INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC/PAS 62282-6-1

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Fuel cell technologies – Part 6-1: Micro fuel cell power systems – Safety

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International Standard IEC 62282-6-1 has been prepared by IEC technical committee 105:

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date[1)] 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- withdrawn,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.

1) The National Committees are requested to note that for this publication the maintenance result date is ....

CONTENTS

1 SCOPE

1.1 System Boundary

1.1.1 Scope: This consumer safety standard covers fuel cell power systems, power units and fuel cartridges that are wearable or easily carried by hand, providing dc outputs that do not exceed 60 V D.C. and power outputs that do not exceed 240 VA. As such, the externally accessible circuitry are considered circuits that are “SELV” as defined in IEC 60950-1, and are considered to be limited power circuits if further compliance with IEC 60950-1, Section 2.5 is demonstrated. Systems that have internal systems exceeding 60 V D.C. Or 240 VA must be appropriately evaluated in accordance with separate criteria of IEC 60950-1.

1.1.2 This consumer safety specification covers all fuel cell power systems, units and cartridges. This specification establishes requirements for all fuel cell power systems, units and cartridges to ensure a reasonable degree of safety for normal use, reasonably foreseeable misuse, and consumer transportation of such items. The cartridges covered by this standard are not intended to be refilled by the consumer. Cartridges refilled by the manufacturer or by trained technicians must meet all requirements of this standard as unused cartridges.

1.1.3 This Standard also covers compatible and separately transported fuel storage fuel cartridges for supplying fuel to the fuel cell power unit.

1.1.4 Fuel cell power systems that provide output levels that exceed electrical limits specified in 1.1.1 are covered by the Standard for Portable Fuel Cell Power Systems, IEC 62282-X.

1.1.5 These products are not intended for use in hazardous areas.

1.1.6 Fuels and technologies covered:

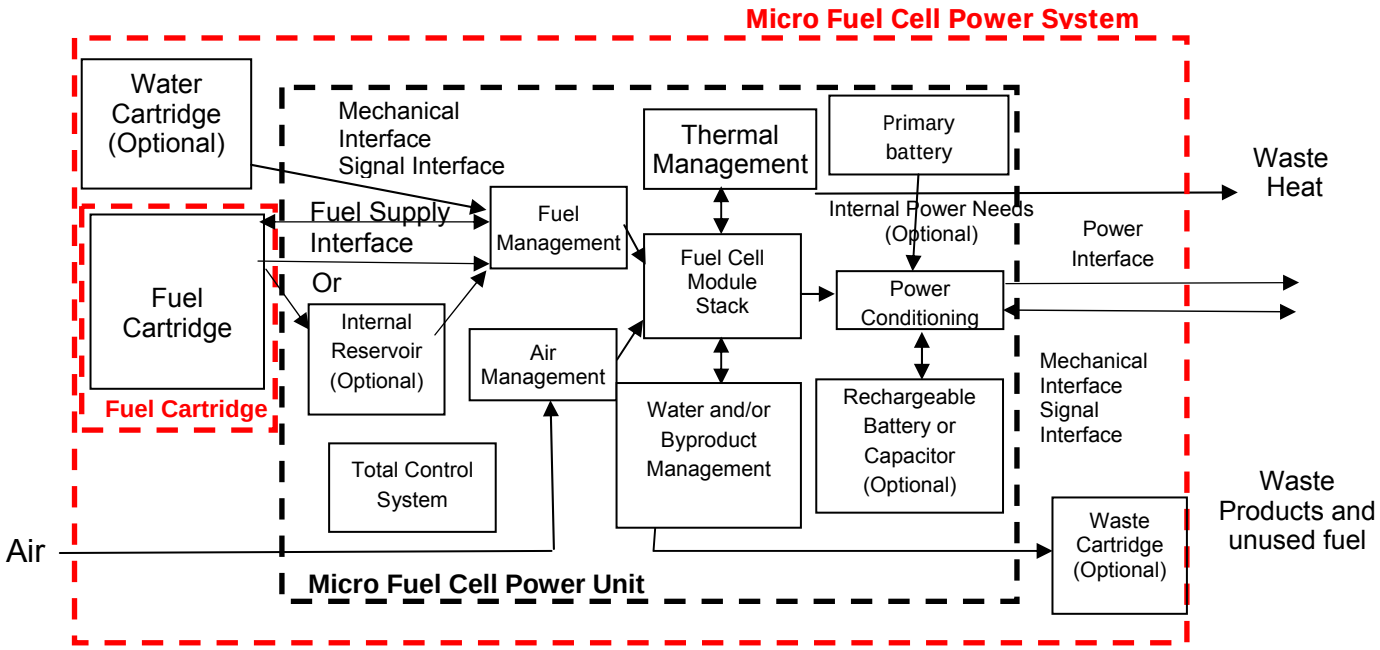
1.1.6.1 This standard includes methanol or methanol and water solutions as fuels.

