IEC 62282-6-101

Edition 1.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fuel cell technologies –
Part 6-101: Micro fuel cell power systems – Safety – General requirements

Technologies des piles à combustible –
Partie 6-101: Systèmes à micropiles à combustible – Sécurité – Exigences générales

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 62282-6-101

Edition 1.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fuel cell technologies –
Part 6-101: Micro fuel cell power systems – Safety – General requirements

Technologies des piles à combustible –
Partie 6-101: Systèmes à micropiles à combustible – Sécurité – Exigences générales

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.070

ISBN 978-2-8322-8158-1

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
1.1 General 8
1.2 Fuels and technologies covered 8
1.3 Equivalent level of safety 9
2 Normative references 9
3 Terms and definitions 10
4 Safety principles 14
4.1 General 14
4.2 Chemical safety principles 14
4.3 Materials considerations 15
4.4 Mechanical safety 15
4.4.1 General 15
4.4.2 Micro fuel cell power system 16
4.4.3 Fuel cartridge 17
4.5 Electrical safety 17
4.5.1 General 17
4.5.2 Shock hazard 17
4.5.3 Fire hazard 17
4.5.4 Electric components and attachment 17
4.6 Hazard analysis and risk assessment 17
4.7 Functional safety 17
5 General safety requirements 18
5.1 General 18
5.1.1 Cartridge 18
5.1.2 Fuel quantity limit 18
5.2 Chemical safety requirements 18
5.3 Material requirements 19
5.3.1 General 19
5.3.2 Micro fuel cell power systems 20
5.3.3 Parts exposed to moisture, fuel or by-products 20
5.3.4 Elastomeric materials 21
5.3.5 Polymeric materials 21
5.4 Mechanical design requirements 21
5.4.1 General 21
5.4.2 Micro fuel cell power system 22
5.4.3 Fuel cartridge 22
5.4.4 Fuel valves and connections 23
5.5 Electrical requirements 24
5.5.1 Shock hazard 24
5.5.2 Fire hazard 24
5.5.3 Output terminal area 24
5.5.4 Electric components and attachments 24
5.5.5 Electrical conductors and wiring 24
5.5.6 Requirements related to potential ignition sources 25

5.6 Hazard analysis and risk assessment 26
5.7 Functional safety requirements 26
5.7.1 General 26
5.7.2 Software or electronics controls 27
5.8 Small parts 27
6 Abnormal operating and fault conditions testing and requirements 27
6.1 General 27
6.2 Abnormal operation – Electromechanical components 27
6.3 Abnormal operation of micro fuel cell power systems with integrated batteries 28
6.4 Abnormal operation – Simulation of faults based on hazard analysis 28
7 Instructions and warnings for micro fuel cell power systems and fuel cartridges 28
7.1 General 28
7.2 Minimum markings required on the fuel cartridge 28
7.3 Minimum markings required on the micro fuel cell power system 29
7.4 Additional information required either on the fuel cartridge or on accompanying written information or on the micro fuel cell power system 29
7.5 Technical documentation 29
8 Type tests for micro fuel cell power systems and fuel cartridges 30
8.1 General 30
8.2 General leakage and gas loss measurement protocols 32
8.2.1 General protocols 32
8.2.2 Tests 32
8.2.3 Protocol for performing concentration-based measurements 32
8.2.4 Protocols for the assessment of point source hydrogen gas loss 35
8.2.5 Liquid leak detector test protocol 37
8.2.6 Water immersion test protocol 37
8.2.7 Mass loss measurement protocols 38
8.2.8 Methods for the detection of accessible hazardous liquids 38
8.2.9 Protocol for gas loss test for devices to be used in close proximity to user's mouth or face 38
8.3 Type tests 40
8.3.1 Pressure differential tests 40
8.3.2 Vibration test 42
8.3.3 Temperature cycling test 43
8.3.4 High-temperature exposure test 44
8.3.5 Drop test 44
8.3.6 Compressive loading test 45
8.3.7 External short-circuit test 46
8.3.8 Surface, component and exhaust gas temperature test 47
8.3.9 Long-term storage test 47
8.3.10 High-temperature connection test 47
8.3.11 Connection cycling tests 48
8.3.12 Gas loss tests 50
Annex A (informative) Background and rationale for type tests 52
Bibliography 54

