IEC 62282-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fuel cell technologies – Part 2: Fuel cell modules

Technologies des piles à combustible – Partie 2: Modules à piles à combustible

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

Part 2: Fuel cell modules

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.

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International Standard IEC 62282-2 has been prepared by IEC technical committee 105: Fuel cell technologies.

This second edition cancels and replaces the first edition, published in 2004, its amendment 1 (2007) and constitutes a technical revision.

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

- inclusion of definitions for hazards and hazardous locations based on the IEC 60079 series;
- the general safety strategy is modified to reflect the needs for different application standards. The modifications are in line with similar modifications made to IEC 62282-3-100;
- the electrical components clause is modified to reflect the needs for different application standards. The modifications are in line with similar modifications made to IEC 62282-3-100;

- the marking and instructions have been enlarged to provide the system integrator with the necessary information.

The text of this standard is based on the following documents:

FDIS	Report on voting
105/378/FDIS	105/389/RVD

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

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

A list of all the parts in the IEC 62282 series, published under the general title *Fuel cell technologies*, can be found on the IEC website.

The reader's attention is drawn to the fact that Annex B lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this standard.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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

Fuel cell modules are electrochemical devices which convert continuously supplied fuel, such as hydrogen or hydrogen rich gases, alcohols, hydrocarbons and oxidants to d.c. power, heat, water and other by-products.

Fuel cell modules are sub-assemblies that are integrated into end-use products incorporating one or more fuel cell stacks and, if applicable, additional components.

FUEL CELL TECHNOLOGIES –

Part 2: Fuel cell modules

1 Scope

This part of IEC 62282 provides the minimum requirements for safety and performance of fuel cell modules and applies to fuel cell modules with the following electrolyte chemistry:

– alkaline;
– polymer electrolyte (including direct methanol fuel cells)[1];
– phosphoric acid;
– molten carbonate;
– solid oxide;
– aqueous solution of salts.

Fuel cell modules can be provided with or without an enclosure and can be operated at significant pressurization levels or close to ambient pressure.

This standard deals with conditions that can yield hazards to persons and cause damage outside the fuel cell modules. Protection against damage inside the fuel cell modules is not addressed in this standard, provided it does not lead to hazards outside the module.

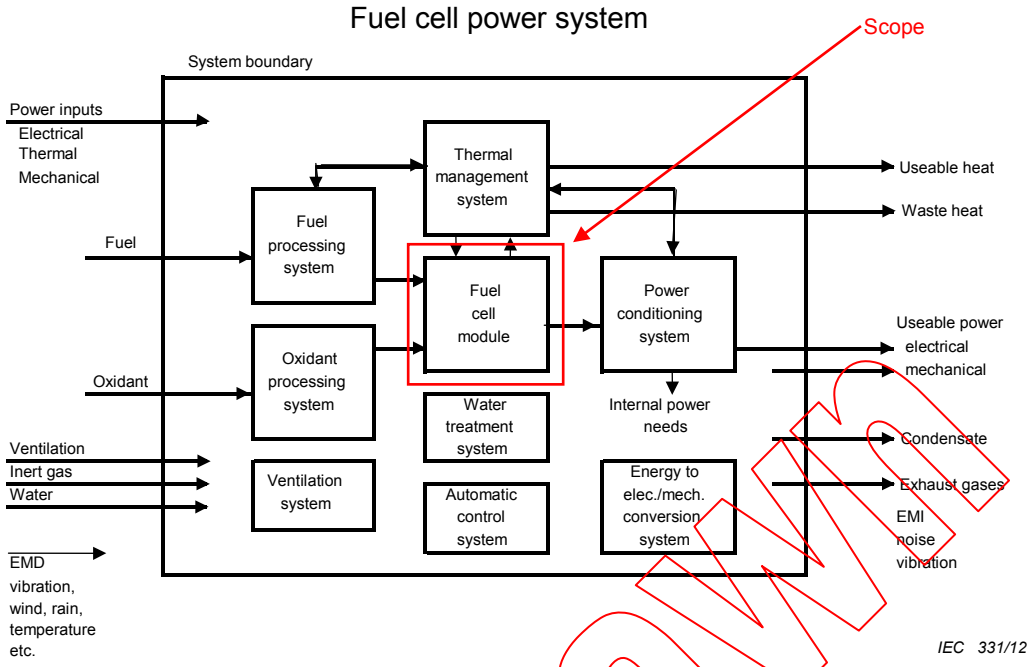
These requirements may be superseded by other standards for equipment containing fuel cell modules as required for particular applications.

This standard does not cover road vehicle applications.

This standard is not intended to limit or inhibit technological advancement. An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the purpose of these requirements and, if found to be substantially equivalent, may be considered to comply with this standard.

