UNITED
NATIONS

ST

Secretariat

Distr.
GENERAL

ST/SG/AC.10/C.3/2004/49
19 April 2004

ORIGINAL: ENGLISH

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

Twenty-fifth session, 5-14 July 2004
Item 6 of the provisional agenda

LISTING, CLASSIFICATION AND PACKING

New entries for fuel cell cartridges and fuel cell powered devices

Transmitted by the experts from Japan and the United States of America

Introduction

1. Fuel cell technologies have advanced rapidly in recent years such that commercial products may be introduced in the marketplace as soon as 2004. Fuel cell applications can roughly be categorized into the following areas: (1) Motor vehicles, (2) Stationary (for generation of electricity) and (3) Portable (small) electronic equipment. Technologies and materials involved in these fuel cell applications are still in the infant stages. Among the different fuel cell technologies, Methanol Fuel Cells (MFC's) technology is the most developed technology for portable electronic equipments such as cell phones, computers, cameras and others that are typically powered by batteries. It is anticipated that in the near future a percentage of commercially available electronic equipment will be powered by methanol fuel cells. Methanol fuel cells use methanol or methanol/water solutions as fuel. For portable electronic equipment, the fuel is contained in a small replaceable cartridge, which is installed directly into the electronic devices. Methanol fuel cells do not burn the methanol; they produce electricity through an electrochemical process that combines protons from methanol and oxygen. A simplified diagram shown in Annex 1 explains the mechanism of how a direct methanol fuel cell (one type of methanol fuel cell) works.

2. Portable electronic equipment is intended for consumer use. Currently there are provisions in the UN Model Regulations for transport of portable electronic equipment powered by batteries but not by fuel cells containing methanol or methanol/water solutions. UN 3363, Dangerous Goods in Machinery or Apparatus (Class 9) may be used for fuel cells containing small quantities of methanol but is not specific enough to address the need of fuel cells cartridges

considering the unique feature of the cartridges, the manner in which they function and the expected volume in which they will be transported worldwide. Therefore, the Experts from Japan and the United States of America have proposed requirements including new entries for the Dangerous Goods List, a special provision describing them, a packing instruction and design type tests applicable to the cartridges for consideration by the Sub-Committee. The main goal of our proposal is to provide an appropriate level of safety for fuel cell cartridges containing methanol or methanol/water solutions while at the same time not imposing undue restrictions for their use.

3. The experts from Japan and the United States of America are proposing that the fuel cell cartridges be assigned to Class 9 on the basis that the fuel cell cartridges are designed and constructed to function as articles not merely as fuel containers. A fuel cell cartridge must have a valve (or release device) built into it as an integral part of the cartridge. The cartridge valve is designed to only release the fuel at a controlled rate to generate electricity and only when the cartridge is inserted into a fuel cell unit. The methanol or methanol/water solution in a fuel cell cartridge is not accessible by the user unless intentionally broken. The cartridge containing methanol or methanol/water solutions is to be used as a completed article. To illustrate this point some prototype pictures and diagram of fuel cell cartridges are shown in Annex 2 and 3. The quantity of fuel in each cartridge would be limited to not more than 200 ml. This limit is well within the quantities allowed for "Limited Quantity" in the UN Model Regulations and "Consumer commodities of Class 9" in the ICAO Technical Instructions. The proposed capacity of 200 millilitre of methanol or methanol/water solution for a cartridge is based on the need of today's laptop computers. Given the average power consumption of today's laptops (20 Watts) and the demonstrated power output rates of today's MFC technologies (1 Watt-hour/ml methanol), a 200 ml cartridge of methanol is required to provide a 10-hour continuous run time for a laptop computer. Other portable, consumer electronic devices will most likely use smaller capacity cartridges.

4. It is proposed that fuel cell cartridges be assigned to Class 9 if they can be shown to meet the requirements of a series of five tests that are intended to minimize the probability of leakage of methanol or methanol/water solutions under normal conditions of transport. The test methods proposed include an altitude simulation pressure differential test, an extreme temperature test, a vibration test, a drop test and a crush test and are intended to ensure that the cartridges are robust, resistant to leakage and afford a high level of safety in transport. These tests and the requirements proposed in this paper are intended to ensure that methanol fuel cartridges are transported safely including when contained or packed with equipment.

