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Part 3: Fuel cell systems for propulsion - Performance test methods

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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.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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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.	

PROJECT NUMBER: IEC 63341-3 ED1	
DATE OF CIRCULATION: 2023-01-20	CLOSING DATE FOR COMMENTS: 2023-04-14
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IEC TC 105 : FUEL CELL TECHNOLOGIES	
SECRETARIAT: Germany	SECRETARY: Mr David Urmann
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 9	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☒ QUALITY ASSURANCE ☐ SAFETY	

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- any relevant patent rights of which they are aware and to provide supporting documentation,
- any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "in some countries" clauses. See AC/22/2007.

TITLE:

Railway applications – Rolling stock – Part 3: Fuel cell systems for propulsion – Performance test methods

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RAILWAY APPLICATIONS – ROLLING STOCK

Part 3: Fuel cell systems for propulsion – Performance test methods

FOREWORD

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IEC 63341-3 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an International Standard.

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

Draft	Report on voting
105/XXX/FDIS	105/XXX/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. The main document types developed by IEC are described in greater detail at <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 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

The IEC 63341 series deals with categories such as fuel cell power system, compressed hydrogen storage system, and performance test method.

This part of IEC 63341 provides consistent and repeatable test methods for the electric and environmental performance of fuel cell power systems for rolling stock. No categories of tests are required or identified, and no performance targets are set in this standard.

Fuel cells used in rolling stock, such as light rail vehicles, tramways, streetcars, metros, commuter trains, regional trains, high speed trains, locomotives, etc., are hybrids and so operate in several different modes. Similarly, rolling stock operates in different modes. The purpose of this document is to evaluate the fuel cell system in the various combinations of fuel cell modes and rolling stock operation modes. This part of IEC 63341 will break down these different modes and provide a framework for designing and evaluating a fuel cell system for use specifically in a rolling stock.

This part of IEC 63341 is expected to be used by manufacturers of fuel cell power systems used for rolling stock and/or those who evaluate the performance of their systems.

Users of this document could 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.

RAILWAY APPLICATIONS – ROLLING STOCK

Part 3: Fuel cell systems for propulsion – Performance test methods

1 Scope

This document provides the performance test methods of fuel cell power systems intended to be used for electrically powered rolling stock.

The scope of this document is limited to electrically powered rolling stock. Hydrogen rolling stocks that include an internal combustion engine are not included in the scope.

This document applies to hydrogen-fuelled fuel cell power systems for electrically powered rolling stock.

This document applies to DC type fuel cell power systems for using on rolling stock.

This document does not apply to reformer-equipped fuel cell power systems.

This document does not cover the fuel source containers which are permanently attached or fixed separately to either the rolling stock or the fuel cell power system. They are covered by IEC 63341-2.

The fuel cell power system perimeter is described in figure 1. The broken lines represent links between the different block diagrams.

