

Rules for the Type Approval of Fuel Cell Power Modules

Effective from 15/3/2022

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 Governments.

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

Article 2

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

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

The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:

- (i) in the selection of its Surveyors
- (ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

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

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).

The Society is under no obligation to make statements or provide information about elements or facts which are not part of the specific scope of the Service requested by the Interested Party or on its behalf.

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

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certification and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaworthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

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

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

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

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

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

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

Article 4

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

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

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

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

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

Article 5

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

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

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

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

Article 6

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

6.2. However,

- (i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and
- (ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the

right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

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

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without 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 class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

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

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

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

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

Article 8

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

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1 GENERAL

1.1 FIELD OF APPLICATION

1.1.1 These Rules apply to fuel cell power modules intended for marine and offshore application using proton exchange membrane (PEM) technology. For fuel cell power modules based on other technologies, these Rules may be used as guidance and specific requirements are to be agreed with Tasneef.

1.1.2 These Rules are to be used in conjunction with the requirements of the Tasneef Rules for the Classification of Ships (hereafter referred to simply as «Tasneef Rules») and Rules for Testing and Certification of Marine Materials and Equipment.

1.1.3 These Rules are applicable to installations with several different configurations of fuel cell power modules. 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.

1.1.4 The requirements of these Rules are relevant to fuel cell power modules (as defined in [1.2.1]) including all mechanical, electrical and control equipment contained within the fuel cell module casing or which forms an integral part of the fuel cell module casing. The fuel cell power modules may contain one or more fuel cell modules consisting of one or more fuel cell stacks and the fuel supply module consisting of the reforming equipment for the conditioning of the fuel. The electrical equipment needed for the conditioning of the electrical output from the fuel cell power modules (e.g. e-filters, inverters, converters, transformers) are covered by Pt C, Ch 3, Sec 6 of the Tasneef Rules. The reforming equipment as well auxiliary systems are covered by Pt C, Ch 1, Sec 3 and Sec 10 of the Tasneef Rules.

1.1.5 The fuel cell power modules type approved according to these Rules may be used for propulsion and main source of electrical power for services as defined in Pt C, Ch 2, Sec 1, [3] of the Tasneef Rules. The application of type approved fuel cell power modules for emergency services may be evaluated only on case-by-case basis.

1.1.6 In case the fuel cell power modules are used to supply only non-essential services, some type tests may be omitted at discretion of Tasneef and upon request from the manufacturer.

1.1.7 Where changes are proposed to be carried out to a type approved fuel cell power module, if the responsible party submits to Tasneef for consideration and/or approval those documents concerning the fuel cell power module parts which have undergone changes and the proposed modifications are evaluated by Tasneef as non-substantial, the type approval may be considered as extended to the modified fuel cell power module without a new type test.

1.2 DEFINITIONS

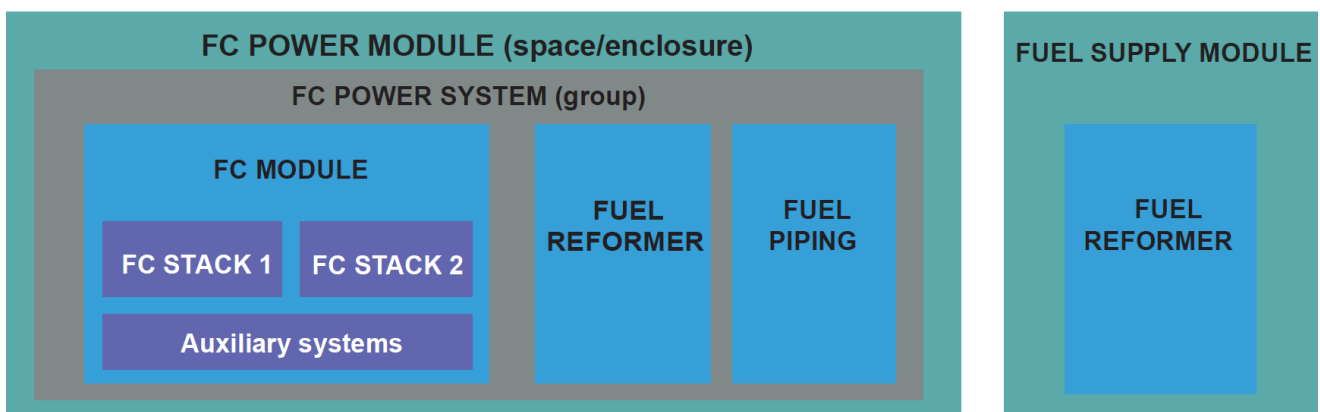
1.2.1 For the purposes of these Rules, the following terms and definitions apply.

