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Part 3-202: Stationary fuel cell power systems - Performance test methods for small fuel cell power systems that can be complemented with a supplementary heat generator for multiple units operation by an energy management system

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## Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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## Template for comments and secretariat observations

|                  |                        |
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|------------------|------------------------|

| 1  | 2                                          | (3)                          | 4               | 5                                                                                                                                  | (6)                                                                      | 7                                                  |
|----|--------------------------------------------|------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------|
| MB | Clause No./ Subclause No./Annex (e.g. 3.1) | Paragraph/Figure/ Table/Note | Type of comment | Commend (justification for change) by the MB                                                                                       | Proposed change by the MB                                                | Secretariat observations on each comment submitted |
|    | 3.1                                        | Definition 1                 | ed              | Definition is ambiguous and needs clarifying.                                                                                      | Amend to read '...so that the mains connector to which no connection...' |                                                    |
|    | 6.4                                        | Paragraph 2                  | te              | The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK. | Delete reference to UV photometer.                                       |                                                    |

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105/961/CD, 105/990A/CC

## IEC TC 105 : FUEL CELL TECHNOLOGIES

SECRETARIAT:

Germany

SECRETARY:

Mr David Urmann

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 8, TC 57, TC 120, SyC Smart Energy

PROPOSED HORIZONTAL STANDARD ☐

Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC☐ ENVIRONMENT☒ QUALITY ASSURANCE☐ SAFETY☒ SUBMITTED FOR CENELEC PARALLEL VOTING☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING**Attention IEC-CENELEC parallel voting**

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

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TITLE:

**Fuel cell technologies – Part 3-202: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems that can be complemented with a supplementary heat generator for multiple units operation by an energy management system**

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FUEL CELL TECHNOLOGIES –

**Part 3-202: Stationary fuel cell power systems –  
Performance test methods for small fuel cell power systems that can be  
complemented with a supplementary heat generator for multiple units  
operation by an energy management system**

## FOREWORD

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

| Draft       | Report on voting |
|-------------|------------------|
| 105/XX/FDIS | 105/XX/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/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

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,

replaced by a revised edition, or

amended.

## INTRODUCTION

This part of IEC 62282 provides consistent and repeatable test methods for the electrical thermal and environmental performance of small stationary fuel cell power systems.

This document limits its scope to small stationary fuel cell power systems (electric power output below 10 kW) and provides test methods specifically designed for them in detail. It is based on IEC 62282-3-201.

For multiple units operation, each electric power output of the unit is limited to below 10kW.

This document is intended for manufacturers of small stationary fuel cell power systems and/or those who evaluate the performance of their systems for certification purposes.

Users of this document may selectively execute test items that are suitable for their purposes from those described in this document. This document is not intended to exclude any other methods.

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.

## FUEL CELL TECHNOLOGIES –

### Part 3-202: Stationary fuel cell power systems – Performance test methods for small fuel cell power systems that can be complemented with a supplementary heat generator for multiple units operation by an energy management system

#### Scope

This document provides performance test methods specialized for the thermal and electrical characteristics which are required by an energy management system to effectively share the heat and power of networked small stationary fuel cell power systems. These test methods are applied for each small stationary fuel cell power system. This document covers small stationary fuel cell power systems which can be complemented with a supplementary heat generator and/or a thermal storage system such as:

output: rated electric power output of less than 10 kW for each system;

output mode: grid-connected/independent operation or stand-alone operation with alternating current (AC) output not exceeding 240 V or direct current (DC) output;

operating pressure: maximum allowable working pressure of less than 0.1 MPa (G) for the fuel and oxidant passages;

fuel: Gaseous fuel (natural gas, liquefied petroleum gas, propane, butane, hydrogen) or liquid fuel (kerosene, methanol);

oxidant: air.

This document does not apply to small stationary fuel cell power systems with electricity storage other than (small scale) back-up power for safety, monitoring and control.

