



# INTERNATIONAL STANDARD

---

**Fuel cell technologies -  
Part 3-200: Stationary fuel cell power systems - Performance test methods**

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. [Click here to purchase the full version from the ANSI store.](#)

FOREWORD .....	4
INTRODUCTION .....	6
1 Scope .....	7
2 Normative references .....	8
3 Terms, definitions and symbols .....	10
3.1 Terms and definitions .....	10
3.2 Symbols .....	16
4 Reference conditions .....	19
4.1 General .....	19
4.2 Temperature and pressure .....	19
4.3 Heating value base .....	19
5 Items of performance test .....	19
6 Operating process .....	20
7 Test preparation .....	22
7.1 General .....	22
7.2 Uncertainty analysis .....	22
7.2.1 Uncertainty analysis items .....	22
7.2.2 Data acquisition plan .....	22
8 Measurement instruments and measurement methods .....	22
8.1 General .....	22
8.2 Measurement instruments .....	23
8.3 Measurement methods .....	23
8.3.1 General .....	23
8.3.2 Electric power measurements .....	23
8.3.3 Fuel input measurement .....	24
8.3.4 Recovered heat measurement .....	27
8.3.5 Purge gas flow measurement .....	27
8.3.6 Oxidant (air) input measurement .....	28
8.3.7 Other fluid flow measurement .....	29
8.3.8 Exhaust gas flow measurement .....	29
8.3.9 Discharge water measurement .....	30
8.3.10 Noise level measurement .....	30
8.3.11 Vibration level measurement .....	31
8.3.12 Total harmonic distortion measurement .....	31
8.3.13 Ambient condition measurement .....	31
9 Test plan .....	32
9.1 General .....	32
9.2 Ambient conditions .....	32
9.3 Maximum permissible variation in steady state operating conditions .....	33
9.4 Test operating procedure .....	34
9.5 Duration of test and frequency of readings .....	34
10 Test methods and computation of test results .....	34
10.1 General .....	34
10.2 Efficiency test .....	34
10.2.1 General .....	34
10.2.2 Test method .....	34

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. [Click here to purchase the full version from the ANSI store.](#)

10.2.4	Computation of output .....	46
10.2.5	Computation of waste heat rate .....	48
10.2.6	Computation of efficiencies.....	48
10.3	Electric power and thermal power response characteristics test.....	49
10.3.1	General .....	49
10.3.2	Criteria for the determination of attaining the steady state set value .....	50
10.3.3	Electric power output response time test .....	51
10.3.4	90 % power response time towards rated net electric power output (optional).....	52
10.3.5	Thermal power output response time test .....	53
10.4	Start-up and shutdown characteristics test.....	54
10.4.1	General .....	54
10.4.2	Test method for start-up characteristics test .....	54
10.4.3	Test method for shutdown characteristics test .....	55
10.4.4	Calculation of the start-up time .....	55
10.4.5	Calculation of the shutdown time .....	56
10.4.6	Calculation of the different forms of start-up energy.....	56
10.4.7	Calculation of the start-up energy .....	57
10.5	Purge gas consumption test.....	58
10.5.1	General .....	58
10.5.2	Test method .....	58
10.6	Water consumption test (optional).....	58
10.6.1	General .....	58
10.6.2	Test method .....	58
10.7	Exhaust gas emission test .....	59
10.7.1	General .....	59
10.7.2	Test method .....	59
10.7.3	Data processing of emission concentration.....	59
10.7.4	Calculation of mean mass discharge rate.....	60
10.7.5	Calculation of mass concentration .....	60
10.8	Noise level test .....	60
10.8.1	General .....	60
10.8.2	Test method .....	60
10.8.3	Data processing.....	61
10.9	Vibration level test .....	61
10.10	Discharge water quality test.....	62
10.10.1	General .....	62
10.10.2	Test method .....	62
11	Test reports.....	62
11.1	General.....	62
11.2	Title page.....	63
11.3	Table of contents .....	63
11.4	Summary report .....	63
11.5	Detailed report.....	63
11.6	Full report .....	64
Annex A (informative)	Uncertainty analysis .....	65
A.1	General.....	65
A.2	Preparations .....	65

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. [Click here to purchase the full version from the ANSI store.](#)

A.4	General approach .....	67
Annex B (informative)	Calculation of fuel heating value.....	69
Annex C (normative)	Reference gas .....	74
Annex D (informative)	Maximum acceptable instantaneous electric power output transient .....	77
Bibliography	.....	78
Figure 1	– Fuel cell power system diagram .....	8
Figure 2	– Symbol diagram for power inputs and outputs .....	19
Figure 3	– Operating process chart of fuel cell power system.....	21
Figure 4	– Electric and thermal power response time .....	50
Figure 5	– Criteria for attaining steady state .....	51
Figure 6	– Example of electric power chart at start-up.....	54
Figure 7	– Electric power chart at shutdown.....	55
Table 1	– Symbols .....	16
Table 2	– Test classification and test item .....	20
Table 3	– Test item and system status .....	32
Table 4	– Maximum permissible variations in test operating conditions .....	33
Table 5	– Vibration correction factors.....	62
Table B.1	– Heating value for component of gaseous fuel.....	69
Table B.2	– Worksheet 1 – Calculation worksheet for energy of fuel gases .....	71
Table B.3	– Worksheet 2 – Calculation worksheet for energy of air .....	73
Table C.1	– Examples of compositions of natural gas .....	75
Table C.2	– Examples of compositions of liquified petroleum gas (LPG) .....	76