The fuel cell modules are components of final products. These products require evaluation to appropriate end-product safety requirements.

[1] Also known as proton exchange membrane fuel cell.



Key

EMD electromagnetic disturbance
EMI electromagnetic interference

Figure 1 – Fuel cell system components

This standard covers only up to the d.c. output of the fuel cell module.

This standard does not apply to peripheral devices as illustrated in Figure 1.

This standard does not cover the storage and delivery of fuel and oxidant to the fuel cell module.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60079-10 (all Parts 10), *Explosive atmospheres − Part 10: Classification of areas*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60335-1, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60352 (all parts), *Solderless connections*

IEC 60512-15 (all parts), *Connectors for electronic equipment – Tests and measurements – Part 15: Connector tests (mechanical)*

IEC 60512-16 (all parts) *Connectors for electronic equipment – Tests and measurements – Part 16: Mechanical tests on contacts and terminations*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60617, *Graphical symbols for diagrams*

IEC 60695 (all parts), *Fire hazard testing*

IEC 60730-1, *Automatic electrical controls for household and similar use – Part 1: General requirements*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 62040-1, *Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

ISO 13849-1, *Safety of machinery – Safety related parts of control systems – Part 1: General principles for design*

ISO 23550, *Safety and control devices for gas burners and gas-burning appliances – General requirements*

EN 50178, *Electronic equipment for use in power installations*

3 Terms and definitions

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

3.1
acceptance test
contractual test to prove to the customer that the item meets certain conditions of its specification

[SOURCE: IEC 60050-151:2001, 151-16-23] [1][2]

3.2
allowable differential working pressure
maximum pressure difference between the anode and cathode side specified by the manufacturer which the fuel cell module can withstand without any damage or permanent loss of functional properties

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2 References in square brackets refer to the bibliography.

3.3
allowable working pressure
maximum gauge pressure specified by the manufacturer which the fuel cell module can withstand without any damage or permanent loss of functional properties

Note 1 to entry: For fuel cell modules incorporating pressure relief devices, this is normally used to define the threshold of the set pressure.

3.4
ambient temperature
temperature of the medium surrounding a device, equipment or installation which may affect the performance of the device, equipment or installation

3.5
conditioning
(related to cells/stacks) preliminary step that is required to properly operate a fuel cell module (3.8) and that is realized following a protocol specified by the manufacturer

Note 1 to entry: The conditioning may include reversible and/or irreversible processes depending on the cell technology.

3.6
fuel cell
electrochemical device that converts the chemical energy of a fuel and an oxidant to electrical energy (DC power), heat and reaction products

Note 1 to entry: The fuel and oxidant are typically stored outside the fuel cell and transferred into the fuel cell as they are consumed.

3.7
fuel cell stack
assembly of cells, separators, cooling plates, manifolds and a supporting structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reaction products

[SOURCE: IEC 62282-1:2010, 3.50] [2]

3.8
fuel cell module
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 is comprised of the following main components: one or more fuel cell stack(s), piping system for conveying fuels, oxidants and exhausts, electrical connections for the power delivered by the stack(s) and means for monitoring and/or control. Additionally, a fuel cell module may comprise: means for conveying additional fluids (e.g. cooling media, inert gas), means for detecting normal and/or abnormal operating conditions, enclosures or pressure vessels and module ventilation systems.

3.9
rated current
maximum continuous electric current as specified by the fuel cell module manufacturer at which the fuel cell module has been designed to operate

3.10
crossover
cross leakage
leakage between the fuel side and the oxidant side, of a fuel cell, in either direction, generally through the electrolyte

3.11
gas leakage
sum of all gases leaving the fuel cell module except the intended exhaust gases

Note 1 to entry: Gas leakage may occur from

– the fuel cell stack;

– associated pressure relief devices;

– other gas ducting and flow controlling components.

3.12
hazard
potential source of harm in the form of physical injury to the health of people, property or the environment

3.13
hazardous area
classified area
area or space where combustible dust, ignitable fibres, or flammable, volatile liquids, gases, vapours or mixtures are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures

3.14
heat deflection temperature
temperature at which a standard test bar deflects a specified distance under load

Note 1 to entry: It is used to determine short-term heat resistance.

3.15
lower flammability limit
LFL
minimum concentration of fuel in a fuel-air mixture where a combustion can be ignited by an ignition source

Note 1 to entry: A fuel-air mixture is flammable when combustion can be started by an ignition source. The main component is the proportions or composition of the fuel-air mixture. A mixture that has less than a critical amount of fuel, known as the lower flammability limit (LFL) or more than a critical amount of fuel, known as the rich or upper flammability limit (UFL), will not be flammable.

3.16
maximum operating pressure
maximum pressure, specified by the manufacturer of a component or system, at which it is designed to operate continuously

Note 1 to entry: The maximum operating pressure is expressed in Pa.

