

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Fuel cell technologies –
Part 3-100: Stationary fuel cell power systems – Safety**

**Technologies des piles à combustible –
Partie 3-100: Systèmes à piles à combustible stationnaires – Sécurité**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 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 Central Office
3, rue de Varembe
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

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 It also gives information on projects, replaced and withdrawn publications.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 also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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.

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.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 21 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

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.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Fuel cell technologies –
Part 3-100: Stationary fuel cell power systems – Safety**

**Technologies des piles à combustible –
Partie 3-100: Systèmes à piles à combustible stationnaires – Sécurité**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.070

ISBN 978-2-8322-6256-6

**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.....	6
INTRODUCTION.....	8
1 Scope.....	10
2 Normative references	11
3 Terms and definitions	13
4 Safety requirements and protective measures	19
4.1 General safety strategy.....	19
4.2 Physical environment and operating conditions.....	20
4.2.1 General	20
4.2.2 Electrical power input	20
4.2.3 Physical environment.....	20
4.2.4 Fuel input	20
4.2.5 Water input.....	20
4.2.6 Vibration, shock and bump	20
4.2.7 Handling, transportation, and storage	20
4.2.8 System purging.....	21
4.3 Selection of materials	21
4.4 General requirements	22
4.5 Pressure equipment and piping.....	24
4.5.1 Pressure equipment.....	24
4.5.2 Piping systems	24
4.5.3 Flue gas venting systems	25
4.5.4 Gas-conveying parts.....	25
4.6 Protection against fire or explosion hazards.....	26
4.6.1 Prevention against fire and explosion hazards in fuel cell power systems provided with enclosures.....	26
4.6.2 Prevention of fire and explosion hazards in burners.....	28
4.6.3 Prevention of fire and explosion hazards in catalytic fuel oxidation systems (catalytic burners)	30
4.7 Electrical safety	31
4.8 Electromagnetic compatibility (EMC).....	31
4.9 Control systems and protective components	31
4.9.1 General requirements	31
4.9.2 Control systems.....	32
4.9.3 Protective components	34
4.10 Pneumatic and hydraulic powered equipment	35
4.11 Valves.....	35
4.11.1 Shut-off valves.....	35
4.11.2 Fuel valves	35
4.12 Rotating equipment.....	36
4.12.1 General requirements	36
4.12.2 Compressors	36
4.12.3 Pumps	37
4.13 Enclosures.....	37
4.14 Thermal insulating materials	38
4.15 Utilities	38

4.15.1	General requirements	38
4.15.2	Water supply	38
4.15.3	Fuel gas supply	38
4.15.4	Electrical connections	38
4.16	Installation and maintenance	40
4.16.1	Installation	40
4.16.2	Maintenance	40
4.17	Equivalent safety	40
5	Type tests	41
5.1	General requirements	41
5.1.1	General	41
5.1.2	Operating parameters for tests	41
5.2	Test fuels	42
5.3	Basic test arrangements	43
5.4	Leakage tests	43
5.4.1	General	43
5.4.2	Pneumatic leakage tests	43
5.4.3	Hydrostatic leakage tests	47
5.5	Strength tests	47
5.5.1	General	47
5.5.2	Pneumatic strength tests	47
5.5.3	Hydrostatic strength test	49
5.6	Normal operation type test	49
5.7	Electrical overload test	50
5.8	Shutdown parameters	50
5.9	Burner operating characteristics tests	50
5.9.1	General	50
5.9.2	General testing	50
5.9.3	Limit testing	50
5.10	Automatic control of burners and catalytic oxidation reactors	51
5.10.1	General	51
5.10.2	Automatic ignition control burners	51
5.10.3	Automated control of catalytic oxidation reactors	53
5.11	Exhaust gas temperature test	54
5.12	Surface and component temperatures	54
5.13	Wind tests	55
5.13.1	General	55
5.13.2	Wind source calibration procedure for winds directed perpendicular to the wall	55
5.13.3	Verification of operation of outdoor fuel cell power systems under wind conditions	56
5.13.4	Verification of operation of indoor fuel cell power systems vented horizontally through an outside wall	57
5.13.5	Carbon monoxide (CO) and flammable gas components emissions under wind – Indoor units	59
5.13.6	Carbon monoxide (CO) and flammable gas components emissions under wind – Outdoor units	59
5.14	Rain test	60
5.14.1	Outdoor units	60
5.14.2	Indoor units supplied with horizontal venting hardware	60