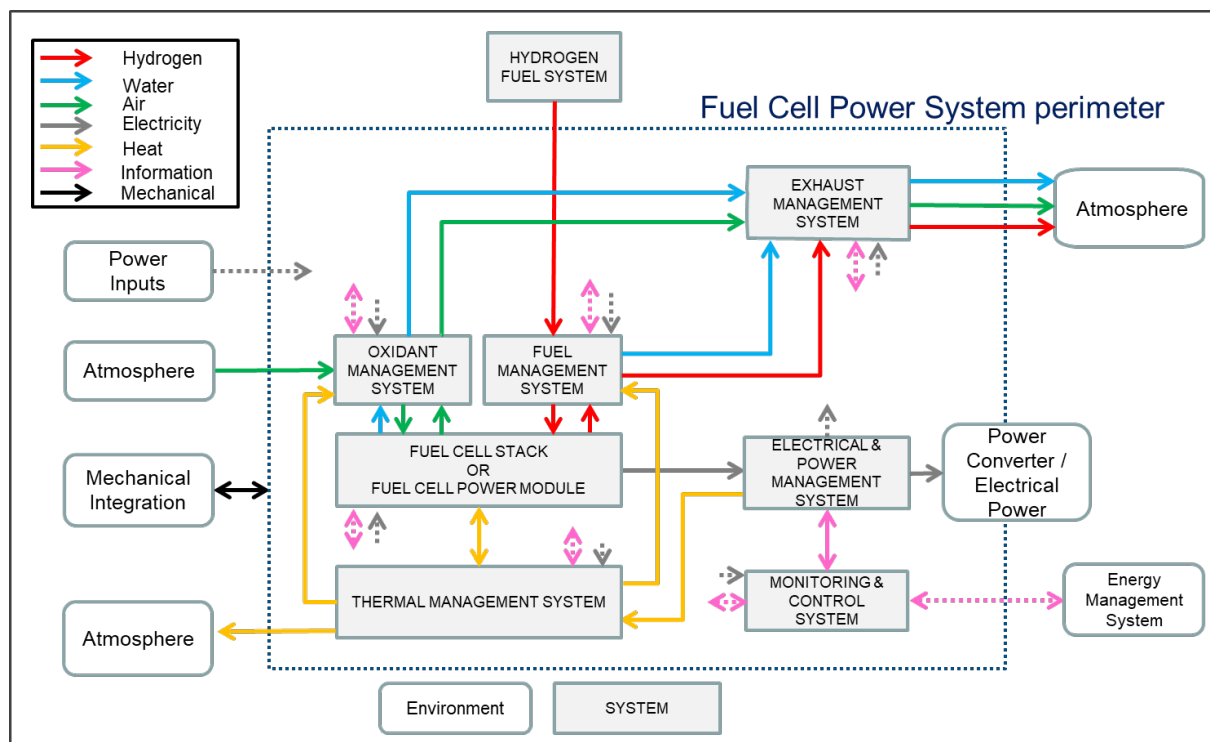


Figure 1 – Example of the main block diagrams for a Fuel cell power system for railway applications

All related standards are described in IEC 63341-1. Fuel Cell performance targets shall be agreed between the user and manufacturer.

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 60050-485:2020, International Electrotechnical Vocabulary (IEV) - Part 485: Fuel cell technologies

IEC 60050-551:1998, International Electrotechnical Vocabulary - Part 551: Power electronics

IEC 60077-1, Railway applications - Electric equipment for rolling stock - Part 1: General service conditions and general rules

IEC 60571, Railway applications - Electronic equipment used on rolling stock

IEC 60850, Railway applications - Supply voltages of traction systems technologies

IEC 61287-1:2014, Railway applications - Power converters installed on board rolling stock - Part 1: Characteristics and test methods

IEC 62236-3-1, Railway applications - Electromagnetic compatibility Part 3-1: Rolling stock - Train and complete vehicle

IEC 62236-3-2, Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock – Apparatus

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

IEC 62498-1:2010, Railway applications - Environmental conditions for equipment - Part 1: Equipment on board rolling stock

IEC 62928:2017, Railway applications - Rolling stock - Onboard lithium-ion traction batterie

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 3746, Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - survey method using an enveloping measurement surface over a reflecting plane

ISO 9614-1, Acoustics; determination of sound power levels of noise sources using sound intensity; part 1: measurement at discrete points

ISO 9614-2, Acoustics; determination of sound power levels of noise sources using sound intensity; part 2: Measurement by scanning

3 Terms, definitions and abbreviated term

3.1 Terms and definition

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>

3.1.1

fuel cell power system
FCPS

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

Note 1 to entry: This system typically contains the following subsystems: fuel cell power module (FCPM), oxidant management system (OMS), fuel management system (FMS), thermal management system (TMS), exhaust management system (ExMS), electrical and power management system, and their monitoring & control system (EPMS).

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

3.1.2

fuel cell power module

FCPM

Assembly incorporating one or more fuel cell stacks and other main and, if applicable, additional components, which is intended to be integrated into a power system

Note 1 to entry: A fuel cell module can contain the following equipment: its control system and in option, the cell voltage monitoring device, the fuel recirculation device, the humidification device for reactants, sensors, valves and actuators.

