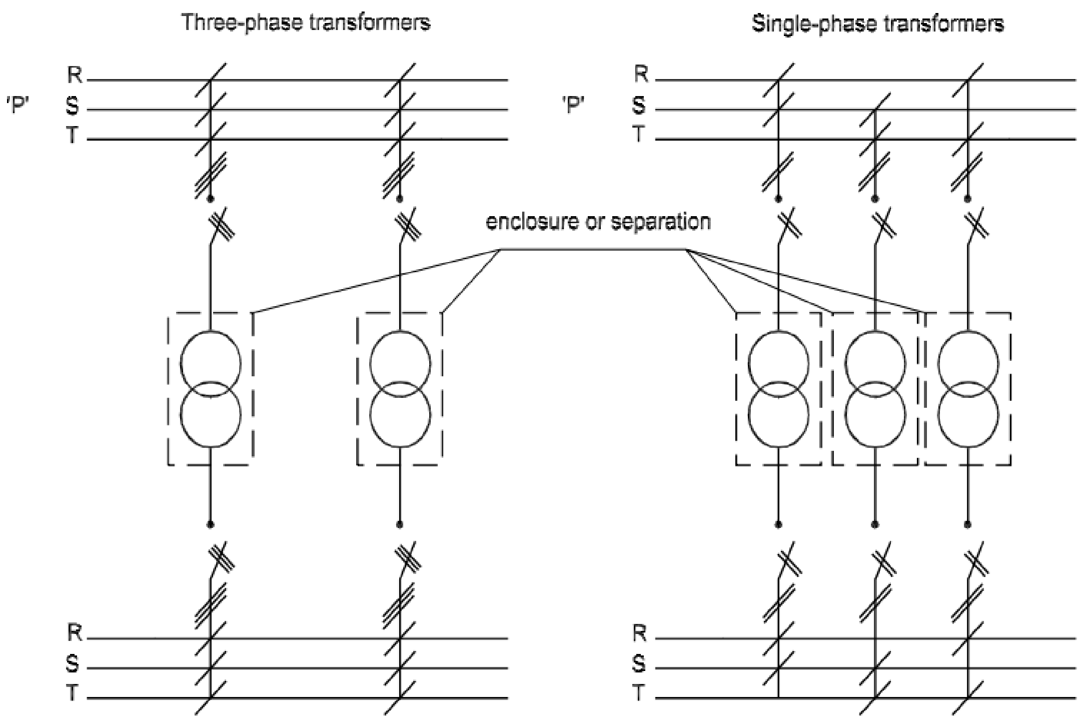
b) "dead ship" situation

c) routine use for testing

d) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

**2.3.3** The electrical emergency power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.

**Figure 1**



**2.3.4** The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services stated in [3.6.3] for the period specified.

**2.3.5** The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in [3.6.7] for half an hour, if they depend upon an electrical source for their operation.

**2.3.6** An indicator is to be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in [2.3.13] and [2.3.14] are being discharged.

**2.3.7** If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor convertors, means are to be provided for supplying such services also in the event of failure of the convertor (e.g. providing a bypass feeder or a duplication of convertor).

**2.3.8** Provision is to be made for the periodic testing of the complete emergency system and is to include the testing of automatic starting arrangements, where provided.

**2.3.9** The emergency accumulator battery is to be capable of:

a) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;

b) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

c) immediately supplying at least those services specified in [3.6.7].

**2.3.10** The transitional source of emergency electrical power where required by [2.3.9] (item c) is to consist of an storage battery which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the services in [3.6.7].

### 2.4 Emergency electrical system in craft with L ≤ 20 m

**2.4.1** An emergency electrical source is to be provided in a suitable position as to be used in emergency, outside the propulsion machinery space and the main battery room(s).

The emergency electrical source is to be capable of supplying simultaneously at least the following services for a six hours period:

- emergency lighting
- navigation lights and other lights established in the "Convention on the International Regulations for Preventing Collisions at Sea" in force
- radio systems
- the internal communication systems required during emergency
- fire detection and alarm system
- the non-continuous duty of the lamp for daytime signs, of the craft hoot, of the manual control alarms and of internal signalling requested in emergency.

Note 1: Such period of time may be reduced by Tasneef in relation to the mission maximum time provided for the craft, referring also to the maximum autonomy of the craft.

**2.4.2** For craft having length L ≤ 15 m the emergency electrical source can be provided by a battery pack different form those in [2.4.1] and with enough capacity to feed for three hours the following services:

- navigation lights
- radio systems
- fire detection and alarm systems
- non-continuous duty of the signal lamp and craft hoot.

Note 1: Such period of time may be reduced by Tasneef in relation to the mission maximum time provided for the craft, referring also to the maximum autonomy of the craft.

## 3 Distribution

### 3.1 Earthed distribution systems

**3.1.1** System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts.

**3.1.2** Means of disconnection are to be fitted in the neutral earthing connection of each electrical power source so that the power source may be disconnected for maintenance or insulation resistance measurements.

**3.1.3** Where a switchboard is split into sections operated independently or where there are separate switchboards, neutral earthing is to be provided for each section or for each switchboard. Means are to be provided to ensure that the earth connection is not removed when electrical power sources are isolated.

**3.1.4** Where for final sub-circuits it is necessary to locally connect a pole (or phase) of the sub-circuits to earth after the protective devices (e.g. in automation systems or to avoid electromagnetic disturbances), provision (e.g. d.c./d.c. convertors or transformers) is to be made such that current unbalances do not occur in the individual poles or phases.

### 3.2 Insulated distribution systems

**3.2.1** Every insulated distribution system, whether primary or secondary (see Note 1), for power, heating or lighting, is to be provided with a device capable of continuously monitoring the insulation level to earth (i.e. the values of electrical insulation to earth) and of giving an audible and visual indication of abnormally low insulation values (see Sec 15).

Note 1: A primary system is one supplied directly by main electrical power supply. Secondary systems are those supplied by transformers or convertors.

### 3.3 Distribution systems with hull return

**3.3.1** Where the hull return system is used, if permitted, all final sub-circuits, i.e. all circuits fitted after the last protective device, are to be two-wire.

The hull return is to be achieved by connecting to the hull one of the busbars of the distribution board from which the final sub-circuits originate.

### 3.4 General requirements for distribution systems

**3.4.1** The distribution system is to be such that the failure of any single circuit will not endanger or impair primary essential services and will not render secondary essential services inoperative for longer periods.

**3.4.2** No common switchgear (e.g. contactors for emergency stop) is to be used between the switchboard’s busbars and two primary non duplicated essential services.

**3.4.3** The electrical supply to equipment necessary for propulsion and steering and to ensure safety of the craft will be maintained or immediately restored in the case of loss of any one of the battery systems in service.

**3.4.4** The non-essential services, service for habitable conditions may be shed and, where necessary, additionally, the secondary essential services, sufficient to ensure the connected battery system(s) are not overloaded.

### 3.5 Main distribution of electrical power

**3.5.1** Where the main source of electrical power is necessary for propulsion of the craft, the main busbar is to be divided into at least two parts which are normally to be connected by circuit breakers or other approved means such as circuit breakers without tripping mechanisms or disconnecting links or switches by means of which busbars can be split safely and easily.

The connection of generating sets and associated auxiliaries and other duplicated equipment is to be equally divided between the parts as far as practicable, so that in the event of damage to one section of the switchboard the remaining parts are still supplied.

**3.5.2** Two or more units serving the same consumer (e.g. main and standby lubricating oil pumps) are to be supplied by individual separate circuits without the use of common feeders, protective devices or control circuits.

This requirement is satisfied when such units are supplied by separate cables from the main switchboard or from two independent section boards.

**3.5.3** A main electric lighting system which is to provide illumination throughout those parts of the craft normally accessible to and used by (passengers or) crew is to be supplied from the main source of electrical power.

### 3.6 Emergency distribution of electrical power

**3.6.1** The emergency switchboard is to be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power.

Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

**3.6.2** In order to ensure ready availability of the emergency source of electrical power, arrangements are to be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power is to be available to the emergency circuits.

**3.6.3** The emergency source of electrical power is to be capable of supplying simultaneously at least the following services for the periods specified hereafter, if they depend upon an electrical source for their operation:

a) for a period of 3 hours, emergency lighting at every muster and embarkation station and over the sides;

b) for a period of 18 hours, emergency lighting:
   1) in all service and accommodation alleyways, stairways and exits;
   2) in the machinery spaces and main generating stations including their control positions;
   3) in all control stations, machinery control rooms, and at each main and emergency switchboard;
   4) at all stowage positions for firemen’s outfits;
   5) at the steering gear;
   6) at the fire pump referred to in (e) below, at the sprinkler pump, if any, at the emergency bilge pump, if any, and at the starting positions of their motors;

c) for a period of 18 hours:
   1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force; and
   2) radio installations;

d) for a period of 18 hours:
   1) all internal communication equipment as required in an emergency [3.6.4];
   2) the fire detection and fire alarm systems; and
   3) intermittent operation of the daylight signaling lamp, the craft's whistle, the manually operated call points and all internal signals (see [3.6.5]) that are required in an emergency, unless such services have an independent supply for the period of 18 hours from

an storage battery suitably located for use in an emergency;

e) for a period of 18 hours: one of the fire pumps required by the relevant provisions of Chapter 4, if dependent upon the emergency battery power for its source of power;

f) for the period of time required in Pt C, Ch 1, Sec10, [2], the steering gear where it is required to be so supplied.

Note 1: Such periods of time may be reduced by Tasneef in relation to the mission maximum time provided for the craft, referring also to the maximum autonomy of the craft.

**3.6.4** Internal communication equipment required in an emergency generally includes:

a) the means of communication between the navigating bridge and the steering gear compartment,

b) the means of communication between the navigating bridge and the position in the machinery space or control room from which the propulsion machinery are normally controlled.

**3.6.5** Internal signals required in an emergency generally include:

a) general alarm,

b) watertight door indication.

**3.6.6** The transitional source of emergency electrical power, where required, is to supply for half an hour at least the following services if they depend upon an electrical source for their operation:

a) the lighting required by [3.6.3](item a, b, c1); for this transitional phase, the required emergency electric lighting, in respect of the machinery space and the accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

b) all services required by [3.6.3] (item d1, d2, d4) unless such services have an independent supply for the period specified from an storage battery suitably located for use in an emergency.

## 3.7 Shore supply

**3.7.1** Where arrangements are made for supplying the electrical installation from a source on shore or elsewhere, a suitable connection box is to be installed on the craft in a convenient location to receive the flexible cable from the external source.

**3.7.2** Permanently fixed cables of adequate rating are to be provided for connecting the box to the main switchboard.

**3.7.3** Where necessary for systems with earthed neutrals, the box is to be provided with an earthed terminal for connection between the shore’s and craft’s neutrals or for connection of a protective conductor.

**3.7.4** The connection box is to contain a circuit-breaker or a switch-disconnector and fuses.

The shore connection is to be protected against short-circuit and overload; however, the overload protection may be omitted in the connection box if provided on the main switchboard.

**3.7.5** Means are to be provided for checking the phase sequence of the incoming supply in relation to the craft's system.

**3.7.6** The cable connection to the box is to be provided with at least one switch-disconnector on the main switchboard.

**3.7.7** The shore connection is to be provided with an indicator at the main switchboard in order to show when the cable is energised.

**3.7.8** At the connection box a notice is to be provided giving full information on the nominal voltage and frequency of the installation.

**3.7.9** The switch-disconnector on the main switchboard is to be interlocked with the battery system circuit-breakers in order to prevent its closure when any battery system is supplying the main switchboard unless special provisions to the satisfaction of Tasneef are taken to permit safe transfer of electrical load.

**3.7.10** Adequate means are to be provided to equalise the potential between the hull and the shore when the electrical installation of the craft is supplied from shore.

## 3.8 Supply of motors

**3.8.1** A separate final sub-circuit is to be provided for every motor required for an essential service (and for every motor rated at 1 kW or more).

**3.8.2** Each motor is to be provided with controlgear ensuring its satisfactory starting.

Depending on the capacity of the electrical power sources or the cable network, it may be necessary to limit the starting current to an acceptable value.

Direct on line starters are accepted if the voltage drop does not exceed 15% of the network voltage.

**3.8.3** Efficient means are to be provided for the isolation of the motor and its associated control gear from all live poles of the supply.

Where the control gear is mounted on or adjacent to a switchboard, a disconnecting switch in the switchboard may be used for this purpose.

Otherwise, a disconnecting switch within the control gear enclosure or a separate enclosed disconnecting switch is to be provided.

**3.8.4** Where the starter or any other apparatus for disconnecting the motor is remote from the motor itself, one of the following is to be arranged:

a) provision for locking the circuit disconnecting switch in the OFF position; or

b) an additional disconnecting switch fitted near the motor; or

c) provision such that the fuses in each live pole or phase can be readily removed and retained by persons authorised to have access to the motor.

### 3.9 Specific requirements for special power services

**3.9.1** For the supply and characteristics of the distribution of the following services see the requirements listed:

- Steering gear: Ch 1, Sec 10, [2]
- Fire-extinguishing and detecting systems: Ch 4, Sec 4 and 7
- Permanently installed submergible bilge pump: Ch 1, Sec 9, [5.5.7]
- Ventilation fans: Chapter 4
- Pumps discharging overboard above the lightest water line Ch 1, Sec 9.

### 3.10 Power supply to heaters

**3.10.1** Each heater rated more than 16A is to be connected to a separate final circuit.

### 3.11 Power supply to lighting installations

**3.11.1** Final sub-circuits for lighting supplying more than one lighting point and for socket-outlets are to be fitted with protective devices having a current rating not exceeding 16 A.

### 3.12 Special lighting services

**3.12.1** In spaces such as:

- main and large machinery spaces
- passageways
- stairways leading to boat-decks
- public spaces

there is to be more than one final sub-circuit for lighting such that failure of any one circuit does not reduce the lighting to an insufficient level.

**3.12.2** Where the emergency installation is required, one of the circuits in [3.12.1] may be supplied from the emergency source of power.

### 3.13 Navigation lights

**3.13.1** Navigation lights are to be connected separately to a distribution board specially reserved for this purpose.

Signalling lights may be connected to the navigation light distribution board, or to a separate distribution board.

