



Guideline No. E-23 (202204)

# **E-23**

# **HYDROGEN FUEL CELLS**

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## **Foreword**

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed [service@ccs.org.cn](mailto:service@ccs.org.cn).

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## HYDROGEN FUEL CELLS

### 1 Application

1.1 The Guidelines are applicable to the approval and survey of hydrogen fuel cell power generation systems and hydrogen fuel cell modules installed and used on ships and offshore installations.

1.2 As fuel cell technology continues to develop, special and novel hydrogen fuel cell power generation systems that do not meet the requirements of the Guidelines shall be subject to consideration by CCS on a case-by-case basis.

1.3 Fuel cells can be categorized based on the electrolyte type into Alkaline Fuel Cells (AFC), Phosphoric Acid Fuel Cells (PAFC), Molten Carbonate Fuel Cells (MCFC), Solid Oxide Fuel Cells (SOFC), and Polymer Electrolyte Fuel Cells. The hydrogen fuel cells referred to in the Guidelines are Proton Exchange Membrane Fuel Cells (PEMFC), which belong to the Polymer Electrolyte Fuel Cell category. For approval of other fuel cell categories by CCS, the applicable requirements of the Guidelines may also be referenced.

1.3.1 The Guidelines do not cover fuel reforming and processing systems for hydrogen fuel cells.

### 2 Normative References

2.1 CCS Rules for Classification of Sea-Going Steel Ships and its amendment notices

2.2 CCS Guidelines for Ships Using Fuel Cell Power Installations

2.3 IEC 62282-2-100:2020 Fuel cell technologies – Part 2-100: Fuel cell modules – Safety

2.4 IEC 62282-3-100:2019 Fuel cell technologies – Part 3-100: Stationary fuel cell power systems – Safety

2.5 IEC 62282-3-200:2015 Fuel cell technologies – Part 3-200: Stationary fuel cell power systems – Performance test methods

2.6 GB/T 29838-2013 Fuel cell modules

2.7 GB/T 27748.1-2017 Stationary fuel cell power systems – Part 1: Safety

2.8 GB/T 27748.2-2013 Stationary fuel cell power systems – Part 2: Performance test methods

2.9 GB/T 28816-2020 (IEC 62282-1:2013, idt) Fuel cells – Terminology

2.10 CCS GD22-2015: Guidelines for Type Approval Test of Electrical and Electronic Products (Currently effective)

2.11 IACS UR E10 Rev.7: Type Approval Test Procedures

### 3 Terms and Definitions

The terms and definitions as determined in the aforementioned survey references apply to the Guidelines. For the purpose of compilation and ease of use, the Guidelines directly cite or supplement the following definitions.

3.1 SS Rules: Refers to the CCS Rules for Classification of Sea-going Steel Ships and its amendment notices.

3.2 Fuel cell: Refers to an energy conversion device that can directly convert the chemical energy from fuel into electrical energy and thermal energy through electrochemical reactions.

3.3 Fuel cell stack: Refers to equipment composed of a certain number of single cells, separators, cooling plates, manifolds, and supporting structures, which converts (typically) hydrogen-rich gas and air reactants into direct current, heat, and other reaction products through electrochemical reactions. Hereinafter referred to as "stack" (hereinafter referred to as "stack").

3.4 Fuel cell module: Refers to an integrated unit comprising one or more fuel cell stacks and other primary and appropriate additional components (hereinafter referred to as "module").

3.5 Fuel cell power generation system: Refers to an integrated assembly composed of fuel cells, fuel reformers (if installed), and their associated piping (hereinafter referred to as "system").

### 4 Drawings and Documents

4.1 The following drawings and documents shall be submitted to CCS for approval.

- (1) General arrangement drawings (outline and structural drawings);
- (2) Electrical schematic diagrams;
- (3) Piping system diagrams for hydrogen, air (including oxygen), and cooling water (applicable to systems);
- (4) Major part and component drawings (e.g., stacks, modules, etc.);
- (5) Product technical specifications;
- (6) Factory test program;
- (7) Type test program (for approval);
- (8) Dilution zone analysis report as required by Clause 4.6.1 of IEC 62282-3-100:2019.

