

Fuel cell technologies - Part 4-102: Fuel cell power systems for industrial electric trucks - Performance test methods

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN 62282-4-102:2017 sisaldab Euroopa standardi EN 62282-4-102:2017 ingliskeelset teksti.	This Estonian standard EVS-EN 62282-4-102:2017 consists of the English text of the European standard EN 62282-4-102:2017.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 30.06.2017.	Date of Availability of the European standard is 30.06.2017.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 27.070

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

ICS 27.070

English Version

Fuel cell technologies - Part 4-102: Fuel cell power systems for  
industrial electric trucks - Performance test methods  
(IEC 62282-4-102:2017)

Technologies des piles à combustible - Partie 4-102:  
Systèmes à piles à combustible pour chariots de  
manutention électriques - Méthodes d'essai des  
performances  
(IEC 62282-4-102:2017)

Brennstoffzellen-Technologien - Teil 4-102: Antriebe mit  
Brennstoffzellen-Energiesystemen für elektrisch betriebene  
Flurförderfahrzeuge - Leistungskennwerteprüfverfahren  
(IEC 62282-4-102:2017)

This European Standard was approved by CENELEC on 2017-05-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

## European foreword

The text of document 105/635/FDIS, future edition 1 of IEC 62282-4-102, prepared by IEC TC 105 "Fuel cell technologies" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62282-4-102:2017.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2018-02-15
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2020-05-15

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

## Endorsement notice

The text of the International Standard IEC 62282-4-102:2017 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 62282-3-200	NOTE	Harmonized as EN 62282-3-200.
IEC 62282-4-101	NOTE	Harmonized as EN 62282-4-101
ISO 6060	NOTE	Harmonized as EN ISO 6060
ISO 6976	NOTE	Harmonized as EN ISO 6976
ISO 10523	NOTE	Harmonized as EN ISO 10523

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	9
4 Symbols.....	11
5 Reference conditions.....	13
6 Heating value base.....	13
7 Test preparation.....	14
7.1 General.....	14
7.2 Data acquisition plan .....	14
8 Test setup .....	14
9 Instruments and measurement methods .....	16
9.1 General.....	16
9.2 Measurement instruments.....	16
9.3 Measurement points.....	17
9.4 Minimum required measurement systematic uncertainty.....	18
10 Test conditions .....	18
10.1 Laboratory conditions.....	18
10.2 Installation and operating conditions of the system .....	18
10.3 Indication of battery condition .....	18
10.4 Quality of test fuel.....	18
10.4.1 Hydrogen.....	18
10.4.2 Methanol solution .....	19
11 Fuel consumption test.....	19
11.1 Hydrogen fuel consumption test.....	19
11.1.1 General .....	19
11.1.2 Test method .....	19
11.1.3 Calculation of results .....	19
11.2 Methanol fuel consumption test.....	21
11.2.1 General .....	21
11.2.2 Test method .....	21
11.2.3 Calculation of average methanol fuel power input .....	21
12 Electrical power output test.....	22
12.1 General.....	22
12.2 Test method.....	22
12.3 Calculation of average electrical power output .....	22
12.4 Computation of electrical efficiency.....	23
13 Type tests on operational performance .....	23
13.1 Cold start maximum power output test .....	23
13.1.1 General .....	23
13.1.2 Test method .....	23
13.1.3 Processing of data.....	23
13.2 Power cycling electrical load test .....	23
13.2.1 General .....	23

13.2.2	Test method .....	23
13.2.3	Processing of data .....	24
13.3	Accessory load voltage spike test .....	24
13.3.1	General .....	24
13.3.2	Test method .....	24
13.3.3	Data processing.....	24
14	Power stability under the operation.....	24
14.1	General.....	24
14.2	Power delivered .....	24
14.3	Power absorbed.....	25
15	Type tests on environmental performance .....	25
15.1	General.....	25
15.2	Noise test .....	25
15.2.1	General .....	25
15.2.2	Test conditions .....	26
15.2.3	Test method .....	27
15.2.4	Processing of data .....	27
15.3	Exhaust gas test .....	27
15.3.1	General .....	27
15.3.2	Components to be measured .....	27
15.3.3	Test method .....	28
15.3.4	Processing of data .....	28
15.4	Discharge water test .....	30
15.4.1	General .....	30
15.4.2	Test method .....	30
16	Test reports .....	30
16.1	General.....	30
16.2	Title page.....	31
16.3	Table of contents .....	31
16.4	Summary report .....	31
Annex A (informative)	Heating values for hydrogen and methanol at reference conditions .....	32
Annex B (informative)	Guidelines for the contents of detailed and full reports .....	33
B.1	General.....	33
B.2	Detailed report .....	33
B.3	Full report .....	33
Bibliography.....		34
Figure 1 – Fuel cell power systems for industrial electric trucks .....		10
Figure 2 – Example of a test setup for hydrogen fuel .....		15
Figure 3 – Example of a test setup for methanol fuel.....		16
Figure 4 – Noise measurement points for fuel cell power systems.....		26
Table 1 – Symbols and their meanings for electric/thermal performance .....		12
Table 2 – Symbols and their meanings for environmental performance .....		13
Table 3 – Power delivered measurements.....		25
Table 4 – Power absorbed measurements .....		25