**3.13.2** The navigation light distribution board is to be supplied from two alternative circuits, one from the main source of power and one from the emergency source of power; see also [3.6].

The transfer of supply is to be practicable from the bridge, for example by means of a switch.

**3.13.3** Each navigation light is to be controlled and protected in each insulated pole by a double-pole switch and a fuse or, alternatively, by a double-pole circuit-breaker, fitted on the distribution board referred to in [3.13.1].

**3.13.4** Where there are double navigation lights, i.e. lights with two lamps or where for every navigation light a spare is also fitted, the connections to such lights may run in a single cable provided that means are foreseen in the distribution board to ensure that only one lamp or light may be supplied at any one time.

**3.13.5** Each navigation light is to be provided with an automatic indicator giving audible and/or visual warning in the event of failure of the light. If an audible device alone is fitted, it is to be connected to a separate source of supply from that of the navigation lights, for example an storage battery.

If a visual signal is used connected in series with the navigation light, means are to be provided to prevent the extinction of the navigation light due to the failure of the visual signal.

A minimum level of visibility is to be assured in the case of use of dimmer devices.

**3.13.6** In craft with Length $L \leq 20$ m the navigation light board and the second supply line are not requested.

Supply is to be derived from the emergency source.

### 3.14 General emergency alarm system

**3.14.1** An electrically operated bell or klaxon or other equivalent warning system installed in addition to the craft's whistle or siren, for sounding the general emergency alarm signal, is to be driven from the fore bridge, is to be continuously supplied by an electrical emergency source.

**3.14.2** The system is to be powered by means of two circuits, one from the craft's main supply and the other from the emergency source of electrical power required by [2.3] and [3.6].

**3.14.3** The system is to be capable of operation from the navigation bridge and, except for the craft's whistle, also from other strategic points.

Note 1: Other strategic points are taken to mean those locations, other than the navigation bridge, from where emergency situations are intended to be controlled and the general alarm system can be activated. A fire control station or a cargo control station should normally be regarded as strategic points.

**3.14.4** The alarm is to continue to function after it has been triggered until it is manually turned off.

**3.14.5** The alarm system is to be audible throughout all the accommodation and normal crew working spaces.

### 3.15 Control and indication circuits

**3.15.1** For the supply of automation systems, comprising control, alarm and safety system, see the requirements of Chapter 3.

**3.15.2** Control and indicating circuits relative to primary essential services are to be branched off from the main circuit in which the relevant equipment is installed. Equivalent arrangements may be accepted by Tasneef.

**3.15.3** Control and indicating circuits relative to secondary essential services and to non-essential services may be supplied by distribution systems reserved for the purpose to the satisfaction of Tasneef.

## 4 Degrees of protection of the enclosures

### 4.1 General

**4.1.1** The minimum required degree of protection for electrical equipment, in relation to the place of installation, is generally that specified in Tab 2.

**4.1.2** Equipment supplied at nominal voltages in excess of 500 V and accessible to non-authorised personnel (e.g. equipment not located in machinery spaces or in locked compartments under the responsibility of the craft's officers) is to have a degree of protection against touching live parts of at least IP4X.

**4.1.3** In addition to the requirements of this sub-article, equipment installed in spaces with an explosion hazard is also subject to the provisions of Pt C, Ch 2, Sec 2, [6].

**4.1.4** The enclosures of electrical equipment for the monitoring and control of watertight doors which are situated below the bulkhead deck are to provide suitable protection against the ingress of water.

In particular, the minimum required degree of protection is to be:

- IPX7 for electric motors, associated circuits and control components
- IPX8 for door position indicators and associated circuit components
- IPX6 for door movement warning signals.

Note 1: The water pressure testing of the enclosures protected to IPX8 is to be based on the pressure that may occur at the location of the component during flooding for a period of 36 hours.

**Table 2 : Minimum required degrees of protection**

| Condition in location | Example of location | Switchboard Control gear Motor starters | Motors | Transfor mers | Luminaires | Heating applian ces | Cooking applian ces | Socket outiets | Accessories (e.g. switches, connection boxes) |
|---|---|---|---|---|---|---|---|---|---|
| Danger of touching live parts only | Dry accommodation spaces Dry control rooms | I P 20 | I P 20 | I P 20 | I P 20 | I P20 | I P 20 | I P 20 | I P 20 |
| Danger of dripping liquid and/for moderate mechanical damage | Control rooms, wheel-house, radio room | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | I P 22 | I P 22 | I P 22 |
| | Machinery space above floor | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | I P 22 | I P 44 | I P 44 |
| | Steering gear rooms | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | X | I P 44 | I P 44 |
| | Emergency power source space | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | X | I P 44 | I P 44 |
| | General storerooms | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | X | I P 22 | I P 44 |
| | Pantries | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | I P 22 | I P 44 | I P 44 |
| | Provision rooms | I P 22 | I P 22 | I P 22 | I P 22 | I P22 | X | I P 44 | I P 44 |
| | Ventilation ducts | X | I P 22 | X | X | X | X | X | X |
| Increased danger of liquid and/for mechanical damage | Bathrooms and/or showers | X | X | X | I P 34 | I P44 | X | I P 55 | I P 55 |
| | Machinery space below floor | X | I P 44 | X | I P 34 | I P44 | X | X | I P 55 |
| Increased danger of liquid and mechanical damage | Ballast pump rooms | I P 44 | I P 44 **(2)** | I P 44 **(2)** | I P 34 | I P44 | X | I P 55 | I P 55 |
| | Refrigerated rooms | X | I P 44 | X | I P 34 | I P44 | X | I P 55 | I P 55 |
| | Galleys and laundries | I P 44 | I P 44 | I P 44 | I P 34 | I P44 | I P 44 | I P 44 | I P 44 |
| | Public bathrooms and shower | X | I P 44 | I P 44 | I P 34 | I P44 | X | I P 44 | I P 44 |

| Condition in location | Example of location | Switchboard Control gear Motor starters | Motors | Transfor mers | Luminaires | Heating applian ces | Cooking applian ces | Socket outiets | Accessories (e.g. switches, connection boxes) |
|---|---|---|---|---|---|---|---|---|---|
| Danger of liquid spraying. Presence of cargo dust. Serious mechanical damage. Aggressive fumes | Shaft or pipe tunnels in double bottom | I P 55 | I P 55 | I P 55 | I P 55 | I P55 | X | I P 56 | I P 56 |
| | Holds for general cargo | X | I P 55 | X | I P 55 | I P55 | X | I P 56 | I P 56 |
| | Ventilation trunks | X | I P 55 | X | X | X | X | X | X |
| Danger of liquid in massive quantities | Open decks | I P 56 | I P 56 | X | I P 55 | I P56 | X | I P 56 | I P 56 |
| **(1)** The symbol "X" denotes equipment which it is not advised to install.<br>**(2)** Electric motors and starting transformers for lateral thrust propellers located in spaces similar to ballast pump rooms may have degree of protection IP22. | | | | | | | | | |

## 5 Diversity (demand) factors

### 5.1 General

**5.1.1** The cables and protective devices of final sub-circuits are to be rated in accordance with their connected load.

**5.1.2** Circuits supplying two or more final sub-circuits are to be rated in accordance with the total connected load subject, where justifiable, to the application of a diversity (demand) factor.

**5.1.3** A diversity (demand) factor may be applied provided that the known or anticipated operating conditions in a particular part of an installation are suitable for the application of diversity.

## 6 Electrical protection

### 6.1 General

**6.1.1** Electrical installations including propulsion machinery, measuring instruments, pilot lamps and controlling circuits, are to be protected against accidental overcurrents including short-circuit.

**6.1.2** General principles of IEC 60092-507 is to be made referenced and applied as far as practicable.

## 7 System components

### 7.1 General

**7.1.1** The components of the electrical system are to be dimensioned such as to withstand the currents that can pass through them during normal service without their rating being exceeded.

**7.1.2** The components of the electrical system are to be designed and constructed so as to withstand for the admissible duration the thermal and electrodynamic stresses caused by possible overcurrents, including short-circuit.

## 8 Electrical cables

### 8.1 General

**8.1.1** All electrical cables and wiring external to equipment are to be at least of a flame-retardant type, in accordance with IEC Publication 60332-1.

**8.1.2** In addition to the provisions of [9.1.1], when cables are laid in bundles, cable types are to be chosen in compliance with IEC Publication 60332-3 Category A, or other means (see Sec 12 [7]) are to be provided such as not to impair their original flame-retarding properties.

**8.1.3** Where necessary for specific applications such as radio frequency or digital communication systems, which require the use of particular types of cables, Tasneef may permit the use of cables which do not comply with the provisions of [8.1.1] and [8.1.2].

**8.1.4** Cables which are required to have fire-resisting characteristics are to comply with the requirements stipulated in IEC Publication 60331.

### 8.2 Cables choice

**8.2.1** Cables are to respond to the provisions given IEC 60092-507 and IEC 60092 series.

## 9 Electrical installations in hazardous areas

### 9.1 General

**9.1.1** In hazardous areas (e.g.: storage batteries rooms, paint lockers) cables and electrical equipment are to be in accordance with the requirements given in IACS UR E12, IEC 60092-506 and IEC 60079 series.

# SECTION 4 ROTATING MACHINES

## 1 Constructional and operational requirements for motors

### 1.1 General

**1.1.1** Motors are to be constructed and tested in accordance with requirements given in IACS UR E13, IEC 60092-301 and IEC 60034 series.

**1.1.2** For craft with Length L≤20 m, a test certificate made in internal factory or independent laboratory may be accepted; the mark C.E.I. applied on the nameplate may replace such test documents.

# SECTION 5 TRANSFORMERS

## 1 Constructional and operational requirements

### 1.1 General

**1.1.1** Transformers are to generally comply with IEC 60092-303 and 60092-507.

**1.1.2** For craft with Length L≤20 m, a test certificate made in internal factory or independent laboratory may be accepted; the mark C.E.I. applied on the nameplate may replace such test documents.

# SECTION 6 SEMICONDUCTOR CONVERTORS

## 1 Constructional and operational requirements

### 1.1 General

**1.1.1** Semiconductor converters are to generally comply with IEC 60092-507 60092-304 and IEC 60146.

**1.1.2** For craft with Length L≤20 m, a test certificate made in internal factory or independent laboratory may be accepted; the mark C.E.I. applied on the nameplate may replace such test documents.

# SECTION 7 STORAGE BATTERIES AND CHARGERS

## 1 Constructional and operational requirements

### 1.1 General

**1.1.1** Storage batteries (other than Lithium based battery) for fixed installation and charges are to generally comply with IEC 60092-507, 60092-305 and for UPS is to comply with IACS UR E21.

**1.1.2** For craft with Length L≤20 m, a test certificate made in internal factory or independent laboratory may be accepted; the mark C.E.I. applied on the nameplate may replace such test documents.

# SECTION 8 SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

## 1 Constructional and operational requirements

### 1.1 General

**1.1.1** Main and emergency boards, section boards and distribution boards are to generally comply with IEC 60092-507, 60092-302 and IEC 60947 series.

**1.1.2** For craft with Length L≤20 m, a test certificate made in internal factory or independent laboratory may be accepted; the mark C.E.I. applied on the nameplate may replace such test documents.

The electrical board may be arranged in the main control station rather than in battery room and unsupplied of handrail.

Devices verifying the isolation state are not required in craft provided with electrical safety voltage system.

# SECTION 9 CABLES

## 1 Constructional requirements

### 1.1 General

**1.1.1** Cables and internal wiring are to be constructed following standards given in IEC 60092-350 and 60092 series.

**1.1.2** In craft with Length L≤20 m cables relating to electrical safety voltage are admitted not to be totally in conformity with Tasneef Rules, providing that they satisfy the following conditions:

- external round shape
- the core (most insulator conductor) in case of unipolar cable or the group of cores in case of multipolar cables, are to be protected by one or more protective sheathes
- insulating and sheathes materials are to be taken from the ones provided in IEC standards of TC 18 or other standards relating to electrical cables for shipping use
- not spreading flames or fireproofs (as necessary) in according to the standard requirements.

# SECTION 10 MISCELLANEOUS EQUIPMENT

## 1 Application

### 1.1 General

**1.1.1** The miscellaneous equipment described in this section are:

- Switchgear and controlgear
- Protection devices
- Lighting fittings
- Accessories
- Plug-and-socket connections
- Heating and cooking appliances
- Cable trays/protective casings made of plastics materials

**1.1.2** Equipments listed in [1.1.1] are to generally comply with IEC 60092-507, 60092-306 and 60092-307.

**1.1.3** For craft with Length L≤20 m equipments not totally in conformity with standards of these Guidelines may be accepted by Tasneef if believed adequate for safety and for the sea ambient.

# SECTION 11 LOCATION

## 1 General

### 1.1 Location

**1.1.1** The degree of protection of the enclosures and the environmental categories of the equipment are to be appropriate to the spaces or areas in which they are located.

### 1.2 Areas with a risk of explosion

**1.2.1** Except where the installation of equipment for explosive gas atmosphere is provided for by the Rules, electrical equipment is not to be installed where flammable gases or vapours are liable to accumulate; see Sec 3, [9].

## 2 Main electrical system

### 2.1 Location in relation to the emergency system

**2.1.1** The arrangement of the emergency electrical system is to be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated converting equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render inoperative the main electric lighting system and the other primary essential services.

### 2.2 Main switchboard

**2.2.1** *The main switchboard shall be so placed relative to one electrical power source so that, as far as is practicable, the integrity of the normal electrical supply may be affected only by a fire or other casualty in one space.*

**2.2.2** *An environmental enclosure for the main switchboard, such as may be provided by a machinery control room situated within the main boundaries of the space, is not to be considered as separating switchboards from main electrical power source.*

**2.2.3** Any bulkhead between the extreme main transverse watertight bulkheads is not regarded as separating the equipment in the main generating station provided that there is access between the spaces.

**2.2.4** The main switchboard is to be located as close as practicable to the electrical power source, within the same machinery space and the same vertical and horizontal A60 fire boundaries.

In craft with Length L≤20 m, the main electrical board may be arranged in the main control station.

**2.2.5** Where essential services for steering and propulsion are supplied from distribution boards, these and any transformers, convertors and similar appliances constituting an essential part of the electrical supply system are also to satisfy the above provisions.

