

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fuel cell technologies –
Part 4-101: Fuel cell power systems for electrically powered industrial trucks –
Safety**

**Technologies des piles à combustible –
Partie 4-101: Systèmes à pile à combustible pour chariots de manutention
électriques – Sécurité**





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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 It also gives information on projects, replaced and withdrawn publications.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. 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 22 300 terminological entries in English and French, with equivalent terms in 19 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. 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 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fuel cell technologies –
Part 4-101: Fuel cell power systems for electrically powered industrial trucks –
Safety**

**Technologies des piles à combustible –
Partie 4-101: Systèmes à pile à combustible pour chariots de manutention
électriques – Sécurité**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.070

ISBN 978-2-8322-4167-7

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	9
3 Terms and definitions	13
4 Construction requirements for safety	16
4.1 General	16
4.2 Hydrogen and other fluid containing parts	17
4.2.1 General	17
4.2.2 Piping, hoses, tubing and fittings	17
4.2.3 Hydrogen pressure vessels	18
4.2.4 Metal hydride container	19
4.2.5 Methanol fuel tank	19
4.3 Refueling	19
4.4 Over-pressure and thermal protection	19
4.5 Regulators	21
4.6 Operating and shut-off valves	21
4.7 Filters	21
4.8 Pumps and compressors	21
4.9 Electrically operated pressure sensing and controlling devices	22
4.10 Ventilation to prevent the build up of flammable gases	22
4.11 Electrostatic discharge (ESD)	23
4.12 Discharges including methanol emissions and waste materials	23
4.13 Enclosures	23
4.14 Electrical system	24
4.14.1 General	24
4.14.2 Internal wiring	24
4.14.3 External wiring	25
4.14.4 Emergency switching off requirements (disconnection) for connections for fuel cell power system	25
4.14.5 Motors	26
4.14.6 Switches and motor controllers	26
4.14.7 Transformers and power supplies	26
4.14.8 Inverters, converters and controllers	26
4.14.9 Lamps and lampholders	26
4.14.10 Energy storage components	27
4.14.11 Electrical insulation	27
4.14.12 Limited power circuit	28
4.14.13 Electrical spacings	28
4.14.14 Separation of circuits	29
4.15 Control circuits	30
4.15.1 Safety controls	30
4.15.2 Start	30
4.15.3 Drive off	30
4.15.4 Emergency stop	30
4.16 Risk assessment and risk reduction	30

5	Performance requirements for safety and type tests	31
5.1	General.....	31
5.2	Vibration test	31
5.2.1	General	31
5.2.2	Vertical axis test.....	31
5.2.3	Longitudinal and lateral axes tests.....	31
5.3	Fuel container securement test	31
5.4	Endurance test.....	32
5.5	External leakage test	32
5.6	Dilution test	32
5.6.1	Releases	32
5.6.2	Setup and operation	32
5.6.3	Exhaust dilution.....	32
5.6.4	Dilution boundaries.....	32
5.7	Ultimate strength test.....	32
5.8	Potential failure modes test.....	33
5.9	Temperature test	33
5.10	Continuity test.....	35
5.11	Non-metallic tubing test for accumulation of static electricity.....	35
5.11.1	Passing criteria.....	35
5.11.2	Test method	35
5.12	Dielectric voltage – Withstand test	36
5.13	Limited power circuit test	36
5.14	Rated power output test.....	37
5.15	Abnormal operation test – Electric equipment failures	37
5.16	Emission of effluents test (only for methanol fuel cells)	38
5.17	Environmental test.....	38
5.17.1	Rain test.....	38
5.17.2	Test of equipment – Exposure to wind	39
5.18	Enclosure tests	39
5.18.1	Enclosure loading test	39
5.18.2	Test for thermoplastic enclosures	39
5.19	Marking plate adhesion test	40
5.20	Test for elastomeric seals, gaskets and tubing.....	40
5.20.1	General	40
5.20.2	Accelerated air-oven ageing test.....	40
5.20.3	Cold temperature exposure test.....	40
5.20.4	Immersion test.....	40
5.21	Test for permeation of non-metallic tubing and piping	41
5.22	Test for electrical output leads	41
5.23	Emergency stop	41
6	Routine tests	41
6.1	External leakage.....	41
6.2	Dielectric voltage-withstand test.....	41
7	Markings.....	41
8	Instructions.....	42
8.1	General.....	42
8.2	Maintenance instructions	43

8.3	Operating instructions	43
8.4	Installation instructions	44
Annex A (informative)	Comparison of pressure terms.....	45
Annex B (informative)	Significant hazards, hazardous situations and events dealt with in this document	46
Bibliography.....		48
Figure 1 – Fuel cell power systems for industrial trucks		9
Figure 2 – Example of a diagram with vent system covering components downstream of the regulator		20
Figure 3 – Example of a diagram with vent system covering all components		20
Figure 4 – Example of a diagram with vent system covering all components in a multiple storage vessel system		21
Table 1 – Appliance-wiring material		25
Table 2 – Spacings		29
Table 3 – Temperature rise limits.....		34
Table 4 – Limits for inherently limited power sources		37
Table 5 – Limits for power sources not inherently limited (overcurrent protection required).....		37
Table 6 – Emission rate limits		38
Table A.1 – Comparison table of pressure terms.....		45

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

**Part 4-101: Fuel cell power systems for
electrically powered industrial trucks – Safety**

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

International Standard IEC 62282-4-101 has been prepared by IEC technical committee 105: Fuel cell technologies.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

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

- a) revision of the title of this document;
- b) revision of reference standards;
- c) addition of new subclauses (4.3, 4.14.5, 4.15.3, 4.15.4, 4.16, 5.6, and 5.23);
- d) previous 4.15 was revised as “4.16 Risk assessment and risk reduction”;
- e) revision of 4.6 3), access to the manual shutoff valve;
- f) revision of requirements for battery terminals that are threaded (4.14.10.1);

- g) revision of requirements for double layer capacitors (4.14.10.2);
- h) revision of external leakage test (5.5) and ultimate strength test (5.7);
- i) revision of temperature limits on capacitors depending on the temperature rating of the material (Table 3);
- j) revision of markings that are not relevant (Clause 7);
- k) added “Significant hazards, hazardous situations and events dealt with in this document” as a new informative annex (Annex B).

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

Draft	Report on voting
105/912/FDIS	105/922/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/standardsdev/publications.

A list of all parts of 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,
- replaced by a revised edition, or
- amended.

INTRODUCTION

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 (APU). Among the categories mentioned above, this document, IEC 62282-4-101, focuses on safety of electrically powered industrial trucks with fuel cell power systems because such applications are urgently demanded in the world. Future documents in this part of IEC 62282-4 will deal with other applications related to onboard vehicles other than road vehicles and auxiliary power units (APU).