- **Exhaust air** is exhaust from the cathode side of the fuel cell stack.
- **Exhaust gas** is exhaust from the reformer or anode side of the fuel cell stack.
- **Fuel cell** is a source of electrical power in which the chemical energy of a fuel cell fuel is converted directly into electrical and thermal energy by electrochemical oxidation.
- **Fuel cell module** is the assembly incorporating one or more fuel cell stacks.
- **Fuel cell power installation** is the fuel cell power system and other components and systems required to supply electrical power to the ship. It may also include ancillary systems for the fuel cell operation
- **Fuel cell power module** is the fuel cell power systems or parts of fuel cell power systems and their enclosure.
- **Fuel cell power system** is the group of components which may contain fuel or hazardous vapors, fuel cell(s), fuel reformers, if fitted, and associated piping systems.
- **Fuel cell space** is a room containing fuel cell power systems or parts of fuel cell power systems.
- **Fuel cell stack** is the assembly of cells, separators, cooling plates, manifolds and a supporting structure that electrochemically converts, typically, hydrogen-rich gas and air-reactants to DC power, heat and other reaction products.
- **Fuel reformer** is the arrangement of all related fuel-reforming equipment for processing gaseous or liquid primary fuels to reformed fuel for use in the fuel cells.
- **Fuel supply module** is the enclosure containing the fuel reforming and fuel conditioning equipment.

- **Hazardous area** as defined in the IEC 60079-10 is an area in which an explosive gas atmosphere is or may be expected to be present, in quantities, such as, to require special precautions for the construction, installation and use of apparatus. Hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:
 - Zone 0 is an area in which an explosive gas atmosphere is present continuously, for long periods or frequently;
 - Zone 1 is an area in which an explosive gas atmosphere is likely to occur in normal operation occasionally; and
 - Zone 2 is an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
- **Inert gas** is a gas mixture with at least 95% nitrogen concentration.
- **LEL** means lower explosive limit, which, in the context of these Rules, should be taken as identical to the Lower Flammable Limit (LFL) and which is 4.0% vol. fraction for hydrogen. For flammability limits for hydrogen refer to ISO /TR 15916:2015 on Basic considerations for the safety of hydrogen systems.
- **Non-hazardous area** is an area in which an explosive gas atmosphere is not expected to be present in quantities sufficient to require special precautions for the construction, installation and use of apparatus.
- **Oxidant** is air, oxygen gas or oxygen rich compounds used to oxidize fuel within the fuel cell stack.
- **Power conditioning system** is the group of components which regulate and condition the electrical output of the fuel cell modules to match the requirements of the on-board electrical distribution system or electrical consumers supplied by the fuel cell power system. The Power Conditioning System is an auxiliary system which is part of the Fuel Cell Power Installation.
- **Primary fuel** is fuel supplied to the fuel cell power modules.
- **Process air** is air supplied to the reformer and/or the cathode side of the fuel cell.
- **Process water** is fresh water (possibly mixed with other medium e.g., glycol) supplied to the fuel cell modules for cooling or reforming purpose.
- **Reformed fuel** is hydrogen or hydrogen-rich gas generated in the fuel reformer.
- **Service profile** is a description of the use of the fuel cell modules for the power supply to on-board systems considering the operational profile of the ship (navigation, maneuvering and port stay).
- **Thermal management system** is the group of components which provide cooling and/or heating to the fuel cell power system, humidity management and condensate removal. The thermal management system is an auxiliary system which forms part of the Fuel Cell Power Installation.
- **Ventilation air** is air used to ventilate the fuel cell space.

An example of typical installation for the fuel cell is given in Fig 1 below.

