International Civil Aviation Organization

WORKING PAPER

DANGEROUS GOODS PANEL (DGP)
MEETING OF THE WORKING GROUP OF THE WHOLE

Atlantic City, United States, 4 to 8 April 2011

Agenda Item 2: Development of recommendations for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2013-2014 Edition
2.4: Part 4 — Packing Instructions
2.8: Part 8 — Provisions Concerning Passengers and Crew

FUEL CELL INDUSTRY UPDATE INTERNATIONAL ELECTROTECHNICAL COMMITTEE (IEC) 62282-6-100 INTERNATIONAL STANDARD FOR MICRO FUEL CELLS

(Presented by Fuel Cell and Hydrogen Energy Association (FCHEA))

SUMMARY

This paper provides an update on the adoption by the IEC of an International Standard for micro fuel cell safety and recommends to the DGP-WG/11 some follow up action.

Action by the DGP-WG is in paragraph 4.

1. INTRODUCTION

1.1 The *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) make conformance to IEC PAS 62282-6-1 ***Fuel cell technologies — Part 6-1: Micro fuel cell power systems — Safety*** mandatory for fuel cell systems, cartridges and fuel cell battery interaction under the provisions for dangerous goods carried by passengers or crew, Part 8;1.1.2 t). Similar requirements are also applicable to cargo transport on passenger aircraft of fuel cell cartridges and fuel cell systems when transported under packing instructions for fuel cell cartridges contained in equipment in Part 4 of the Technical Instructions.

1.2 Subsequent to the publication of IEC PAS 62282-6-1 the fuel cell industry worked through the International Electrotechnical Commission (IEC) to develop IEC International Standard 62282-6-100 ***Fuel cell technologies — Part 6-100: Micro fuel cell power systems — Safety*.** The standard was approved for publication by the responsible IEC National Committee members, in accordance with relevant International Standards Organization and IEC Directives. The following member countries were involved in the development of this standard: Canada, Japan, US, Germany, France, Korea, UK, Egypt. In order to maintain continuity within the IEC standards for fuel cells, the IEC

National Committees were requested to allow national adoption of IEC International Standard 62282-6-100 not before 1 January 2011.

1.3 During the Dangerous Goods Panel (DGP) Working Group of the Whole meeting held in Abu Dhabi, United Arab Emirates, 7 to 11 November 2010 (DGP-WG/10) the USFCC presented DGP-WG/10-WP/2 to discuss this issue and how it could affect the Technical Instructions. During discussions of DGP-WG/10-WP/2, the working group was asked to replace references in the Technical Instructions to IEC PAS 62282-6-1 with the new IEC 62282-6-100 standard and to provide a transition period to allow time for industry to conform in an orderly manner to the new standard while allowing fuel cell units and cartridges built to the old standard to be transported without hindrance. The Working group was also invited to discuss how they wished to review the standard. As a result of these discussions the working group requested a summary of substantive changes to the specification be provided to them so that a review could be made ensuring that requirements continue to be met. The Working group made it clear that in terms of a transition period, shelf life would need to be taken into consideration. The fuel cell industry agreed to prepare a working paper for submission at the DGP-WG/11 meeting to summarize substantive changes and to provide information relevant to a transition period. This paper here will provide that information. (Reference: Report of DGP-WG/11 (DGP-WG/11-WP/51)).

1.4 As changes like these are made to update the standards and specifications that cover fuel cell cartridges, fuel cells and fuel cell powered devices, the fuel cell industry will continue to keep the Dangerous Goods Panel apprised.

2. DISCUSSION OF SUBSTANTIVE DIFFERENCES BETWEEN IEC PAS 62282-6-1 AND IEC 62282-6-100

2.1 Overall increased stringency for higher level of safety

2.1.1 Design, construction, marking and testing requirements were strengthened and clarified throughout the standard and the limits for leakage and emissions were made more limiting. This results in more rigorous analysis and testing and requires additional detail to give guidance to the manufacturer and the testing personnel. For these reasons the IEC 62282-6-100 document is much larger than IEC PAS 62282-6-1. This paper is intended to summarize the substantive changes, but please be advised that much additional text has been added to the new standard to provide clear guidance to the manufacturers and to those doing the analysis and testing of the fuel cell cartridges, fuel cell devices and their components.

2.2 Definitions for gas or vapour loss clarified

2.2.1 The definitions for gas loss and vapour loss were clarified in IEC 62282-6-100 to give more guidance to the manufacturer and to the testing personnel. The definitions of fuel vapour loss were revised to take into account the more stringent of either toxicity or flammability limits, assuming storage within a specified volume with no ventilation. This update occurred following consultation with United States Department of Transportation (DOT) and the Federal Aviation Administration (FAA), with a 10 ft^3 (0.28 m^3) enclosed space being selected as representative of an overhead storage bin in an aircraft cabin. The flammability-based gas and vapour loss criteria for non-operating micro fuel cell power systems were based on a scenario of micro fuel cell power systems in the 10 ft^3 (0.28 m^3) enclosed space with no ventilation. The limits were set so that a flammable gas or vapour concentration of greater than 25% of the lower flammability limit (LFL) is not permitted to develop over a twenty-four hour (24 h) period assuming that three micro fuel cell power systems are stored in the enclosed space.

2.2.2 The fuel vapour loss criteria for methanol in IEC PAS 62282-6-1 was based strictly on toxicity of the methanol fuel. In IEC 62282-6-100 this was revised because it was determined that flammability limits based on the smaller unventilated control volume result in a stricter vapour loss limit.