**2.2.6** A non-required subdivision bulkhead, with sufficient access, located between the switchboard and electrical power source(s), or between two or more electrical power source(s), is not to be considered as separating the equipment.

## 3 Emergency electrical system

### 3.1 Spaces for the emergency source

**3.1.1** *The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck.*

*They shall not be located forward of the collision bulkhead.*

**3.1.2** *The spaces containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard are not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard.*

Where this is not practicable, the contiguous boundaries are to be Class A60.

### 3.2 Location in relation to the main electrical system

**3.2.1** *The location of the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Society that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electrical power.*

**3.2.2** The arrangement of the main electrical system is to be such that a fire or other casualty in spaces containing the main source of electrical power, associated converting equipment, if any, the main switchboard and the main lighting switchboard will not render inoperative the emergency electric lighting system and the other emergency services other than those located within the spaces where the fire or casualty has occurred.

### 3.3 Emergency switchboard

**3.3.1** *The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power.*

### 3.4 Emergency battery

**3.4.1** No storage battery fitted in accordance with the provisions of Sec 3, [2.3] is to be installed in the same space as the emergency switchboard.

**3.4.2** Storage batteries fitted in accordance with the provisions of Sec 3, [2.3] and connected to a charging device of power of 2 kW or less may be accepted in the same space as the emergency switchboard but outside the emergency switchboard to the satisfaction of Tasneef.

## 4 Distribution boards

### 4.1 Distribution boards for cargo spaces and similar spaces

**4.1.1** Distribution boards containing multiple switches for the control of power and lighting circuits in bunkers and cargo spaces are to be situated outside such spaces.

### 4.2 Distribution board for navigation lights

**4.2.1** The distribution board for navigation lights is to be placed in an accessible position on the bridge.

### 4.3 Distribution board for 24VDC

**4.3.1** Main and emergency 24VDC distribution boards may be placed in the same space, provided that failure of one board does not impair the functionality of the other board.

## 5 Cable runs

### 5.1 General

**5.1.1** Cable runs are to be selected so as to be as far as practicable accessible, with the exception of single cables, situated behind walls or ceilings constructed of incombustible materials, supplying lighting fittings and socket-outlets in accommodation spaces, or cables enclosed in pipes or conduits for installation purposes.

**5.1.2** Cable runs are to be selected so as to avoid action from condensed moisture and from dripping of liquids.

**5.1.3** Connection and draw boxes are to be accessible.

**5.1.4** Cables are generally not to be installed across expansion joints.

Where this is unavoidable, however, a loop of cable of length proportional to the expansion of the joint is to be provided.

### 5.2 Location of cables in relation to the risk of fire and overheating

**5.2.1** Cables and wiring serving essential or emergency power, lighting, internal communications or signals are, so far as is practicable, to be routed clear of galleys, laundries, and other high fire risk areas, except for supplying equipment in those spaces.

**5.2.2** When it is essential that a circuit functions for some time during a fire and it is unavoidable to carry the cable for such a circuit through a high fire risk area (e.g. cables connecting fire pumps to the emergency switchboard), the cable is to be of a fire-resistant type or adequately protected against direct exposure to fire.

**5.2.3** Main cable runs (see Note 1) and cables for the supply and control of essential services are, as far as is practicable, to be kept away from machinery parts having an increased fire risk (see Note 2) unless:

- the cables have to be connected to the subject equipment,
- the cables are protected by a steel bulkhead or deck, or
- the cables in that area are of the fire-resisting type.

Note 1: Main cable runs are for example:

- cable runs from electrical power sources and propulsion motors to main and emergency switchboards
- cable runs directly above or below main and emergency switchboards, centralised motor starter panels, distribution boards and centralised control panels for propulsion and essential auxiliaries.

**5.2.4** Cables and wiring serving essential or emergency power, lighting, internal communications or signals are to be arranged, as far as practicable, in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space.

**5.2.5** Cables are to be arranged as remote as possible from sources of heat such as hot pipes, resistors, etc. Where installation of cables near heat sources cannot be avoided, and where there is consequently a risk of damage to the cables by heat, suitable shields are to be installed, or other precautions to avoid overheating are to be taken, for example use of ventilation, heat insulation materials or special heat-resisting cables.

### 5.3 Location of cables in relation to electromagnetic interference

**5.3.1** For the installation of cables in the vicinity of radio equipment or of cables belonging to electronic control and monitoring systems, steps are to be taken in order to limit the effects of unwanted electromagnetic interference (see Ch 3, Sec 5).

### 5.4 Services with a duplicate feeder

**5.4.1** In the case of essential services requiring a duplicate supply (e.g. steering gear circuits), the supply and associated control cables are to follow different routes which are to be as far apart as practicable, separated both vertically and horizontally.

### 5.5 Emergency circuits

**5.5.1** Cables supplying emergency circuits are not to run through spaces containing the main source of electrical power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard, except for cables supplying emergency equipment located within such spaces (see [3.2.2]).

## 6 Batteries

### 6.1 General

**6.1.1** This article applies to lead, Nickel-Cadmium and Nickel-Metal-Hydride batteries. For Lithium based battery systems, refer to Ch 5, Sec 1.

**6.1.2** Batteries are to be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration. They are to be installed in such a way that no damage may be caused to surrounding appliances by the vapours generated.

**6.1.3** Storage batteries are to be suitably housed, and compartments (rooms, lockers or boxes) used primarily for their accommodation are to be properly constructed and efficiently ventilated so as to prevent accumulation of flammable gas.

**6.1.4** Storage *batteries shall not be located in sleeping quarters except where hermetically sealed to the satisfaction of the Society.*

**6.1.5** Lead-acid batteries and alkaline batteries are not to be installed in the same compartment (room, locker, box), unless of valve-regulated sealed type.

### 6.2 Large vented batteries

**6.2.1** Batteries connected to a charging device of power exceeding 2 kW, calculated from the maximum obtainable charging current and the nominal voltage of the battery (hereafter referred to as "large batteries") are to be installed in a room assigned to batteries only.

Where this is not possible, they may be arranged in a suitable locker on deck.

**6.2.2** Rooms assigned to large batteries are to be provided with mechanical exhaust ventilation.

Natural ventilation may be employed for boxes located on open deck.

**6.2.3** The provisions of [6.2.1] and [6.2.2] also apply to several batteries connected to charging devices of total power exceeding 2 kW calculated for each one as stated in [6.2.1].

### 6.3 Moderate vented batteries

**6.3.1** Batteries connected to a charging device of power between 0,2 kW and 2 kW calculated as stated in [6.2.1] (hereafter referred to as "moderate batteries") are to be arranged in the same manner as large batteries or placed in a box or locker in suitable locations such as machinery spaces, storerooms or similar spaces. In machinery spaces and similar well-ventilated compartments, these batteries may be installed without a box or locker provided they are protected from falling objects, dripping water and condensation where necessary.

**6.3.2** Rooms, lockers or boxes assigned to moderate batteries are to be provided with natural ventilation or mechanical exhaust ventilation, except for batteries installed without a box or locker (located open) in well-ventilated spaces.

**6.3.3** The provisions of [6.3.1] and [6.3.2] also apply to several batteries connected to charging devices of total power between 0,2 kW and 2 kW calculated for each one as stated in [6.2.1].

### 6.4 Small vented batteries

**6.4.1** Batteries connected to a charging device of power less than 0,2 kW calculated as stated in [6.2.1] (hereafter referred to as "small batteries") are to be arranged in the same manner as moderate or large batteries, or without a box or locker, provided they are protected from falling objects, or in a box in a ventilated area.

**6.4.2** Boxes for small batteries may be ventilated only by means of openings near the top to permit escape of gas.

### 6.5 Ventilation

**6.5.1** The ventilation of battery compartments is to be independent of ventilation systems for other spaces.

**6.5.2** The quantity of air expelled (by natural or forced ventilation) for compartments containing vented type batteries is to be at least equal to:

$$Q = 110 \cdot I \cdot n$$

where:

- Q : Quantity of air expelled, in litres per hour
- I : Maximum current delivered by the charging equipment during gas formation, but not less than one quarter of the maximum obtainable charging current in amperes
- n : Number of cells in series.

**6.5.3** The quantity of air expelled (by natural or forced ventilation) for compartments containing valve-regulated sealed batteries is to be at least 25% of that given in [6.5.2].

**6.5.4** Ducts are to be made of a corrosion-resisting material or their interior surfaces are to be painted with corrosion-resistant paint.

**6.5.5** Adequate air inlets (whether connected to ducts or not) are to be provided near the floor of battery rooms or the bottom of lockers or boxes (except for that of small batteries).

Air inlet may be from the open air or from another space (for example from machinery spaces).

**6.5.6** Exhaust ducts of natural ventilation systems:

a) are to be run directly from the top of the compartment to the open air above (they may terminate in the open or in well-ventilated spaces)

b) are to terminate not less than 90 cm above the top of the battery compartment

c) are to have no part more than 45° from the vertical

d) are not to contain appliances (for example for barring flames) which may impede the free passage of air or gas mixtures.

Where natural ventilation is impracticable or insufficient, mechanical exhaust ventilation is to be provided.

**6.5.7** In mechanical exhaust ventilation systems:

a) electric motors are to be outside the exhaust ducts and battery compartment and are to be of safe type if installed within 3 m from the exhaust of the ventilation duct

b) fans are to be so constructed and of a material such as to render sparking impossible in the event of the impeller touching the fan casing

c) steel or aluminium impellers are not to be used

d) the system is to be interlocked with the charging device so that the battery cannot be charged without ventilation (trickle charge may be maintained)

e) a temperature sensor is to be located in the battery compartment to monitor the correct behaviour of the battery in cases where the battery element is sensitive to temperature.

**6.5.8** For natural ventilation systems for deck boxes:

a) holes for air inlet are to be provided on at least two opposite sides of the box

b) the exhaust duct is to be of ample dimensions

c) the duct is to terminate at least 1,25 m above the box in a goose-neck or mushroom-head or the equivalent

d) the degree of protection is to be in accordance with Sec 3, Tab 2.

**6.5.9** In craft with Length L≤20 m, in case of natural ventilation, the air range to discharge is considered achieved when the section, in $cm^2$, of the ventilation pipes is not less than the one indicated in Tab 1, relating to the battery nature and to the charge power.

**Table 1 :**

| **Charge power (W) (1)** | **Minimum section for natural ventilation [$cm^2$]** | | |
|---|---|---|---|
| | Lead | Alkaline | Sealed |
| 2000 | 160 | 240 | To consider case by case |
| 1500 | 120 | 180 | |
| 1000 | 80 | 160 | |
| 500 | 40 | 60 | |

**(1)** Charge power is calculated as product of the maximum possible charge stream for the battery nominal pressure.

# SECTION 12 INSTALLATION

## 1 General

### 1.1 Protection against injury or damage caused by electrical equipment

**1.1.1** All electrical equipment is to be so installed as not to cause injury when handled or touched in the normal manner.

**1.1.2** All electrical equipment is to be installed in such a way that live parts cannot be inadvertently touched, unless supplied at a safety voltage.

**1.1.3** For protective earthing as a precaution against indirect contact, see [2].

**1.1.4** Equipment is to be installed so as not to cause, or at least so as to reduce to a minimum, electromagnetic interference.

### 1.2 Protection against damage to electrical equipment

**1.2.1** Electrical equipment is to be so placed that as far as practicable it is not exposed to risk of damage from water, steam, oil or oil vapours.

**1.2.2** The air supply for internal ventilation of electrical equipment is to be as clean and dry as practicable; cooling air for internal ventilation is not to be drawn from below the floor plates in machinery space.

**1.2.3** Equipment is to be so mounted that its enclosing arrangements and the functioning of the built-in equipment will not be affected by distortions, vibrations and movements of the craft's structure or by other damage liable to occur.

**1.2.4** If electrical fittings, not of aluminium, are attached to aluminium, suitable provision is to be made to prevent galvanic corrosion.

### 1.3 Accessibility

**1.3.1** Equipment is to be so installed that sufficient space is available for inspection and maintenance as required for all its parts.

## 2 Earthing of non-current carrying parts

### 2.1 General

**2.1.1** The requirements given in IEC 60092-507 apply.

For craft with hull in composite material the provisions given in Ch 1, Sec 2 of these Rules for hull in different material than steel, apply in addition.

## 3 Rotating machines

### 3.1 General

**3.1.1** Pt C, Ch 2, Sec 12, [3] of Tasneef Rules for the Classification of Ships apply.

## 4 Semiconductor convertors

### 4.1 Semiconductor power convertors

**4.1.1** Naturally air-cooled semiconductor convertors are to be installed such that the circulation of air to and from the stacks or enclosures is not impeded and that the temperature of the cooling inlet air to convertor stacks does not exceed the ambient temperature for which the stacks are specified.

## 5 Vented type storage batteries and UPS

### 5.1 General

**5.1.1** The requirements given in IEC 60092-507, 60092-305 and IACS UR E21 apply.

## 6 Switchgear and controlgear assemblies

### 6.1 General

**6.1.1** The requirements given in IEC 60092-507 and 60092-302 apply.

## 7 Cables

### 7.1 General

**7.1.1** The requirements given in IEC 60092-507 and 60092-352 apply.

## 8 Various appliances

### 8.1 General

**8.1.1** The requirements given in IEC 60092-507, 60092-306 and 60092-307 apply.

# SECTION 13 ELECTRIC PROPULSION PLANT

## 1 General

### 1.1 Applicable standards

**1.1.1** The requirements given in IEC 60092-507 and 60092-502 apply.

# SECTION 14 TESTING

## 1 General

### 1.1 Application

**1.1.1** Before a new installation, or any alteration or addition to an existing installation, is put into service, the electrical equipment is to be tested in accordance with IEC 60092-507 and to the satisfaction of the Surveyor in charge.

### 1.2 Insulation-testing instruments

**1.2.1** Insulation resistance may be measured with an instrument applying a voltage of at least 500 V. The measurement will be taken when the deviation of the measuring device is stabilised.

Note 1: Any electronic devices present in the installation are to be disconnected prior to the test in order to prevent damage.