This subsystem is a part of the fuel cell power system.

[SOURCE: IEC 60050-485:2020, 485-09-03, modified]

3.1.3

fuel cell stack

FCS

Equipment assembly of two or more cells, separators, cooling plates, manifolds and a support structure that electrochemically converts, typically, hydrogen rich gas and air reactants to electrical power, heat and other reactant bi-products

[SOURCE: IEC 60050-485:2020, 485-06-01]

3.1.4

oxidant management system

OMS

System including filtering and pressuring equipments (and in option humidifying equipments), sensor and valve, able to manage the incoming oxidant such as air from the environment (as an example) to supply the FCPM (or fuel cell stack). This subsystem is a part of the fuel cell power system.

3.1.5

fuel management system

FMS

System including filtering and depressuring equipments, sensor and valve able to manage the incoming fuel from the hydrogen fuel system to supply the FCPM (or fuel cell stack). This subsystem is a part of the fuel cell power system.

3.1.6

thermal management system

TMS

Thermal loop including pump, heat exchanger, fan, heater, sensors and valves, (and in option ion removal device...) able to manage the FC temperatures for cooling purpose and heating purpose. This subsystem is a part of the fuel cell power system.

3.1.7**exhaust management system****ExMS**

Fluidic circuit able to manage the gas exhaust from the fuel cell power system to the environment. This subsystem is a part of the fuel cell power system

3.1.8**electrical and power management system****EPMS**

Electrical distribution able to supply power for the auxiliary equipments within the fuel cell power system and to deliver the power to the power converter. This subsystem is a part of the fuel cell power system.

3.1.9**monitoring and Control System****MCS**

System including the monitoring device, the control and communication units to manage the different subsystems of the fuel cell power system (fuel management system, oxidant management system, fuel cell power module, thermal management system, electrical and power management system, exhaust management system) and to communicate with the external systems and vehicle control. This subsystem is a part of the fuel cell power system

3.1.10**hydrogen Fuel system****HFS**

System designed to store Hydrogen and to process it to supply the Fuel Cell Power System. It includes the refuelling on-board devices, fuel lines and the associated monitoring & control & safety devices

3.1.11**(electronic) (power) converter**

an operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

Note 1 to entry: It can be DC/DC converter (insulated type) or chopper (non insulated type).

[SOURCE: IEC 60050-551:1998, 551-12-01]

3.1.12**gross power**

DC outlet power of total fuel cell stack in the fuel cell power system

Note 1 to entry: If a fuel cell power system with the power converter, the output and input power shall be corrected according to 6.2.3.

Note 2 to entry: Figure 2 shows the typical power distribution of the fuel cell power system. The figure provides definitions for the power terms corresponding to the different consumption. Power indicates electrical power.

Note 3 to entry: Power convert is optional.

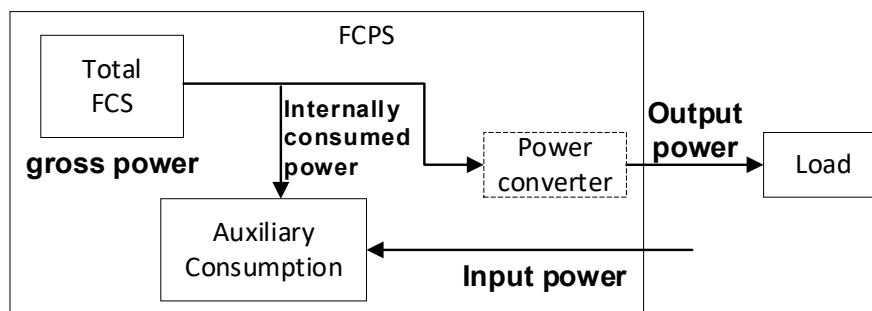


Figure 2 – Example of power distribution of FCPS

[SOURCE: IEC 60050-485:2020, 485-14-01]

3.1.13

output power

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

Note 1 to entry: Output Power = Gross Power – Internal Consumed Power.

note 2 to entry: If a fuel cell power system includes a power converter, the output power shall be corrected according to 6.2.3.

