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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

Thirtieth session
Geneva, 4-12 (a.m.) December 2006
Item 2(a) of the provisional agenda

PROPOSALS OF AMENDMENTS TO THE RECOMMENDATIONS ON THE TRANSPORT OF DANGEROUS GOODS

Fuel cell cartridges containing Division 2.1 substances

Transmitted by the expert from Canada

Referenced documents from the 29th session:
ST/SG/AC/10/C.3/2006/58/Add.1
ST/SG/AC.10/C.3/2006/50
UN/SCETDG/29/INF.11
UN/SCETDG/29/INF.15
UN/SCETDG/29/INF.58
UN/SCETDG/29/INF.68

Background

1. At its twenty-ninth session the Sub-Committee adopted new entries for fuel cells and cartridges containing Division 4.3 and Class 8 substances (ST/SG/AC.10/C.3/2006/58/Add.1) and agreed to consider additional new entries for fuel cells and cartridges containing liquefied gases and hydrogen in metal hydrides. The expert from Canada agreed to provide a revised

proposal for new entries for these fuel cells and cartridges taking into account the decisions already made for Class 3, Class 8 and Division 4.3 fuel cell cartridges and papers submitted to the 29th session (ST/SG/AC.10/C.3/2006/50 by the United States of America and France, UN/SCETDG/29/INF.11 by Canada and UN/SCETDG/29/INF.15 by Dangerous Goods Advisory Council (DGAC) and US Fuel Cell Council (USFCC), and the report of the fuel cell lunch hour working group UN/SCETDG/29/INF.68). In preparing this proposal, the expert from Canada also endeavoured to take into account comments from other delegations through intersessional communications.

ISO TS 16111

2. At the 29th session the representative from ISO noted that ISO TS 16111, which covers the requirements applicable to the design, construction and filling of transportable gas storage devices containing hydrogen in metal hydrides, had been distributed for voting and, should the vote be favourable, could be issued as a Technical Specification as early as mid September 2006 (the text of ISO TS 1611 is provided in UN/SCETDG/29/INF.58). The proposal in this document is based on the assumption that ISO TS 16111 will be issued before the Sub-Committee's 30th session in December 2006.

3. Should the ISO TS 16111 not be completed before December 2006, a special provision, 3CC, is provided in the Annex to this paper specifying the relevant requirements from ISO TS 16111 for fuel cell cartridges with a water capacity less than or equal to 120 ml and requiring that fuel cell cartridges with a larger water capacity be subject to approval by the competent authority. The 120 ml limit also appears in ISO TS 16111 and is the volume limit to which the requirements in the special provision in the Annex are applicable. While this special provision is quite lengthy, it would likely only be in the UN Model Regulations for a two-year period pending completion of ISO TS 16111.

Revision of SP 328

4. In this paper an addition to the last sentence of the first paragraph of special provision 328 is proposed to clarify that no leakage of the content of the cartridge in any configuration for transport is acceptable.

In addition, a minor amendment is proposed to the text of special provision 328 which was adopted at the 29th session. This amendment acknowledges that fuel cell cartridges containing hydrogen in metal hydride are already subject to a more severe series of drop tests under ISO TS 16111 or the special provision provided in the annex to this paper.

Production leak testing

5. This paper proposes that fuel cell cartridges containing liquefied gas or hydrogen in metal hydride be subjected to a production leak test.

For fuel cell cartridges containing liquefied gas, this paper proposes to require the water bath test currently prescribed for similar articles transported under UN 2037, Receptacles, Small, Containing Gas, and changes to Chapter 6.2 are included in this proposal.

For fuel cell cartridges containing hydrogen in metal hydride, a production leak test is already required in ISO TS 16111. A similar test requirement is included in special provision 3CC in the annex should the ISO TS 16111 not be adopted in time for the 30th session.

Limited Quantity Values

6. Values of 120 ml are proposed as limited quantity values for the two types of gas entries. For fuel cell cartridges containing liquefied gas this limit is substantially more conservative than the one litre limit for UN2037, Receptacles, Small, Containing Gas, under which similar and even higher pressure gases could be transported. In addition, a new special provision, 3BB, specifies a minimum design pressure for fuel cell cartridges containing liquefied gas of two times the vapour pressure of the gas at 55 °C.

7. The expert from Canada believes that a limited quantity value of 120 ml for fuel cell cartridges containing hydrogen in metal hydride that are in compliance with the rigorous requirements of ISO TS 16111 or the special provision in the Annex to this paper, 3CC, is appropriate. Metal hydrides offer a safe means of containing hydrogen in a fuel cell cartridge. The hydrogen is absorbed into the metal hydride and even when exposed to the atmosphere is only released slowly. Further, as hydrogen gas is desorbed, the metal hydride cools, requiring additional input of heat to release more gas, thus precluding rapid release.

Proposal

8. Based on the above discussion, the following amendments are proposed.

9. Add the following new entries to the Dangerous Goods List

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
WWWW	FUEL CELL CARTRIDGE; or FUEL CELL CARTRIDGE CONTAINED IN EQUIPMENT; or FUEL CELL CARTRIDGE PACKED WITH EQUIPMENT, containing liquefied flammable gas	2.1			328 3BB	120ml	P004			
XXXX	FUEL CELL CARTRIDGE; or FUEL CELL CARTRIDGE CONTAINED IN EQUIPMENT; or FUEL CELL CARTRIDGE PACKED WITH EQUIPMENT, containing hydrogen in metal hydride	2.1			328 3CC	120ml	P004			

10. Revise Special Provision 328 as follows (proposed text is underlined):

"328 This entry applies to fuel cell cartridges including when contained in equipment or packed with equipment. Fuel cell cartridges installed in or integral to a fuel cell system are regarded as contained in equipment. Fuel cell cartridge means an article that stores fuel for discharge into the fuel cell through a valve(s) that controls the discharge of fuel into the fuel cell. Fuel cell cartridges, <u>including when contained in equipment</u>, shall be designed and constructed to prevent fuel leakage under normal conditions of transport.