## 2 Type approved components

### 2.1

**2.1.1** The following components are to be type tested or type approved or in accordance with [2.1.2]:

- electrical cables (internal wiring of equipment excluded)
- transformers
- electric motors, including electric motors for propulsion
- electrical convertors for primary essential services
- switching devices (circuit-breakers, contactors, etc.) and overcurrent protective devices (fuses excluded)
- sensors, alarm panels, electronic protective devices, automatic and remote control equipment, actuators, safety devices for installations intended for essential services (steering, controllable pitch propellers, etc.)
- computers used for tasks essential to safety.

**2.1.2** Case by case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

**2.1.3** For craft with Length L≤15 m, except for electrical cables, homologated components for the products in [2.1.1], are not required. A declaration by the Manufacturer attesting the suitability of the product to work in sea environment will be satisfactory.

Part C

# Machinery, Systems and Fire Protection

Chapter 3

# AUTOMATION

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# SECTION 1 GENERAL REQUIREMENTS

## 1 General

### 1.1 Field of application

**1.1.1** The following requirements apply to automation systems, installed on all craft, intended for essential services as defined in Ch 2, Sec 1. They also apply to systems required in Chapter 1 and Chapter 2, installed on all craft.

**1.1.2** This chapter is intended to avoid that failures or malfunctions of automation systems associated with essential and non-essential services cause danger to other essential services.

### 1.2 Applicable standards

**1.2.1** For definitions, documents to be submitted to the examination, ambient and supply conditions, materials and construction the requirements given in IEC 60092-504 are valid.

# SECTION 2 DESIGN REQUIREMENTS

## 1 General

### 1.1

**1.1.1** All control systems essential for the propulsion, control and the craft's safety are to be independent or designed such that failure of one system does not degrade the performance of another system.

**1.1.2** Controlled systems are to have manual operation. Failure of any part of such systems is not to prevent the use of the manual override.

**1.1.3** Automation systems are to have constant performance.

**1.1.4** Safety functions are to be independent of control and monitoring functions.

As far as practicable, control and monitoring functions are also to be independent.

**1.1.5** Control, monitoring and safety systems are to have self-check facilities. In the event of failure, an alarm is to be activated.

In particular, failure of the power supply of the automation system is to generate an alarm.

**1.1.6** When a computer based system is used for control, alarm or safety systems, it is to comply with the requirements of Sec 3.

## 2 Applicable standards

### 2.1

**2.1.1** Control, alarm and safety systems are to respect the provisions given in IEC 60092-504.

# SECTION 3 COMPUTER BASED SYSTEMS

## 1 General Requirements

### 1.1 General

**1.1.1** The characteristics of the system are to be compatible with the intended applications, under normal and abnormal process conditions. The response time for alarm function is to be less than 5 seconds.

**1.1.2** When systems under control are required to be duplicated and in separate compartments, this is also to apply to control elements within computer based systems.

**1.1.3** As a rule, computer based systems intended for essential services are to be type approved.

## 2 Applicable standards

### 2.1

**2.1.1** Hardware, software, connection of data communication, man-machine interface, integrated systems and test on systems are to respect the provisions given in IEC 60092-504 and IACS UR E22.

# SECTION 4 CONSTRUCTIONAL REQUIREMENTS

## 1 General

### 1.1 General

**1.1.1** Automation systems are to be so constructed as:

- to withstand the environmental conditions, as defined in Ch 2, Sec 2, [1], in which they operate
- to have necessary facilities for maintenance work.

### 1.2 Materials

**1.2.1** Materials are generally to be of the flame-retardant type.

**1.2.2** Connectors are to be able to withstand standard vibrations, mechanical constraints and corrosion conditions as given in Sec 6.

### 1.3 Component design

**1.3.1** Automation components are to be designed to simplify maintenance operations. They are to be so constructed as to have:

- easy identification of failures
- easy access to replaceable parts
- easy installation and safe handling in the event of replacement of parts (plug and play principle) without impairing the operational capability of the system, as far as practicable
- facility for adjustment of set points or calibration
- test point facilities, to verify the proper operation of components.

### 1.4 Ambient and supply conditions

**1.4.1** The environmental and supply conditions are specified in Pt C, Ch 3, Sec 1. Specific environmental conditions are to be considered for air temperature and humidity, vibrations, corrosion from chemicals and mechanical or biological attacks.

## 2 Applicable standards

### 2.1

**2.1.1** Electric and electronic systems, pneumatic systems, oil-pressure systems and automation consoles are to respect the provisions given in IEC 60092-504.

# SECTION 5 INSTALLATION REQUIREMENTS

## 1 General

### 1.1 General

**1.1.1** Automation systems are to be installed taking into account:

- the maintenance requirements (test and replacement of systems or components)
- the influence of EMI. The IEC 60533 standard is to be taken as guidance
- the environmental conditions corresponding to the location in accordance with Ch 2, Sec 2.

**1.1.2** Control stations are to be arranged for the convenience of the operator.

**1.1.3** Automation components are to be properly fitted. Screws and nuts are to be locked, where necessary.

## 2 Applicable standards

### 2.1

**2.1.1** Sensors and components, cables, pipes and automation consoles are to respect the provisions given in IEC 60092-504.

# SECTION 6 TESTING

## 1 General

### 1.1 General

**1.1.1** Automation systems are to be tested for type approval, acceptance or commissioning, when required.

Testing are to be carried out under the supervision of a Surveyor of Tasneef.

**1.1.2** The type testing homologation conditions for electrical, control and instrumentation equipment, computers and peripherals are described in [2].

**1.1.3** Automation systems are to be inspected at works, according to the requirements of [3], in order to check that the construction complies with the Guidelines.

**1.1.4** Automation systems are to be commissioned when installed on board and prior to sea trials, to verify their performance and adaptation on site, according to [2].

## 2 Type approval

### 2.1 Applicable standards

**2.1.1** For the approval of the hardware and software types the requirements given in IACS UR E10 apply.

## 3 Acceptance testing - commissioning

### 3.1 Applicable standards

**3.1.1** The requirements given in IEC 60092-504 apply.

Part C

# Machinery, Systems and Fire Protection

Chapter 4

# FIRE PROTECTION

## SECTION 1 GENERAL

# SECTION 1 GENERAL

## 1 General

### 1.1 Application

**1.1.1** The requirements of the Flag Administration may be applied instead of those of this section.

**1.1.2** For craft assigned with a restricted navigation notation and/or limited length, in general L ≤ 20 m, these requirements may be relaxed at Tasneef's discretion, based on risk analysis and alternative design.

### 1.2 Alternative Design

**1.2.1** Alternative design may be proposed based on:

- Formal Safety Assessment (FSA) procedure of IMO Guidelines (MSC-MEPC.2/Circ.12/Rev.2);
- Risk Assessment (RA) and ensuring technical evidence & document according to Tasneef Guide for Risk

Analysis. **1.2.2** Alternative design is to be submitted with:

- the outcome and report of FSA or RA as per [1.2.1];
- the departure of requirements with detailed comparison between the part of Guidelines and the alternative proposal
- the documents (plans, diagrams, specifications and calculations etc.) resulting from the alternative proposal with detailed comparison between the original documents and the ones reflecting alternative design.

### 1.3 Documentation to be submitted

**1.3.1** The following drawings are to be submitted to Tasneef:

- structural fire protection
- ventilation
- means of escape
- fire detection
- fixed fire extinguishing system
- mobile fire application
- safety plan (if required)

### 1.4 Safety Plan

**1.4.1** If required the safety plan is to include:

- life saving equipment
- fire alarm and fire fighting
- emergency exits
- emergency systems (alarms, fans, valves etc.).

In addition for information only:

- emergency instruction
- first aids

## 2 Structural fire protection, ventilation, means of escape and fire detection

### 2.1 Structural fire protection

**2.1.1** Battery room(s) in craft made of GRP of more than 15 m are to be made with laminated construction with fire retarding resin and/or intumescent resin. Arrangement and materials for structural fire protection are to be recognized by Tasneef. The fire protection is to cover the entire boundary of the battery room(s) starting from 300mm below the lowest waterline.

**2.1.2** Battery room(s) in craft made of glass reinforced plastic of not more than 15 m is/are to be made with laminated construction with fire retarding resin and/or intumescent resin.

### 2.2 Ventilation

**2.2.1** Ventilation fans for machinery spaces and enclosed galleys are to be capable of being stopped and main inlets and outlets of the ventilation system closed from outside the spaces being served. This position is not to be readily cut off in the event of a fire in the spaces served.

**2.2.2** Adequate means of ventilation are to be provided to prevent the accumulation of dangerous concentrations of flammable gas which may be emitted from batteries.

### 2.3 Means of access and escape

**2.3.1** All accommodation, service spaces and machinery spaces that are accessible have to be provided with at least 2 means of escape located as far as possible from each other, and be suitable to be used in an emergency.

Width of corridors in accommodation and machinery area is to be at least 700 mm in general, 600 mm for spaces not normally used.

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

Normally escape hatches have to be:

- minimum light opening 450 × 450 mm, or equivalent
- provided with fixed step, ladder and handholds where necessary
- clearly marked and with appropriate instructions
- readily opened from both sides without tools
- direct access to open deck or to a safe escape route.

Emergency light has to be provided for accommodation and relevant escape ways.

Reference may be made to ISO 9094.

### 2.4 Fire Detection and alarm

**2.4.1** The fixed fire detection and fire alarm system is to be installed in accordance with the requirements of IMO Fire Safety System Code, Chapter 9. Manually operated call points are to be placed to ensure a readily accessible means of notification.

## 3 Fire extinguishing systems

### 3.1 Fire Pumps

**3.1.1** Two electric driven fire pumps are to be provided.

**3.1.2** The two pumps are to be installed in two different spaces together with their own source of power and sea connection.

**3.1.3** The second pump (additional fire pump) may be hand-operated, provided that it is in compliance with the requirements of [3.1.1]. Bilge sanitary and general services pumps may be accepted as fire pumps.

### 3.2 Provisions of water jet

**3.2.1** It is to be ensured that at least one jet of water from a single length of hose is capable of reaching any part of the craft normally accessible to persons and any store-room or storage compartment when empty.

### 3.3 Pump capacity

**3.3.1** Each mechanically operated primary fire pump is to have a capacity not less than that given in Tab 1.

**Table 1 :**

| Craft length (LH) | Minimum capacity |
|---|---|
| Below 20 m | 5,5 $m^3$/h |
| At least 20 m but less than 24 m | 11 $m^3$/h |

In addition, when the pump is discharging at full capacity through two adjacent fire hydrants, is to be capable of maintaining a water pressure of 0,1 N/$mm^2$ at any hydrant.

**3.3.2** The additional fire pump is to have a capacity not less than 80% of the primary fire pump.

**3.3.3** All the mechanical pumps are to be of the self-priming type. If centrifugal pumps are fitted, they are to be provided with a non-return valve in the connection with the fire main.

### 3.4 Fire main and hydrants

**3.4.1** A fire main, water service pipes and fire hydrants are to be fitted.

**3.4.2** The fire main and water service pipe connections to the hydrants are to be sized for the maximum discharge rate of pump(s) connected to the main.

**3.4.3** The fire main, water service pipes and fire hydrants are to be constructed such that they will:

a) not be rendered ineffective by heat;

b) not readily corrode; and

c) be protected against freezing.

**3.4.4** The fire main is to have no connections other than those necessary for fire fighting or washing down.

**3.4.5** Fire hydrants are to be located for easy attachment of fire hoses, protected from damage and distributed so that a single length of the fire hoses provided can reach any part of the craft.

**3.4.6** Fire hydrants are to be fitted with valves that allow a fire hose to be isolated and removed when a fire pump is operating.

### 3.5 Fire hoses

**3.5.1** Fire hoses are not to exceed 18 metres in length.

**3.5.2** Fire hoses and associated tools and fittings are to be kept in readily accessible and known locations close to hydrants or connections on which they will be used. Hoses supplied from a powered pump are to have jet/spray nozzles (incorporating a shut-off facility) of diameter 19 mm, 16 mm or 12 mm depending on the fire-fighting purposes.

**3.5.3** At least one hydrant is to have one hose connected at all times. For use within accommodation and service spaces, proposals to provide a smaller diameter of hoses and jet/spray nozzles will be specially considered.

## 4 Fixed fire extinguishing systems

### 4.1 General

**4.1.1** A fixed fire-extinguishing system is to be provided in battery spaces.

For battery related fire extinguishing systems, refer to Ch 5, Sec 1, [4.2.4].

The system is to be a manual system or a manual/automatic combined system if applicable. A manual release system is to be activated from the helm position. The system activation controls are to be protected from environment and unintended operation and provided with operation instructions.

Automatic release of the system, acceptable only in unmanned rooms, is to be indicated by both audible and visual alarms at the helm position. The mechanical ventilation has to be automatically shut down in case of activation of the fixed fire extinguishing system.

**4.1.2** The extinguishing medium is to be suitable for the intended use and its amount and time of acting suitable for the intended use.

**4.1.3** The system is to be in compliance with the IMO FSS Code and with the applicable Tasneef Rules if carbon dioxide is used as fire extinguishing medium. Systems using other suitable extinguishing medium (e.g. aerosol, gaseous agent, water mist system) may be accepted if certified in accordance with IMO requirements.

**4.1.4** Cylinders for the extinguishing medium are to be protected from environment and unintended operation, mechanical damage and temperatures exceeding 50ºC. Cylinders are not to be located in accommodation spaces.

**4.1.5** Nozzles are to be located to grant uniform distribution of the extinguishing agent.

### 4.2 CO2 system

**4.2.1** The system is to be manually operated only. Discharge is to be indicated by both audible and visible alarm.

**4.2.2** CO2 cylinders are not to be located in the machinery space.

**4.2.3** CO2 cylinders or fittings on distribution lines are not to be located in a way that any extinguishing medium can enter into the accommodation area in the event of leakage in the system.

CO2 systems are to have a separate fire detection system.

## 5 Mobile Fire appliances

### 5.1

**5.1.1** Any portable fire extinguisher is to be type approved by Tasneef.

**5.1.2** Any individual portable extinguisher is to have a capacity according to Tab 2.

A suitable sized fire extinguisher is to be fitted in the following locations:

- close to the main helm position (at least one EII)
- in the accommodation area (at least one EI each 20m)
- close to any permanent installed cocker/stove or open flame device or cooking appliance (at least one DII)
- battery space (at least one F-II).