---

## Fuel cell technologies - Part 3-200: Stationary fuel cell power systems - Performance test methods

### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62282-3-200 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an International Standard.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) revision of the Introduction, Scope and Clause 3;
- b) revision of the symbols in Table 1;
- c) revision of Figure 2 (symbol diagram);
- d) revision of measurement methods (8.3);
- e) revision of the efficiency test (10.2);

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. Click here to purchase the full version from the ANSI store.

- g) revision of the start-up and shutdown characteristics test (10.4);
- h) revision of Annex C.

The text of this International Standard is based on the following documents:

Draft	Report on voting
105/1124/FDIS	105/1134/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 62282 series, published under the general title *Fuel cell technologies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. [Click here to purchase the full version from the ANSI store.](#)

This part of IEC 62282 describes how to measure the performance of stationary fuel cell power systems for residential, commercial, agricultural and industrial applications.

This document describes type tests and their test methods only. In this document, no routine tests are required or identified, and no performance targets are set.

A related but independent standard IEC 62282-3-201 on the performance test methods of small stationary fuel cell power systems has been aligned with this document.

This part of IEC 62282 covers operational and environmental aspects of the stationary fuel cell power systems performance. The test methods apply as follows:

- power output under specified operating and transient conditions;
- electrical and heat recovery efficiency under specified operating conditions;
- environmental characteristics, for example, exhaust gas emissions, noise, under specified operating and transient conditions.

This document applies to all kinds of stationary fuel cell technologies, such as:

- alkaline fuel cells (AFC);
- phosphoric acid fuel cells (PAFC);
- polymer electrolyte fuel cells (PEFC);
- molten carbonate fuel cells (MCFC);
- solid oxide fuel cells (SOFC).

This document does not provide coverage for electromagnetic compatibility (EMC).

This document does not apply to small stationary fuel cell power systems with rated electric power output of less than 10 kW which are dealt with in IEC 62282-3-201.

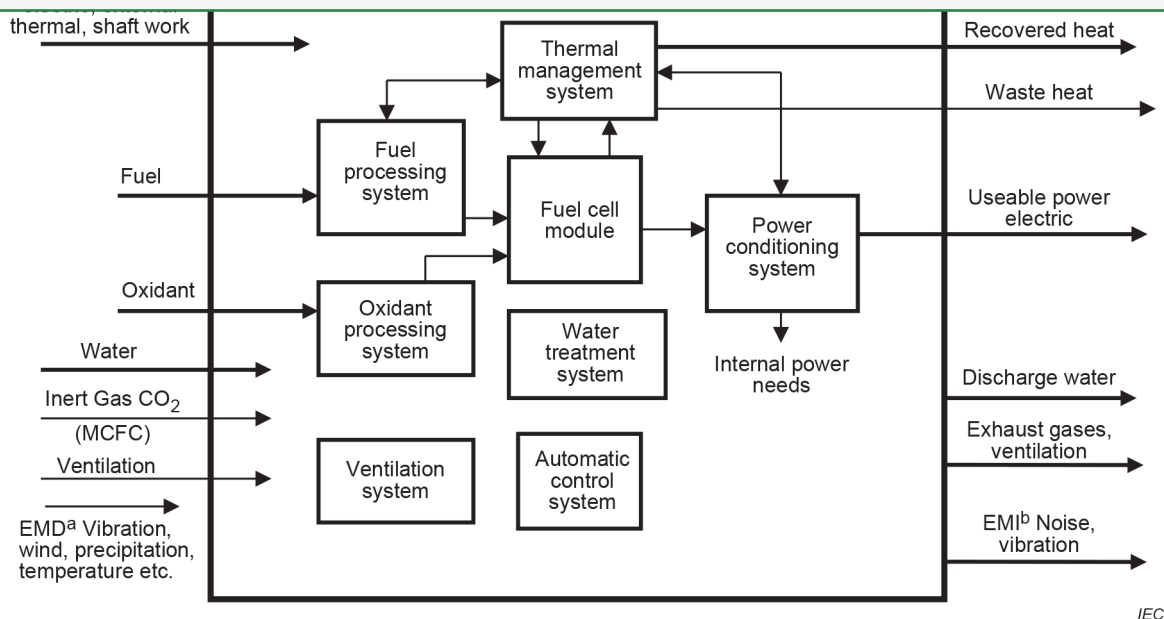
Fuel cell power systems can have different subsystems depending upon types of fuel cell and applications, and they have different streams of material and energy into and out of them. However, a common system diagram and boundary has been defined for evaluation of the fuel cell power system (see Figure 1).

