

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1 AMENDEMENT 1

Fuel cell technologies –
Part 6-100: Micro fuel cell power systems – Safety

Technologies des piles à combustible –
Partie 6-100: Systèmes à micropiles à combustible – Sécurité



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FOREWORD

This amendment has been prepared by IEC technical committee 105: Fuel cell technologies.

This bilingual version (2019-09) corresponds to the monolingual English version, published in 2012-10.

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

FDIS	Report on voting
105/402/FDIS	105/408/RVD

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

The French version of this amendment has not been voted upon.

The committee has decided that the contents of this amendment and the base 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

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2 Normative references

Add the following reference:

ISO 7010:2003, *Graphical symbols – Safety colours and safety signs – Safety signs used in workplaces and public areas*

6.1 General

Replace the existing text of 6.1 with the following new text:

All micro fuel cell power systems, micro fuel cell power units and fuel cartridges shall be accompanied by appropriate safety information (instructions, warnings, or both) communicating the intended safe transportation, use, storage, maintenance and disposal of the product, including warnings regarding adequate ventilation for storage.

If space does not permit all markings on the fuel cartridge, markings corresponding to a) through f) in 6.2 may be on the smallest unit package, or on a package insert. The fuel cartridge shall also be marked with the appropriate signal word ("CAUTION", "WARNING" or "DANGER") and the general warning sign (W001 specified in ISO 7010:2003) plus the text:

"(See accompanying Warning Information.)".

E.3 Terms and definitions

Add, after E.3.5, the following new terminological entry:

E.3.6

fuel cartridge

removable article that contains fuel and supplies fuel or hydrogen to the micro fuel cell power unit or internal reservoir, not to be refillable by the user

E.3.11

leakage

Replace the definition of terminological entry E.3.11 with the following:

accessible fuel, hazardous fuel byproducts, electrolyte or hazardous liquid fuel outside the micro fuel cell power system, micro fuel cell power unit or fuel cartridge as described in E.7.2.1

E.3.43

impermissible hydrogen gas loss

Replace the definition of terminological entry E.3.43 with the following:

hydrogen gas escaping non-operating micro fuel cell power system, micro fuel cell power unit, or fuel cartridge greater than or equal to 0,0032 g/h

E.3.52

hydrogen leakage

Replace the definition of terminological entry E.3.52 with the following:

accessible hazardous hydrogen gas outside containment system, including fuel cartridge, fuel management and internal reservoir (see E.7.2.2)

E.3.53

positive pH indication of liquid borohydride fuel and by product

Delete this entry (number, term and definition).

E.7.2.2 Hydrogen leakage measurement from fuel cartridges and measurement procedures

Replace the existing text of E.7.2.2, with the following new text:

- a) For fuel cartridges containing Class 8 (corrosive) borohydride compounds, the measurement of hydrogen leakage shall be done following each type test using a liquid leak detector (bubble forming) solution or other equivalent means, such as a water immersion test, on all possible leak locations of the fuel cartridge.
- b) If bubbles are observed, hydrogen point source gas loss detection testing in accordance with E.7.3.13 shall be performed to ensure no release of hazardous materials to the environment.
- c) If point source testing is performed, hydrogen leakage measurement in accordance with paragraph (a) shall be repeated one hour after completion of the point source test. If bubbles due to hydrogen leakage are observed, the fuel cartridge fails the hydrogen leakage test. See Figure E.2 and Figure E.3.

E.7.2.3 Hydrogen gas loss measurements from micro fuel cell power systems and micro fuel cell power units and measuring procedures

Replace the existing text of E.7.2.3, with the following new text:

For micro fuel cell power systems, or micro fuel cell power units, following the completion of each type test, the micro fuel cell power system or unit shall be tested for hydrogen gas loss according to Figure E.4 as follows.

- a) Perform hydrogen emission testing in accordance with E.7.3.12 with the exception that the micro fuel cell power system or unit shall be off ("DEVICE – OFF"). Hydrogen gas loss shall be less than 0,0032 g/h. If transient emission rates greater than 0,016 g/h are observed during hydrogen emission testing, hydrogen point source gas loss detection testing in accordance with E.7.3.13 shall be performed. See Table E.7.
- b) Perform hydrogen emission testing in accordance with E.7.3.12 with the micro fuel cell power system or unit turned on ("DEVICE – ON") to test for hydrogen emissions whether or not the micro fuel cell power system or unit is operational. Hydrogen emissions shall be less than 0,8 g/h and hydrogen leakage from any single point leak shall be less than 0,016 g/h. See Table E.7.