Figure 1: Example of typical configuration of Fuel Cell Power Module



1.3 DOCUMENTATION TO BE SUBMITTED

1.3.1 The documents listed in Tab 1 are to be submitted for review:

Table 1: Documents to be submitted

No	Document
1	Technical specification of the fuel cell modules, 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	List of mechanical and electrical components which are part of the fuel cell modules with specification of the pumps, compressors and fans.
3	P&I diagrams of systems conveying fuel (primary and reformed type), exhaust air/gas, cooling media, process air, technical water, ventilation and of other systems in the fuel cell modules.
4	Description of thermal insulation (if any), electrical heat tracing.
5	Fuel cell module casing construction details with strength analysis.
6	Construction drawings of all components of the reforming equipment considered as pressure vessel e.g. burner, reformer, heat exchangers.
7	Functional description of the fuel cell modules including at least their 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	Block diagram of the safety, control and monitoring system of the fuel cell power modules.
9	Wiring diagrams of power supply and automation system of the fuel cell power modules.
10	List of controlled and monitored parameters and cause and effect matrix with normal/emergency shutdown functions.
11	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	Functional profile description of the fuel cell power modules, highlighting if the fuel cell power generation is used for essential or non-essential ship services according to Tasneef notation FC-SHIPS.
13	A FMEA according to the Tasneef "Guide for Failure mode and Effect Analysis" or other equivalent methods for the fuel cell power module.
14	Type test reports including information about overview, adopted standards, test laboratory, test rig description, witnessing persons and final results.
15	Lifecycle operational, maintenance and inspection manual of the fuel cell power modules.

2 PRODUCT REQUIREMENTS

2.1 CONSTRUCTIONAL REQUIREMENTS

2.1.1 The type approved fuel cell power module is to comply with the constructional requirements of the applicable Part C and Part D of Tasneef Rules.

2.2 DESIGN REQUIREMENTS

2.2.1 The type approved fuel cell power module is to comply with the design requirements of Part C of Tasneef Rules as applicable and IMO Interim Guidelines for the Safety of Ships Using Fuel Cell Power Installations.

2.2.2 The fuel cell power modules designed to use as primary fuel low-flashpoints fuels - e.g., like natural gas, LNG, LPG, Ammonia, methyl/ethyl alcohol, hydrogen - are additionally to comply with the following rules as applicable:

- Tasneef Rules, Pt C, Ch 1, App 7 (Gas Fuelled Ships – LNG)
- Tasneef Rules, Pt C, Ch 1, App 13 (LPG or NH3 Fuelled Ships)
- Tasneef Rules, Pt C, Ch 1, App 14 (Hydrogen Fuelled Ships)
- Tasneef Rules, Pt C, Ch 1, App 15 (Methyl/Ethyl Alcohol Fuelled Ships)

2.2.3 The fuel cell power modules are to be arranged with drip tray or similar arrangement to ensure that possible liquid leakages and condensate from the fuel reforming process and auxiliary systems are safely collected, within the fuel cell module casing or enclosure. Means for drainage and disposal in the bilge are to be provided.

2.2.4 The fuel cell power modules are to be designed with a redundant mechanical forced ventilation system independent from any other ventilation system, having capacity to dilute gas leakages from the reforming equipment and fuel cell stack according to IEC 60079-10 standard.

2.2.5 Where the fuel cell stacks inside the fuel cell modules are subject to specific air quality requirements (e.g., limits on dust, humidity, salinity, temperature) the arrangements for air conditioning, air drying and air filtering are to be fitted inside or outside the module and the air quality parameters are to be monitored.

2.2.6 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 module, arrangements for fuel conditioning system are to be fitted (inside or outside the module).

2.2.7 The fuel cell power module casing is to be designed and constructed to limit gas leakage toward the adjacent spaces, e.g. through differential pressure of module space and appropriate design of weld seams, cabling/piping penetrations and sealing of cladding panels.

2.2.8 The fuel supply modules and fuel cell modules are to be fitted with sampling point connections for detecting explosive atmosphere by means of portable equipment.

2.2.9 The fuel supply modules and fuel cell modules are to be fitted with means for gas freeing for safe inspection and safe maintenance of internal components.

2.2.10 All pressure vessels and piping conveying the primary fuel and the reformed fuel are to be considered to belong to class I according to Pt C, Ch 1, Sec 3 and Sec 10 of Tasneef Rules.

2.2.11 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.

2.2.12 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.

2.2.13 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.

2.2.14 The fuel cell power module is to be fitted with integrated 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 Pt C, Ch 3. Sec 2, [7] of Tasneef Rules.

3 TYPE TESTING REQUIREMENTS

3.1 GENERAL

3.1.1 The type testing requirements of fuel cell power modules are divided into:

- verification
- fuel cell module tests (refer to [3.3])
- fuel cell power module tests (refer to [3.4])
 - environmental tests
 - performance tests
 - safety tests
 - emissions test

The test programs are to be reviewed before the tests are performed. The test reports are to be submitted for review after the type tests are satisfactory completed.