5.14.3	Test method	60
5.15	Emissions	60
5.15.1	General	60
5.15.2	Carbon monoxide (CO) and flammable gas emissions	60
5.15.3	Normal conditions	61
5.16	Blocked condensate line test	61
5.17	Condensate discharge test	61
5.18	Electrical safety tests	62
5.19	EMC test	62
5.20	Venting system leakage test	62
5.21	Leakage tests (repeat)	63
6	Routine tests	63
6.1	General requirements	63
6.2	Leakage test	63
6.3	Dielectric strength test	64
6.4	Burner operation test	64
7	Marking, labelling and packaging	64
7.1	General requirements	64
7.2	Fuel cell power system marking	64
7.3	Marking of components	65
7.4	Technical documentation	65
7.4.1	General	65
7.4.2	Installation manual	66
7.4.3	User's information manual	66
7.4.4	Operating manual	69
7.4.5	Maintenance manual	70
Annex A (informative) Significant hazards, hazardous situations and events dealt with in this document		71
Annex B (informative) Carburation and material compatibility for hydrogen service		73
B.1	Carburization	73
B.2	Material compatibility for hydrogen service	73
B.2.1	General	73
B.2.2	Metals and metallic materials	73
B.2.3	Polymers, elastomers, and other non-metallic materials	75
B.2.4	Reference documents	75
Annex C (informative) Normative replacement subclauses for small fuel cell power systems with rated electrical output less than 10 kW, and maximum pressure of less than 0,1 MPa (gauge) for fuel and oxidant passages		79
Bibliography		81
Figure 1 – Typical stationary fuel cell power system		8
Figure 2 – Minimum test pressures		49
Figure 3 – Test wall with static pressure ports and vent terminal locations		56
Figure 4 – Vent test wall		57
Figure 5 – Piezo ring and details of typical construction		58
Figure 6 – Safety precautions for odorized gas-fuelled systems		67
Figure 7 – Safety precautions for odorant-free gas fuelled systems		68
Figure 8 – Safety precautions for liquid fuelled systems		68

Table 1 – Allowable surface temperature rises	23
Table 2 – Leakage test requirements	46
Table 3 – Ultimate strength test requirements	48
Table 4 – Wind calibration	56
Table A.1 – Hazardous situations and events.....	71

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

Part 3-100: Stationary fuel cell power systems – 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 62282-3-100 has been prepared by IEC technical committee 105: Fuel cell technologies.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

- a) recognition that fuel carrying components qualified to leakage standards (soundness) need not be considered as potential flammable leak sources;
- b) new Annex C for small power systems; and
- c) clarifications for numerous requirements and tests.

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

FDIS	Report on voting
105/695/FDIS	105/705/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "<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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

A typical stationary fuel cell power system is shown in Figure 1.