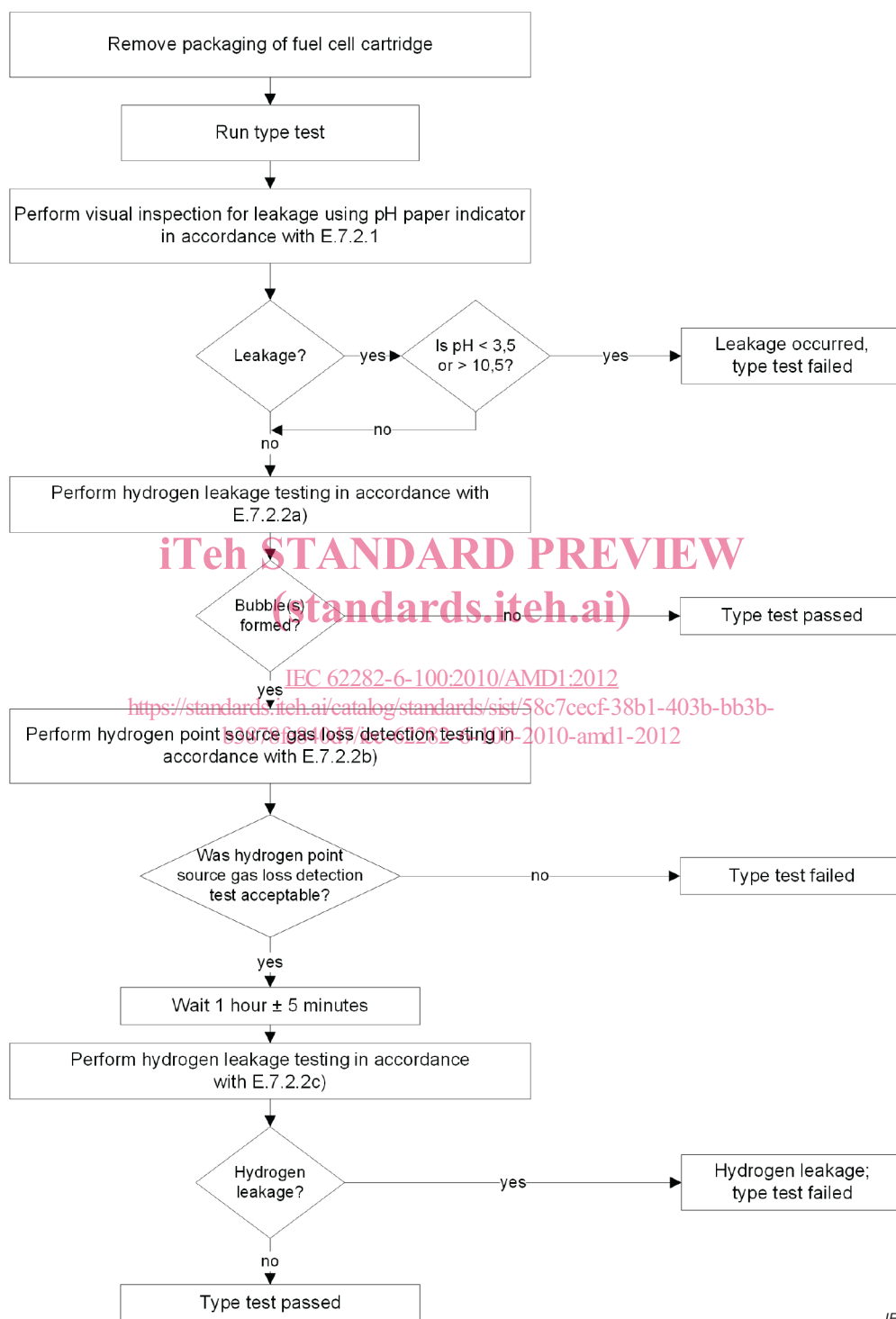
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Figure E.2 – Fuel cartridge leakage test flow chart for vibration, drop, compressive loading – Replaces Figure 2

Replace the existing Figure E.2, together with its title, with the following:

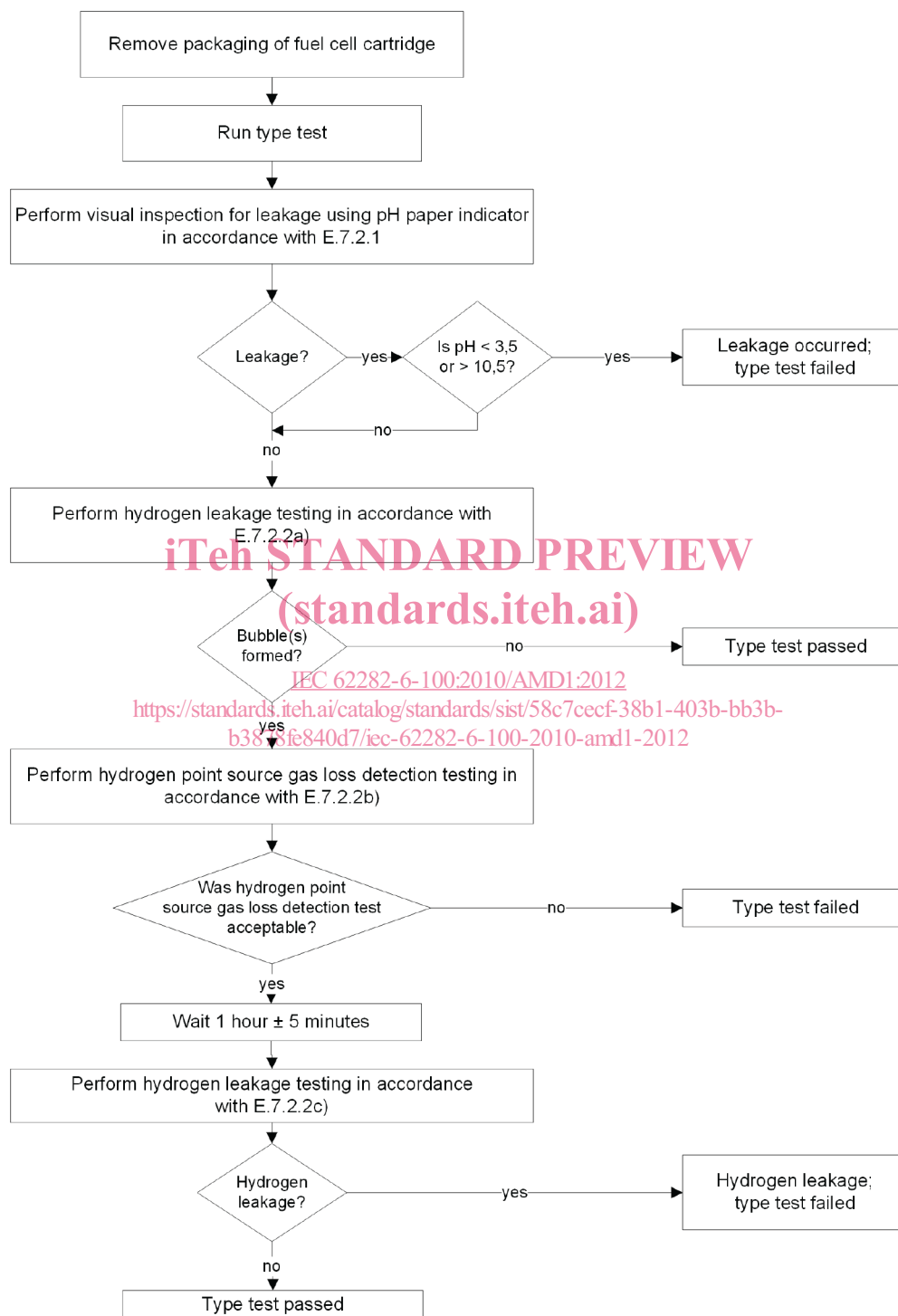


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Figure E.2 – Fuel cartridge leakage and hydrogen leakage and test flow chart for vibration, drop, compressive loading – Replaces Figure 2

Figure E.3 – Fuel cartridge leakage and mass loss test flow chart for temperature cycling test and high temperature exposure test – Replaces Figure 3

Replace the existing Figure E.3, together with its title, with the following:

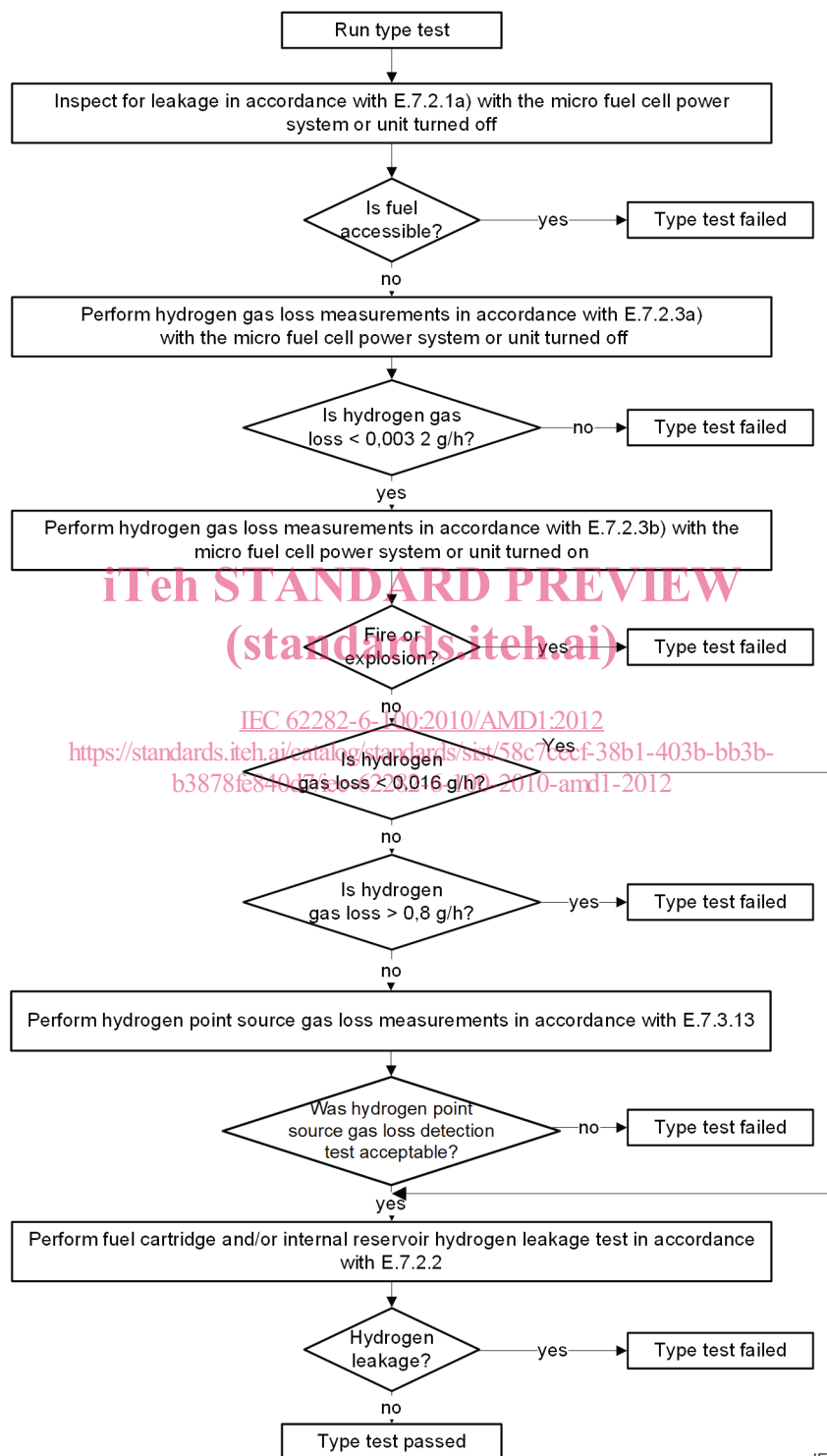


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Figure E.3 – Fuel cartridge leakage and hydrogen leakage test flow chart for temperature cycling test and high temperature exposure test – Replaces Figure 3

Figure E.4 – Micro fuel cell power system or micro fuel cell power unit leakage and mass loss test flow chart for pressure differential, vibration, temperature cycling, drop and compressive loading tests – Replaces Figure 4

Replace, the existing Figure E.4, together with its title, with the following:



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Figure E.4 – Micro fuel cell power system or micro fuel cell power unit leakage and hydrogen gas loss test flow chart for pressure differential, vibration, temperature cycling, drop and compressive loading tests – Replaces Figure 4