1.1.6.2 This standard includes equipment designs that include proton exchange membrane (PEM) fuel cell stacks and direct methanol fuel cell stacks (DMFC).

1.1.6.3 This standard includes requirements for other fuels and the associated systems in the annexes, formatted as deviations or additional requirements to the main standard.

1.1.6.4 It is understood that all fuel cartridges, power units and fuel cell systems shall comply with applicable country and local requirements including transportation, child-resistance, and storage, where required.

Figure 1.1


Micro Fuel Cell Power System
Water Cartridge (Optional)
Mechanical Interface Signal Interface
Thermal Management
Primary battery
Waste Heat
Fuel Supply Interface
Fuel Management
Internal Power Needs (Optional)
Power Interface
Fuel Cartridge
Or
Fuel Cell Module Stack
Power Conditioning
Internal Reservoir (Optional)
Air Management
Mechanical Interface Signal Interface
Fuel Cartridge
Water and/or Byproduct Management
Rechargeable Battery or Capacitor (Optional)
Total Control System
Waste Products and unused fuel
Air
Waste Cartridge (Optional)
Micro Fuel Cell Power Unit

1.2 Equivalent Level of Safety

The requirements of this standard are not intended to constrain innovation. The manufacturer may consider fuels, materials, designs or constructions not specifically dealt with in this document. These alternatives shall be evaluated as to their ability to yield levels of safety equivalent to those prescribed by this standard.

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 60950-1, Information Technology Equipment – Safety - Part 1: General Requirements

ISO 188, Rubber, Vulcanised or Thermoplastic – Accelerated Ageing and Heat Resistance;

ISO 1817, Rubber, Vulcanised – Determination of the Effects of Liquids.

ISO 175, Plastics – Methods of Test for Determination of the Effects of Immersion in Liquid Chemicals.

ISO 15649, Petroleum and natural gas industries – Piping

ANSI/ASME B31.3, Process Piping

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

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

IEC 60695-2-20, Fire hazard testing - Part 2-20: Glowing/hot wire based test methods - Hot-wire coil ignitability - Apparatus, test method and guidance

ISO 9772, Cellular plastics -- Determination of horizontal burning characteristics of small specimens subjected to a small flame

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 60079-15, Electrical apparatus for explosive gas atmospheres - Part 1: Flameproof enclosures 'd'

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

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

IEC 60086-4 Edition 2 (2000-03), Primary Batteries – Part 4: Safety of Lithium Batteries

IEC 6190 Edition 1.0 (2003-12) Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Secondary Lithium Cells and Batteries for Portable Applications.

3 DEFINITIONS

The following definitions apply in this Standard:

3.1
ENCLOSURE
Parts of the micro fuel cell intended to be a barrier to protect, shield, and control access to the internal components or material.

3.2
FIRE ENCLOSURE
A part of the fuel cell power unit that is intended to minimize the spread of fire or flames from within.

3.3
FUEL
The following substances are considered fuels:

1. Methanol or methanol/water solution regardless of the concentration that is used to produce electricity in the fuel cell unit
2. Formic Acid
3. Hydrogen
4. Methanol Clathrate Compound
5. Borohydride Compounds
6. Butane

Note: Fuel 1, methanol or methanol / water solution, is covered by the main body of the standard. Annexes A through F cover other fuels 2 through 6.

3.4
FUEL CARTRIDGE
An removable article that contains and supplies fuel to the fuel cell power unit or internal reservoir, not to be refilled by the user.

3.5
INSERT CARTRIDGE
A fuel cartridge, which has its own enclosure and is installed within the enclosure of the device powered by the fuel cell power system.

3.6
EXTERIOR CARTRIDGE
A fuel cartridge, which has its own enclosure that forms a portion of the enclosure of the device powered by the fuel cell power system.

3.7
ATTACHED CARTRIDGE
A fuel cartridge, which has its own enclosure that connects to the device powered by the fuel cell power system.

3.8
SATELLITE CARTRIDGE
A fuel cartridge that is intended to be connected to and removed from the fuel cell power unit to transfer fuel to the internal reservoir inside the micro fuel cell power unit.

3.9
FUEL CELL POWER UNIT
A fuel cell power unit is intended for use in a product in which service and replacement of the fuel cell power unit will be done only by the user or by a person who has been trained to service and repair the product.