Proposals

5. Create two new entries:

(1) ID #: UN XXXX
PSN: Fuel Cell Cartridges *containing methanol or methanol/water solutions*
Class: 9
Packing Group: II
Special Provision: SP ZZZ
Packing Instruction: P90X

(2) ID#: UN YYYY
PSN: Fuel Cell Cartridges *containing methanol or methanol/water solutions*
Contained In Equipment or
Fuel Cell Cartridges *containing methanol or methanol/water solutions*

Packed With Equipment
Class: 9
Packing Group: II
Special Provision: SP ZZZ
Packing Instruction: P90X

6. Create a new Special Provision SP ZZZ:

This entry applies to fuel cell cartridges containing methanol or methanol/water solutions. Fuel cell cartridges may be transported under this entry if they meet the following provisions:

(a) Each fuel cell cartridge shall contain no more than 200 ml of methanol or methanol/water solution;

(b) Each fuel cell cartridge is of the type proved to meet the requirements of each test of the Manual of Tests and Criteria, Part III, Sub-section 38.4;

(c) Equipment containing fuel cell cartridges or packed with fuel cell cartridges shall be protected to prevent short circuit.

(d) The testing requirements in Chapter 38.4 of the Manual of Tests and Criteria do not apply to production runs or pre-production prototypes consisting of not more than 100 fuel cell cartridges when theses cartridges are transported for testing, if:

(i) the fuel cell cartridges are transported in an outer packaging that meets the criteria for packing group I packagings; and
(ii) each fuel cell cartridge is individually packed in an inner packaging that meets the requirements for packing group II further packed inside an outer packaging and is surrounded with non-combustible absorbent material.

7. Insert a new Packing Instruction 90X in Chapter 4.1 as follows:

P90X	**PACKING INSTRUCTION**	**P90X**
This instruction applies to UN Nos XXXX and YYYY		
Packaging shall conform to the packing group II performance level and are authorized, provided the general provisions of **4.1.1** and **4.1.3** are met. When fuel cell cartridges are packed with equipment, they shall be separately packed in inner packagings and protected against damage that may be caused by the movement or placement of the equipment and the cartridges within the outer packaging. When fuel cell cartridges are contained in equipment, the equipment shall be packed in strong outer packagings in such a manner as to prevent operation during transport.		
Additional requirement: When fuel cells or equipment are transported with fuel cell cartridges installed the fuel cells or equipment shall be protected against short circuit and inadvertent operation.		

8. Proposed fuel cell cartridge tests (to be incorporated in the Manual of Tests and Criteria, Part III, Section 38.4)

38.4 Fuel cell cartridges

38.4.1 Purpose

This section presents the procedures to be followed for the classification of fuel cell cartridges containing methanol or methanol/water solutions (see UN XXXX and applicable special provisions of Chapter 3.3 of the Model Regulations).

38.4.2 Scope

38.4.2.1 Fuel cell cartridges containing methanol or methanol/water solutions shall be subjected to the tests, as required by special provision SP ZZZ of Chapter 3.3 of the Model Regulations prior to the transport of a particular type of fuel cell cartridge. Fuel cell cartridges containing methanol or methanol/water solutions which differ from a tested type by a change that would materially affect the test results shall be considered to be new types and shall be subjected to the required tests.

38.4.2.2 For the purposes of classification, the following definitions apply:

Fuel cell means a device that produces electricity through an electrochemical process by combining protons from a fuel such as methanol or methanol/water solutions with oxygen.

Methanol fuel cell means a fuel cell that operates on methanol or methanol/water solutions.

Fuel cell powered equipment means an article or device that is electronically powered by a methanol fuel cell.

Fuel cell cartridge means a container that stores methanol or methanol/water solutions for discharge into fuel cell powered equipment through a valve(s) that controls the discharge of fuel into such equipment. It is to be designed and constructed using materials in its structure, valve(s) and all other components that will securely contain fuel from leakage when tested in the performance tests specified in this section.

Mass loss means a loss of the total test cartridge mass of greater than 1.0 % after the test.