Figure 1 – Micro fuel cell power system block diagram 9
Figure 2 – Ingestion gauge 27

Figure 3 – Gas loss test apparatus 34
Figure 4 – Operational gas loss concentration testing apparatus 39
Figure 5 – Temperature cycling 44

Table 1 – Technology specific parts 8
Table 2 – Scenarios and control volumes 14
Table 3 – Guidelines for determining leakage and gas loss limits for mitigating hazards 15
Table 4 – Gas loss limits for concentration-based testing 19
Table 5 – List of type tests 30
Table 6 – Laboratory conditions 41
Table A.1 – Purpose of tests 52

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

FUEL CELL TECHNOLOGIES –

Part 6-101: Micro fuel cell power systems – Safety – General requirements

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 62282-6-101 has been prepared by IEC technical committee 105: Fuel cell technologies. It is an international Standard.

This first edition, together with the other parts of the IEC 62282-6-1XX series, cancels and replaces IEC 62282-6-100:2010 and IEC 62282-6-100:2010/AMD1:2012.

This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 62282-6-100:2010 and IEC 62282-6-100:2010/AMD1:2012:

a) A new structure has been set up: IEC 62282-6-101 covers the general safety requirements common to all fuel types whereas IEC 62282-6-102 and subsequent parts of the IEC 62282-6-1XX series cover particular requirements for specific fuel types based on the requirements given in IEC 62282-6-101.

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

Draft	Report on voting
105/1010/FDIS	105/1023/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 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 in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months from the date of publication.

INTRODUCTION

IEC 62282-6-100 has been restructured to make it more user friendly.

The new IEC 62282-6-1XX series consists of IEC 62282-6-101 and subsequent parts of the IEC 62282-6-1XX series which will replace IEC 62282-100 on a case-by-case basis. Until subsequent specific parts of the IEC 62282-6-1XX series are completed, a suitable transition period will apply.

IEC 62282-6-101 covers general safety requirements common to all fuel types.

IEC 62282-6-102 and subsequent parts in the IEC 62282-6-1XX series will cover detailed requirements for specific fuel cartridges based on the requirements of IEC 62282-6-101, as shown in Table 1: Technology specific parts.

FUEL CELL TECHNOLOGIES –

Part 6-101: Micro fuel cell power systems – Safety – General requirements

1 Scope

1.1 General

a) This part of IEC 62282 covers micro fuel cell power systems and fuel cartridges that are wearable or easily carried by hand, providing direct current outputs that do not exceed 60 V DC and power outputs that do not exceed 240 VA. Portable fuel cell power systems that provide output levels that exceed these electrical limits are covered by IEC 62282-5-100.

b) Externally accessible circuitry is therefore considered to be ES1 energy source as defined in IEC 62368-1, and as limited power source if further compliance with IEC 62368-1:2023, Annex Q is demonstrated. Micro fuel cell power systems that have internal circuitry exceeding 60 V DC or 240 VA are addressed with the separate criteria of IEC 62368-1.

c) This document covers micro fuel cell power systems and fuel cartridges. This document establishes the requirements for micro fuel cell power systems and fuel cartridges to ensure a reasonable degree of safety for normal use, reasonably foreseeable misuse, and cargo and consumer transportation and storage of such items. Fuel cartridges refilled by the manufacturer or by trained technicians are covered by this document. The fuel cartridges covered by this document are not intended to be refilled by the consumer.

d) Micro fuel cell power systems and fuel cartridges that are covered by this document are not intended for use in hazardous areas as defined by IEV 426-03-01.

1.2 Fuels and technologies covered

a) A micro fuel cell power system block diagram is shown in Figure 1.

b) This document, including all annexes, apply to micro fuel cell power systems and fuel cartridges as defined in 1.1 above.

c) Clause 4 to Clause 8 cover the general safety requirements for all micro fuel cell power systems. IEC 62282-6-101 together with the appropriate technology specific parts shown in Table 1 cover the requirements for the specific technologies in the IEC 62282-6-1XX series.

Table 1 – Technology specific parts

Specific technology supplement standard	Title
IEC 62282-6-106	Fuel cell technologies – Part 6-106: Micro fuel cell power systems – Safety – Indirect Class 8 (corrosive) compounds
IEC 62282-6-107	Fuel cell technologies – Part 6-107: Micro fuel cell power systems – Safety – Indirect water reactive (Division 4.3) compounds