**5.1.3** Portable CO2 extinguishers are not to be fitted in accommodation spaces.

**5.1.4** If the portable fire extinguisher is located where it is exposed to splashed or sprayed water, the nozzle and triggering device is to be shielded.

**5.1.5** The extinguisher may be stowed in a locker or other enclosed space. The locker or opening part of the space is to be labelled.

**5.1.6** If an open-flame cooker is fitted, a fire blanket, in accordance with EN 1869, is to be within reach and readily accessible for immediate use.

**Table 2 :**

| Type | Foam (litres) | Carbon dioxide (kg) | Dry chemical powder (kg) |
|---|---|---|---|
| D-II | 9 | - | - |
| E-II | 9 | 5 | 4 |
| F-II | - | 5 | 4 |
| E-I | 6 | 2 | 1 |

Part C

# Machinery, Systems and Fire Protection

Chapter 5

# BATTERY AND FUEL CELL POWER

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# SECTION 1 BATTERY POWER

## 1 General

### 1.1 Application

**1.1.1** The provisions of this Section apply to craft where batteries, other than Lead and Nickel-Cadmium and Nickel-Metal-Hydride batteries, are installed to supply essential or not-essential services and emergency services, except batteries embedded in consumer products like computers and similar appliances.

**1.1.2** The requirements in this Section are applicable to installations with a variety of lithium battery chemistry; since the battery technology is under development, additional requirements may be required by the Society on a case by case basis.

**1.1.3** When the aggregated capacity of a battery system exceeds the rating of 20 kWh, the requirements in this Section are to be strictly complied with.

**1.1.4** It is to be duly noted that the provisions of this Section is limited to the installation onboard and for normal operation condition of the craft and hence all the installation and activities outside the craft and out of normal operation are not covered. For instance, charging of swappable battery at port, storage & containment of batteries shoreside or elsewhere the craft, battery swapping station, onboard charge of swappable batteries, etc. are not the remit of this Section.

### 1.2 Alternative design

**1.2.1** Alternative design may be proposed based on:

- Formal Safety Assessment (FSA) procedure of IMO Guidelines (MSC-MEPC.2/Circ.12/Rev.2);
- Risk Assessment (RA) and ensuring technical evidence & document according to Tasneef Guide for Risk

Analysis. **1.2.2** Alternative design is to be submitted with:

- The outcome and report of FSA or RA as per [1.2.1];
- The departure of requirements with detailed comparison between the part of Guidelines and the alternative proposal
- The documents (plans, diagrams, specifications and calculations etc.) resulting from the alternative proposal with detailed comparison between the original documents and the ones reflecting alternative design.

### 1.3 Definitions

**1.3.1** The following definitions and abbreviations are additional to those given in the other Parts of the Rules:

- Battery Management System (BMS): an electronic system that controls and monitors the state of the batteries by protecting the batteries from operating outside its safe operating area.
- Energy Management System (EMS): a system providing monitoring and control of the energy.
- Cell: an individual electrochemical unit of a battery consisting of electrodes, separators, electrolyte, container and terminals.
- Battery: assembly of cells ready for use as storage of electrical energy characterized by its voltage, size terminal arrangement, capacity and rate capability.
- Battery space: compartments (rooms, lockers or boxes) used primarily for accommodation of batteries .
- Battery system: the battery installation including battery banks, electrical interconnections, BMS and other safety features.
- Swappable battery system: battery pack with a coupler for connecting charger/craft, lock/unlock devices, battery control unit, thermal management unit, electrical protection circuit, enclosure and supporting devices
- Swappable battery system coupler: dedicated coupler for connecting a swappable battery system to a craft or to a charging rack
- Battery swap equipment: equipment used for mounting/unmounting a swappable battery system to/from the craft
- Battery swap system: battery swap station and supporting systems
- Battery swap station: facility that provides craft with a swappable battery system
- Supporting system for battery swapping: system which serves the battery swap station
- Module: group of cells connected together either in a series and/or parallel configuration.
- State of Charge (SOC): state of charge expressed as a percentage of the rated capacity giving an indication of the energy available from the battery.
- State of Health (SOH): general condition of a battery, including its ability to deliver the specified performance compared with a new battery.
- Venting: release of excessive internal pressure from a cell/battery in a manner intended by design to preclude rupture or explosion.
- Explosion: failure that occurs when a cell container or battery case opens violently and major components are forcibly expelled.
- Fire: the emission of flames from a cell or battery.
- Upper limit of the charging voltage: the highest allowable charging voltage as specified by the cell Manufacturer.

### 1.4 Documentation to be submitted

**1.4.1** In addition to the documents required in Sec 1, for battery powered craft the plans and documents listed in Tab 1 are to be submitted.

The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the systems and components.

## 2 System design

### 2.1 General

**2.1.1** The battery installation is to be divided into at least two independent battery systems and where practical, located in two separate battery spaces. In case of failure of one battery system, the capacity of the unaffected battery system(s) is to be sufficient for a safe return to base and to provide power to essential systems on board.

**2.1.2** An Energy Management System (EMS) according to [3.5] is to be provided for battery systems that are used as storage of power for the propulsion or as the main source of electrical power.

**Table 1 : Documentation to be submitted**

| No. | A/I **(1)** | Document |
|---|---|---|
| 1 | A | Block diagram and electrical wiring diagram of the battery system and system interfaced to the battery system, including control, monitoring and alarm system, emergency shutdown, PMS, etc. |
| 2 | I | Technical specification of the batteries, including technical data (electrical characteristics like voltage and capacity, discharge and recharge rates), battery chemistry and functional description of cell/battery system including at least cell/batteries configuration, safety devices (BMS), interfaces to monitoring/safety, diagnostic, including the list of controlled and monitored parameters. |
| 3 | I | Functional description of the energy management system (EMS), when required (see [2.1.3]. |
| 4 | A | A risk assessment addressing all potential hazards represented by the type (chemistry) of batteries, the evaluation of the risk factors and measures to control and reduce the identified risks.<br>Note: for the Risk Assessment reference is to be made to Tasneef "Guide for Risk Analysis". |
| 5 | A | Test program<br>Note: the test program is to include the functional tests as per [5.2] (alarm system, safety system, control system, etc.) [5] and further tests, if any, resulting from the Risk Assessment for the specific battery system. |
| 6 | A | Electrical load balance capable of reflecting the operational mode stated in the battery system operating philosophy (maximum designed deterioration rate is to be included). |
| 7 | A | A general arrangement plan of battery installation including the indication of structural fire protection and the safety systems **(2)** **(3)**. |
| 8 | I | Battery Manufacturer's instructions on active fire extinguishing system and confirmation about suitability of the proposed extinguishing agent for the specific type of batteries. |
| 9 | I | Statement of conformity of the batteries to IEC 62619, IEC 62620, IEC 62840 and IEC 60529. (For coupler/decoupler, IEC 62196) |
| 10 | I | Copy of type approval certificate of the battery systems, when the aggregate capacity exceeds 20 kWh |
| 11 | I | An overall description of the battery system operating philosophy for each operational mode (including charging). |
| 12 | I | Operation and maintenance manuals including instructions for the safe connection/disconnection of batteries, and swapping of batteries if any (see [5.4]). |
| 13 | A | Hazardous area classification (if applicable to the specific battery chemistry) and list of certified safety type electrical equipment installed in hazardous areas (as applicable). |

**(1)** A: to be submitted for approval I: to be submitted for information

**(2)** For battery space(s), based on the Risk Assessment (see [4.2]), evidence of the solution adopted for the battery space is to be given in the craft's active (detection and fighting) and passive fire protection, gas detection system and ventilation system drawings.

**(3)** The plan has to show:
- the battery pack arrangement with respect to the space it is being installed in
- the clearance distances between the other ancillary equipment in the space and the battery pack.

| No. | A/I **(1)** | Document |
|---|---|---|
| 14 | I | Test Report of battery system at cellular, modular and system level in order to identify the damage potential of a possible thermal runaway event (Propagation Test) including gas analysis and explosion analysis as appli-cable and depending on the safety concept adopted. |
| 15 | I | Battery system maker statement confirming suitability of the selected fire extinguishing system and ventilation arrangement for the specific project. |

**(1)** A: to be submitted for approval I: to be submitted for information
**(2)** For battery space(s), based on the Risk Assessment (see [4.2]), evidence of the solution adopted for the battery space is to be given in the craft's active (detection and fighting) and passive fire protection, gas detection system and ventilation system drawings.
**(3)** The plan has to show:
- the battery pack arrangement with respect to the space it is being installed in
- the clearance distances between the other ancillary equipment in the space and the battery pack.

**2.1.3** The battery system is to be so arranged as such that the electrical supply to equipment, necessary for propulsion and steering will be maintained or immediately restored in the case of battery system failure.

**2.1.4** Cables connecting each battery system to the main switchboard are to be arranged as per Sec 11, [5.2].

**2.1.5** A Risk Assessment, to be initiated in the design phase, is to be carried out to cover, but not limited to:
- evaluation of the risk factors,
- measures to control and reduce the identified risk, including potential gas development (e.g. toxic, corrosive), fire and explosion risk and
- action to be implemented.

The outcome of the assessment will give the additional measures to be adopted for minimizing the risks related to the use of batteries and among such measures, if the battery system needs to be installed in a space assigned to batteries only.

**2.1.6** The risk assessment has:
- to identify risks due to external heating, fire or flooding
- to identify any fault in the battery system that may cause malfunction to essential services including but not limited to propulsion and steering or to emergency services and measures to mitigate the related risk,
- to evaluate any risk related to the location of batteries in the same spacewith other system supporting craft's essential or emergency services, including pipes and electrical cables, distribution switchboards and so on, including but not limited to thermal runaway of the battery system, external and internal short-circuit,
- to evaluate any risk related to the location, in the same space, of batteries and other systems related to non-essential services,
- to address sensor failures (e.g. temperature measurement sensor failure, individual cell voltage measurement sensor failure) and alarm, control and safety system failures (e.g. BMS and EMS failures including power and communication failures),
- to assess the selected fire extinguishing and ventilation arrangement according to battery system maker guidelines considering the specific design features of the craft
- to consider any risk arising from battery swapping, including transferring, coupling/decoupling, weather conditions and human intervention.

**2.1.7** Battery cells of different physical characteristics, chemistries and electrical parameters are not to be used in the same electrical circuit.

**2.1.8** The batteries are to be properly located (see [4]) and, where necessary, insulated to prevent overheating of the system.

**2.1.9** The minimum required degree of protection is to be, in relation to place of installation of the battery system, according to Sec 3, [4]. Where water-based fire extinguishing system is used in the battery space, IP 44 is required as a minimum (see Note 1 and Note 2).

Note 1: if other fire-extinguish systems are used, the minimum IP can be reduced as result of the risk assessment.

Note 2: where the risk assessment identifies risks from water immersion (e.g. when batteries are installed below the freeboard deck), the batteries are to have a minimum degree of protection IP X7.

## 2.2 Constructional requirements

**2.2.1** Battery enclosure covering modules and cells are to be made of flame retardant materials.

**2.2.2** Each cell or battery case is to incorporate a pressure relief mechanism or is to be constructed in such a way to relieve excessive internal pressure at a value and rate that will be precluded rupture, explosion and self-ignition.

**2.2.3** A thermal protection device, capable to disconnect the battery in case of high temperature, is to be provided in the battery.

**2.2.4** The design and construction of battery modules have to reduce the risk of a thermal propagation due to a cell thermal runaway, maintaining it confined at the lowest possible level (e.g. confined within a module). This may be achieved by means of partition plates or sufficient distance in accordance with maker recommendation to prevent escalation between battery modules in case of a thermal runaway.

**2.2.5** Terminals are to have clear polarity marking on the external surface of the battery. The size and shape of the terminal contacts are to ensure that they can carry the maximum cur- rent. External terminal contact surfaces are to be made of conductive materials with good mechanical strength and corrosion resistance. Terminal contacts are to be arranged so as to minimize the risk of short circuits.

**2.2.6** The battery system is to be provided with a Battery Management System (BMS) according to [3.2].

### 2.3 Electrical protection

**2.3.1** The outgoing circuits of the battery system are to be protected against overload and short-circuit by means of fuses or multi-pole circuit breakers having isolating capabilities.

**2.3.2** An emergency shutdown system is to be installed and capable of disconnecting the battery system in an emergency.

**2.3.3** The battery system is to have means for isolating purpose for maintenance purposes. This isolating device is to be independent of the emergency shutdown arrangement.

### 2.4 Battery swapping

**2.4.1** The pre-requisite, e.g. mooring/anchoring of the craft, recommended weather conditions, equipment/personnel to be in place, other provisions to be checked and in ready, is to be set out.

**2.4.2** Battery swapping procedure, including cross-linked safety aspects between the craft and battery swap station, is to be prepared and reviewed/agreed by the Society.

**2.4.3** The battery swap system is to provide quick, safe and reliable swapping of the swappable battery system. The batteries will be loaded in a battery swap station, and the battery swapping is carried out by means of appropriate battery swap equipment and support system.

**2.4.4** The battery swap station, lifting, transfer, support system and onshore charging are out of remit of classification and to be take care of by the Company in charge of the battery swap station, transfer and support system.

**2.4.5** Battery swapping is to be carried out under the supervision of the competent personnel who is trained and qualified for the purpose. There is to be an appropriate procedure and checklist to be provided to the competent personnel for the proper completion of battery swapping.

**2.4.6** The status and each step of battery swapping, including coupling/decoupling is to be monitored by supervisory system. Safety measures, such as shut down of overall battery system, are to be in place.

**2.4.7** Means of communication, including vocal communication, between the competent personnel and the supervisory control station such as wheel house are to be provided.

**2.4.8** Contingency plan against accidental situation is to be prepared and emergency contact points are to be designated and regularly checked and updated.

### 2.5 Battery charging

**2.5.1** When batteries are charged by means of battery charger fitted on board. Battery chargers are to comply with the requirements of Ch 2, Sec 7, in addition to following requirements. When batteries are charged in charging station outside the craft, the requirements given by the charging station are to be taken into account.

**2.5.2** The battery charger is to be designed to operate without exceeding the limits given by the battery system Manufacturer (e.g. current and voltage level).

**2.5.3** The battery charger is to be interfaced with and controlled by the BMS.

**2.5.4** Any failure in the battery charger, including charging/discharging failure, is to give an alarm in a continuously manned control position.