3.10
FUEL SUPPLY UNIT, NON-PRESSURIZED
A cartridge in which the normal working pressure does not exceed a gauge pressure of 50 kPa at 22 DEG C.

3.11
FUEL SUPPLY UNIT, PRESSURIZED
A cartridge in which the normal working pressure exceeds a gauge pressure of 50 kPa at 22 DEG C.

3.12
HAZARDOUS LIQUID FUEL
Any liquid fuel amount over 5 ml or a concentration of methanol greater than or equal to 4% by weight in water. Other hazardous fuel definitions are given in annexes a through f.

3.13
INTERNAL RESERVOIR
A structure in a fuel cell power unit that stores fuel and cannot be removed.

3.14
LEAKAGE
Accessible hazardous liquid fuel outside the system or cartridge.

3.15
LIMITED POWER SOURCES
Circuits supplied by a limited power source are not considered to be a potential fire hazard due to the limits on available power to the circuits. A limited power source is either inherently or non-inherently limited.

Note: An inherently limited power source does not rely on a current limiting device to meet limited power requirements although it may rely on an impedance to limit its output. However, a non-inherently limited power source relies upon a current limiting device such as a fuse, etc. to limit meet limited power requirements.

3.16
MATERIAL, TOXIC
Any material having a toxic hazard rating of 2, moderate, in the Sax's Dangerous Properties of Industrial Materials reference book or related reference guide.

3.17
MECHANICAL ENCLOSURE
Parts of the micro fuel cell intended to be a barrier to protect, shield, and control access to the internal components or material.

3.18
MICRO FUEL CELL
Fuel cell power system and fuel cartridge that is wearable or easily carried by hand, providing dc output that do not exceed 60 V D.C. and power outputs that do not exceed 240 VA.

3.19
NO ACCESSIBLE LIQUID
Consumer cannot come into physical contact with HAZARDOUS liquid fuel.

3.20
NO FUEL VAPOR LOSS
Fuel vapor escaping from the cartridge or system is less than 0.33 g/h.

3.21
NO LEAKAGE
No accessible hazardous liquid fuel outside the system or cartridge.

3.22
ROOM
Denotes a constructed closed environment having a 2.1 – 2.4 m (7 – 8 ft) high ceiling and having a total volume based on the intended portable fuel cell power unit application.

3.23
VALVE, REFILL
Component of the non-user-refillable fuel cartridge that allows refilling the cartridge only by trained technicians.

3.24
VALVE, SHUT-OFF
Component of a fuel cartridge that controls the release of fuel.

3.25
WASTE CARTRIDGE
The cartridge that stores waste and by-products from the power unit.

3.26
WATER CARTRIDGE
The cartridge that is filled with water (no additives) to adjust fuel concentration.

4 Materials and Construction of Fuel cartridge, Micro Fuel Cell Power Unit and Micro Fuel Cell Power System for Portable Devices

4.1 General

4.1.1 The fuel cell power unit when coupled to the fuel cartridge shall be designed and constructed to avoid any credible risk of fire or explosion posed by the fuel cell power system itself or gases, vapors, liquids or other substances produced or used by the fuel cell power system.

4.1.2 To prevent a fire or explosion hazard within the fuel cell power system, the manufacturer shall eliminate potential ignition source(s) within areas where fuel is present (or can be potentially released).

4.1.3 Flammable, toxic and corrosive fluids shall be kept within a closed containment system such as within fuel piping, in a reservoir, a cartridge or similar enclosure to avoid leakage.

4.2 FMEA/Hazard Analysis

4.2.1 A Failure Modes and Effects analysis (FMEA) or equivalent reliability analysis shall be conducted by the manufacturer to identify faults which can have safety related consequences and the design features that serve to mitigate those faults. The analysis shall include failures that may result in leakage. Failures related to refilling of non-user refillable cartridges, if anticipated by the manufacturer or trained technicians, must be considered.

4.2.2 Guidance can be found in IEC 61025, Fault Tree Analysis and IEC 60812, Procedures for Failure Mode and Effects Analysis (FMEA).

4.3 Fuel Input

4.3.1 The manufacturer of the fuel cell system, power unit and/or fuel cartridges shall specify the type and characteristics of the fuel and if applicable, the quality and characteristics of the fuel and water to be employed with the fuel cell power system. This information shall be provided as part of the documentation provided with the system.

4.3.2 The fuel cell power units shall specify the fuel cartridge(s) that it is intended for. This information shall be provided as part of the documentation provided with the fuel cell power unit or fuel cell power system.

