

Fuel cell technologies —

Part 5-1: Portable fuel cell power systems — Safety

The European Standard EN 62282-5-1:2007 has the status of a
British Standard

ICS 27.070

National foreword

This British Standard is the UK implementation of EN 62282-5-1:2007. It is identical to IEC 62282-5-1:2007.

The UK participation in its preparation was entrusted to Technical Committee GEL/105, Fuel cell technologies.

A list of organizations represented on this committee can be obtained on request to its secretary.

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CENELEC

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Foreword

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Endorsement notice

The text of the International Standard IEC 62282-5-1:2007 was approved by CENELEC as a European Standard without any modification.

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FUEL CELL TECHNOLOGIES –

Part 5-1: Portable fuel cell power systems – Safety

1 Scope

This part of IEC 62282 covers construction, marking and test requirements for a.c. and d.c. type portable fuel cell systems. These fuel cell systems are movable and not fastened or otherwise secured to a specific location. The purpose of the portable fuel cell system is to produce useable power.

This standard applies to a.c. and d.c. type portable fuel cell systems, with a rated output voltage not exceeding 600 V a.c., or 850 V d.c. for indoor and outdoor use in a non-hazardous area.

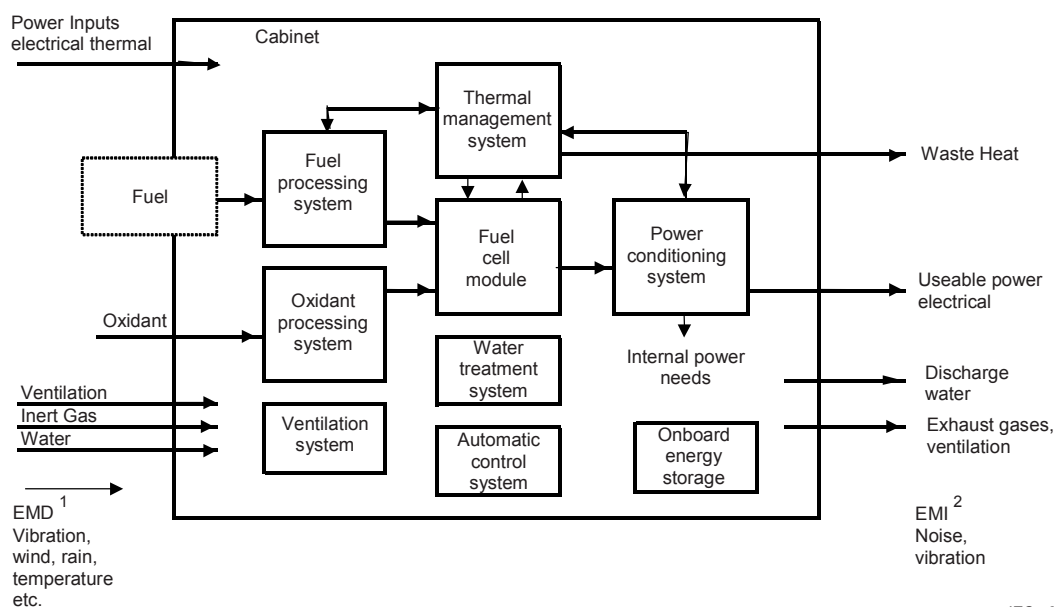
This standard does not apply to portable fuel cell systems that are:

- a) permanently connected (hard wired) to the electrical distribution system;
- b) permanently connected to a utility fuel distribution system;
- c) exporting power to the grid;
- d) for propulsion or auxiliary power of road vehicles;
- e) micro fuel cell systems.

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

- natural gas;
- liquefied petroleum gas, such as propane and butane;
- liquid alcohols, for example methanol, ethanol;
- gasoline;
- diesel;
- kerosene;
- hydrogen;
- metals (e.g. Mg, Al or Zn) or metal alloys immersed in electrolyte (e.g. aqueous solutions of salts or alkali) in air or oxygen;
- chemical hydrides.

This standard does not preclude the use of similar fuels or oxidants from sources other than air provided the unique hazards are addressed through additional requirements.



IEC 285/07

Key

¹ EMD: Electromagnetic disturbance² EMI: Electromagnetic interference

Figure 1 – Portable fuel cell power systems

1.1 System boundary

The overall design of a portable fuel cell system anticipated by this standard shall form an assembly of some or all of the following systems (see Figure 1), integrated as necessary, to perform designated functions, as follows:

Fuel processing system – chemical processing equipment including any associated heat exchanges and controls required to convert input fuel to a composition suitable for the fuel cell stack.