## 3 Control, monitoring, alarm and safety systems

### 3.1 General

**3.1.1** For the purpose of these rules, unless differently state in the text, a required alarm is to be intended as an audible and visual alarm and is to be given in a continuously manned control position.

**3.1.2** Control, monitoring, alarm and safety systems are to comply with the requirements of Chapter 3 and are to be type approved or type tested according to Ch 3, Sec 6.

### 3.2 Battery management systems (BMS)

**3.2.1** The BMS and related monitoring and safety systems (see [3.4]) are to have self-check facilities.

In the event of a failure, an alarm is to be activated.

**3.2.2** The BMS is to be continuously powered so that a single failure of the power supply system does not cause any degradation of the BMS functionality; an alarm is to be given in the event of failure of any of the power supplies.

Unless the power supply is derived from different strings of batteries, one of the power supplies is to be derived from the emergency source of electrical power.

Where each battery is fitted with a BMS card, the individual cards may have a single power supply from the relevant battery.

An alarm is to be given and safety action taken in the event of loss of all the power supplies.

**3.2.3** The battery management system (BMS) is to:

- provide limits for charging and discharging of the battery,
- protect against over-current, over-voltage and under-voltage by disconnection of the battery system,
- protect against over-temperature by disconnection of the battery system,
- provide cell and module balancing.

**3.2.4** The following parameters are to be continuously monitored and indications are to be provided at a local control panel and in a continuously manned control position for:

- system voltage,
- max, min, average cell voltage,
- max, min and average cell or module temperature,
- battery string current.

**3.2.5** When battery system is used as storage of power for the propulsion system or as part of the main source of electrical power, State of Charge (SOC) and State of Health (SOH) of the batteries are to be displayed at a continuously manned control station.

### 3.3 Alarm system

**3.3.1** Abnormal conditions which can develop into safety hazards are to be alarmed before reaching the hazardous level.

**3.3.2** Any abnormal condition in the battery system is to initiate an alarm.

**3.3.3** At least the following conditions or events have to initiate an alarm at a local control panel and in a continuously manned control position:

- safety intervention of the BMS of the battery system,
- high ambient temperature,
- failure of cooling system or leakage of liquid cooling system,
- low ventilation flow inside the battery room,
- overvoltage and undervoltage,
- cell voltage unbalance,
- high cell temperature,
- other safety protection functions.

Other possible abnormal conditions are to be considered on the basis of the outcome of the Risk Assessment (see [2.1.7]) and relevant mitigating measures are to be adopted.

**3.3.4** An alarm is to be given on the bridge when State of Charge (SOC) reaches minimum required capacity for the craft intended operations.

### 3.4 Safety system

**3.4.1** The safety systems are to be:

- designed so as to limit the consequence of internal failures (e.g. failure in the safety system is not to cause shut down of battery system)
- self-monitoring,
- capable of acting on the controlled system following the fail-to safety principle,
- capable of detecting sensor malfunctions.

**3.4.2** The safety systems are to be activated automatically in the event of identified conditions which could lead to damage of the battery system. Activation of any automatic safety actions is to activate an alarm. Manual override of safety functions is not to be possible.

**3.4.3** Voltage of any one of the single cells is not to exceed the upper limit of the charging voltage as specified by the cell Manufacturer. The battery charger is to be stopped when the upper limit of the charging voltage is exceeded for any one of the single cells.

**3.4.4** An emergency shutdown (ESD) system is to be arranged as a separated hardwired circuit and it is to be independent from the control system.

**3.4.5** Activation means of the ESD are to be provided locally, from outside the battery space, and from a continuously manned control station.

**3.4.6** The emergency shutdown is also to be located on the bridge.

**3.4.7** In case of over temperature in the battery system, an alarm and a request of manual load reduction is to be given on the bridge at a temperature lower than the one causing intervention of the BMS. As an alternative an automatic load reduction system may be provided. Its intervention is to generate an alarm.

**3.4.8** Other possible abnormal conditions, which could lead to damage or additional hazards to battery system, are to be considered on the basis of the outcome of the Risk Assessment.

**3.4.9** Sensors are to be designed to withstand the local environment.

**3.4.10** The enclosure of the sensor and the cable entry are to be appropriate to the space in which they are located.

**3.4.11** Cables to be operable under fire conditions (e.g. where required as result of the Risk Assessment), are to be of a fire- resistant type complying with IEC Publication 60331 series.

## 3.5 Energy Management system

**3.5.1** When required per [2.1.3], an energy management system (EMS) is to be provided complying with the requirements of Chapter 3 consisting of several levels of controls and alarm functions, such as:

- monitoring and alarm functions of all power sources, inverters and disconnectors;
- voltage and power control for DC distribution system;
- available power and charge/discharge status of the storage energy source;
- interface with Power Management System (PMS) for combinations of AC and DC distribution systems;
- inverter control for the overall system.

The energy management system (EMS) is to be independent from the battery management system (BMS) for lithium batteries, however EMS may be integrated in the PMS.

The EMS is to be continuously supplied by uninterruptible power supply systems (UPS) and a failure is to initiate an alarm in a manned location.

The energy management system is to be type tested or type approved according to the tests listed in Ch 3, Sec 6, Tab 1, as far as applicable (see Note 1).

Note 1: If the energy management functionality is implemented in another system, e.g. as part of the power management system (PMS), then the systems are to be certified together.

**3.5.2** The EMS is to be capable to provide at least the following information on the bridge:

- energy available from batteries (SOC),
- power available from batteries,
- time or range for which the battery can provide energy according to actual operational conditions,
- alarm for minimum capacity reached,
- battery state of health (SOH).

# 4 Location

## 4.1 General

**4.1.1** Batteries are to be arranged aft of collision bulkhead and in such a way that danger to persons and damage to the craft due to failure of the batteries (e.g. caused by gassing, explosion, and fire) is minimized.

**4.1.2** Batteries are not to be located in a battery box on the open deck exposed to sun and frost.

They are to be located where they are not exposed to excessive heat, extreme cold, spray, steam, shocks or vibration or other conditions which would impair their safety, performance or accelerate deterioration.

**4.1.3** Batteries are to be located in such a way that the ambient temperature remains within the Manufacturer's specification at all times.

**4.1.4** Batteries are to be suitably housed by means of compartments (rooms, lockers or boxes) which are to be properly constructed and efficiently ventilated and cooled (as necessary) in such a way to keep the battery system at a specified set of environmental conditions.

**4.1.5** Battery system is to be arranged following the Manufacturer's prescriptions in particular to prevent cascade effects in case of a thermal runaway (e.g. partition plates or distance in accordance with Manufacturer's recommendations).

**4.1.6** Batteries are to be located in a battery space placed within the extreme borders of the main machinery space or adjacent to it.

**4.1.7** One of the two battery systems required in [2.1.2] is to be placed in a battery space located in the same machinery space of the main switchboard.

**4.1.8** Depending on the battery chemistry, it may be necessary to define a hazardous area for the installation of appropriate equipment (see Tab 1 No. 6).

## 4.2 Battery space

**4.2.1** When required, based on [4.1.6] or the Risk Assessment (see [2.1.6]), a space assigned to batteries only is to be foreseen.

**4.2.2** Access to this space is to be through self-closing doors. As an alternative normally closed doors with alarm may be considered.

**4.2.3** External hazards, such as fire and water ingress are to be taken into account in the Risk Assessment, in order to assess the risk associated with an external event (e.g. a fire spreading from adjacent rooms to the battery space, water flooding and so on) and possible countermeasures (e.g. suitable segregation of the battery space).

No heat sources or high fire risk equipment are to be located in battery spaces.

**4.2.4** A fire detection system and a fixed fire extinguishing system appropriate to the battery chemistry are to be provided in the battery space. This requirement may be waived if equivalent fire detection and fire extinguishing provisions are fitted within the battery system's enclosure(s).

The type is to be chosen following the battery Manufacturer's instructions.

Examples of fire extinguishing systems may be a powder or a gas based or water-based fixed fire extinguishing system provided that the suitability of the extinguishing agent for the specific type of batteries is confirmed by the battery Manufacturer.

Automatic release is only acceptable for small, not accessible, battery spaces.

Where an automatic release of fire extinguishing media is accepted, its activation is to be confirmed by more than one sensor.

**4.2.5** The battery spaces are to be fitted with a forced ventilation system of extraction type, which is to be:

- independent from any other ventilation system serving other craft's spaces,
- provided with local manual stop, still available in case of failure of the automatic and or remote control system,
- provided with indication of ventilation running and of battery space ambient temperature,
- with a capacity (rate) according to battery manufacturer guidelines on the basis of the gas release identified in the gas analysis or propagation test,
- fitted with inlet from open air,
- fitted with exhaust outlet to open air far from accommodation and machinery ventilation inlets,
- fitted with non-sparking fans driven by a certified safe type electric motor in case the ventilation duct is considered to contain ex-plosive atmosphere in case of thermal runaway.

**4.2.6** Appropriate means to maintain the battery working temperature within the Manufacturer's declared limits are to be provided (e.g. by means of liquid cooled solutions or ventilation systems provided with control of air temperature).

**4.2.7** Battery modules with liquid cooling are to be designed such that the risk of a cooling liquid leakage inside the module is minimized.

The cooling system is to include at least two pumps for each primary and secondary circuits: one main and one standby. The standby pump can be omitted only if the consequences of main pump failure are addressed in the risk assessment [2.1.7].

**4.2.8** In case of liquid cooled solutions, a ventilation system is anyway required to extract possible gases or vapours in consequence of a battery abnormal condition.

**4.2.9** Depending on the battery chemistry, a gas detection system, for the gases that may be emitted from the battery system in the event of a serious fault, may be requested as an outcome of the risk assessment.

In this case,

- an alarm at 30% of LEL and automatic disconnection of batteries are to be provided,
- an alarm at 60% of LEL and automatic disconnection of all electrical equipment non-certified of safety type for the specific hazardous area, gas, vapour are to be provided.

A failure in the gas detection system is to be alarmed but is not to cause above mentioned automatic disconnections.

**4.2.10** Depending on the battery chemistry, appropriate ventilation to prevent the formation of explosive atmospheres in the battery space (e.g. to limit the concentration of flammable gasses and thereby reduce the risk for fire) is to be provided.

At this purpose the highest rate of gas emissions is to be considered.

**4.2.11** Depending on the battery chemistry, when a hazardous area is to be considered, mechanical exhaust non-sparking fan driven by a certified safe type electric motor, and inlet from open air are to be arranged.

**4.2.12** Battery spaces on harbour craft carrying passengers, and on cargo craft are to be insulated in way of other spaces as indicated in Tab 2.

**4.2.13** Battery spaces are to be considered as spaces not normally manned.

**4.2.14** The battery space is not to contain other systems supporting essential or emergency services, including piping and electric cables serving such systems, in order to prevent their loss upon possible failures (e.g. thermal runaway) in the battery system.

**Table 2**

| Bulkhead | Control Station 1 | Corridor 2 | Accommodation spaces 3 | Stairways 4 | Service spaces (low risk) 5 | Machinery Space 6 | Cargo 7 | Service spaces (high risk) 8 | Open deck 9 | Special category 10 | Muster stations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Li Battery Space | A60 | A15 | A30 | A15 | A0 | A0 | A60 | A30 | A0 | A60 | A60 |
| Li Battery Space Below | A60 | A60 | A30 | A60 | A0 | A0 | A60 | A30 | A0 | A60 | A60 |
| Li Battery Space Above | A0 | A0 | A0 | A0 | A0 | A0 | A60 | A0 | A0 | A60 | A60 |

# 5 Testing

## 5.1 General

**5.1.1** Battery systems are to be tested by the Manufacturer.

**5.1.2** Batteries are to be subjected to functional and safety tests according to IEC Publication 62619 and 62620, also 62840 for swappable batteries, or in accordance with other equivalent national or international standards (For coupler/decoupler IEC 62196).

**5.1.3** When the aggregate capacity of a battery system exceeds the rating of 20 kWh, the battery system is to be of a type approved in accordance with the Society "Rules for the type approval certification of lithium battery systems".

### 5.2 Testing and inspection at Manufacturer premises

**5.2.1** Battery systems are to be tested by the Manufacturer according to a test program proposed by the Manufacturer and approved by the Society and which is to include at least functional tests of battery system/BMS and control, monitoring and safety systems and further tests, if any, resulting from the Risk Assessment.

**Table 3**

| No. | Test/inspection |
|---|---|
| 1 | Examination of the technical documentation, as appropriate, and visual inspection |
| 2 | Functional test of the BMS, including safety functions and applicable alarms listed in [3.3.3] |
| 3 | Dielectrical strength (high voltage test) **(1)** |
| 4 | Insulation resistance test **(1)** |
| 5 | Sensor failure test (e.g. power supply failure, disconnection, short circuit, etc.) |
| 6 | Emergency shutdown (ESD) functional test |
| 7 | Communication failure between BMS and battery charger **(2)** |
| 8 | Testing of the cooling system when submitted to acceptance testing together with the battery system |
| 9 | Check of test certificate for prescribed degree of protection |

**(1)** Refer to Sec 8, [3.3] and Sec 8, [3.4]. In order to prevent damages to the electronic components of the battery system, the electronic components can be disconnected during the high voltage test.
**(2)** Only when batteries are charged by battery charger fitted on board.

### 5.3 Testing and inspection after installation on board

**5.3.1** After installation, and after any important repair or alteration which may affect the safety of the arrangement, following a check of compliance with the plans, the battery system is to be subjected to tests and inspections, to the satisfaction of the Surveyor in charge.

**5.3.2** Performance tests are to be carried out on the battery system; the test program is to include functional tests as per Tab 4 and further tests, if any, resulting from the Risk Assessment.