3.1.14

input power

power not internally supplied by the fuel cell power system, needed for the fuel cell power system operation, and consumed by the auxiliaries

Note 1 to entry: The consumption of the auxiliaries is part or all provided by the input power.

Note 2 to entry: If a fuel cell power system includes a power converter, the input power shall be corrected according to 6.2.3.

3.1.15

net power

remaining power generated by the fuel cell power system usable in totality for external use

Note 1 to entry: Net power=output power-input power.

Note 2 to entry: If a fuel cell power system includes a power converter, the output and input power shall be corrected according to 6.2.3.

[SOURCE: IEC 60050-485:2020, 485-14-03 for net electric power, modified]

3.1.16

auxiliary consumption

Power consumed by all the fuel cell power system auxiliaries necessary for the fuel cell power system operation, which is the sum of the input power and the internally consumed power

Note 1 to entry : Auxiliary consumption=gross power- output power +input power.

Note 2 to entry : If a fuel cell power system includes a power converter, the output and input power shall be corrected according to 6.2.3.

[SOURCE: IEC 60050-485:2020, 485-09-08 for parasitic load, modified]

3.1.17

internally consumed power

Power consumed internally by the fuel cell power system auxiliaries

Note 1 to entry: Internally consumed power = Gross power – Output power.

Note 2 to entry: Internally consumed power could be 0.

3.1.18

minimum power

Lowest output power at which the fuel cell power system is able to operate (for transient mode)

Note 1 to entry: If the operation with minimum power is limited in time, the maximum duration shall be specified by the manufacturer.

Note 2 to entry: Minimum power can be lower than idle power.

[SOURCE IEC 60050-485:2020, 485-14-02]

3.1.19

idle power

minimum output power at which the fuel cell power system can operate continuously in a stable manner.

Note 1 to entry: Idle Power can be identical or higher than Minimum Power.

3.1.20

rated power

maximum continuous output power that the fuel cell power system is designed to generate, established for a specific set of operating conditions specified by the manufacturer.

[SOURCE: IEC 60050-485:2020, 485-14-04]

3.1.21

maximum power

highest output power at which the fuel cell power system is able to operate (for transient mode)

Note 1 to entry: if the operation with maximum power is limited in time, the maximum duration shall be specified.

Note 2 to entry: Maximum power can be higher than rated power.

3.1.22

maximum system efficiency power

output power level at which the fuel cell power system is most efficient specified by the manufacturer

3.1.23

passive State

state of the fuel cell power system with no power input or output

Note 1 to entry: Figure 3 shows the typical flow chart of a fuel cell power system. The figure provides definitions for the state, transient phase and dynamic response time.