Fuel means methanol or methanol/water solution used to produce electricity in a fuel cell.

Type means a particular fuel cell design type.

38.4.3 Procedure

Each type of fuel cell cartridge containing methanol or methanol/water solutions shall be subjected to tests 1 to 3 in sequence on the same cartridge. Tests 4 and 5 should be conducted using not otherwise tested cartridges or undamaged cartridges previously used in Tests 1 to 3. Ten (10) representative samples of the same type of fuel cell cartridge, filled to their design capacity, shall be tested.

38.4.3.1 Test 1: Altitude Simulation

38.4.3.1.1 Purpose

This test assesses the ability of a fuel cell cartridge to resist leakage under differential pressure conditions during air transport.

38.4.3.1.2 Test procedure

Test fuel cell cartridges shall be stored at a pressure of 11.6 kPa or less for at least six hours at ambient temperature (20 ± 5 °C).

38.4.3.1.3 Requirement

Cartridges meet this requirement if there is no leakage or mass loss after the test is performed.

38.4.3.2 Test 2: Extreme temperature exposure:

38.4.3.2.1 Purpose

This test assesses fuel cell cartridge's structure and valve integrity using rapid and extreme temperature changes.

38.4.3.2.2 Test procedure

Test fuel cell cartridges shall be stored for at least 2 hours at a test temperature of 75 ± 2 °C, followed by storage for at least 2 hours at a temperature of - 40 ± 2 °C. This procedure is to be repeated 10 times, with no more than a 30-minute maximum time interval allowed between each temperature extreme.

38.4.3.2.3 Requirement

Cartridges meet this requirement if there is no leakage or mass loss after the test is performed.

38.4.3.3 Test 3: Vibration test:

38.4.3.3.1 Purpose

This test simulates vibration during transport.

38.4.3.3.2 Test procedure

Test fuel cell cartridges are firmly secured to the platform of the vibration machine without distorting the cartridges in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the fuel cell cartridges. The logarithmic frequency sweep is as follows: from 7 Hz a peak acceleration of 1 g_n is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8 g_n occurs (approximately 50 Hz). A peak acceleration of 8 g_n is then maintained until the frequency is increased to 200 Hz.

38.4.3.3.3 Requirement

Cartridges meet this requirement if there is no leakage or mass loss after the test is performed.

38.4.3.4 Test 4: Drop test:

38.4.3.4.1 Purpose

This test simulates possible impacts to a fuel cell cartridge during transport.

38.4.3.4.2 Test procedure

Test fuel cell cartridges are dropped from a height of 1.5 m onto a rigid (e.g., concrete) surface in three orientations: valve up, valve down and horizontal. Three separate drops shall be conducted on each test cartridge. Prior to conducting the drops, 5 of the fuel cell cartridges shall be stored for at least 2 hours at 50 ± 2 °C, and 5 of the fuel cell cartridges shall be stored for at least 2 hours at –18 ± 2 °C.

38.4.3.4.3 Requirement

Cartridges meet this requirement if there is no rupture, leakage or mass loss after the test is performed.

38.4.3.5 Test 5: Crush (compressive loading) test:

38.4.3.5.1 Purpose

This test simulates possible crushing force applied to a fuel cell cartridge.