4.4 General Materials

The materials and coating shall be resistant to corrosion under the normal transportation and normal usage conditions over the life span of the product.

4.5 Selection of Materials

4.5.1 Non-metallic materials such as rubber and plastics shall be selected so as to be resistant to deterioration under their normal usage conditions over the life span of the product.

4.5.2 Materials employed in the fuel cell system and cartridge shall be resistant to the affects of temperature and exposure to fuels and the effects of weather as outlined in 4.7.

4.5.3 Metallic and non-metallic materials used to construct internal or external parts of the fuel cell power system, in particular those exposed directly or indirectly to moisture, fuel and/or by-products in either a gas or liquid form as well as all parts and materials used to seal or interconnect the same, e.g. welding consumables, shall be suitable for all physical, chemical and thermal conditions which are reasonably foreseeable within the scheduled lifetime of the equipment and for all test conditions; in particular:

- They shall retain their mechanical stability with respect to strength (fatigue properties, endurance limit, creep strength) under normal usage.

- They shall be sufficiently resistant to the chemical and physical action of the fluids that they contain and to environmental degradation;

- The chemical and physical properties necessary for operational safety shall not be significantly affected within the expected lifetime of the equipment;

- Specifically, when selecting materials and manufacturing methods, due account shall be taken of the material’s corrosion and wear resistance, electrical conductivity, impact strength, ageing resistance, the effects of temperature variations, the effects arising when materials are put together (e.g. galvanic corrosion), and the effects of ultraviolet radiation.

- Where conditions of erosion, abrasion, corrosion or other chemical attack may arise, adequate measures shall be taken to:

- minimise that effect by appropriate design, e.g. additional thickness, or by appropriate protection, e.g. use of liners, cladding materials or surface coatings, taking due account of NORMAL use,

- permit replacement of parts which are most affected,

- and draw attention, in the manual referred to in clause 6, to type and frequency of inspection and maintenance measures necessary for continued safe use; where

appropriate, it shall be indicated which parts are subject to wear and the criteria for replacement.

4.5.4 Elastomeric materials such as gaskets and tubing in contact with fuels shall be resistant to deterioration when in contact with those fuels and shall be suitable for the temperatures that they are exposed to during normal use. Compliance shall be determined by the following: ISO 188, Rubber, Vulcanized or Thermoplastic – Accelerated Aging and Heat Resistance; ISO 1817: Rubber, Vulcanized – Determination of the Effects of Liquids.

4.5.5 Polymeric materials in contact with fuels shall be resistant to deterioration when in contact with those fuels and shall be suitable for the temperature they are exposed to during normal use. Compliance shall be determined by ISO 175, Plastics – Methods of Test for Determination of the Effects of Immersion in Liquid Chemicals.

4.6 Deleted

4.7 General Construction

4.7.1 Micro fuel cell power systems shall have a safe construction that is resistant to impact (DROP), vibration, crushing, environmental changes such as temperature, moisture and atmospheric pressure fluctuations during normal use, reasonably foreseeable misuse, and consumer transportation of such items.

4.7.2 Connection mechanisms, including the connection between a detachable fuel cartridge and the fuel cell system, and the electrical connection between the fuel cell module and device, shall be designed such that they cannot be attached at a wrong location or in an incomplete state in such a way that leakage occurs

4.7.3 An edge projection or corner of a fuel cell power system and a fuel cartridge shall not be sufficiently sharp to result in a risk of injury to persons during intended use or user maintenance.

4.8 Deleted

4.9 Piping and fittings

4.9.1 Where piping systems are designed for internal pressures over 50 kPa they shall be designed, constructed, and tested in accordance with ISO INTERNATIONAL STANDARD ISO 15649, *Petroleum and natural gas industries — Piping*, or its contained normative reference, ANSI/ASME B31.3, *Process Piping*.

4.9.2 Piping designed for operation below 50 kPa or, in accordance with the applicable regional or national pressure equipment codes and standards do not qualify as pressure piping, such as low pressure water hoses, plastic tubing, or other connections to atmospheric or low pressure tanks and similar containers, shall be constructed of suitable materials and their related joints and fittings, shall be designed and constructed with adequate strength and leakage resistance to prevent unintended releases.

4.9.3 The piping shall comply dimensionally with the technical requirements above, and the materials shall be compatible with the intended fluids and process parameters.

4.9.4 Threaded portions shall only be allowed in cases where a leakage does not create a hazard, for example, air supply, cooling circuits. All other joints shall be glued, welded, brazed, or sealed, or at least have fitting connections with a defined sealing area as specified by the manufacturer.