The following conditions are considered in order to determine the system boundary of the fuel cell power system:

- all energy recovery systems are included within the system boundary;
- all kinds of electric energy storage devices are considered outside the system boundary;
- calculation of the heating value of the input fuel (such as natural gas, propane gas and pure hydrogen gas) is based on the conditions of the fuel at the boundary of the fuel cell power system.

The document does not provide safety requirements for the testing of stationary fuel cell power systems. Details on safe operation of the tested system can be obtained from the manufacturers instructions.

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. Click here to purchase the full version from the ANSI store.



#### Key



Fuel cell power system including subsystems. The interface is defined as a conceptual or functional one instead of hardware such as a power package.



Subsystems: fuel cell module, fuel processor, etc. These subsystem configurations depend on the kind of fuel, type of fuel cell or system.



The interface points in the boundary to be measured for calculation data.

<sup>a</sup> EMD electromagnetic disturbance

<sup>b</sup> EMI electromagnetic interference

**Figure 1 – Fuel cell power system diagram**

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60359, *Electrical and electronic measurement equipment - Expression of performance*

IEC 60688, *Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 61028, *Electrical measuring instruments - X-Y recorders*

IEC 61143 (all parts), *Electrical measuring instruments - X-t recorders*

IEC 61672-2, *Electroacoustics - Sound level meters - Part 2: Pattern evaluation tests*

IEC 62052-11, *Electricity metering equipment - General requirements, tests and test conditions - Part 11: Metering equipment*

IEC 62053-22, *Electricity metering equipment - Particular requirements - Part 22: Static meters for AC active energy (classes 0,1S, 0,2S and 0,5S)*

IEC 62282-3-201, *Fuel cell technologies - Part 3-201: Stationary fuel cell power systems - Performance test methods for small fuel cell power systems*

ISO 3648, *Aviation fuels - Estimation of net specific energy*

ISO 3744, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane*

ISO 4677-1, *Atmospheres for conditioning and testing - Determination of relative humidity – Part 1: Aspirated psychrometer method*

ISO 4677-2, *Atmospheres for conditioning and testing - Determination of relative humidity – Part 2: Whirling psychrometer method<sup>1</sup>*

ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

ISO 5348, *Mechanical vibration and shock - Mechanical mounting of accelerometers*

ISO 5815-2, *Water quality - Determination of biochemical oxygen demand after n days (BOD<sub>n</sub>) - Part 2: Method for undiluted samples*

ISO 6060, *Water quality - Determination of the chemical oxygen demand*

ISO 6974 (all parts), *Natural gas - Determination of composition and associated uncertainty by gas chromatography*

ISO 6975, *Natural gas - Extended analysis - Gas chromatographic method*

ISO 7934, *Stationary source emissions - Determination of the mass concentration of sulfur dioxide - Hydrogen peroxide/barium perchlorate/Thorin method*

ISO 7935, *Stationary source emissions - Determination of the mass concentration of sulfur dioxide in flue gases - Performance characteristics of automated measuring systems*

ISO 8217:2024, *Products from petroleum, synthetic and renewable sources - Fuels (class F) - Specifications of marine fuels*

ISO 10101 (all parts), *Natural gas - Determination of water by the Karl Fisher method*

---

<sup>1</sup> This publication was withdrawn.

This is a preview of IEC 62282-3-200 Ed. 3.0 en:2025. [Click here to purchase the full version from the ANSI store.](#)

*emission concentrations for permanently-installed monitoring systems*

ISO 10523, *Water quality - Determination of pH*

ISO 11626, *Natural gas - Determination of sulfur compounds - Determination of hydrogen sulfide content by UV absorption method*

ISO 10849, *Stationary source emissions - Determination of the mass concentration of nitrogen oxides in flue gas - Performance characteristics of automated measuring systems*

ISO 11042-1, *Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation*

ISO 11042-2, *Gas turbines - Exhaust gas emission - Part 2: Automated emission monitoring*

ISO 11541, *Natural gas - Determination of water content at high pressure*

ISO 11564, *Stationary source emissions - Determination of the mass concentration of nitrogen oxides - Naphthylethylenediamine photometric method*

ISO 11632, *Stationary source emissions - Determination of mass concentration of sulfur dioxide - Ion chromatography method*

ISO 14687, *Hydrogen fuel - Product specification*

ISO/TR 15916, *Basic considerations for the safety of hydrogen systems*

ISO 16622, *Meteorology - Sonic anemometers/thermometers - Acceptance test methods for mean wind measurements*

ISO 16960, *Natural gas - Determination of sulfur compounds - Determination of total sulfur by oxidative microcoulometry method*

ISO 19739, *Natural gas - Determination of sulfur compounds using gas chromatography*

ISO 20729, *Natural gas - Determination of sulfur compounds - Determination of total sulfur content by ultraviolet fluorescence method*

ASTM D4809, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)*