Oxidant processing system – subsystem that meters, conditions processes, and may pressurize the incoming oxidant supply for use within the fuel cell power system.

Thermal management system – subsystem intended to provide cooling and heat rejection in order to maintain thermal equilibrium within the fuel cell power system, and, if necessary, to affect the recovery of excess heat and to assist in heating the power train during start-up.

Power conditioning system– equipment which is used to change the magnitude or waveform of the voltage, or otherwise alter or regulate the output of a power source.

Automatic control system – assembly of sensors, actuators, valves, switches and logic components (including process controllers) that maintains the fuel cell power system parameters within the manufacturers specified limits without manual intervention.

Fuel cell module – assembly including a fuel cell stack(s) which electrochemically converts chemical energy to electric energy and thermal energy intended to be integrated into a power generation system.

Fuel supply system – shall be either integral to the portable fuel cell system, or supplied through a removable and refillable container assembly.

Onboard energy storage system – an internal energy source intended to aid or complement the fuel cell module in providing power to internal or external loads.

Ventilation systems – subsystem of the fuel cell power system that provides, by mechanical means, air to its cabinet.

Water treatment systems – provides for treatment and purification of recovered or added water for use within the portable fuel cell system.

1.2 Equivalent level of safety

These requirements are not intended to prevent the design and construction of a portable fuel cell system not specifically prescribed in this standard, provided that such alternative has been considered in testing and listing the portable fuel cell system. In considering alternative designs or construction, the materials or methods used shall be evaluated as to their ability to yield equivalent performance to that prescribed by this standard.

This standard does not cover requirements of pressurized or non-pressurized fuel supply containers upstream of the appliance gaseous or liquid fuel supply connector that are not integral to the portable fuel cell system.

1.3 General statements

All pressures in this standard are considered to be gauge pressures, unless otherwise specified.

2 Normative references

The following referenced documents are indispensable for the application 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 60034 (all parts), *Rotating electrical machines*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection 'n' electrical apparatus*

IEC 60079-20, *Electrical apparatus for explosive gas atmospheres – Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

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

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4: Ageing ovens – Section 1: Single-chamber ovens*

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

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

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

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignitability test method for materials*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*

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

IEC 60730-2-5, *Automatic electrical controls for household and similar use – Part 2-5: Particular requirements for automatic electrical burner control*

IEC 60730-2-17, *Automatic electrical controls for household and similar use – Part 2-17: Particular requirements for electrically operated gas valves, including mechanical requirements*

IEC 60812, *Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)*

IEC 60884-1, *Plugs and socket-outlets for household and similar purposes – Part 1: General requirements*

IEC 60934, *Circuit-breakers for equipment (CBE)*

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

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic currents emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-6-1, *Electromagnetic compatibility – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61025, *Fault tree analysis (FTA)*

IEC 61032, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61340-2-1, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

IEC 61511-3, *Functional safety – Safety instrumented systems for the process industry sector – Part 3: Guidance for the determination of the required safety integrity levels*

IEC 61779-4, *Electrical apparatus for the detection and measurement of flammable gases – Part 4: Performance requirements for group II apparatus indicating a volume fraction up to 100 % lower explosive limit*

IEC 61779-6, *Electrical apparatus for the detection and measurement of flammable gases – Part 6: Guide for the selection, installation, use and maintenance of apparatus for the detection and measurement of flammable gases*

IEC 61882, *Hazard and operability studies (HAZOP studies) – Application guide*

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

IEC 62040-1-2, *Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations*

IEC 62282-2, *Fuel cell technologies – Part 2: Fuel cell modules*

ISO 3864, *Graphical symbols – Safety colours and safety signs*

ISO 4080, *Rubber and plastics hoses and hose assemblies – Determination of permeability to gas*

ISO 7000, *Graphical symbols for use on equipment – Index and synopsis*

ISO 15156-1, *Petroleum and natural gas industries – Materials for use in H₂S-containing environments in oil and gas production – Part 1: General principles for selection of cracking-resistant materials*

ISO 15394, *Packaging – Bar code and two-dimensional symbols for shipping, transport and receiving labels*

ISO 15649, *Petroleum and natural gas industries – Piping*

ISO 16110-1, *Hydrogen generators using fuel processing technologies*¹

ISO 16528, *Boilers and pressure vessels – Registration of Codes and Standards to promote international recognition*

3 Terms and definitions

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

3.1

basic insulation

insulation to provide primary protection against electric shock

3.2

electromagnetic interference

EMI

degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

[IEV 161-01-06]

¹ To be published.