Figure E.5 – Micro fuel cell power system or micro fuel cell power unit leakage and mass loss test flow chart for external short-circuit test – Replaces Figure 5

Replace, the existing Figure E.5, together with its title, with the following:

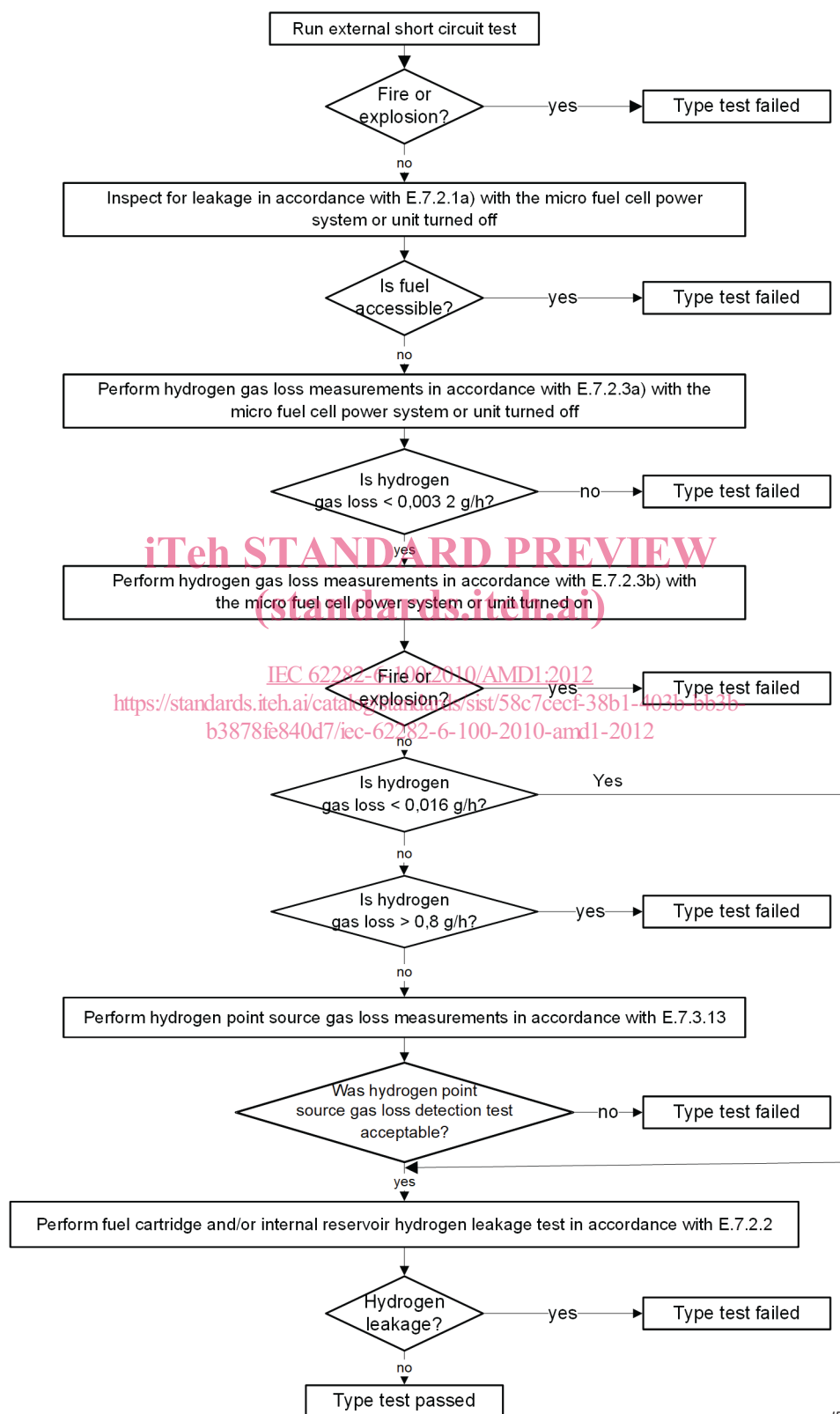


Figure E.5 – Micro fuel cell power system or micro fuel cell power unit leakage and hydrogen gas loss test flow chart for external short-circuit test – Replaces Figure 5

Figure E.6 – Micro fuel cell power system or micro fuel cell power unit leakage and mass loss test flow chart for 68 kPa low external pressure test – Replaces Figure 6

Replace, in the title of Figure E.6, the word “mass” with “hydrogen gas”.