Note: The actual names of drawings/documents may differ from those listed above, but shall reflect their content requirements.

4.2 The following drawings and documents shall be submitted to CCS for information:

- (1) External wiring diagrams;
- (2) External piping connection diagrams;
- (3) List of major components;
- (4) Principle description and system block diagram of the hydrogen fuel cell power generation system (module);
- (5) User manual for the hydrogen fuel cell power generation system (module);
- (6) Risk assessment for the hydrogen fuel cell power generation system (module);
- (7) Overview of key production processes (for stacks and modules);
- (8) Nameplate drawing.

Note: The actual names of drawings/documents may differ from those listed above, but shall reflect their content requirements.

## **5 Technical Requirements**

5.1 Equipment shall operate normally under the operating conditions specified in Section 2, Chapter 1, Part 4 of the SS Rules and shall meet the stated technical parameters.

5.2 The commissioning, testing, and maintenance of hydrogen fuel cell power generation systems shall meet safety, availability, and reliability requirements.

5.3 The design, manufacturing, installation, operation, maintenance, and protection of hydrogen fuel cell power generation systems and their components shall ensure their safe and reliable operation.

5.4 The structural design of hydrogen fuel cell power generation systems (modules) shall prevent the unintended accumulation of explosive, flammable, or toxic gas concentrations. If structural design cannot ensure rapid dispersion of flammable, explosive, or toxic gases, forced (ventilation) dilution or dispersion must be considered. Flammable materials shall be avoided inside the system as far as possible. Enclosure materials shall provide protection for system components against external damage.

5.5 The installation of fuel piping systems for hydrogen fuel cell power generation systems shall have sufficient flexibility. Connections of fuel pipelines shall adopt full penetration welds wherever possible, and butt welds shall be inspected by radiography. If other connection methods are unavoidable, appropriate protection measures shall be provided. Pipeline joints shall be minimized and readily accessible for maintenance.

5.6 For auxiliary systems of hydrogen fuel cells where gas may leak into the system medium (e.g.,

cooling water), a suitable gas monitoring device shall be installed at the medium outlet to monitor for gas leakage.

5.7 Pipes, fittings, joints, and valves for hydrogen, oxygen, and similar fuel supply systems shall meet the requirements for Class I piping systems.

5.8 Metallic components supporting and securing hydrogen piping shall not be in direct contact with the piping.

5.9 Electrical equipment within hydrogen fuel cell power generation systems shall be provided with appropriate fire and explosion protection measures according to IEC 62282-3-100 standards. If located in positions where contact with fuel is likely, they shall have the corresponding explosion-proof rating.

5.10 A necessary purge system shall be provided to keep any fuel cell power generation system in a passive state after shutdown or before startup. The purge system may use media specified by the manufacturer, including but not limited to purging the fuel cell power generation system with nitrogen, air, or steam under non-hazardous conditions.

5.11 Outlets where hydrogen may be discharged or leaked shall be well-ventilated, free from overhead obstructions, and located away from equipment that may produce sparks or high heat.

5.12 A disconnecting device, such as an isolating switch, shall be provided in the output circuit of the hydrogen fuel cell power generation system to facilitate maintenance. Contactors shall not be used as disconnecting devices.

5.13 Hydrogen fuel cell power generation systems shall be protected against over-power conditions and ensure disconnection from the load under any possible load conditions.

5.14 Reverse power protection shall be provided for hydrogen fuel cell modules to prevent energy from flowing back from the load side into the modules. If a hydrogen fuel cell module is connected to a power converter, reverse power protection may be provided by this converter, which can be equipped with a braking resistor or functionally equivalent component to achieve this function.