**Table 4**

| No. | Test/verification |
|---|---|
| 1 | Insulation resistance test as per Sec 15, [3.3] |
| 2 | Test of the functionality of the battery system and BMS and its auxiliaries, including alarms, and safety functions, emergency stop, including simulation of changes in parameters and simulation of sensor failure and of communication failure (e.g. with battery charger) |
| 3 | Test of the functionality of the auxiliary services in the battery space (e.g. ventilation, liquid cooling, gas detection, fire detection, leakage detection) |
| 4 | Verification of proper calculation and indication of SOC and SOH (when required per [3.2.4]) **(1)** |
| 5 | Verification of correct regulation of charging and discharging currents |
| 6 | Verification of the functionality of the EMS (when required per [2.1.3]) |
| 7 | Test of the independent disconnecting device as per [2.3.3] |
| 8 | Verification of battery swapping procedure in place **(2)** |

**(1)** Tests for the verification of the battery SOH are to be carried out (e.g. complete charge/discharge cycle or other methods as per Manufacturer's indications).
**(2)** Only when battery swapping system is applied.

## 5.4 Plans to be kept on board

**5.4.1** An operation manual is to be kept on board which includes at least:

- charging, and/or battery swapping procedure,
- normal operation procedures, including instructions for the safe connection/disconnection of batteries,
- emergency operation procedures,
- estimated battery deterioration (ageing) rate curves, considering modes of operation.

**5.4.2** A maintenance manual for systematic maintenance and functional testing is to be kept on board which includes at least:

- tests on all the equipment affecting the battery system (e.g. instrumentation, sensors, etc.),
- recommended test intervals to reduce the probability of failure,
- recommended survey plan (annual and renewal surveys),
- functional tests of control, monitoring, safety and alarm system,
- verification of the State of Health (SOH),
- instructions for Software Maintenance.

# SECTION 2 FUEL CELL POWER

## 1 General

### 1.1 Scope

#### 1.1.1 Application

The provisions of this Section apply to the arrangement, installation, control, monitoring and safety systems of craft using fuel cell power installations. These Rules are applicable to installations with several different configurations of fuel cell power installations. Since the fuel cell is a novel technology under continuous development, additional requirements to those specified in these Rules may be required by Tasneef on a case-by-case basis depending on the design principles of the fuel cell in subject. Where the fuel cell power installations consist of the fuel cell power systems which are enclosed in modules, the Tasneef "Rules for the Type Approval of Fuel Cell Power Modules" apply in conjunction with this Section.

#### 1.1.2 Acceptance by the flag Administration

The use of fuel cells on craft requires acceptance by the Administration of the State whose flag the craft is entitled to fly.

#### 1.1.3 MSC.1/Circ.1647 requirements and the Society's rules

For fuel cell powered craft, the requirements of the IMO Interim Guidelines for the Safety of Ships using Fuel Cell Power Installations set out in the annex of IMO circular MSC.1/Circ.1647 (hereinafter named "MSC.1/Circ.1647") are to be applied as class requirements as specified and with the deviations given in this Section.

For the scope of classification, when reference is made to paragraphs of MSC.1/Circ.1647 where the wording "Administration" is used, it is to be regarded as referring to the "Society".

In general, this Section applies to fuel cell power installations and to their interfaces with the other craft systems. Unless otherwise specified, the machinery, equipment and systems of fuel cell powered craft are also to comply with the requirements given in Part C.

The fuel cell power installations designed to use low-flashpoints fuels as primary fuel (e.g. LNG, LPG, NH3, methyl/ethyl alcohol, hydrogen) are additionally to comply with the requirements in Appendixes of Pt C, Ch 1 of the Rules for the Classification of Ships.

The electrical equipment needed for the conditioning of the electrical output from the fuel cell power installation such as e-filters, inverters, converters and transformers are to comply with Ch 2, Sec 5 and Sec 6. The reforming equipment as well auxiliary systems are to comply with the requirements for Boilers and Pressure Vessels and Piping System in Ch 1, Sec 3 and Ch 1, Sec 10 of the Rules for the Classification of the Ships.

#### 1.1.4 MSC.1/Circ.1647 requirements not within the scope of classification

The following requirements of MSC.1/Circ.1647 are not within the scope of classification:

- Section 3 - Fire Safety

These requirements are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see [1.1.6]).

#### 1.1.5 Correspondence of the MSC.1/Circ.1647 with the Rules

All the requirements of this Section are cross referenced to the applicable paragraphs of MSC.1/Circ.1647, as appropriate.

#### 1.1.6 Statutory certificates

The responsibility for interpretation of the MSC.1/Circ.1647 requirements for the purpose of issuing statutory certificates for fuel cell powered craft lies with the Administration of the State whose flag the craft is entitled to fly.

Whenever the Society is authorized by an Administration to issue on its behalf the statutory certificates for fuel cell powered craft, or where the Society is authorized to carry out investigations and surveys on behalf of an Administration on the basis of which the statutory certificates for fuel cell powered craft will be issued by the Administration, or where the Society is requested to certify compliance with MSC.1/Circ.1647, the full compliance with the requirements of MSC.1/Circ.1647, including the fire safety requirements mentioned in [1.1.4], will be granted by the Society, subject to [1.1.2].

#### 1.1.7 FUEL CELL POWERED CRAFT additional class notation

The **FUEL CELL POWERED CRAFT** additional class notation is assigned to craft where fuel cells are installed to supply essential or not-essential services, in compliance with the design and constructional requirements of this Section, as follows:

- **FUEL CELL POWERED CRAFT (E)** when fuel cell is used to power at least one of the essential services defined in Ch 2, Sec 1, [3.2.1] and is necessary to ensure the compliance of the main source of electrical power to the requirements in Ch 2, Sec 3, [2.2.3]
- **FUEL CELL POWERED CRAFT (NE)** when fuel cell is used to power only services not falling under the definition of essential services in Ch 2, Sec 1, [3.2.1].

## 1.2 Documentation to be submitted

### 1.2.1

Tab 1 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules, for the portion of the craft not involved in fuel cell power installations.

The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the system, equipment or components.

**Table 1 : Documents to be submitted**

| No. | I/A **(1)** | Document |
|---|---|---|
| 1 | I | Technical specification of the fuel cell power installation, including technical data as power output parameters including min./max. design voltage and current, information about min/max temperature/pressure/rate of process air/cooling water/ventilation. |
| 2 | I | List of mechanical and electrical components which are part of the fuel cell power installation with specification of the pumps, compressors and fans. |
| 3 | A | P&I diagrams of systems conveying fuel (primary and reformed type), exhaust air/gas, cooling media, process air, technical water, ventilation, inerting and of other systems in the fuel cell power installation. |
| 4 | I | Description of thermal insulation and heat tracing, if any. |
| 5 | A | Construction details with strength analysis of fuel cell power installation frame and foundation, if any. |
| 6 | A | Construction drawings of all components of the reforming equipment considered as pressure vessel e.g. burner, reformer, heat exchangers. |
| 7 | I | Functional description of the fuel cell power installation including at least its design, safety principles, ventilation and gas detection concept, auxiliary systems arrangement (e.g. cooling medium, process air, ventilation, venting, process water, inert gas, as applicable). |
| 8 | A | Block diagram of the safety, control and monitoring system of the fuel cell power installation. |
| 9 | A | Wiring diagrams of power supply and automation system of the fuel cell power installation. |
| 10 | I | List of controlled and monitored parameters and cause and effect matrix with normal/emergency shutdown functions. |
| 11 | A | Hazardous zones categorization study with calculation according to IEC 60079-10 (using CFD simulations or empirical formula) and list of EX equipment with relevant EX certificates, as applicable. |
| 12 | A | Service profile description of the fuel cell power installations, highlighting if the fuel cell power generation is used for essential or non-essential craft services. |
| 13 | I | A FMEA according to the Tasneef "Guide for Failure mode and Effect Analysis" or other equivalent methods for the fuel cell power installation. |
| 14 | I | Lifecycle operational, maintenance and inspection manual of the fuel cell power installation. |
| 15 | I | Testing reports or type approval reference of the fuel cell power installation components such as fuel cell stacks, reforming equipment according to applicable international recognized standards. |
| **(1)** A = to be submitted for approval<br>I = to be submitted for information | | |

## 1.3 Definitions

MSC.1/Circ.1647 REFERENCE: para. 1.4

### 1.3.1

The terms used in this Section have the meanings defined in MSC.1/Circ.1647, para. 1.4 and in the Tasneef "Rules for the Type Approval of Fuel Cell Power Modules".

Terms not defined have the same meaning as in SOLAS chapter II-2 and the IGF Code.

### 1.3.2

Certified safe type: means electrical equipment that is certified safe by the relevant recognized authorities for operation in a flammable atmosphere based on a recognized standard.

Note 1: Refer to IEC 60079 series, Explosive atmospheres and IEC 60092-502:1999 Electrical Installations in Ships - Tankers - Special Features.

### 1.3.3

Fuel cell power module: is the fuel cell power system or parts of fuel cell power system and relevant enclosure.

### 1.3.4

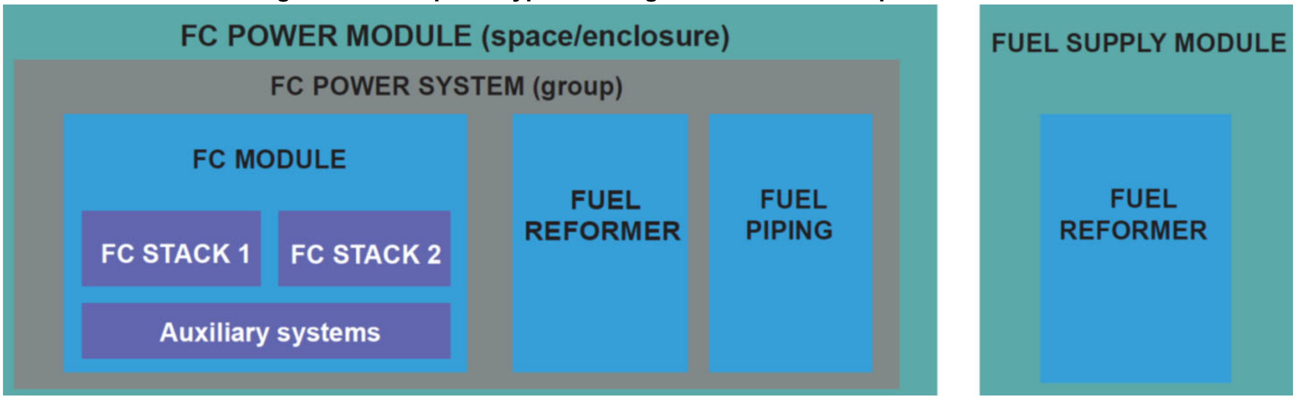
Fuel cell module: is the assembly incorporating one or more fuel cell stacks and auxiliary systems.

### 1.3.5

Fuel supply module: is the enclosure containing the fuel reforming and fuel conditioning equipment.

**1.3.6**
Service profile: is a description of the use of the fuel cell for the power supply to on-board systems considering the operational profile of the craft (navigation, maneuvering and port stay).

**Figure 1 : Example of typical configuration of Fuel cell power module**




# 2 Goal and functional requirements

MSC.1/Circ.1647 REFERENCE: para. 1.2 and 1.3

## 2.1 Goal

**2.1.1**

*The goal of this Section is to provide for safe and reliable delivery of electrical and/or thermal energy through the use of fuel cell technology.*

## 2.2 Functional requirements

**2.2.1**

*The safety, reliability and dependability of the systems is to be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery installations, regardless of the specific fuel cell type and fuel.*

A FMEA consistent with the Tasneef "Guide for Failure Mode and Effect Analysis" is to be carried out for the whole fuel cell power installation to check the potential existence of failure modes that can jeopardize the craft's safety. The results of the FMEA are then to be used to establish a trial program.

**2.2.2**

*The probability and consequences of fuel-related hazards are to be limited to a minimum through arrangement and system design, such as ventilation, detection and safety actions. In the event of gas leakage or failure of the risk reducing measures, necessary safety actions are to be initiated.*

**2.2.3**

*The design philosophy is to ensure that risk reducing measures and safety actions for the fuel cell power installation do not lead to an unacceptable loss of power.*

**2.2.4**

*Hazardous areas are to be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the craft, persons on board, and equipment.*

**2.2.5**

*Equipment installed in hazardous areas are to be minimized to that required for operational purposes and are to be suitably and appropriately certified.*

**2.2.6**

*Unintended accumulation of explosive, flammable or toxic gas concentrations are to be prevented.*

**2.2.7**

*System components are to be protected against external damages.*

**2.2.8**

*Sources of ignition in hazardous areas are to be minimized to reduce the probability of explosions.*

**2.2.9**

*Piping systems and overpressure relief arrangements that are of suitable design, construction and installation for their intended application are to be provided.*

**2.2.10**

*Machinery, systems and components are to be designed, constructed, installed, operated, maintained and protected to ensure safe and reliable operation.*

**2.2.11**

*Fuel cell spaces are to be arranged and located such that a fire or explosion in either will not lead to an unacceptable loss of power or render equipment in other compartments inoperable.*

**2.2.12**

*Suitable control, alarm, monitoring and shutdown systems are to be provided to ensure safe and reliable operation.*

**2.2.13**

*Fixed leakage detection suitable for all spaces and areas concerned is to be arranged.*

**2.2.14**

*Fire detection, protection and extinction measures appropriate to the hazards concerned are to be provided.*

**2.2.15**

*Commissioning, trials and maintenance of fuel systems and gas utilization machinery are to satisfy the goal in terms of safety, availability and reliability.*

#### 2.2.16

*The technical documentation is to permit an assessment of the compliance of the system and its components with the applicable rules, guidelines, design standards used and the principles related to safety, availability, maintainability and reliability.*

#### 2.2.17

*A single failure in a technical system or component is not to lead to an unsafe or unreliable situation.*

The fuel cell power installations that:

- are used to power at least one essential service as defined in Ch 2, Sec 1, [3.2.1], and
- are necessary to ensure the compliance of the main source of electrical power to the requirements in Ch 2, Sec 3, [2.2.3]

are to be specifically considered in terms of reliability, availability and redundancy.

#### 2.2.18

*Safe access is to be provided for operation, inspection and maintenance.*

# 3 Alternative design

MSC.1/Circ.1647 REFERENCE: para. 1.5

## 3.1

#### 3.1.1

*Appliances and arrangements of fuel cell power systems may deviate from those set out in this Section provided that they meet the intent of the goal and functional requirements concerned and provide an equivalent level of safety of the relevant paragraphs.*

#### 3.1.2

*The equivalence of the alternative design is to be demonstrated as specified in SOLAS regulation II-1/55, and approved by the Society. However, the Society will not allow operational methods or procedures as an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by this Section.*

# 4 Design principles for fuel cell power installations

MSC.1/Circ.1647 REFERENCE: para. 2

## 4.1 Fuel cell spaces

#### 4.1.1

The requirements in MSC.1/Circ.1647 para. 2.1 apply.