Figure E.7 – Micro fuel cell power system or micro fuel cell power unit leakage and mass loss test flow chart for 11,6 kPa low external pressure test – Replaces Figure 7

Replace, in the title of Figure E.7, the word “mass” with “hydrogen gas”.

E.7.3.1.3 Fuel cartridge low external pressure test

Replace, under item c), the existing text of point 5) with the following new text:

- 5) Check for hydrogen leakage as described in E.7.2.2. See Figure E.16.

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No impermissible hydrogen gas loss. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator specified in the leakage measurement and test procedure in Subclause E.7.2.1 for the fuel cartridge and the micro fuel cell power system or unit. Hydrogen gas loss shall meet the requirements of Subclause E.7.2.3 (less than 0,0032 g/h) for the fuel cartridge and micro fuel cell power system or unit. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2.

E.7.3.1.4.1 Micro fuel cell power system or micro fuel cell power unit 68 kPa low external pressure test

Replace, under item c), the existing text of point 3) with the following new text:

- 3) For the micro fuel cell power system or unit, perform hydrogen gas loss measurements in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See B.7.3.1.3 for alternative methods to measure and calculate impermissible hydrogen gas loss during step 2.

E.7.3.1.4.2 Micro fuel cell power system or micro fuel cell power unit 11,6 kPa low external pressure test

Replace, under item c), the existing text of point 3) with the following new text:

- 3) For the micro fuel cell power system or unit, perform hydrogen gas loss measurements in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See B.7.3.1.4 for alternative methods to measure and calculate impermissible hydrogen gas loss during step 2.

E.7.3.2 Vibration test

Replace, under item c), the existing text of point 6) with the following new text:

- 6) Perform the following leakage tests:
- i) For the fuel cartridge, perform leakage tests in accordance with E.7.2.1, hydrogen leakage measurements in accordance with E.7.2.2. See Figure E.2.
 - ii) For the micro fuel cell power system or unit, perform visual inspection for leakage using pH paper in accordance with E.7.2.1a, and then perform hydrogen gas loss

testing in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See Figure E.4.

- iii) If the micro fuel cell power system or unit contains a fuel cartridge perform hydrogen leakage measurements in accordance with E.7.2.2.
- iv) If the micro fuel cell power system or unit contains an internal reservoir that contains hydrogen gas above ambient pressure, hydrogen leakage shall be checked following E.7.3.3, in accordance with E.7.3.3 c) 9(iii).

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator specified in the leakage measurement and test procedure in Subclause E.7.2.1 for the fuel cartridge and the micro fuel cell power system or unit. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge and micro fuel cell power system or unit. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually to verify that there is no disturbance to the micro fuel cell power system/unit. Emissions shall meet the passing criteria in E.7.3.12. If the micro fuel cell power system/unit does not operate but emissions do not exceed the limits of E.7.3.12, the emission test is acceptable.

E.7.3.3 Temperature cycling test

Replace, under item c), the existing text of points 9) and 10) with the following new text:

- 9) Perform the following leakage tests:
 - i) For the fuel cartridge, perform leakage tests in accordance with E.7.2.1, hydrogen leakage measurements in accordance with E.7.2.2. See Figure E.3.
 - ii) For the micro fuel cell power system or unit, perform visual inspection for leakage using pH paper in accordance with E.7.2.1a, and then perform hydrogen gas loss testing in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See Figure E.4.
 - iii) If the micro fuel cell power system or unit contains a fuel cartridge or an internal reservoir that contains hydrogen gas above ambient pressure, perform hydrogen leakage measurements in accordance with E.7.2.2.

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1 for the fuel cartridge and the micro fuel cell power system or unit. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge and the micro fuel cell power system or unit. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually to verify that there is no disturbance to the micro fuel cell power system/unit. Emissions shall meet the passing criteria in E.7.3.12. If the micro fuel cell power system/unit does not operate but emissions do not exceed the limits of E.7.3.12, the emission test is acceptable.

E.7.3.4 High temperature exposure test

Add, under item c), at the end of point 4), the following new text:

See Figure E.3.

Delete, under item c), the entirety of point 5).

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually.