Note: Regarding data linkage for conducting performance tests specified in this document with operating management systems (Energy Management System) of multiple Fuel Cell Power System (mFCPS), an appropriate IEC standard is recommended to select and implement. The related standards are IEC 61850-7-420, IEC 61850-90-27, IEC 62394 Ed4.0, IEC 62746-10-1, IEC 62746-10-3 Ed.1, etc. The data linkage and implementation for realizing the functions of the system that monitors mFCPS and peripherals differ depending on the vendor of the mFCPS control system, so the methods for data linkage and implementation are not specified in this document.

#### 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 62282-3-200:2015, *Fuel cell technologies – Part 3-200: Stationary fuel cell power systems – Performance test methods*

#### Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

IEC Electropedia: available at <http://www.electropedia.org/>

ISO Online browsing platform: available at <http://www.iso.org/obp>

**cold state**

state of a fuel cell power system at ambient temperature with no power input or output, ready for start-up

[SOURCE: IEC 60050-485:2020, 485-21-01, modified — "ready for start-up" added.]

**electrical efficiency**

ratio of the average net electric power output produced by a fuel cell power system to the average fuel power input supplied to the fuel cell power system

Note 1 to entry: The lower heating value (LHV) is assumed unless otherwise stated

[SOURCE: IEC 60050-485:2020, 485-10-02, modified — "electrical" instead of "electric" in the term; "average net electric power output" instead of "net electric power"; "average fuel power input" instead of "total enthalpy flow".]

**electric energy input**

integrated value of electric power input at the electric input terminal

[SOURCE: IEC 62282-3-201:2021, 3.8]

**electric energy output**

integrated value of electric power output at the electric output terminal

[SOURCE: IEC 62282-3-201:2021, 3.9]

**electric power input**

electric power input at the electric input terminal of the fuel cell power system

[SOURCE: IEC 62282-3-201:2021, 3.10]

**electric power output**

electric power output at the electric output terminal of the fuel cell power system

[SOURCE: IEC 62282-3-201:2021, 3.11]

**fuel cell power system**

generator system that uses one or more fuel cell modules to generate electric power and heat

[SOURCE: IEC 60050-485:2020, 485-09-01]

**fuel input**

amount of natural gas, hydrogen, methanol, liquid petroleum gas, propane, butane, or other material containing chemical energy entering the fuel cell power system while it is working at the specified operating conditions

[SOURCE: IEC 62282-3-201:2021, 3.13]

**fuel power input**

fuel energy input per unit of time

[SOURCE: IEC 62282-3-201:2021, 3.14]

**heat recovery efficiency**

ratio of the average recovered thermal power output of a fuel cell power system to the average total power input supplied to the fuel cell power system

[SOURCE: IEC 60050-485:2020, 485-10-04, modified — “the average recovered thermal power output” instead of “recovered heat flow”; “average total power input” instead of “total enthalpy flow”; Note 1 to entry deleted.]

**heat recovery fluid**

fluid circulating between the fuel cell power system and a heat sink for recovering the thermal energy output

[SOURCE: IEC 62282-3-201:2021, 3.16]

**hot restart**

start operation of the fuel cell power system before the power system temperature condition reach the “cold state”

**inert purge gas**

inert gas or dilution gas, not containing chemical energy, supplied to the fuel cell power system during specific conditions to make it ready for operation or shutdown

Note 1 to entry: Dilution gas containing chemical energy shall be considered as fuel.

[SOURCE: IEC 62282-3-201:2021, 3.17]

**integrated fuel input**

volume or mass of fuel consumed by the fuel cell power system under specified operating conditions

[SOURCE: IEC 62282-3-201:2021, 3.18]

**interface point**

measurement point at the boundary of a fuel cell power system at which material or energy, or both, either enters or leaves

Note 1 to entry: This boundary is intentionally selected to accurately measure the performance of the system, including all normal operation, both steady state and transient. If necessary, the boundary or the interface points of the fuel cell power system (Figure 1) to be assessed should be determined by agreement between the parties.

Note 2 to entry: Typical conditions to be standardized refer to fuel and oxidant parameters, like compositions, flow rates, temperature, pressure and humidity, as well as to the fuel cell parameters, like temperature.

