



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

2.8: Part 8 — Provisions Concerning Passengers and Crew

DIVISION 4.3 FUEL CELL CARTRIDGES IN CHECKED BAGGAGE

(Presented by Dangerous Goods Advisory Council (DGAC) and the Fuel Cell and Hydrogen Energy Association (FCHEA))

SUMMARY

This paper identifies existing applicable requirements and solicits the working group's advice on what additional measures might be needed in gaining acceptance of the proposal below to permit passengers and crew to place Division 4.3 fuel cell cartridges, already permitted as carry-on, to be carried in checked baggage.

Action by the DGP-WG is in paragraph 5.

1. INTRODUCTION

1.1 On the basis of DGP/22-WP/49 submitted by the USFCC (now the Fuel Cell and Hydrogen Energy Association (FCHEA)), DGP/22 considered extending the provisions covering fuel cell cartridges carried by passengers and crew to permit carriage in checked baggage. While agreeing to authorize other fuel cell cartridges (i.e. those containing flammable liquids, corrosive substances, liquefied flammable gas and hydrogen in metal hydrides) in checked baggage, DGP/22 did not extend this provision to Division 4.3 fuel cell cartridges. The report of DGP/22 (DGP/22-WP/100, paragraph 2.9.4.3) indicates many members were wary of allowing "those containing water reactive substances, until more experience with these cartridges could be gained." Unfortunately time did not permit a comprehensive discussion surrounding the concerns relative to water reactive fuel cell cartridges.

1.2 From the report we assume that the panel is open to further consideration and we believe this may be an appropriate time to reconsider the DGP/22 decision, in light of recent developments affecting Division 4.3 fuel cell cartridges and availability of prototype units that provide a better

understanding of the ruggedness of cartridges based on IEC requirements. The Dangerous Goods Advisory Council (DGAC) and FCHEA make this submission to the working group in anticipation that further information may be needed before a final decision can be taken at DGP/23.

2. APPLICABLE IEC SPECIFICATIONS

2.1 DGAC and FCHEA believe that as part of this discussion, it is worthwhile to consider the degree of integrity and safety provided by the relevant UN Model Regulation requirements and IEC specifications. The test requirements applicable to Division 4.3 fuel cell cartridges include:

- a) a 1.2 meter drop test unpackaged onto an unyielding surface (UN);
- b) a 1.8 meter drop test unpackaged;
- c) a 100 kg (981 N) crush test;
- d) a 95 kPa differential pressure test;
- e) vibration testing (up to 8 gn at 200 Hz);
- f) temperature extremes from -40 °C to + 70 °C;
- g) external short circuit;
- h) leak tests after most of the physical tests that include full water immersion to a depth of at least 1 m; and
- i) requirements to prevent mixing of incompatible materials are included where “Two independent means for preventing inadvertent or uncontrolled mixing of these materials shall be provided during transportation and storage prior to use”.

2.2 The outcome of these requirements is illustrated by the commercial system shown in Figure 1. Water is contained in the left-hand (as viewed) portion of the system, while solid water reactive material is contained in the replaceable cartridge on the right-hand side.



Figure 1. Representative fuel cell system using a fuel cartridge (“Power Pukk”) containing Division 4.3 materials. Note that, in this design, the fuel cell cartridge itself does not contain water; only the complete system, when prepared for operation contains water, as well as, water reactive material

2.3 It is also noted that Division 4.3 materials that may be used must be solid materials. Further, as noted in a separate document by FCHEA, the types of Division 4.3 materials that may be used in cartridges will be limited by the adoption of IEC PAS 62282-6-150. The specification would limit materials to:

“Division 4.3 mixtures, alloys, compounds or chemical hydrides of the following materials: sodium, magnesium, borohydride compounds, silicon, silicon dioxide, iron, nickel, cobalt.”

2.4 The specification further restricts the materials that may be used as follows:

“Only UN Division 4.3 (water reactive) solid compounds which solely evolve hydrogen gas upon contact with water (or non-hazardous aqueous solutions) shall be permitted. Compounds with a subsidiary hazard risk, or which are not permitted to be transported by air according to the ICAO Technical Instructions, shall not be permitted under this PAS.”

3. **FAA TESTING**

3.1 A report entitled “Preliminary Investigation of the Fire Hazard Inherent in Micro Fuel Cell Cartridges” by the FAA Test Center has become available. The report is available at <http://www.fire.tc.faa.gov/pdf/09-53.pdf>. In testing of the one Division 4.3 cartridge examined by FAA, the cartridge did not ignite in burn tests, and fumes from the cartridge extinguished the test fire.

4. **FURTHER CONSIDERATIONS**

4.1 DGAC and FCHEA surmise that a reason for some Panel members at DGP22 in, for now, limiting Division 4.3 cartridges to carry-on baggage may have been that passenger and crew baggage, when offered as checked baggage, is deemed as not affording adequate protection considering

the rough handling that baggage may experience prior to being placed onboard an aircraft. While this concern is understandable, we would note that the design tests that these devices are subjected to would tend to indicate that these, as well as, other fuel cell cartridges are more likely to survive such handling than other goods which may be placed in checked baggage and where such rigorous testing does not apply.

4.2 Further, under Y495, the limited quantity packing instruction applicable to Division 4.3 cartridges, limited quantity packages with a gross mass of cartridges of up to 2.5 kg and with no more than 0.2 kg (i.e., the same quantity limit applicable to cartridges carried by passengers and crew) of fuel per cartridge may be transported as cargo on both passenger and cargo aircraft. Such cartridges are not subject to the rigorous IEC requirements noted above. Considering the IEC tests that are applicable to cartridges used by passengers, one would expect that carriage in checked baggage offers at least an equivalent level of safety to those carried as cargo.

4.3 Our analysis suggests that the main risks associated with stowage of fuel cell cartridges containing Division 4.3 materials in checked baggage comes from exposure to water, which in principle could release the hydrogen contents of the fuel cartridge. However, as the testing requirements illustrate, this hazard is well managed. As constructed, the cartridge must withstand foreseeable loads of up to 100 kg followed by immersion in up to 1 m of water. As can be seen from the example unit (Figure 1), the IEC requirements yield a fuel cell system and cartridge which would obviously require very special, aggressive, conditions to breach both a water reservoir and a fuel compartment simultaneously. Very often, as is the case with the example shown, water will not even be present in the 4.3 cartridge.

5. ACTION BY THE DGP-WG

5.1 The DGP-WG is invited to discuss the issues raised by DGAC and FCHEA in this paper. We are interested in the working group's thoughts on the information that has been provided and are interested in knowing what other information the working group may consider necessary in order to reach a decision on allowing water reactive material cartridges to be carried by passengers and crew in checked baggage. Such a decision would result in the following amendment to 8;1.1.2 t) 6) to read as follows:

t) fuel cells used to power portable electronic devices (for example cameras, cellular phones, laptop computers and camcorders) and spare fuel cell cartridges, under the following conditions:

6) no more than two spare fuel cell cartridges may be carried by a passenger in carry-on baggage, in checked baggage or on the person, as follows:

~~a) fuel cell cartridges containing flammable liquids, corrosive substances, liquefied flammable gas or hydrogen in metal hydride in carry-on baggage, in checked baggage or on the person; and~~

~~b) fuel cell cartridges containing water-reactive substances in carry-on baggage or on the person;~~

— END —