3.3 electromagnetic disturbance EMD

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

[IEV 161-01-05]

3.4 enclosure

part of the equipment providing one or more of the functions as described in a), b) and c) below

- a) Fire enclosure – a part of the equipment intended to minimize the spread of fire or flames from within.
- b) Mechanical enclosure – a part of the equipment intended to reduce the risk of injury due to mechanical and other physical hazards.
- c) Electrical enclosure – a part of the equipment intended to limit access to parts that may be at hazardous voltage or hazardous energy levels.

NOTE One type of enclosure can be inside another type (e.g. an electrical enclosure inside a fire enclosure or a fire enclosure inside an electrical enclosure). Also, a single enclosure can provide the functions of more than one type (e.g. those of both an electrical enclosure and a fire enclosure).

3.5 energy hazard

hazard considered to exist at any exposed live parts of a power supply if, between the exposed live parts and an adjacent exposed live or unenergized metal part of different polarity, there exists a potential of 2 V or more and either an available continuous power level of 240 VA or more, or a reactive energy level of 20 J or more

3.6 hazardous location

any area or space where combustible dust, ignitable fibers, or flammables, volatile liquids, gases, vapours or mixtures are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures

3.7 hazardous energy level

stored energy level of 20 J or more, or an available continuous power level of 240 VA or more, at a potential of 2 V or more

3.8 hazardous voltage

voltage exceeding 42,4 V a.c. peak (30 V r.m.s.), or 60 V d.c., existing in a circuit which does not meet the requirements for a limited current circuit

3.9 heat deflection temperature HDT

measure of a polymer's resistance to distortion under a given load at elevated temperatures. The deflection temperature is the temperature at which a test bar, loaded to the specified bending stress, deflects by 0,25 mm

3.10**limited current circuit**

circuit which is so designed and protected that, under both normal operating conditions and single fault conditions, the current which can be drawn is not hazardous

NOTE For specific limits, refer to 2.4 of IEC 60950.

3.11**live part**

metal or other conductive part that has a voltage difference with respect to earth or any conductive part in normal use

3.12**maximum allowable working pressure****MAWP**

maximum gauge pressure at which a part or system may be operated

NOTE It is the pressure used in determining the setting of pressure-limiting/relieving devices installed to protect the part or system from accidental over-pressuring.

3.13**maximum operating pressure**

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

3.14**micro fuel cell systems**

fuel cell power systems and fuel containers that are wearable or easily carried by hand, providing d.c. outputs that do not exceed 60 V d.c.. and power output of 240 VA. These d.c. units power or recharge consumer electric devices

3.15**operator access area**

area for which under normal operating conditions

- a) access is gained without the use of a tool; or
- b) the means of access is deliberately provided to the operator; or
- c) the operator is instructed to enter regardless of whether or not tools are needed to gain access

NOTE In this standard, the terms "access" and "accessible", unless qualified, relate to operator access as defined above.

3.16**portable fuel cell system(s)**

fuel cell power system which is intended to be moved while in operation and not fastened or otherwise secured to a specific location

3.17**portable stand alone system**

system that is not designed to be connected to the energized mains

3.18**reinforced insulation**

single insulation system that provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the standard

3.19

secondary circuit

circuit which has no direct connection to a *primary circuit* and derives its power from a transformer, converter or equivalent isolation device, or from a battery

[IEC 60950]

3.20

SELV

Safety Extra Low Voltage

secondary circuit which is so designed and protected that under normal operating conditions and single fault conditions, its voltages do not exceed a safe value

[IEC 60950]

Safety Extra Low Voltage Circuit abbreviated is SELV Circuit.

3.21

service personnel

trained persons having familiarity and experience with the construction and operation of the system and the risks involved

3.22

supplementary insulation

independent insulation applied in addition to basic insulation in order to reduce the risk of electric shock in the event of a failure of the basic insulation

3.23

thermal stability

stable temperature conditions, pseudo steady-state, arbitrarily indicated by temperature changes of no more than 3 K or 1 % of the absolute operating temperature, whichever is higher between two readings 15 min apart

3.24

tool

screwdriver, coin, key, or any other object that may be used to operate a screw, latch, or similar fastening means

3.25

touch voltage

voltage between conductive parts when touched simultaneously by a person or an animal

NOTE The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

3.26

uninterruptible power system

UPS

combination of convertors, switches and energy storage devices (for example, batteries), constituting a power system for maintaining continuity of load power in case of input power failure

3.27

wet battery

battery in which the electrolyte is in liquid and mobile form

4 Requirements

4.1 Physical environment and operating conditions

The portable fuel cell system and its protective systems shall be so designed and constructed as to be capable of performing their intended function in the physical environment and operating conditions specified in 4.1.1 to 4.1.2.