5.15 Any hydrogen fuel cell power generation system that has completed the "Additional Test for Equivalent Generator Set Characteristics" as per Clause 7.3.10 may be used as the ship's main power source or a component thereof, which shall be noted on its certificate.

5.16 Considering the selective protection of protective devices in the distribution system, the short-circuit current of the fuel cell power generation unit shall be sufficient to activate the short-circuit protective device of its branch circuit. When a short circuit occurs on the main busbar, protection measures shall be in place to ensure the fuel cell is not endangered and can be used again after the fault is cleared.

5.17 When any fuel cell power generation system stops supplying power due to a fault, the

remaining standby fuel cell power generation systems shall be able to start automatically as soon as possible, preferably within 30 seconds after power loss, and not exceeding 45 seconds at the maximum.

5.18 Necessary monitoring of hydrogen fuel cell power generation systems (modules) shall be conducted to avoid compromise or reduction of its safety, such as hydrogen leakage monitoring.

5.19 A Failure Mode and Effects Analysis (FMEA) shall be performed for all possible faults in hydrogen fuel cell power generation systems that may affect operation and safety. Based on the analysis results, the scope of monitoring and control shall be determined, which shall at least include the following:

- (1) Air ingress into the fuel lines (may be monitored indirectly);
- (2) Fuel ingress into the air pipelines (may be monitored indirectly);
- (3) Hydrogen fuel cell voltage and its fluctuations;
- (4) Exhaust gas temperature (if applicable);
- (5) Internal temperature of hydrogen fuel cell (if applicable);
- (6) Purity of fuel gas (if applicable);
- (7) Output current;
- (8) Control system faults;
- (9) Tail gas hydrogen concentration detection.

5.20 Depending on the operating mode and characteristics of a hydrogen fuel cell, consideration shall be given to adding the following monitoring items:

- (1) Air flow rate;
- (2) Air pressure;
- (3) Cooling medium flow rate, pressure, and temperature (if applicable);
- (4) Fuel flow rate;
- (5) Fuel temperature;
- (6) Fuel pressure;
- (7) Exhaust gas detection;
- (8) Liquid level in water system;
- (9) Water system pressure;

(10) Purity of water system;

(11) Parameters that influence and reflect the lifespan or degradation of fuel cells and must be monitored.

5.21 Measures to prevent overpressure shall be provided in the hydrogen and air pipeline systems for hydrogen fuel cell power systems.

## **6 Materials and Components**

6.1 Materials used in hydrogen fuel cell power systems (modules) shall conform to recognized standards. Relevant materials shall meet the requirements of standards acceptable to CCS<sup>1</sup>.

6.2 Materials used in components exposed to hydrogen shall exhibit resistance to hydrogen embrittlement and hydrogen corrosion.

6.3 Seamless steel pipes or equivalent materials shall be used for fuel piping.

## **7 Type Tests**

Hydrogen fuel cell power generation systems (modules) shall be subject to CCS' type approval. The issuance, maintenance, modification, renewal, and cancellation of the Type Approval Certificate shall follow the relevant requirements of Chapter 3, Part 1 of the SS Rules.

7.1 Selection of representative samples

7.1.1 The model and specifications of the test sample(s) shall be technically representative and shall cover the range of products for which type approval is sought.

7.1.2 For products with identical structure and working principles, the product with the maximum rated output power may be selected for type approval tests. For the selected product model, a quantity of one unit may be taken as the test sample. The test sample(s) shall be selected on-site at the product manufacturer's premises by a CCS surveyor.

7.2 Testing bodies

Type approval tests shall preferably be conducted by testing bodies approved by CCS or by authoritative and impartial testing bodies. For certain functional test items, if the manufacturer possesses adequate testing conditions, they may be conducted at the manufacturer's premises subject to the review, agreement, and on-site supervision of a CCS surveyor.

7.3 Type approval test requirements:

7.3.1 The test items and test method reference standards for hydrogen fuel cell power generation systems are listed in Table 7.3.1.