2.2.3 When systems using fuels that might evolve hydrogen are covered, a new definition of impermissible hydrogen gas loss was developed to avoid confusion between the vapour loss terms in other parts of the standard and the terms involving loss of hydrogen gas. This definition was applied consistently wherever hydrogen gas might be involved. The limits for hydrogen are based on avoiding flammability in the specified volume, as updated following consultation with United States DOT and the FAA, of a 10 ft^3 (0.28 m^3) enclosed space.

2.3 Summary table of limits included in IEC PAS 62282-6-1 and IEC 62282-6-100

2.3.1 This table includes not only the changes, but also the most important testing limits for both IEC PAS 62282-6-1 and IEC 62282-6-100. All of the relevant limits have been included for completeness. To note the changes, read from left to right on the same line. This summary is provided for the information of the Working group. For the specific language, please refer to the documents directly. Copies of these documents will be provided upon request.

	IEC PAS 62282-6-1	**IEC 62282-6-100**
Methanol System Limits	No hazardous liquid or clathrate carrier leakage allowed. Cartridge - 0.33 g/h vapour loss limit Device off — 20 g/h vapour loss limit at 95 kPa overpressure Device on — 2.6 g/h vapour loss limit Hydrogen limits apply if hydrogen is generated. Operating Emissions Limits for: Formaldehyde, CO, CO2, Formic Acid, Methyl Formate	No hazardous liquid or clathrate carrier leakage allowed. Cartridge - 0.08 g/h vapour loss limit Device off - 2 g/h vapour loss limit at 11.6 kPa external pressure (vacuum) Device on — 2.6 g/h vapour loss limit Hydrogen limits apply if hydrogen is generated. Operating ***and breathing zone*** Emissions Limits for: Formaldehyde, CO, CO2, Formic Acid, Methyl Formate
Formic Acid System Limits	No hazardous liquid leakage allowed. Cartridge - 0.018 g/h vapour loss limit Device off 0.018 g/h vapour loss limit at 95 kPa overpressure Device off — 0.018 g/h vapour loss limit Device on — 0.09 g/h vapour loss limit Hydrogen limits apply if hydrogen is generated. Operating Emissions Limits for: Formaldehyde, CO, CO2, Formic Acid, Methyl Formate	No hazardous liquid leakage allowed. Cartridge - 0.018 g/h vapour loss limit Device off - 23 g/h vapour loss limit at 11.6 kPa (vacuum) Device off — 0.018 g/h vapour loss limit Device on — 0.09 g/h vapour loss limit Hydrogen limits apply if hydrogen is generated. Operating ***and breathing zone*** Emissions Limits for: Formaldehyde, CO, CO2, Formic Acid, Methyl Formate

	IEC PAS 62282-6-1	IEC 62282-6-100
Hydrogen System Limits	0.016 g/h hydrogen limit from a single source. System cannot build up a 25% flammable mixture in 10 m^3 volume with 1 air change per hour.	No hydrogen absorbing metal alloy leakage. Cartridge — Bubble tight Device off - 0.0032 g/h total Device on - 0.8 g/h total, 0.016 g/h from a single source Connection - Bubble tight
Borohydride System Limits	No hazardous liquid leakage Hydrogen limits apply if hydrogen is generated.	No hazardous liquid or solid fuel leakage Hydrogen limits apply if hydrogen is generated. Water immersion testing ensures cartridge integrity following type testing. Operating ***and breathing zone*** Emissions Limits for: Formaldehyde, CO, CO2, and volatile organic carbon compounds.
Butane System Limits	Cartridge — Bubble tight Device off - 0.9 g/h vapour loss limit Device on — 19 g/h emissions Operating Emissions Limits for: Butane, Formaldehyde, CO, CO2, NO, NO2, Formic Acid, Methyl Formate	Cartridge — Bubble tight Device off - 0.045 g/h vapour loss limit Device off — 0.9 g/h vapour loss limit at 11.6 kPa vacuum. Device on — 0.9 g/h butane vapour loss limit Device on — 0.016 g/h hydrogen Operating ***and breathing zone*** Emissions Limits for: Butane, Formaldehyde, CO, CO2, NO, NO2, Formic Acid, Methyl Formate

2.4 **Testing removed from IEC 62282-6-100**

2.4.1 The internal pressurization system test was replaced by the low pressure (vacuum) test in order to better simulate a loss of pressure (high altitude) situation.

2.5 **Additional "breathing zone" testing added to IEC 62282-6-100**

2.5.1 In order to ensure that users are not adversely affected by using fuel cell powered cell phones, music players, game consoles or anything else that might be used near the mouth and nose, an additional test set was added to check this aspect of the system. Requirements were added to limit emissions of a wide variety of possible compounds to within health guidelines.

2.6 **Additional immersion and bubble testing added for borohydride systems in IEC 62282-6-100**

2.6.1 Additional water immersion testing and liquid leak detector testing was added to IEC 62282-6-100 in order to ensure integrity of these systems in every case. Additional guidance was also added to ensure that safe testing materials are used that do not react with the systems.

3. DISCUSSION OF REQUIREMENTS FOR A TRANSITION PERIOD BEFORE IEC 62282-6-100 TAKES EFFECT.

3.1 Due to the low number of systems and cartridges in service, no transition period may be necessary. Since the IEC provided guidance that IEC 62282-6-100 should not be enforced prior to 1 January 2011, the effective date of the 2013 Edition of the Technical Instructions should be appropriate.

4. ACTION BY THE DGP-WG

4.1 The DGP WG is asked to strike the citations to IEC PAS 62282-6-1 and replace them with IEC International Standard 62282-6-100 in the Technical Instructions for the Safe Transport of Dangerous Goods by Air at Part 8, 1.1.2 t) 4) and t) 8), Provisions for Dangerous Goods Carried by Passengers or Crew, and in Part 4, Packing Instructions 216, 375, 496 and 874, for fuel cell cartridges contained in equipment.

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