E.7.3.5 Drop test

Replace, under item c), the existing text of points 7), 8), and 9) with the following new text:

- 7) Perform the following leakage tests:
- i) For the fuel cartridge, perform leakage tests in accordance with E.7.2.1, hydrogen leakage measurements in accordance with E.7.2.2. See Figure E.2.
 - ii) For the micro fuel cell power system or unit, perform visual inspection for leakage using pH paper in accordance with E.7.2.1a, and then perform hydrogen gas loss testing in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See Figure E.4.
 - iii) If the micro fuel cell power system or unit contains a fuel cartridge or an internal reservoir that contains hydrogen gas above ambient pressure, perform hydrogen leakage measurements in accordance with E.7.2.2.

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually to verify that there is no disturbance to the micro fuel cell power system/unit. Emissions shall meet the passing criteria in E.7.3.12. If the micro fuel cell power system/unit does not operate but emissions do not exceed the limits of Subclause E.7.3.12, the emission test is acceptable. If the micro fuel cell power system or unit is still operational, protective circuitry specified by the FMEA as part of the safety systems shall still be fully functional. There shall be no exposure of hazardous parts.

E.7.3.6.1 Micro fuel cell power system or micro fuel cell power unit

Replace, under item c), the existing text of point 6) with the following new text:

- 6) Perform the following leakage tests:
- i) Perform visual inspection for leakage using pH paper in accordance with E.7.2.1a, and then perform hydrogen gas loss testing in accordance with E.7.2.3 (including emission testing in accordance with E.7.3.12). See Figure E.4.
 - ii) If the micro fuel cell power system or unit contains a fuel cartridge or an internal reservoir that contains hydrogen gas above ambient pressure, perform hydrogen leakage measurements in accordance with E.7.2.2.

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator specified in the leakage measurement and test procedure in Subclause E.7.2.1, including after the fuel cartridge is installed in a micro fuel cell power system or unit and operated. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2, including after the fuel cartridge is installed in a micro fuel cell power system or unit and operated. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually to verify that there is no disturbance to the micro fuel cell power system/unit. Emissions shall meet the passing criteria in E.7.3.12. If the micro fuel cell power system/unit does not operate but emissions do not exceed the limits of E.7.3.12, the emission test is acceptable.

E.7.3.6.2 Fuel cartridge

Add, under item c), at the end of point 5), the following new text:

See Figure E.2.

Delete, under item c), the entirety of point 6).

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually.

E.7.3.7 External short-circuit test

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1. Hydrogen leakage shall meet the no hydrogen leakage requirements of Subclause E.7.2.2 for the fuel cartridge. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually to verify that there is no disturbance to the micro fuel cell power system/unit.

Exterior surfaces shall not exceed the temperatures shown in Table 2 during or after short circuit testing. Emissions shall meet the passing criteria in E.7.3.12. If the micro fuel cell power system/unit does not operate but emissions do not exceed the limits of E.7.3.12, the emission test is acceptable.

NOTE The external short circuit test can be done sequentially with the surface component and exhaust gas temperature test using the same sample.

E.7.3.9 Long-term storage

Replace, under item c), the existing text of point 7) with the following new text:

- 7) Perform leakage tests in accordance with E.7.2.1 and hydrogen leakage measurements in accordance with E.7.2.2. See Figure E.9.

Add, under item c), the following new item 8):

- 8) See B.7.3.9 for alternative methods to measure and calculate impermissible hydrogen gas loss.

Replace the existing text of item d) with the following new text:

- d) **Passing criteria:** No fire or flame at any time. No explosion at any time. No hydrogen leakage. No leakage of Class 8 (corrosive) borohydride fuel, fuel by-products, electrolyte or liquid fuel components. Leakage of Class 8 (corrosive) borohydride fuel, fuel byproducts, electrolyte, and liquid fuel components shall be determined visually using pH indicator as specified in the leakage measurement and test procedure in Subclause E.7.2.1. Hydrogen gas loss shall meet the requirements of Subclause E.7.2.3 (less than 0,0032 g/h). The hydrogen concentration in the temperature test chamber shall not exceed 25 % LFL at any time during the test. Hydrogen leakage shall meet the no hydrogen leakage of Subclause E.7.2.2. Fire and flame shall be checked using cheesecloth, infrared camera, or other suitable methods. Explosion shall be checked visually.

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