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<sup>1</sup>International, national and industry standards for fuel cells, such as the IEC62282 series of standards.

7.3.2 The test items and test method reference standards for hydrogen fuel cell modules are listed in Table 7.3.2.

7.3.3 For type approval of a hydrogen fuel cell module, its environmental adaptability tests shall meet the relevant requirements of the current CCS Guidelines for Type Approval Test of Electrical and Electronic Products (hereinafter referred to as the "Type Approval Test Guidelines").

7.3.4 For type approval of a hydrogen fuel cell power generation system, its environmental adaptability tests shall meet the relevant requirements of the current CCS Guidelines for Type Approval Test of Electrical and Electronic Products. If its hydrogen fuel cell module already holds a CCS type approval certificate and has undergone the aforementioned environmental adaptability tests, these tests on the hydrogen fuel cell module may be exempted during system type approval.

7.3.5 Hydrogen fuel cell power generation systems shall undergo safety tests in accordance with the requirements of IEC 62282-3-100 Fuel cell technologies – Part 3-100: Stationary fuel cell power systems – Safety. At a minimum, the following test items shall be performed: Pneumatic or hydraulic leakage test (twice), pneumatic or hydraulic strength test, normal operation type test, electrical overload test (based on the manufacturer's design), exhaust gas temperature test, and surface and component temperature test. It is recommended to conduct the tests in the listed sequence.

7.3.6 Hydrogen fuel cell power generation systems shall undergo startup and shutdown function tests, and the functionality of all control systems and protective components that can participate in the test shall be verified as far as possible (as required by Clause 4.9.2.3 of IEC 62282-3-100).

7.3.7 Hydrogen fuel cell power generation systems shall undergo performance tests to verify the values indicated on the nameplate and in the technical specifications. At a minimum, performance test items No. 10~17 in Table 7.3.1 shall be conducted at rated power.

7.3.8 Hydrogen fuel cell modules shall undergo relevant tests in accordance with the requirements of IEC 62282-2 Fuel cell technologies – Part 2: Fuel cell modules.

7.3.9 For fuel cell modules and fuel cell power generation systems produced by the same manufacturer, the duplicate test items in Table 7.3.1 and Table 7.3.2 may be combined.

**Table 7.3.1 Hydrogen Fuel Cell Power Generation System Type Test Items**

S/N	Test Item	Test Method Reference Standard
1.	Appearance inspection	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.1
2.	Pneumatic or hydraulic leakage test	EC 62282-3-100:2019, Clause 5.4
3.	Pneumatic or hydraulic strength test	IEC 62282-3-100:2019, Clause 5.5
4.	Normal operation type test	IEC 62282-3-100:2019, Clause 5.6

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5.	Electrical overload test	IEC 62282-3-100:2019, Clause 5.7
6.	Exhaust gas temperature test	IEC 62282-3-100:2019, Clause 5.11
7.	Surface and component temperature test	IEC 62282-3-100:2019, Clause 5.12
8.	Wind load resistance test (for outdoor installation only)	IEC 62282-3-100:2019, Clause 5.13
9.	Startup and shutdown test	IEC 62282-3-100:2019, Clause 4.9.2.3
10.	Electrical power measurement	IEC 62282-3-200:2015, Clause 7.3.1
11.	Input fuel consumption measurement	IEC 62282-3-200:2015, Clause 7.3.2
12.	Exhaust gas emission measurement	IEC 62282-3-200:2015, Clause 7.3.7
13.	Air consumption measurement	IEC 62282-3-200:2015, Clause 7.3.5
14.	Discharge water flow measurement	IEC 62282-3-200:2015, Clause 7.3.8
15.	Noise level measurement	IEC 62282-3-200:2015, Clause 7.3.9
16.	Total energy efficiency measurement	IEC 62282-3-200:2015, Clause 9.2
17.	Output power response time measurement	IEC 62282-3-200:2015, Clause 9.3
18.	Insulation resistance measurement	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.3
19.	Withstand voltage test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.14
20.	Energy fluctuation test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.4
21.	Energy failure test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.5
22.	Tilt and sway test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.6
23.	Vibration test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.7
24.	High temperature test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.8
25.	Low temperature test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.9