Fuel cell cartridge design types using liquids as fuels shall pass an internal pressure test at a pressure of 100 kPa (gauge) without leakage.

<u>Except for fuel cell cartridges containing hydrogen in metal hydride which shall be in compliance with ISO TS 16111,</u> each fuel cell cartridge design type shall be shown to pass a 1.2 meter drop test onto an unyielding surface in the orientation most likely to result in failure of the containment system with no loss of contents."

11. Add a new special provision for fuel cell cartridges containing liquefied gas as follows:

"3BB Each fuel cell cartridge transported under this entry and designed to contain a liquefied flammable gas shall:

(a) be capable of withstanding, without leakage or bursting, a pressure of at least two times the equilibrium pressure of the contents at 55 ºC;

(b) not contain more than 200 ml of liquefied flammable gas with a vapour pressure not exceeding 1 000 kPa at 55 ºC; and

(c) for each unit placed in transport, pass the hot water bath test prescribed in 6.2.4.1 of Chapter 6.2."

12. Add a new special provision for cartridges containing hydrogen in a metal hydride:

"3CC Fuel cell cartridges containing hydrogen in a metal hydride shall be in compliance with
ISO TS 16111 (2006) and, except during the fire test, shall pass all the required tests without leakage.

Fuel cell cartridges containing hydrogen in a metal hydride which are transported as limited quantities in accordance with Chapter 3.4 shall have a water capacity less than or equal to 120 ml and shall not contain more than 25 g of hydrogen."

13. Revise the title of Chapter 6.2 to read:

REQUIREMENTS FOR THE CONSTRUCTION AND TESTING OF PRESSURE RECEPTACLES, AEROSOL DISPENSERS, RECEPTACLES CONTAINING GAS (GAS CARTRIDGES), AND FUEL CELL CARTRIDGES CONTAINING LIQUEFIED FLAMMABLE GAS

14. Revise the Note in 6.2.1 to read:

NOTE: For aerosol dispensers, small receptacles containing gas (gas cartridges), and fuel cell cartridges containing liquefied flammable gas, see 6.2.4.

15. Revise the title of 6.2.4 to read:

Requirements for aerosol dispensers and small receptacles containing gas (gas cartridges) and fuel cell cartridges containing liquefied flammable gas.

16. Revise the title of 6.2.4.1 to read:

Small receptacles containing gas (gas cartridges) and fuel cell cartridges containing liquefied flammable gas

17. Revise 6.2.4.1.1 and 6.2.4.1.2 to read:

6.2.4.1 Each receptacle or fuel cell cartridge shall be subjected to a test performed in a hot water bath; the temperature of the bath and the duration of the test shall be such that the internal pressure reaches that which would be reached at 55 °C (50 °C if the liquid phase does not exceed 95% of the capacity of the receptacle or the fuel cell cartridge at 50 °C). If the contents are sensitive to heat or if the receptacles or the fuel cell cartridges are made of plastics material which softens at this test temperature, the temperature of the bath shall be set at between 20 °C and 30 °C but, in addition, one receptacle or fuel cell cartridge in 2000 shall be tested at the higher temperature.

6.2.4.1.2 No leakage or permanent deformation of a receptacle or fuel cell cartridge may occur, except that a plastics receptacle or fuel cell cartridge may be deformed through softening provided that it does not leak.

Annex

Special provision 3CC

The proposed special provision 3CC would read as follows in the event that ISO TS 16111 is not published in time for consideration by the Sub -Committee at its 30th session.

3CC Fuel cell cartridges containing hydrogen in a metal hydride transported under this entry 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 may 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 ºC or 200 kPa more than the design pressure of the cartridge at 55 °C, whichever is greater. The pressure at which this test is conducted is referred to in the Drop Test and the Hydrogen Cycling Test as the "minimum shell burst pressure".

Fuel cell cartridges shall be filled in accordance with procedures provided by the manufacturer. The manufacturer shall provide the following information with each fuel cell cartridge:

(a) inspection procedures to be carried out before initial filling and before refilling of the fuel cell cartridge;

(b) safety precautions and potential hazards to be aware of;

(c) method for determining when the rated capacity has been achieved;

(d) minimum and maximum pressure range;

(e) minimum and maximum temperature range; and

(f) any other requirements to be met for initial filling and refilling including the type of equipment to be used for initial filling and refilling.

The fuel cell cartridges shall be designed and constructed to prevent fuel leakage under normal conditions of transport. 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 shut-off valve assembly;

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

(c) horizontally, onto a 38 mm steel apex, with the steel apex in the upward position; and

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

There shall be no leakage, determined by using a soap bubble solution or other equivalent means on all possible leak locations, 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 at least 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.

Production leak test

Each fuel cell cartridge shall be tested for leaks at 15 ºC ±5 ºC, while pressurized to its rated charging pressure. There shall be no leakage, determined by using a soap bubble solution or other equivalent means on all possible leak locations.

Each fuel cell cartridge shall be permanently marked with the following information:

(a) the rated charging pressure in megapascals (Mpa);

(b) the manufacturer's serial number of the fuel cell cartridges or unique identification number; and

(c) the date of expiry based on the maximum service life (year in four digits; month in two digits).

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