3.1.2 The required tests are to be carried out at the presence of a Tasneef surveyor. However, where the testing laboratory is an independent and recognized laboratory complying with the Chapter 5, item [3] of Tasneef "Rules for testing, Certification and Acceptance of Marine Materials and Equipment", the tests may be carried out without the presence of a Tasneef surveyor.

3.1.3 Upon satisfactory review of the required documentation and the test reports Tasneef will issue a Type Approval Certificate.

3.2 VERIFICATION

3.2.1 The Manufacturer is to have in place a Quality Assurance System at least equivalent to one of the ISO 9000 Standards.

3.2.2 Software version for the control, monitoring and safety of fuel cell power modules is to be recorded. If a new version of the software is released during the period of validity of the certificate, Tasneef is to be informed. Software modification is to be managed according to applicable quality procedure.

3.2.3 The electronic and electrical components (e.g., sensors, cables, panels, etc.) are to be provided with type approval certificates according to Pt C, Ch 2, Sec 15, [2] of Tasneef Rules.

3.2.4 The piping components such as flexible hoses, mechanical joints and plastic pipes are to be provided with type approval certificates according to Pt C, Ch 1, Sec 10 of Tasneef Rules.

3.2.5 Visual inspection of prototype fuel cell power module according to approved construction drawings is to be carried out.

3.2.6 The equipment and installations in hazardous areas are to comply with IEC, EN, ISO or similar recognized standard 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 Zone 1.

3.2.7 Earthing and bonding are to be verified according to applicable standards identified by the manufacturer.

3.2.8 In general the fuel cell power module casing is to provide protection against the ingress of dust and water. For a fuel cell power module to be mounted on open deck areas without protection a minimum enclosure protection rating of IP56 is required to protect against:

- a) Ingress of dust in sufficient quantity to interfere with satisfactory operation of the fuel cell module.
- b) Water from heavy seas or water projected in powerful jets entering the fuel cell module in harmful quantities.

3.2.9 For the casing of the fuel cell power modules to be mounted in enclosed 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 module.
- b) Water splashed against the fuel cell module from any direction.

3.2.10 The fuel cell power module is to be provided with operational, maintenance and installation instructions manual including, but not limited to:

- information about piping inlet and outlet connections for fuel, air, oxidant, cooling, condensate, exhaust air and other auxiliary systems, as applicable
- information about cabling for auxiliary and output power
- information about securing and fixing arrangements for the fuel cell power module
- information about the clearances needed for the mobilization and maintenance of the modules

- information about particular installation limits (e.g., vibration, orientation, maximum static and dynamic inclination)

3.3 FUEL CELL MODULE TESTS

3.3.1 The fuel cell module including the fuel cell stack or assembly of fuel cell stacks is to be subjected to functional and safety tests according to IEC 62282-2-100 or other equivalent national or international standards recognized by Tasneef.

3.3.2 The fuel cell module is to be type tested according to Tab 2.

3.3.3 The tests established in Tab 2 may be omitted at discretion of Tasneef taking into account the location, operational profile and assembly arrangement of the fuel cell power modules, as well the satisfactory applications record provided by the manufacturer.

Table 2: Fuel Cell Module Type Tests

No	Type tests	Reference
1	Shock and Vibration Test	IEC 62282-2-100 / 5.2
2	Gas Leakage Test	IEC 62282-2-100 / 5.3, 5.11
3	Normal Operation Test	IEC 62282-2-100 / 5.4, 5.12
4	Pressure Tests	IEC 62282-2-100 / 5.5, 5.6, 5.8
5	Continuous and short-time electrical rating	IEC 62282-2-100 / 5.7
6	Dielectric strength test	IEC 62282-2-100 / 5.9
7	Flammable concentration test	IEC 62282-2-100 / 5.13
8	Tests of abnormal operating conditions	IEC 62282-2-100 / 5.14

3.4 FUEL CELL POWER MODULE TESTS

3.4.1 The fuel cell power module is to be subjected to functional and safety tests according to IEC 62282-3-100 or other equivalent national or international standards recognized by Tasneef.

3.4.2 Safety, control and alarm system and associated electronic equipment are to be subject to the type tests according to Pt C, Ch 3, Sec 6, Tab 1 as applicable.

3.4.3 The software is subject to type approval according to Pt C, Ch 3, Sec 6, [2.3] of Tasneef Rules. Application software is to be fully tested before installation on-board according to Pt C, Ch 3, Sec 6, [3.3] of Tasneef Rules.