4.1.1 Electrical power input

The fuel cell system shall be designed to operate correctly with the conditions of electrical power input specified in IEC 60204-1 or as otherwise specified by the manufacturer.

4.1.2 Handling, transportation, and storage

The portable fuel cell system shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures. The fuel cell system or each component part thereof shall be packaged or designed so that it can be stored safely and without damage (e.g. adequate stability, special supports, etc.).

The manufacturer shall specify special means for handling, transportation and storage if required.

Shipping labels and bar codes should meet requirements described in ISO 15394 (packaging-bar code and two-dimensional symbols for shipping, transport and receiving labels).

4.2 Material compatibility

- a) All parts and all substances shall be suitable for the range of temperatures and pressures to which they are subjected during expected usage; and resistant to the reactions, processes, environments and other conditions to which they are exposed during expected usage.
- b) Any part that is exposed directly to liquid fuel, moisture, condensate, etc. as well as fasteners used to attach any part that must be adjusted or removed for servicing, shall be corrosion-resistant and suitable for the application.
- c) Ferrous materials used in the construction of the outside casing, and in an outside cabinet which is the sole enclosure of current-carrying parts, shall be adequately protected against corrosion.
- d) Asbestos or asbestos-containing material(s) shall not be used in the construction of a portable fuel cell system.

4.2.1 Polymeric and elastomeric components

Polymeric and elastomeric piping, tubing and components shall be permitted under the following conditions:

- a) materials shall be demonstrated to be suitable for the combined maximum operating temperatures and pressures and compatibility with other materials and chemicals with which they will come in contact in normal operation, service and maintenance over the manufacturer-defined life span of the product. Guidance can be found in ISO 4080;

- b) polymeric or elastomeric components shall be protected from mechanical damage within the enclosure. Shielding may be used as appropriate to protect components against failure of rotating equipment or other mechanical devices housed within the unit;
- c) any compartment enclosing polymeric or elastomeric components used to convey flammable gases shall be protected against the possibility of overheating. A control system shall be provided to terminate fuel flow before temperatures reach 10 °C below the lowest HDT (Heat Deflection Temperatures) of the materials used in the fuel conveying components;
- d) polymeric or elastomeric materials used to convey flammable gas shall be conductive to avoid static build-up if conveying dry gases. Materials shall have a maximum resistance of 1 MΩ when tested in compliance with IEC 61340-2-1.

4.2.2 Fuel connection devices

Fuel connection devices constructed of copper alloys, such as brass or bronze, shall be resistant to stress corrosion cracking. Guidance can be found in ISO 15156-1.

4.3 Protection against mechanical hazards

Adequate protection shall be provided against accidental contact with all moving parts. All parts that may be contacted during normal usage, adjustment or servicing shall be free from sharp projections or edges.

Under conditions of normal use, portable fuel cell systems shall not be susceptible to tipping. Compliance with this clause is demonstrated in 8.13.

Equipment shall have adequate mechanical strength and shall be so constructed as to remain safe in the meaning of this standard when subjected to handling as may be expected.

4.4 Protection against toxicity of fuels and fuel feedstocks

Precautions shall be taken in the design of the portable fuel cell system and fuel supply to avoid spillage or unnecessary exposure of personnel to gaseous or liquid fuels, particularly where such fuel may be potentially harmful due to corrosive effects, inhalation or skin absorption.

Such gaseous fuels (or liquid fuels which may produce toxic vapours) shall be stored in sealed containers, with the contents accessible only via couplings which are interactive with the portable fuel cell system supply lines, for example “quick connect” type connectors.

The possible hazards resulting from use of fuels shall be detailed in the operating and storage instructions provided with the portable fuel cell system, together with precautions to be taken when handling the materials, the maximum exposure levels in continuous use, and means to deal with spillage or contamination of personnel.

4.5 Protection against explosion hazards

The portable fuel cell system shall be designed and constructed to avoid any credible risk of fire or explosion posed by the portable fuel cell system itself or by gases, liquids, dust, vapours or other substances produced or used by the portable fuel cell system.