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Fuel cell technologies –

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

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

FOREWORD

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A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62282-6-1 has been processed by IEC technical committee 105: Fuel cell technologies.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
105/96/PAS	105/104/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard. Its structure will then be adapted to the IEC rules.

This PAS shall remain valid for an initial maximum period of three years starting from 2006-02. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

The contents of the corrigendum of April 2007 have been included in this copy.

FUEL CELL TECHNOLOGIES –

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

1 Scope

1.1 System boundary

1.1.1 This consumer safety PAS covers fuel cell power systems, power units and fuel cartridges that are wearable or easily carried by hand, providing d.c. outputs that do not exceed 60 V d.c. and power outputs that do not exceed 240 VA. As such, the externally accessible circuitry is considered as circuits that are "SELV" as defined in IEC 60950-1, and as limited power circuits if further compliance with IEC 60950-1, 2.5 is demonstrated. Systems that have internal systems exceeding 60 V d.c. or 240 VA should be appropriately evaluated in accordance with the separate criteria of IEC 60950-1.

1.1.2 This consumer safety PAS covers all fuel cell power systems, units and cartridges. This PAS 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 PAS are not intended to be refilled by the consumer. Cartridges refilled by the manufacturer or by trained technicians should meet all the requirements of this PAS as unused cartridges.

1.1.3 This PAS 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 IEC 62282-5.

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 PAS includes methanol or methanol and water solutions as fuels.

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

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

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

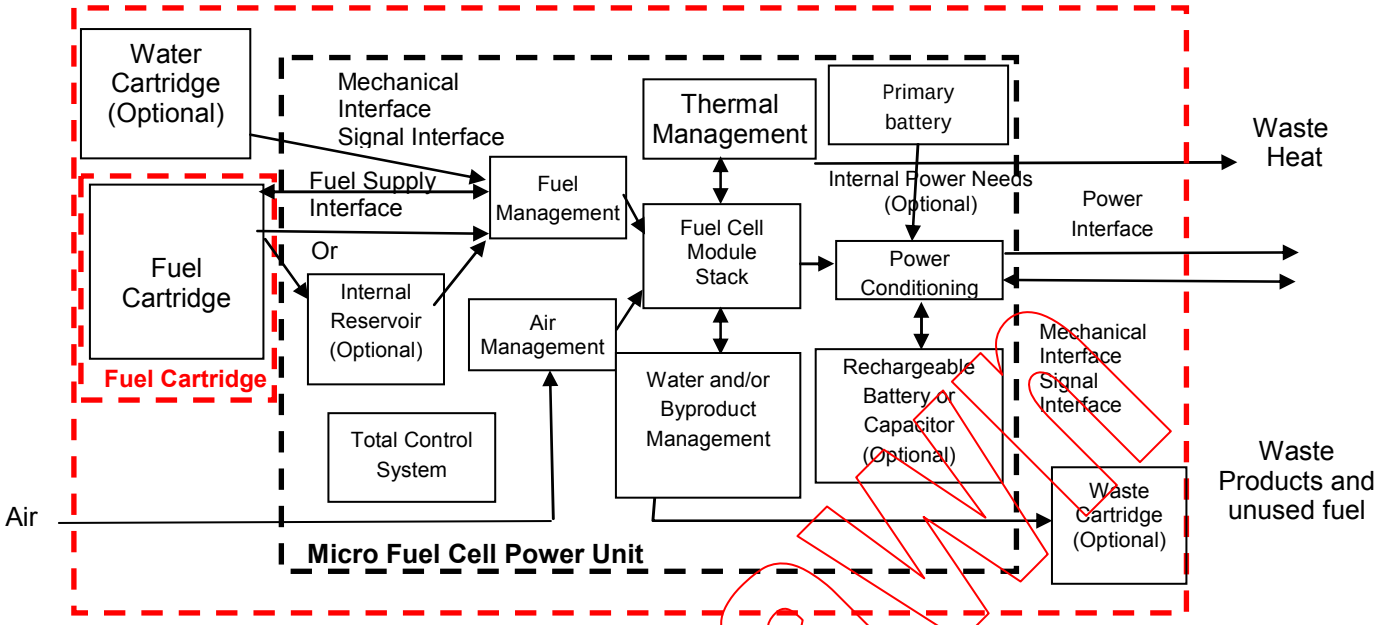

Figure 1 – Micro fuel cell power system

1.2 Equivalent Level of Safety

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

2 Normative references

The following referenced documents are indispensable for the application of this PAS. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-15:2005, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection 'n' electrical apparatus*

IEC 60086-4:2000, *Primary batteries – Part 4: Safety of lithium batteries*

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

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

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 61025, *Fault tree analysis*

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

IEC 61960, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*

ISO 175, *Plastics – Methods of test for determination of the effects of immersion in liquid chemicals*

ISO 188, *Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests*

ISO 1817, *Rubber, vulcanized – Determination of the effect of liquids*

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

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

ISO 16000-3, *Indoor air – Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method*

ISO 16000-6, *Indoor air – Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax Ta sorbent, thermal desorption and gas chromatography using MS/FID*

ISO 16017-1, *Indoor, ambient and workplace air – Part 1: Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography – Part 1: Pumped sampling*

ANSI/ASME B.31.3, *Process piping*

3 Terms and definitions

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

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
part of the fuel cell power unit that is intended to minimize the spread of fire or flames from within

3.3
fuel
one of the following substances:

a) Methanol or methanol/water solution regardless of the concentration that is used to produce electricity in the fuel cell unit

b) Formic acid

c) Hydrogen

d) Methanol clathrate compound

e) Borohydride compounds

f) Butane

NOTE The methanol or methanol/water solution, is covered by the main body of the PAS. Annexes A through F cover the other fuels.

3.4
fuel cartridge
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
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
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
fuel cartridge, which has its own enclosure that connects to the device powered by the fuel cell power system

3.8
satellite cartridge
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
fuel cell power unit 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
cartridge in which the normal working pressure does not exceed a gauge pressure of 50 kPa at 22 °C

3.11
fuel supply unit, pressurized
cartridge in which the normal working pressure exceeds a gauge pressure of 50 kPa at 22 °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
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 meet limited power requirements.

3.16
material, toxic
any material having a toxic hazard rating of 2, moderate, in Sax's "Dangerous Properties of Industrial Materials" 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 a d.c. output that does 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 vapour loss
fuel vapour escaping from the cartridge or system of less than 0,33 g/h

3.21
no leakage
no accessible hazardous liquid fuel outside the system or cartridge

3.22
room
constructed closed environment having a 2,1 m to 2,4 m (7 ft to 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
cartridge that stores waste and by-products from the power unit

3.26
water cartridge
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, vapours, 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, shall be considered.

4.2.2 Guidance can be found in IEC 61025.

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 lifespan 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 lifespan 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

  – minimize 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 ISO 188 and ISO 1817.

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.

4.6 Vacant

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 in such a way that they cannot be attached at a wrong location or in an incomplete state so 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 the intended use or user maintenance.