[SOURCE: IEC 60050-485:2020, 485-09-12]

**minimum electric power output**

minimum net power output, at which a fuel cell power system is able to operate continuously at a steady state

[SOURCE: IEC 62282-3-201:2021, 3.21]

**net electric power output**

power generated by the fuel cell power system and available for external use

[SOURCE: IEC 60050-485:2020, 485-14-03, modified — “output” added to the term, Notes 1 and 2 to entry deleted.]

**rated electric power output**

maximum continuous electric power output that a fuel cell power system is designed to achieve under normal operating conditions specified by the manufacturer

[SOURCE: IEC 60050-485:2020, 485-14-04, modified — “electric” and “output” added to the term, Note 1 to entry deleted.]

**ramp-up energy**

electric and/or chemical (fuel) energy required for transitioning from zero or minimum net electric power output to rated net electric power output

[SOURCE: IEC 62282-3-201:2021, 3.28, modified — “zero or minimum” instead of “positive”; “after start-up” deleted.]

**ramp-up time**

duration required for transitioning from zero or minimum net electric power output to rated net electric power output

[SOURCE: IEC 62282-3-201:2021, 3.29, modified — “zero or minimum” instead of “positive”; “after start-up” deleted.]

**ramp-down energy**

electric and/or chemical (fuel) energy required for transitioning from rated net electric power output to minimum or zero net electric power output

**ramp-down time**

duration required for transitioning from rated net electric power output to minimum or zero net electric power output

**recovered heat**

thermal energy that has been recovered for useful purpose

Note 1 to entry: The recovered heat is measured by determining the temperatures and flow rates of the heat recovery fluid (water, steam, air or oil, etc.) entering and leaving the thermal energy recovery subsystem at the interface point of the fuel cell power system.

[SOURCE: IEC 62282-3-201:2021, 3.30]

**recovered thermal power**

recovered heat per unit of time

[SOURCE: IEC 62282-3-201:2021, 3.31]

**shutdown energy**

sum of electric and/or chemical (fuel) energy required during the shutdown time

[SOURCE: IEC 62282-3-201:2021, 3.32]

**shutdown time**

duration between the instant when a shutdown action is initiated at rated electric power output and the instant when the cold state or storage state, as specified by the manufacturer, is attained

[SOURCE: IEC 60050-485:2020, 485-20-04, modified — “a shutdown action is initiated at rated electric power output” instead of “the load is removed”; “the cold state or storage state, as specified by the manufacturer, is attained” instead of “the shutdown is completed”.]

### start-up energy

sum of the electric, thermal, mechanical and chemical (fuel) energy required by a fuel cell power system for transitioning from cold state or storage state to positive net electric power output

[SOURCE: IEC 60050-485:2020, 485-18-05, modified — “for transitioning from cold state or storage state to positive net electric power output” instead of “during the start-up time”.]

### start-up time

a) <for fuel cell power systems that do not require external energy to maintain a storage state> duration required for transitioning from cold state to positive net electric power output; and

b) <for fuel cell power systems that require external power to maintain a storage state> duration required for transitioning from storage state to positive net electric power output

[SOURCE: IEC 60050-485:2020, 485-20-05 and 485-20-06, modified — “positive” added]

### stationary fuel cell power system

fuel cell power system that is connected and fixed in place

[SOURCE: IEC 60050-485:2020, 485-09-24]

### storage state

state of a fuel cell power system being non-operational and possibly requiring, under conditions specified by the manufacturer, the input of thermal energy, electric energy or an inert atmosphere, or any combination thereof, in order to prevent deterioration of the components and/or energize the control systems and other components, and is ready for start-up

[SOURCE: IEC 60050-485:2020, 485-21-06, modified — “and/or energize the control systems and other components, and is ready for start-up” added.]

### thermal storage unit

unit that stores heat recovered from the fuel cell power system in the thermal storage medium and supplies the heat with heat carrier externally as needed

Note 1 to entry: It is composed of a thermal storage tank, a heat exchanger and a heat carrier supply system.

Note 2 to entry: A typical thermal storage medium is water.

[SOURCE: IEC 62282-3-201:2021, 3.39]

## Symbols

The symbols and their meanings used in this part of IEC 62282 are given in Table 1 with the appropriate units.