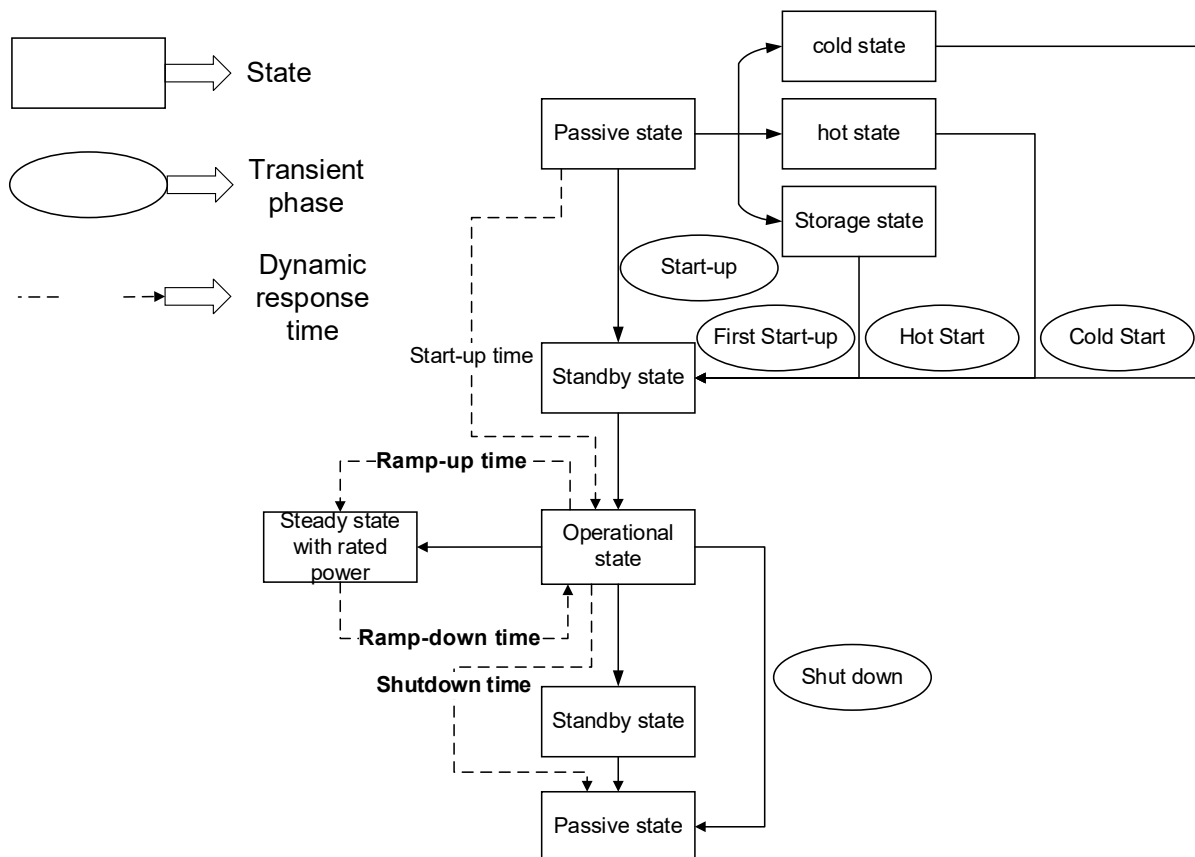


Figure 3 - the typical flow chart of a fuel cell power system

3.1.24

cold state

state of the fuel cell power system at ambient temperature with no power input or output

[SOURCE: IEC 60050-485:2020, 485-21-01]

3.1.25

cold start

start of the fuel cell power system from cold state

3.1.26

hot state

state of the fuel cell power system at normal operating temperature range with no power input or output

3.1.27

hot start

start of the fuel cell power system from hot state

276

277 **3.1.28**278 **standby state**

279 state of the fuel cell power system at a sufficient operating temperature and in such an
280 operational mode, with zero electric power output, that the fuel cell power system is capable
281 of being promptly switched to an operational state with a substantial electric power output

282 [SOURCE : IEC 60050-485, 21-04 for pre-generation state]

283

284 **3.1.29**285 **operational State**

286 state of a fuel cell power system with substantial electrical active output power available

287 [SOURCE IEC 60050-485, 21-02]

288

289 **3.1.30**290 **steady state**

291 the fuel cell power system is in operational state with constant output power and coolant
292 temperature with time

293 Note 1 to entry: the deviation is declared by manufacturer.

294

295 **3.1.31**296 **start-up time**

297 duration required for transitioning from passive state to enter operational state

298

299 **3.1.32**300 **ramp-up time**

301 the time required for the fuel cell power system to transition from entering operational state to
302 rated power

303

304 **3.1.33**305 **ramp-down time**

306 the time required for the fuel cell power system to transition from rated power to exiting
307 operational state.

308

309 **3.1.34**310 **shutdown time**

311 the time required for the fuel cell power system to transition from exiting operational state to
312 passive state.

313

314 **3.1.35**315 **FCPS electric efficiency**

316 ratio of the net electric power produced by a fuel cell power system to the total enthalpy flow
317 supplied to the fuel cell.

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