## 4.2 Arrangement and access

#### 4.2.1

The requirements in MSC.1/Circ.1647 para. 2.2 apply.

## 4.3 Atmospheric control of fuel cell spaces

#### 4.3.1 General

The requirements in MSC.1/Circ.1647 para. 2.3.1 apply.

#### 4.3.2 Ventilation of fuel cell spaces

The requirements in MSC.1/Circ.1647 para. 2.3.2 apply.

When applying the requirements in MSC.1/Circ.1647 para. 2.3.2.3, reference is to be made to IEC 60079-10 standard.

#### 4.3.3 Inerting of fuel cell spaces for fire protection purposes

The requirements in MSC.1/Circ.1647 para. 2.3.3 apply.

## 4.4 Materials

#### 4.4.1

The requirements in MSC.1/Circ.1647 para. 2.4 apply.

#### 4.4.2

The use of plastic materials for piping and pressure vessels is in general not allowed. Specific application may be evaluated on case-by-case basis.

## 4.5 Piping arrangement for fuel cell power system

#### 4.5.1

The requirements in MSC.1/Circ.1647 para. 2.5 apply.

#### 4.5.2

Where the fuel cell stacks are subject to specific air quality requirements (e.g., limits on dust, humidity, salinity, temperature), arrangements for air conditioning, air drying and air filtering are to be fitted and the air quality parameters are to be monitored.

#### 4.5.3

Where the primary fuel is subject to specific quality requirements (e.g., maximum Sulphur content) not to impair the performances of the fuel cell power system, arrangements for fuel conditioning system are to be fitted.

#### 4.5.4

If enclosed fuel supply modules and enclosed fuel cell modules are installed, they are to be fitted with sampling point connections for detecting explosive atmosphere by means of portable equipment.

#### 4.5.5

Where the pressure vessels and the piping in the fuel cell power module may be subject to overpressure, they are to be suitably protected by pressure relief arrangements. The discharge of possible hazardous gases is to be routed to open air.

## 4.6 Exhaust gas and exhaust air

#### 4.6.1

Exhaust gases and exhaust air from the fuel cell power systems should not be combined with any ventilation and should be led to a safe location in the open air.

#### 4.6.2

The arrangement of the process air treatment system is to be subject to the risk assessment as required in [6.3].

# 5 Fire safety

MSC.1/Circ.1647 REFERENCE: para. 3

## 5.1

### 5.1.1

This paragraph is void, as the provisions of MSC.1/Circ.1647 para. 3 are not within the scope of classification.

These provisions are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see [1.1.6]).

# 6 Electrical systems

MSC.1/Circ.1647 REFERENCE: para. 4

## 6.1 General provisions on electrical systems

### 6.1.1

The requirements in MSC.1/Circ.1647 para. 4.1 apply.

### 6.1.2

For the casing of the fuel cell stack to be mounted in the fuel cell space, a minimum enclosure notation of IP54 is required to protect against:

a) ingress of dust in sufficient quantity to interfere with satisfactory operation of the fuel cell; and

b) water splashed against the fuel cell stack from any direction.

### 6.1.3

The equipment and installations in hazardous areas are to comply with recognized international standards including but not limited to the following:

- IEC 60079-0 General requirements
- IEC 60079-1 Flameproof enclosure 'Ex d'
- IEC 60079-7 Increased safety 'Ex e'
- IEC 60079-11 Intrinsic safety 'Ex i'
- IEC 60079-14 Installations
- IEC 60079-17 Electrical Installations inspection and maintenance
- IEC 60079-18 Molded encapsulation 'Ex m'
- IEC 60079-25 Intrinsically safe systems
- IEC 60079-29 Gas detection

The equipment is to be properly EX certified considering the hazardous zone categorization defined by manufacturer according to IEC 60079-10 or according to [6.2].

### 6.1.4

Earthing and bonding are to be arranged according to recognized international standards.

## 6.2 Area classification

### 6.2.1 General

The requirements in MSC.1/Circ.1647 para. 4.2.1 apply.

### 6.2.2 Hazardous areas zone 0

The requirements in MSC.1/Circ.1647 para. 4.2.2 apply.

### 6.2.3 Hazardous areas zone 1

The requirements in MSC.1/Circ.1647 para. 4.2.3 apply.

### 6.2.4 Hazardous areas zone 2

The requirements in MSC.1/Circ.1647 para. 4.2.4 apply.

### 6.2.5 Ventilation ducts

The requirements in MSC.1/Circ.1647 para. 4.2.5 apply.

## 6.3 Risk assessment

### 6.3.1

The requirements in MSC.1/Circ.1647 para. 4.3 apply.

### 6.3.2

Guidance on risk assessment techniques can be found in the Tasneef "Guide for Risk Analysis".

### 6.3.3

The assumptions for the risk assessment are to be agreed by a team of experts acceptable to the Society. It may include a representative of Class, Flag Administration, owner, builder or designer, and consultants having the necessary knowledge and experience in safety, design and/or operation as necessary for the specific evaluation at hand. Other members may include marine surveyors, craft operators, safety engineers, equipment manufacturers, human factors experts, naval architects and marine engineers, according to the problem under scope.

### 6.3.4

The risk assessment can be qualitative or quantitative and is to cover the following aspects:

- Accidental release and dispersion (hydrogen leakages due to tank and piping rupture and permeability, hydrogen dilution in enclosed space, hydrogen effects on material e.g. embrittlement or permeation)
- Ignition (spontaneous ignition of hydrogen during sudden release, minimum energy for ignition)
- Deflagration and detonation (hydrogen explosion hazards)
- Fires (jet fire, radiative heat fluxes, fire resistance of hydrogen system)
- Impact on people, asset and environment (severity of hydrogen incidents)
- Mitigation techniques (detection method, barriers, ventilation level)
- Emergency operation (strategy control of incident)
- Oxygen enrichment due to cryogenic hydrogen temperature.

### 6.3.5

The risk assessment is to follow the steps outlined below.

a) The team of experts is to conduct a Hazard Identification (HAZID) to agree on the scenarios to be subjected to the risk assessment, and on the assumptions regarding the most critical events (typically, connection failures causing an hydrogen or primary fuel release) considering also available internationally recognized standard (e.g. ISO/TR 15916) for the identification of hazards and risks.

b) Reasonable assumptions on the extent of connection failures or other selected events and the process parameters of the hydrogen and primary fuel are to be made by the team of experts, preferably on the basis of statistics available in the public domain or provided and documented by stakeholders.

c) Reasonable assumptions on the operation of ventilation system are to be made according to layout and procedures of the affected space.

d) In order to verify that the hydrogen and primary fuel release will not create flammable concentrations and to demonstrate the drip tray capacity for a liquid leakage, a specific simulation is to be set up, aimed at evaluating the maximum amount of hydrogen spilled and its cloud, the evaporation rate and the possibility to fully accommodate the liquid leakage in the drip tray. The dispersion of vapors resulting from hydrogen evaporation in the affected space is also to be ascertained in respect of explosive atmosphere.

e) The simulation is to be conducted by commercially available and validated tools (typically, by CFD tools). It is to focus on the calculation of the amount of hydrogen or primary fuel spilled before the stop of hydrogen and primary fuel flow. Other calculation methods (e.g. empirical formulas based on literature) will be subject to special consideration.

f) Reasonable assumptions are to be made by the expert team regarding detection time, hydrogen and primary fuel flow stop time and human reaction time, in case operators are credited in the emergency.

g) If the simulation demonstrates that the drip tray cannot accommodate the liquid spill, mitigating measures are to be provided and subjected to the same simulation process, to appreciate the risk reduction.

## 7 Control, monitoring and safety systems

MSC.1/Circ.1647 REFERENCE: para. 5

### 7.1 General provisions on control, monitoring and safety systems

#### 7.1.1

The requirements in MSC.1/Circ.1647 para. 5.1 apply.

#### 7.1.2

The fuel cell power installation is to be provided with a safety system with the following characteristics:

- "fail safe" design, so that any failure of the safety system cannot result in an unsafe status for the fuel cell module
- independent from control and alarm system
- compliant with the requirements in Ch 3, Sec 2.

### 7.2 Gas or vapour detection

#### 7.2.1

The requirements in MSC.1/Circ.1647 para. 5.2 apply.

### 7.3 Ventilation performance

#### 7.3.1

The requirements in MSC.1/Circ.1647 para. 5.3 apply.

### 7.4 Bilge wells

#### 7.4.1

The requirements in MSC.1/Circ.1647 para. 5.4 apply.

### 7.5 Manual emergency shutdown

#### 7.5.1

The requirements in MSC.1/Circ.1647 para. 5.5 apply.

### 7.6 Actions of the alarm system and safety system

#### 7.6.1

The requirements in MSC.1/Circ.1647 para. 5.6 apply.

### 7.7 Alarms

#### 7.7.1

The requirements in MSC.1/Circ.1647 para. 5.7 apply.

### 7.8 Safety actions

#### 7.8.1

The requirements in MSC.1/Circ.1647 para. 5.8 apply.

## 8 Tests on board

### 8.1 Functioning Tests

#### 8.1.1

Where the fuel cell power installation provides power to the electric propulsion system, it is to be verified that the craft has adequate management system of propulsion power in all sailing conditions including maneuvering, according to Ch 1, Sec 16, [3.7] of the Rules for the Classification of Ships.

#### 8.1.2

The fuel cell space ventilation system is to be tested prior to the commencement of the sea trials with the verification of the following items:

- air flow of all fans according to the required capacity as per hazardous zone categorization
- alarms and/or automatic shutdown in case of loss or reduction of required ventilation rate
- gas tightness of all flexible connections of fans to duct
- local and remote functioning test of dampers.

#### 8.1.3

The fuel cell space inerting system is to be tested prior the commencement of the sea trials with the verification of the following items:

- functioning of inert gas generator or inert gas storage means (e.g. bottles)
- purging of fuel cell space piping conveying hydrogen and primary fuel.

#### 8.1.4

The fuel cell space gas detection system is to be tested according to international recognized standard prior the commencement of the sea trials.

#### 8.1.5

The following fuel cell power system items are to be tested:

- all automatic safety shutdowns
- emergency safety shutdown (manual ESD) at maximum power load
- protective devices (e.g. safety and automatic shut-off valves)
- measurements systems (e.g. level indicators, temperature measurement devices, pressure gauges).

#### 8.1.6

The performance test for the fuel cell power system is to be carried out considering the service profile and is to demonstrate that the fuel cell generated power will meet the performance requirements to be previously agreed with Tasneef. During all testing the ambient conditions (air temperature, air pressure and humidity) are to be recorded. Moreover, as a minimum, the following fuel cell power module data are to be measured, recorded and compared with the targeted values:

- Nominal Load Point [A]
- Total Voltage [V]
- Total Current [A]
- Total Power [kW]
- Primary Fuel Consumption [kg/h]
- Fuel Inlet Pressure [bar]
- Fuel Inlet Temperature [C°]
- Cooling Water Inlet Temperature [C°]
- Cooling Water Outlet Temperature [C°]
- Ventilation air flow
- Process air flow

The typical polarization curve (cell voltage vs current) of the fuel cell power system, as created during factory acceptance test, is to be made available on board for prompt reference.

#### 8.1.7

The performance tests are to be carried out considering the following conditions:

- start up, ramp up, rump down and automatic shutdown of the fuel cell power system
- load variations and load shedding as per service profile
- interactions with other sources of power, including change-over with the emergency power source.

### 8.2 Hot spot verification

#### 8.2.1

Thermal imaging scanning of equipment where hot surfaces may be expected is to be carried out within the fuel cell power installation under steady and normal operating conditions, according to Ch 1, Sec 2, [6.10.9] of the Rules for the Classification of Ships. The requirements in Ch 1, Sec 1, [3.7.1] of the Rules for the Classification of Ships apply.

## 9 Material Test, Workshop inspections and testing

### 9.1 General principles

#### 9.1.1

The provisions in this section are to be used in conjunction with the applicable requirements on materials and testing in other parts of these Rules and Tasneef "Rules for Testing and Certification of Marine Materials and Equipment".

#### 9.1.2

Inspection and testing of fuel piping systems are to comply with Ch 1, Sec 10, [21] of the Rules for the Classification of Ships.

#### 9.1.3

All pressure vessels and piping conveying the primary fuel and the reformed fuel belong to Class I piping systems according to Ch 1, Sec 3 and Ch 1, Sec 10 of the Rules for the Classification of Ships.

Outer pipes of double wall fuel piping arrangements are to be considered to belong to Class II piping systems.

#### 9.1.4

The venting and ventilation lines conveying the exhaust air from fuel cell stack cathode side and the exhaust gas from reforming equipment or from fuel cell stack anode side are to be connected with butt welded joints as far as practicable. Alternatively, the use of type approved mechanical joints or other type of connections may be evaluated on case-by-case basis. These lines, if categorized as hazardous, are to be considered to belong to Class I piping systems.

### 9.2 Type approval

#### 9.2.1

Fuel cell modules are to be provided with type approval certificate according to Tasneef "Rules for the Type Approval of Fuel Cell Power modules".

#### 9.2.2

The piping components such as flexible hoses, mechanical joints and plastic pipes are to be provided with type approval certificates according to Ch 1, Sec 10 of the Rules for the Classification of Ships.

#### 9.2.3

The electronic and electrical components (e.g. sensors, cables, panels) are to be provided with type approval certificates according to Ch 2, Sec 14, [2].

### 9.3 Production testing

#### 9.3.1

The fuel cell power system is subject to functioning test at workshop under Tasneef surveyor´s attendance on the basis of previously agreed test program taking into consideration the service profile and the availability of the type approval certificates for the fuel cell modules.

#### 9.3.2

Pressure vessels belonging to the fuel cell power system are subject to testing according to Ch 1, Sec 3, [7] of the Rules for the Classification of Ships.

**9.3.3**

The electrical installations for the fuel cell power conditioning are subject to testing according to Ch 2, Sec 14.

**9.3.4**

The automation system components are subject to testing according to Ch 3, Sec 6.