38.4.3.5.2 Test procedure

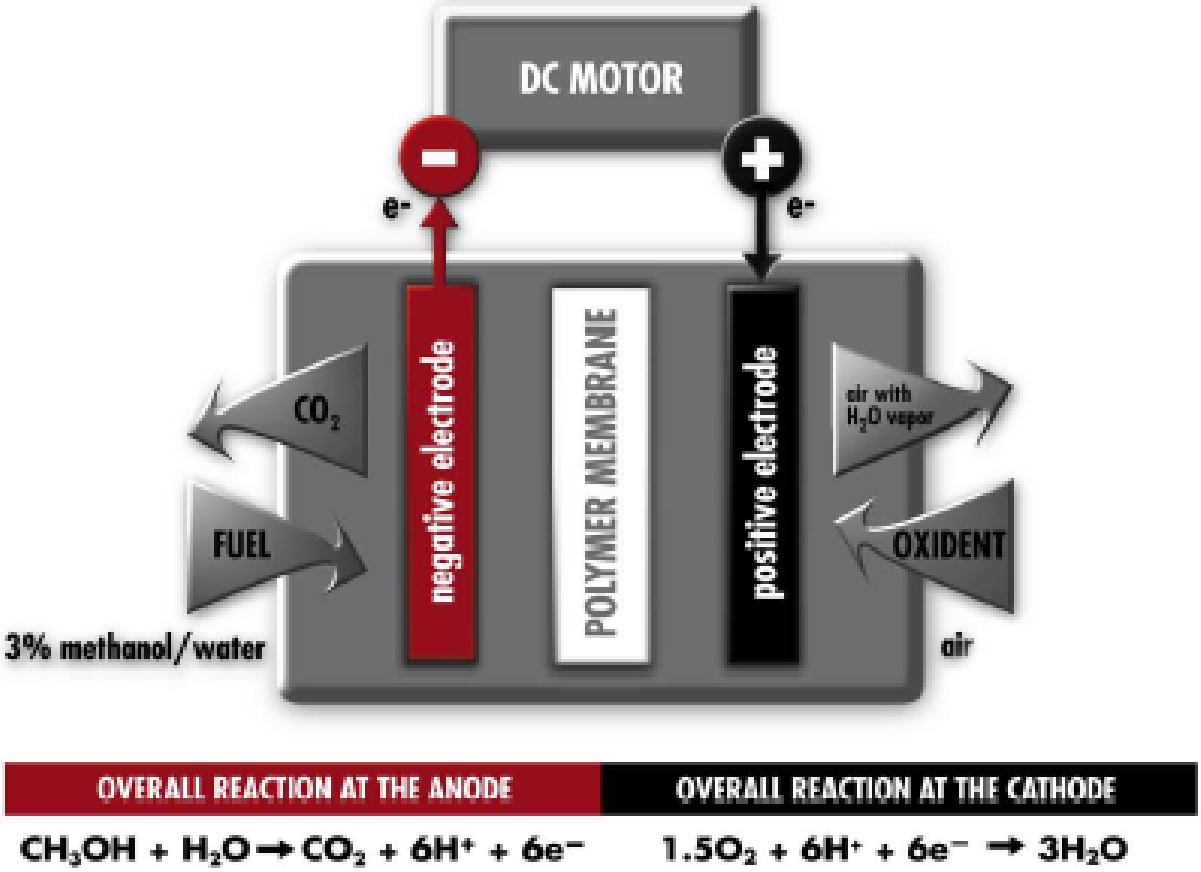
Test fuel cell cartridges are to be placed between two flat wooden blocks of approximately 254 mm (10 inches) long, 101.6 mm (4 inches) wide and 12.7 mm (1/2 inch) thick. The crushing force is to be applied to the exposed surfaces of the enclosure gradually at a rate of 12.7 mm/minute (1/2 inch/minute). Each force applicator is to exert 100 kg on the sample for one minute. Test cartridges are divided into two groups; 5 tested on the wide side and 5 tested on the narrow side. Each sample is to be subjected to only a single crush. Separate samples are to be used for each crush.

38.4.3.5.3 Requirement

Cartridges meet this requirement if there is no rupture, leakage or mass loss after the test is performed.

Annex 1 (in English only)

DIRECT METHANOL FUEL CELL



Annex 2 (in English only)