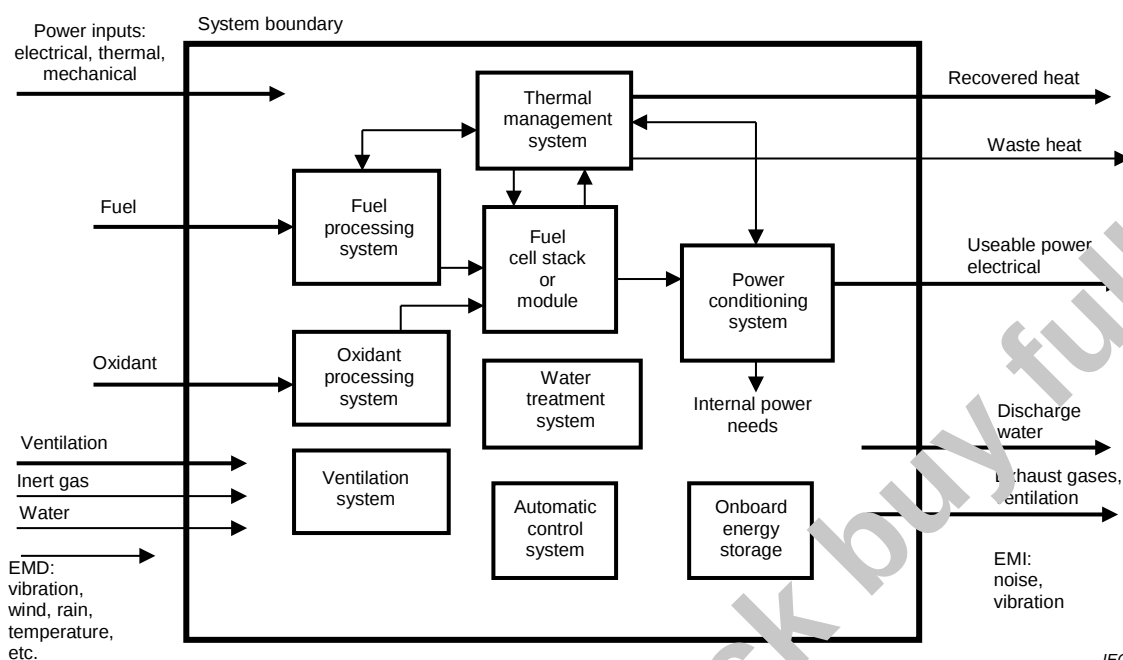


Figure 1 – Typical stationary fuel cell power system

The overall design of the power system anticipated by this document forms an assembly of integrated systems, as necessary, intended to perform designated functions, as follows.

- Fuel processing system – System of chemical and/or physical processing equipment plus associated heat exchangers and controls required to prepare, and if necessary, pressurize, the fuel for utilization within a fuel cell power system.
- Oxidant processing system – System that meters, conditions, processes and may pressurize the incoming supply for use within the fuel cell power system.
- Thermal management system – System that provides heating or cooling and heat rejection to maintain the fuel cell power system in the operating temperature range, and may provide for the recovery of excess heat and assist in heating the power train during start-up.
- Water treatment system – System that provides all the necessary purification treatment of the recovered or added water for use within the fuel cell power system.
- Power conditioning system – Equipment that is used to adapt the electrical energy produced by the fuel cell stack(s) to application requirements as specified by the manufacturer.
- Automatic control system – System(s) that is composed of sensors, actuators, valves, switches and logic components that maintain the fuel cell power system parameters within the manufacturer's specified limits including moving to safe states without manual intervention.
- Ventilation system – System that provides air through mechanical or natural means to the fuel cell power system's enclosure.
- Fuel cell modules – Equipment assembly of one or more fuel cell stacks which electrochemically converts chemical energy to electric energy and thermal energy intended to be integrated into a power generation system.

- Fuel cell stack – Equipment assembly of cells, separators, cooling plates, manifolds and a support structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reactant bi-products.
- Onboard energy storage – System of internal electric energy storage devices intended to aid or complement the fuel cell module in providing power to internal or external loads.

FUEL CELL TECHNOLOGIES –

Part 3-100: Stationary fuel cell power systems – Safety

1 Scope

This part of IEC 62282 applies to stationary packaged, self-contained fuel cell power systems or fuel cell power systems comprised of factory matched packages of integrated systems which generate electricity through electrochemical reactions.

This document applies to systems

- a) intended for electrical connection to mains direct, or with a transfer switch, or to a stand-alone power distribution system;
- b) intended to provide AC or DC power;
- c) with or without the ability to recover useful heat;
- d) intended for operation on the following input fuels:
 - 1) natural gas and other methane rich gases derived from renewable (biomass) or fossil fuel sources, for example, landfill gas, digester gas, coal mine gas;
 - 2) fuels derived from oil refining, for example, diesel, gasoline, kerosene, liquefied petroleum gases such as propane and butane;
 - 3) alcohols, esters, ethers, aldehydes, ketones, Fischer-Tropsch liquids and other suitable hydrogen-rich organic compounds derived from renewable (biomass) or fossil fuel sources, for example, methanol, ethanol, di-methyl ether, biodiesel;
 - 4) hydrogen, gaseous mixtures containing hydrogen gas, for example, synthesis gas, town gas.

This document does not cover:

- micro fuel cell power systems;
- portable fuel cell power systems;
- propulsion fuel cell power systems.

NOTE For special applications such as “marine auxiliary power”, additional requirements can be given by the relevant marine ship register standard.

This document is applicable to stationary fuel cell power systems intended for indoor and outdoor commercial, industrial and residential use in non-hazardous areas.

This document contemplates all significant hazards, hazardous situations and events, with the exception of those associated with environmental compatibility (installation conditions), relevant to fuel cell power systems, when they are used as intended and under the conditions foreseen by the manufacturer.

This document deals with conditions that can yield hazards on the one hand to persons, and on the other to damage outside the fuel cell power system only. Protection against damage to the fuel cell power system internals is not addressed in this document, provided it does not lead to hazards outside the fuel cell power system.