26.	Alternating damp heat test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.10
27.	Enclosure protection test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.15
28.	Electromagnetic compatibility test (for systems)	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Chapter 3
29.	Flame retardation test (if applicable)	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.16
30.	Salt spray test (if applicable)	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.12

**Note 1: For safety considerations during the environmental and electromagnetic compatibility tests (items 20-28 above), operation with air or nitrogen supplied through the fuel piping system under no-load conditions may be considered. The test subjects may be the hydrogen fuel cell module and other electrical parts.**

**Table 7.3.2 Hydrogen Fuel Cell Module Type Test Items**

S/N	Test Item	Test Method Reference Standard
1.	Appearance inspection	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.1
2.	Shock and vibration test (Note 2)	IEC 62282-2-100:2020, Clause 5.2
3.	Gas leakage test	IEC 62282-2-100:2020, Clauses 5.3, 5.11; GB/T 29838-2013, Clauses 5.3, 5.12
4.	Normal operation test	IEC 62282-2-100:2020, Clauses 5.4, 5.12; GB/T 29838-2013, Clauses 5.4, 5.13; (Factory tests only for voltage and current at nominal power output)
5.	Permitted working pressure test	IEC 62282-2-100:2020, Clause 5.5; GB/T 29838-2013, Clause 5.5
6.	Pressure withstanding test of cooling system	IEC 62282-2-100:2020, Clause 5.6; GB/T 29838-2013, Clause 5.6
7.	Continuous and short-term electric power test	IEC 62282-2-100:2020, Clause 5.7; GB/T 29838-2013, Clause 5.7
8.	Overpressure test	IEC 62282-2-100:2020, Clause 5.8; GB/T 29838-2013, Clause 5.8
9.	Insulation strength test	IEC 62282-2-100:2020, Clause 5.9; GB/T 29838-2013, Clauses 5.9, 6.3
10.	Insulation (static) test	GB/T 29838, Clause 5.10
11.	Differential pressure test	IEC 62282-2-100:2020, Clause 5.10; GB/T 29838-2013, Clause 5.11
12.	Combustible concentration test	IEC 62282-2-100:2020, Clause 5.13; GB/T 29838-2013, Clause 5.14
13.	Abnormal condition test	IEC 62282-2-100:2020, Clause 5.14;

		GB/T 29838-2013, Clause 5.15
14.	Air tightness test	IEC 62282-2-100:2020, Clause 6.2; GB/T 29838-2013, Clause 6.2
15.	Energy fluctuation test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.4
16.	Energy failure test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.5
17.	Tilt and sway test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.6
18.	Vibration test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.7
19.	High temperature test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.8
20.	Low temperature test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.9
21.	Alternating damp heat test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.10
22.	Enclosure protection test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.15
23.	Electromagnetic compatibility test	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Chapter 3
24.	Flame retardation test (if applicable)	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.16
25.	Salt spray test (if applicable)	CCS Guidelines for Type Approval Test of Electrical and Electronic Products, Clause 2.12

Note 1: For safety considerations during the environmental adaptability tests (items 15-23 above), operation with air or nitrogen supplied through the fuel piping system under no-load conditions may be considered. Other type test items should be performed using the same prototype.

Note 2: If the manufacturer does not specify the shock and vibration limits, this test can be omitted.

7.3.10 Additional test for "Equivalent Generator Set Characteristics" of fuel cell power generation systems. This additional test is voluntary for manufacturers to apply for during type approval.

7.3.10.1 A fuel cell power generation system, together with its power converter, shall withstand the mechanical stresses and thermal effects of short-circuit currents within any time-delay tripping time/fusing time of selective protective devices.