Note 2 to entry: Includes all normal operation, both steady state and transient.

3.17
minimum voltage
lowest voltage that a fuel cell module is able to produce continuously at its rated power or during its maximum permissible overload conditions, whichever voltage is lower

Note 1 to entry: The minimum voltage is expressed in V.

3.18
natural ventilation
movement of air and its replacement with fresh air due to the effects of wind and/or temperature gradients

3.19
open-circuit voltage
voltage across the terminals of a fuel cell with fuel and oxidant present and in the absence of external current flow

Note 1 to entry: The open-circuit voltage is expressed in V.

3.20
routine test
conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

Note 1 to entry: Not to be confused with "Conformity test" [IEC 60050-151:2001, 151-16-15]: test for conformity evaluation or "Conformity evaluation" [IEC 60050-151:2001, 151-16-14]: systematic examination of the extent to which a product, process or service fulfils specified requirements.

3.21
standard conditions
test or operating conditions that have been predetermined to be the basis of the test in order to have reproducible, comparable sets of test data

3.22
safeguarding
control system actions, based on process parameters, taken to avoid conditions that might be hazardous to personnel or might result in damage to the fuel cell or its surroundings

3.23
safety extra low voltage
SELV
voltage under normal and single fault conditions that do not exceed 30 V r.m.s. or 42,4 V peak/d.c. in dry environments or when wet contact is likely to occur, 15 V r.m.s. or 21,2 V peak/d.c.

3.24
thermal equilibrium conditions
stable temperature conditions indicated by temperature changes of no more than 3 K (5 °F) or 1 % of the absolute operating temperature, whichever is higher between two readings 15 min apart

3.25
thermal stability
stable temperature isothermal conditions

3.26
type test
conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-151:2001, 151-16-16]

Note 1 to entry: Not be confused with "Conformity test" [IEC 60050-151:2001, 151-16-15]: test for conformity evaluation or "Conformity evaluation" [IEC 60050-151:2001, 151-16-14]: systematic examination of the extent to which a product, process or service fulfils specified requirements.

4 Requirements

4.1 General safety strategy

The manufacturer shall perform in written form a risk analysis to ensure that

a) all reasonably foreseeable hazards, hazardous situations and events throughout the anticipated fuel cell power system's lifetime have been identified (see Annex A for a listing of typical hazards),

b) the risk for each of these hazards has been estimated from the combination of probability of occurrence of the hazard and of its foreseeable severity,

c) the two factors which determine each one of the estimated risks (probability and severity) have been eliminated or reduced to a level not exceeding the acceptable risk level, as far as is practically possible, through

   1) inherently safe design of the construction and its methods, or

   2) passive control of energy releases without endangering the surrounding environment (for example, burst disks, release valves, thermal cut-off devices) or by safety related control functions, and

   3) for residual risks which could not have been reduced by the measures according to 1) and 2), provision of labels, warnings or requirements of special training shall be given, considering that such measures need to be understood by the persons which are in the area of the hazards.

For functional safety, the required severity level, performance level or the class of control function shall be determined and designed in accordance with e.g.:

- IEC 62061 (respectively ISO 13849-1) for applications according to IEC 60204-1;
- IEC 60730-1 for appliances according to IEC 60335-1;
- IEC 61508 (all parts) for other applications.

For failure mode and effects analysis (FMEA) and fault tree analysis methods, the following standards can be used as guidance:

- IEC 60812 [3];
- SAE J1739 [4];
- IEC 61025 [5].

The assessment shall also cover the following possible risks:

– stack temperature, and
– stack and/or cell voltage;
– pressure of pressurized parts.

Furthermore, care shall be taken to address the following:

– mechanical hazards – sharp surfaces, tripping hazards, moving masses and instability, strength of materials, and liquids or gases under pressure;
– electrical hazards – contact of persons with live parts, short-circuits, high voltage;
– EMC hazards – malfunctions of the fuel cell module when exposed to electromagnetic phenomena or malfunctions of other (nearby) equipment due to electromagnetic emissions from the fuel cell module;
– thermal hazards – hot surfaces, release of high temperature liquids or gases, thermal fatigue;
– fire and explosion hazards – flammable gases or liquids, potential for explosive mixtures during normal or abnormal operating conditions, potential for explosive mixtures during faulted conditions;
– malfunction hazards – unsafe operation due to failures of software, control circuit or protective/safety components or incorrect manufacturing or misoperation;
– material and substance hazards – material deterioration, corrosion, embrittlement, toxic releases;
– waste disposal hazards – disposal of toxic materials, recycling, disposal of flammable liquids or gases;
– environmental hazards – unsafe operation in hot/cold environments, rain, flooding, wind, earthquake, external fire, smoke.