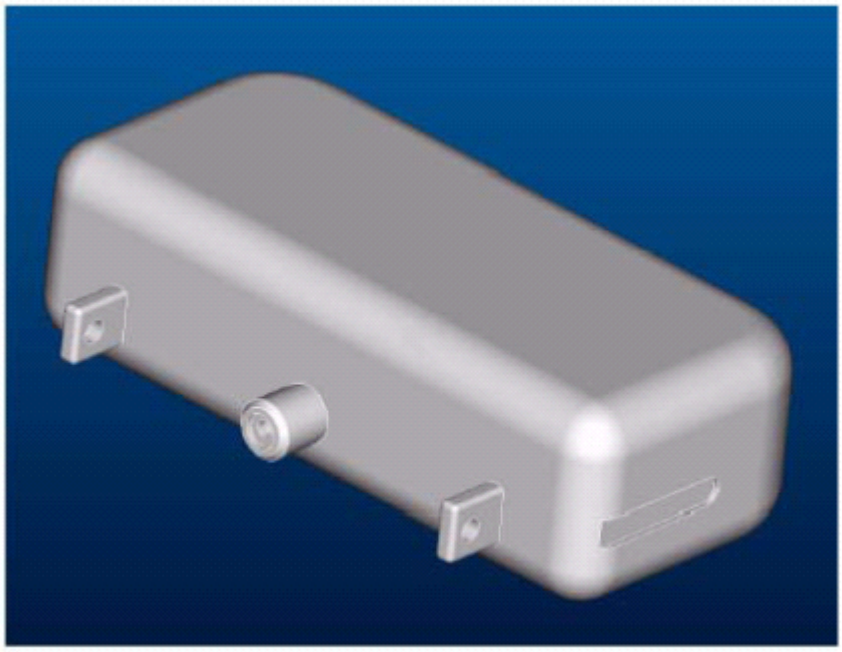
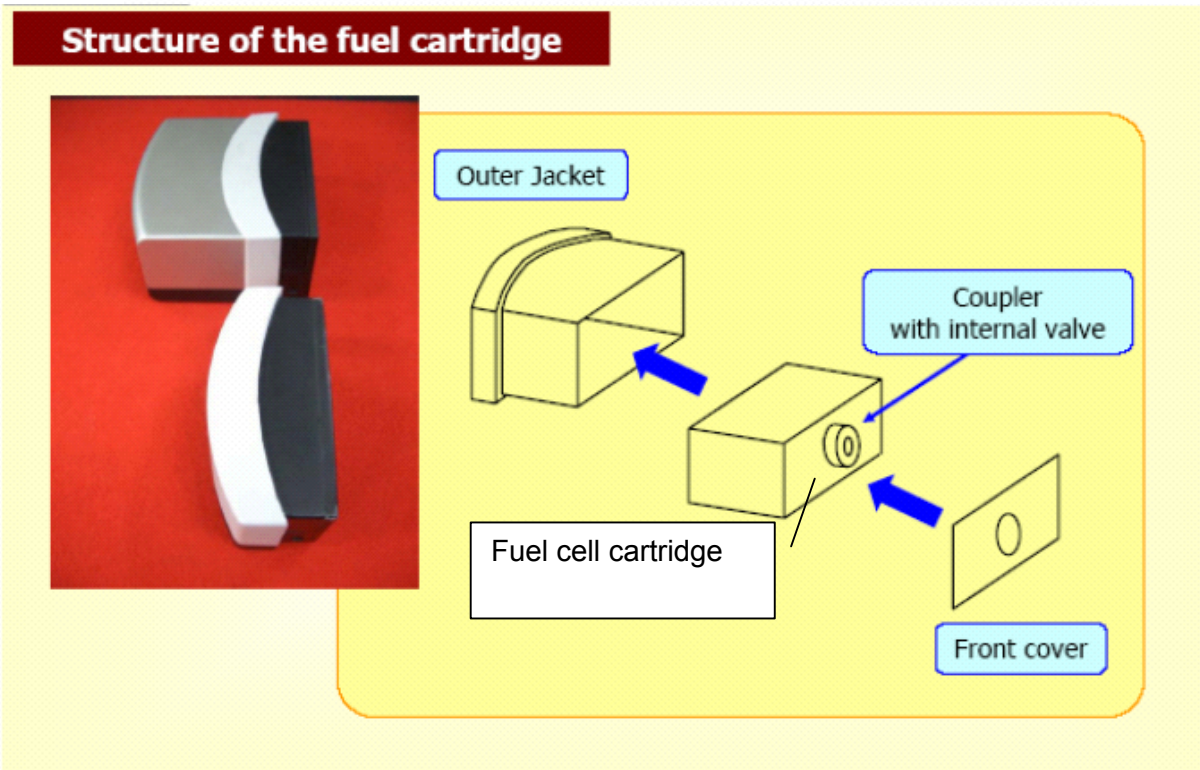


Image of Fuel Cell Cartridge (200cc)



Annex 3 (in English only)

Fuel cell functions as an article