**Table 1 – Symbols and their meanings for electric and thermal performance**

| Symbol   | Definition                                            | Unit                                 |
|----------|-------------------------------------------------------|--------------------------------------|
| $c$      | <b>Specific heat</b>                                  |                                      |
| $c_{HR}$ | Specific heat capacity of heat recovery fluid         | $\text{kJ}/(\text{kg}\cdot\text{K})$ |
| $c_{pj}$ | Specific heat of water at the temperature of $T_{Vj}$ | $\text{kJ}/(\text{kg}\cdot\text{K})$ |

| Symbol                    | Definition                                                           | Unit              |
|---------------------------|----------------------------------------------------------------------|-------------------|
| <b><math>E</math></b>     | <b>Energy</b>                                                        |                   |
| $E_{mf}$                  | Energy input of gaseous fuel per unit mass                           | kJ/kg             |
| $E_{vf}$                  | Energy input of the fuel per unit volume                             | kJ/m <sup>3</sup> |
| $E_{fin}$                 | Fuel energy input                                                    | kJ                |
| <b><math>H</math></b>     | <b>Heating value</b>                                                 |                   |
| $H_{f0}$                  | Heating value of fuel on a molar basis under reference conditions    | kJ/mol            |
| $H_{f0j}$                 | Heating value of component $j$ at reference temperature $T_0$        | kJ/mol            |
| $H_{fl}$                  | Heating value of liquid fuel                                         | kJ/kg             |
| <b><math>M</math></b>     | <b>Molar mass</b>                                                    |                   |
| $M_f$                     | Molar mass of fuel                                                   | kg/mol            |
| <b><math>m</math></b>     | <b>Mass</b>                                                          |                   |
| $m_f$                     | Fuel mass measured over the test duration                            | kg                |
| $m_{HR}$                  | Heat recovery fluid mass                                             | kg                |
| <b><math>P, dP</math></b> | <b>Power, power change rate</b>                                      |                   |
| $P_n$                     | Average net electric power output                                    | kW                |
| $P_{rated}$               | Rated electric power output                                          | kW                |
| $P_{min}$                 | Minimum electric power output                                        | kW                |
| $P_d$                     | Electric power output change range between $P_{rated}$ and $P_{min}$ | kW                |
| $P_{HR}$                  | Average recovered thermal power                                      | kJ/s              |
| $P_{fin}$                 | Average fuel power input                                             | kJ/s              |
| $dP_{downi}$              | Decrease rate of electric power output                               | kW/s              |
| $dP_{upi}$                | Increase rate of electric power output                               | kW/s              |
| <b><math>p</math></b>     | <b>Pressure</b>                                                      |                   |
| $p_0$                     | Reference pressure (101,325 kPa(abs))                                | kPa(abs)          |
| $p_f$                     | Average fuel pressure                                                | kPa(abs)          |
| <b><math>Q</math></b>     | <b>Amount of heat</b>                                                |                   |
| $Q_{full}$                | Storage heat amount of hot water tank                                | kJ                |
| $Q_{remaining}$           | Remaining heat storage amount of hot water tank                      | kJ                |
| $\Delta Q_{loss}$         | Heat loss of the hot water tank                                      | kJ/h              |
| $Q_{init}$                | Initial heat storage amount of hot water tank                        | kJ                |
| $Q_{10h}$                 | Heat storage amount of hot water tank after 10 hours' heat loss      | kJ                |
| <b><math>q_m</math></b>   | <b>Mass flow rate</b>                                                |                   |
| $q_{mf}$                  | Average mass flow rate of fuel                                       | kg/s              |
| $q_{mHR}$                 | Average mass flow rate of heat recovery fluid                        | kg/s              |
| <b><math>q_v</math></b>   | <b>Volumetric flow rate</b>                                          |                   |
| $q_{vf}$                  | Average volumetric flow rate of fuel under the test conditions       | m <sup>3</sup> /s |
| $q_{vf0}$                 | Average volumetric flow rate of fuel under reference conditions      | m <sup>3</sup> /s |
| $q_{VHR}$                 | Average volumetric flow rate of heat recovery fluid                  | m <sup>3</sup> /s |