7.3.10.2 For a fuel cell power generation system together with its power converter, when the load is 20% of the system's rated power, the voltage deviation shall be within 1% of the rated voltage; when the load is at full load, the voltage deviation shall be within 2.5% of the rated voltage. Between 20% load and full load, the deviation of the average curve between the rising and falling curves of the voltage-load characteristic from the rated voltage shall not exceed 3%.

7.3.10.3 When a fuel cell power generation system together with its power converter is suddenly loaded with 50% of the rated load under no-load condition, and after stabilization, the remaining 50% load is applied, the following shall be satisfied:

- (1) When voltage dips, the transient voltage shall not be lower than 85% of the rated voltage, and not lower than the converter's operating threshold voltage;
- (2) When voltage rises, the transient voltage shall not exceed 120% of the rated voltage, and not exceed the converter's operating threshold voltage;
- (3) The time required for the voltage to recover to within 3% of the stable value shall not exceed 1.5 seconds;
- (4) For AC output systems, the transient frequency variation shall not exceed 10% of the rated frequency.

7.3.10.4 For AC output fuel cell power generation systems together with their power converters, the total harmonic distortion (THD) of the no-load line voltage waveform shall not exceed 5%.

7.3.10.5 If it is genuinely difficult for a fuel cell power generation system together with its power converter to meet the requirements of 7.3.10.3, the test may be conducted in combination with a parallel-connected battery pack and converter assembly. The parameters of the additional battery pack, such as capacity and type, shall be clearly stated in technical documents, such as the product manual, for reference during onboard configuration. The actual ship configuration shall refer to these battery pack parameters. When multiple hydrogen fuel cell power generation modules are present, it shall be ensured that each busbar section has a battery pack of sufficient capacity, considering segmented busbar operation.

## **8 Unit/batch inspection (Factory Survey)**

### 8.1 General provisions

8.1.1 After obtaining the type approval certificate for its hydrogen fuel cell power generation systems (modules), a manufacturer shall still perform the factory tests specified below for each hydrogen fuel cell power generation system (module) and issue a factory test report. Based on 100% factory tests at the manufacturer's premises, CCS surveyors may adopt a sampling survey approach. The sampling rate for each model/specification shall be no less than 10%, with a minimum of two units.

8.1.2 System control units, power conversion units, external auxiliary equipment, and their associated piping fittings within hydrogen fuel cell power generation systems shall hold type approval certificates or product certificates according to the relevant certification requirements of Chapter 3, Part 1 of the CCS SS Rules.

8.2 Post-approval single item/batch test items shall include:

8.2.1 For hydrogen fuel cell power generation systems:

- (1) Appearance inspection;
- (2) Performance test under rated operating conditions;
- (3) Startup and shutdown test;
- (4) Gas leakage test;
- (5) Exhaust gas temperature test;
- (6) Surface and component temperature test;
- (7) Insulation resistance test;
- (8) Withstand voltage test.

8.2.2 Hydrogen fuel cell module:

- (1) Appearance inspection;
- (2) Normal operation test;
- (3) Insulation strength test;
- (4) Air tightness test.

8.2.3 Fuel cell power generation systems intended to form part of a ship's main power source shall undergo the additional test for "Equivalent Generator Set Characteristics".

8.2.3.1 A fuel cell power generation system together with its power converter that meets the test requirements of 7.3.10.1 through 7.3.10.5 upon factory tests may be considered as part of the ship's main power source. This shall be noted on the certificate as "Additional Test for Equivalent Generator Set Characteristics Completed". The power converter shall be considered an integral part of the fuel cell power generation system.

8.2.3.2 If it is genuinely difficult for a fuel cell power generation system together with its power converter to meet the requirements of 7.3.10.3, the test may be conducted in combination with a parallel-connected battery pack and converter assembly. The parameters of the fuel cell power generation system and the additional battery pack, such as capacity and type, shall be noted on the product certificate.

8.3 Upon satisfactory completion of the factory tests specified above, CCS will issue a marine product certificate.