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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the
Transport of Dangerous Goods

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LISTING, CLASSIFICATION AND PACKING

Fuel cell cartridges containing hydrogen in metal hydride

Submitted by the expert from Canada

Introduction

1. The expert from Canada has studied the proposal in ST/SG/AC.10/C.3/2006/50 submitted by the experts from France and the United States of America and supports the principle of including in the Model Regulations a new shipping name and UN number for fuel cell cartridges containing Class 2.1, Class 4.3 or Class 8 dangerous goods

2. The expert from Canada does not agree with the proposal in the paper from the experts from France and the United States of America that small fuel cell cartridges (e.g., with a water capacity of 120 ml or less) containing hydrogen in metal hydride should be subject to competent authority approval. While transport under UN 3468 requires competent authority approval for all size storage systems containing hydrogen in metal hydrides, this requirement becomes increasingly impracticable with more widespread use of small fuel cell systems by consumers and can lead to lack of harmonization through different approaches by different competent authorities.

In addition, the proposal in ST/SG/AC.10/C.3/2006/50 does not provide a harmonized multimodal approach for fuel cell cartridges containing hydrogen in metal hydride. Based on proposals from the United States, the 2007-2008 ICAO Technical Instructions will include a packing instruction (ICAO PI 214) for hydrogen in metal hydride storage systems, that may be transported on cargo aircraft.

In this paper, Canada is proposing a new packing instruction for fuel cell cartridges containing hydrogen in metal hydrides that addresses fuel cell cartridges with a water capacity of 120 ml or less and that contain 25 g or less of hydrogen, with a maximum internal pressure of 5 MPa at 55 °C.

It should be noted that the performance requirements in the proposed packing instruction are based on a draft ISO standard (ISO16111) applicable to hydrogen in metal hydride storage systems but which currently does not fully accommodate small units with a water capacity less than 500 ml. In the meantime, the affected industry is more than ready to comply with the proposed packing instruction in this paper and will work with ISO and others like CGA to expedite the development of an appropriate standard that can be considered by the Sub-Committee and perhaps referenced in the Model Regulations.

3. Fuel cartridges that exceed a water capacity of 120 ml or that contain more than 25 g of hydrogen would require competent authority approval.

4. The expert from Canada does not agree with the proposal in the paper from the experts from France and the United States that fuel cell cartridges containing hydrogen in metal hydride should not have a limited quantity number in column 7 of the Dangerous Goods List. While sympathetic to the intent of taking a conservative approach as stated in ST/SG/AC.10/C.3/2006/50, Canada believes that based on the high degree of integrity provided through the requirements in the packing instruction proposed in this paper, a 120 ml limited quantity value for cartridges that are in compliance with the rigorous conditions and testing in the packing instruction is appropriate. Indeed, we believe that the requirements in the proposed packing instruction are more conservative than existing requirements for some other dangerous goods that are transported in limited quantities. We note that unlike other gases under pressure, hydrogen in a metal hydride behaves differently. In the unlikely event that the hydrogen containment system is breached, hydrogen in a metal hydride desorbs slowly and the released hydrogen dissipates.

Proposal

The expert from Canada proposes

1. that a value of **120 ml** be added to column 7 of the new entry for fuel cell cartridges containing hydrogen in metal hydride;

2. that the special provision 3DD proposed in ST/SG/AC.10/C.3/2006/50 be changed to read as follows:

SP3DD: Fuel cell cartridges containing hydrogen in a metal hydride and transported as limited quantities of dangerous goods shall be in compliance with the requirements of packing instruction P2XX;

3. that the second paragraph regarding a 1.2 m drop test in special provision 3AA proposed in ST/SG/AC.10/C.3/2006/50, be deleted since its application is questionable given that inner packagings of limited quantities of dangerous goods and articles like aerosols and receptacles small containing gas are not subjected to similar requirements. If this paragraph is not deleted, we propose to add, at the beginning of the second paragraph of 3AA, the words "<u>Except for fuel cell cartridges containing hydrogen in metal hydride which shall be in compliance with P2XX</u>, each fuel cell …" since the packing instruction proposed in this paper includes a more severe drop test requirement of 1.8 m; and

4. that the following packing instruction P2XX for fuel cell cartridges containing hydrogen in a metal hydride be considered for adoption:

P2XX **PACKING INSTRUCTION** **P2XX**

This packing instruction applies to fuel cell cartridges containing hydrogen in a metal hydride either individually or when the fuel cells are contained in equipment or packed with equipment. These fuel cell cartridges shall have a water capacity less than or equal to 120 ml and shall not contain more than 25 g of hydrogen. Fuel cell cartridges exceeding this water capacity or quantity of hydrogen shall only be transported with competent authority approval.

The pressure in the fuel cell cartridge shall not exceed 5 MPa at 55 °C. The design type shall withstand, without leaking or bursting, a pressure of two (2) times the design pressure of the cartridge at 55°C or 200 kPa more than the design pressure of the cartridge at 55 °C, whichever is greater.

Fuel cartridges shall be filled in accordance with procedures provided by the manufacturer.

Packagings used to transport fuel cell cartridges containing hydrogen in a metal hydride shall

(a) meet the provisions of 4.1.1 and 4.1.3, except for 4.1.1.3, the orientation provision in 4.1.1.5, and 4.1.1.5.1; and

(b) include a rigid outer packaging constructed of suitable material of adequate strength.

Fuel cell cartridges that are packed with equipment shall be

(a) contained in an inner packaging; or

(b) placed in a rigid outer packaging with cushioning material or a divider to protect the fuel cells against damage during normal conditions of transport.

Fuel cell cartridges that are installed in equipment shall be protected against short circuit and the entire system shall be protected against inadvertent operation.

Large, robust equipment containing fuel cell cartridges may be transported unpackaged.

The fuel cell cartridges shall be designed and constructed to prevent fuel leakage under normal conditions. Each cartridge design type, including cartridges integral to a fuel cell, shall be subjected to and shall pass the following tests:

Drop Test

A 1.8 metre drop test onto an unyielding surface in four different orientations:

(a) vertically, on the end containing the valve assembly;

(b) vertically, on the end opposite to the valve assembly;

(c) horizontally, onto a 0.038 metre steel apex, with the steel apex in the upward position; and

(d) at a 45° angle on the end containing the valve assembly.

There shall be no observable leakage in a bubble test when the cartridge is charged to its rated charging pressure. The fuel cell cartridge shall then be hydrostatically pressurized to destruction. The recorded burst pressure shall exceed 85% of the minimum shell burst pressure.

Fire Test

A fuel cell cartridge filled to rated capacity with hydrogen shall be subjected to direct flame impingement. The cartridge design, which may include a vent feature integral to it, is deemed to have passed the fire test if

(a) the internal pressure vents to zero gauge pressure without violent rupture of the cartridge; or

(b) the cartridge withstands the fire for a minimum of 20 minutes without rupture.

Hydrogen Cycling Test

This test is intended to ensure that a fuel cell cartridge design stress limits are not exceeded during use.

The fuel cell cartridge shall be cycled from not more than 5% rated hydrogen capacity to not less than 95% rated hydrogen capacity and back to not more than 5% rated hydrogen capacity. The cycling shall be continued for 100 cycles.

Following the cycling test, the fuel cell cartridge shall be charged and the water volume displaced by the cartridge shall be measured. The cartridge design is deemed to have passed the hydrogen cycling test if the water volume displaced by the cycled cartridge does not exceed the water volume displaced by an uncycled cartridge charged to 95% rated capacity and pressurized to 75% of its minimum shell burst pressure.