3.4.4 The fuel cell power module is subject to type tests according to Tab 3 and Tab 4.

Table 3: Fuel Cell Power Module Type Tests

No	Type tests	Reference
1	Leakage Tests	IEC 62282-3-100 / 5.4
2	Normal Operation Test	IEC 62282-3-100 / 5.6
3	Electrical Overload Test	IEC 62282-3-100 / 5.7
4	Shutdown Parameters	IEC 62282-3-100 / 5.8
5	Burner operating characteristics test	IEC 62282-3-100 / 5.9
6	Automatic control of burners and catalytic oxidation reactors test	IEC 62282-3-100 / 5.10
7	Exhaust gas temperature test	IEC 62282-3-100 / 5.11
8	Surface and component temperatures test	IEC 62282-3-100 / 5.12
9	Emissions Test	IEC 62282-3-100 / 5.15
10	Blocked Condensate line test	IEC 62282-3-100 / 5.16
11	Condensate discharge test	IEC 62282-3-100 / 5.17
12	Venting System leakage test	IEC 62282-3-100 / 5.20

3.4.5 Where it is not practical to conduct vibration testing with the fuel cell power module operational then the vibration testing may be carried out with the fuel cell power module non-operational, and the performance test is to be carried out before and after the vibration testing. The vibration test may be omitted in lieu of vibration analysis demonstrating that the modules are not affected by determined vibration stress limits and the installation of modules is taking into account such limits (e.g., use of dampers).

3.4.6 Anti-condensation devices fitted to the fuel cell power module may be used during the damp heat test. On completion of the performance test there shall be no visible deterioration of the product.

Table 4: Fuel Cell Power Module Type Tests

No	Type tests	Reference
1	IP Protection Enclosure Test	IEC 60529
2	Performance Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 2
3	External Power Supply Failure	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 3
4	Power Supply Variations Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 4
5	Dry Heat Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 5
6	Damp Heat	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 6
7	Vibration Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 7
8	Inclination Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 8
9	Insulation resistance	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 9
10	High Voltage Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 10
11	Cold Test	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 11
12	Salt Mist	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 12
13	Electrostatic discharge	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 13
14	Electromagnetic Field	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 14
15	Conducted Low Frequency	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 15
16	Conducted Radio Frequency	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 16
17	Electrical Fast Transients / Burst	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 17
18	Surge	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 18
19	Radiated Emission	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 19
20	Conducted Emission	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 20
21	Flame retardant	Tasneef Rules, Pt C, Ch 3, Sec 6, Tab 1, Item 21

3.4.7 The fuel cell power module is to be built to ensure that there is no dangerous leakage current between phase conductors and earthed external casings or other exposed parts of the module. This is to be demonstrated by testing the fuel cell module insulation resistance in accordance with IEC 60092-504 Section 5. Where this is not practicable and the established criteria in Pt C, Ch 3, Sec 6, Tab 1, Item 9 of Tasneef Rules cannot be applied due to the design of the fuel cell power module, then an alternative way of demonstrating that there is no dangerous leakage current between phase conductors and the earthed casings or other exposed parts of the module is to be proposed by the manufacturer. Such proposal will be evaluated by Tasneef on case-by-case basis.

3.4.8 In case the high voltage test is not practicable according to Pt C, Ch 3, Sec 6, Tab 1, Item 10 of Tasneef Rules due to the design of the fuel cell power module, then an alternative way of testing is to be submitted by the manufacturer. Such proposal will be evaluated by Tasneef on case-by-case basis.

3.4.9 The performance test shall be carried out considering the service profile and is to demonstrate that the fuel cell power module 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:

- Load Point [A]
- Total Voltage [V]
- Total Current [A]
- Total Power [kW]
- H2 Consumption [kg/h]
- Fuel Consumption [kg/h]
- H2 Leakage [% LEL]
- Time [min]
- Fuel Inlet Pressure [bar]

- Fuel Inlet Temperature [C°]
- Cooling Water Inlet Temperature [C°]
- Cooling Water Outlet Temperature [C°]
- Ventilation air flow
- Process air flow
- Ambient Temperature, Pressure, Humidity
- Anode/Cathod Emissions (Quality and Flow)

The typical polarization curve (cell potential vs current density) and power curve of the fuel power module is to be established using the outcome of the performance tests.

3.4.10 The performance tests are to be performed considering the following conditions:

- 15 minutes at constant 100% nominal power load
- 60 minutes at constant 50% nominal power load
- 60 minutes with ramp up/ramp down profile: 25%, 50%, 75%, 100%, 75%, 50%, 25% nominal power load
- 60 minutes with sinusoidal load profile varying from 25% to 100% nominal power load.