Table 5 – Compensation of readings against the effect of background noise ..... 27  
Table A.1 – Heating values for hydrogen and methanol at reference conditions ..... 32

This document is a preview generated by EVS

## INTRODUCTION

This part of IEC 62282-4 provides consistent and repeatable test methods for the electric/thermal and environmental performance of fuel cell power systems for industrial electric trucks.

The IEC 62282-4 series deals with categories such as safety, performance, and interchangeability of fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APUs). Among the categories mentioned above, this document (IEC 62282-4-102) focuses on fuel cell power systems for industrial electric trucks because such an application is urgently demanded in the world.

This part of IEC 62282-4 describes type tests and their test methods only. No routine tests are required or identified, and no performance targets are set in this standard.

Fuel cells used in industrial electric trucks, such as forklift trucks, are hybrids and so operate in several different modes. Similarly, forklift trucks operate in different modes. The purpose of this document is to evaluate the fuel cell system in the various combinations of fuel cell modes and forklift truck modes. This document will break down these different modes and provide a framework for designing and evaluating a fuel cell system for use specifically in a forklift truck.

This part of IEC 62282-4 is to be used by manufacturers of fuel cell power systems used for industrial electric trucks and/or those who evaluate the performance of their systems for certification purposes.

Users of this document 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.



## FUEL CELL TECHNOLOGIES –

### Part 4-102: Fuel cell power systems for industrial electric trucks – Performance test methods

#### 1 Scope

This document covers performance test methods of fuel cell power systems intended to be used for electrically powered industrial trucks.

The scope of this document is limited to electrically powered industrial trucks. Hybrid trucks that include an internal combustion engine are not included in the scope. The scope of this standard will be applicable to material-handling equipment, e.g. forklifts.

This document applies to gaseous hydrogen-fuelled fuel cell power systems and direct methanol fuel cell power systems for electrically powered industrial trucks.

The following fuels are considered within the scope of this standard:

- gaseous hydrogen, and
- methanol.

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

This document covers fuel cell power systems whose fuel source container is permanently attached to either the industrial truck or the fuel cell power system. A fuel source container of the detachable type is not permitted.

This document applies to DC type fuel cell power systems, with a rated output voltage not exceeding 150 V DC for indoor and outdoor use.

Fuel cell power systems intended for operation in potentially explosive atmospheres are excluded from the scope of this document.

This document does not cover the fuel storage systems using liquid hydrogen.

All systems with integrated energy storage systems are covered by this document. This includes systems, for example, batteries for internal recharges or recharged from an external source.

#### 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 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

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

IEC 62282-6-300, *Fuel cell technologies – Part 6-300: Micro fuel cell power systems – Fuel cartridge interchangeability*

ISO 9000, *Quality management series of standards*

ISO 14687-2, *Hydrogen fuel – Product Specification – Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles*

### 3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardisation 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

##### **noise level**

sound pressure level produced by the fuel cell power system measured at a specified distance in all operation modes

Note 1 to entry: Expressed as decibels (dB) and measured as described in 15.2.

#### 3.2

##### **background noise level**

sound pressure level of ambient noise at the measurement point

Note 1 to entry: This measurement is taken as described in 15.2 with the fuel cell power system in the cold state.

#### 3.3

##### **battery**

electrochemical energy storage device that provides energy input to support parasitic loads and/or provides electrical energy output

Note 1 to entry: Back-up batteries for control software memory and similar applications are not included.

#### 3.4

##### **cold state**

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

[SOURCE: IEC/TS 62282-1:2013, 3.110.1]

#### 3.5

##### **discharge rate**

mass of discharged exhaust gas component per unit of time

#### 3.6

##### **discharge water**

water discharged from the fuel cell power system including waste water and condensate

Note 1 to entry: Discharge water does not constitute part of a thermal recovery system.

[SOURCE: IEC/TS 62282-1:2013, 2.2, modified – Note 1 to entry added.]

#### 3.7

##### **fuel cell system electrical efficiency**

ratio of the average electric power output of a fuel cell power system at a given duration to the average fuel power fed to the same fuel cell power system at the same duration