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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

Twenty-ninth session
Geneva, 3-12 (a.m.) July 2006
Item 6 of the provisional agenda

LISTING, CLASSIFICATION AND PACKING

Fuel Cell Cartridges Containing Division 2.1 or 4.3 or Class 8 Substances

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

Introduction

1. As portable electronic devices continue to evolve, consideration is being given to the use of various types of fuel cell technologies to meet increasing power demands. In addition to flammable liquid fuel cells already provided for by UN 3473, there are a number of other rapidly advancing fuel cell technologies employing a range of fuels, including hydrogen in a metal hydride, butane, borohydrides and formic acid. The fuels may either be a gas (hydrogen in a metal hydride, butane) in Division 2.1, a solid borohydride (including formulations) meeting the criteria for classification in Division 4.3, or in the form of liquid or solid formulations (sodium borohydride, or formic acid) meeting the criteria for classification in Class 8.
 2. At the previous session of the Sub-Committee, the expert from France submitted a document (INF.19) which proposed two new entries, one in Division 4.3 and one in Class 8, under which fuel cells and fuel cell cartridges containing borohydrides could be transported. A number of comments were offered by Sub-Committee members on the
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proposals in document INF.19. This document takes account of the comments offered and presents a comprehensive proposal for all known and anticipated fuel cell types.

3. The main comment offered by Sub-Committee members at the previous meeting was that the proposed entries should not be specific to a particular fuel (i.e., borohydrides), but rather should be generic based on the relevant hazard class - employing an approach similar to that taken in the existing entry for fuel cell cartridges containing flammable liquids (UN 3473). Accordingly, the entries proposed in this document cover fuel cartridges containing any fuel that would meet the criteria for classification in Division 2.1, Division 4.3 or Class 8. In this way, the proposed entries would cover fuel cell cartridges containing fuels actively under consideration at this time as well as others that may be determined viable in the future. A number of Sub-Committee members also emphasized that the entries should clearly treat fuel cell cartridges as “articles” rather than “substances”. The entries proposed in this document take account of this important distinction. Furthermore, the entries are consistent with other entries in the Model Regulations covering articles (e.g., the entry for fuel cell cartridges containing flammable liquid (UN 3473), and various entries for batteries (UN 2794, UN 2795 and UN 2800)). By pursuing consistency with descriptions of other entries in the Model Regulations, the proposal does not include the type of hazard within the Proper Shipping Name. In following this approach the type of hazard is identified by the hazard class and could be viewed as redundant if also added to the Proper Shipping Name. We would welcome discussion by the Sub-Committee if the type of hazard should be added to the Proper Shipping Name (i.e. Fuel Cell Cartridge Containing a Flammable Gas). The proposal also provides a separate description for Fuel Cell Cartridges, and Fuel Cell Cartridges Contained In or Packed With Equipment for each type of hazard. This is suggested in order to easily distinguish between requirements of the different packing configurations. We also welcome comments by the Sub-Committee if the Fuel Cell Cartridge and the Fuel Cell Cartridge Contained in or Packed With Equipment should have two separate descriptions or be combined into one for each hazard.
4. The proposal is intended to establish a regulatory system that comprehensively addresses the transport of fuel cell cartridges containing various dangerous goods. During the development of this proposal, amendments to the existing entry Fuel Cell Cartridge containing flammable liquid, UN3473 were identified and the necessary amendments are included within the proposal. In addition, as suggested by various Sub-Committee members, the proposal clarifies that the proposed entries apply to fuel cell cartridges, and fuel cell cartridges contained in or packed with equipment.
5. Fuel cells are intended for rather rugged consumer, military and industrial purposes and by design offer a high degree of integrity. Nevertheless, to ensure a baseline level of containment integrity is provided, it is proposed that fuel cell cartridges be tested to demonstrate they can withstand a 1.2 meter drop test unpackaged. In addition, fuel cell cartridges designed for liquid fuels shall be able to pass an internal pressure test at a pressure of 100 kPa (gauge). In this proposal Packing Group III performance packaging is proposed for the fuel cell cartridge entries only. This would not apply when the cartridges are packed with or in equipment. A new packing instruction specific to fuel cell cartridges and fuel cell cartridges contained in or packed with equipment is also proposed.

Specific Comments Relating to Fuel Cell Cartridges Containing Liquefied Flammable Gases

6. Liquefied flammable gases and hydrogen in a metal hydride are the two types of gases in use in fuel cell designs. Provisions necessary for the safe transport of articles containing these two different types of dangerous goods are quite different; therefore, it is necessary to distinguish them with different entries. Two new entries for cartridges containing liquefied flammable gases are proposed with size and pressure limits. The capacity and vapor pressure limits were chosen based on industry specifications to address the needs of the consumer portable electronics industry and safety concerns for all modes of transport.
7. Two new entries for hydrogen in a metal hydride are proposed with size and pressure limits for the cartridges specifically designed for fuel cells. In this manner a necessary distinction can be made to the existing entry of UN 3468 which can be large or small articles that may or may not be used in conjunction with a fuel cell. However, to be consistent with current requirements for UN 3468, it is proposed that receptacles used for fuel cell cartridges containing hydrogen in a metal hydride also require approval by the competent authority. An ISO standard (ISO16111) is being developed but is currently not available as a published standard to allow its reference in the Model Regulations. It is further recognized that the requirements for both the newly proposed entries and UN 3468 could be readdressed once that standard has been completed and published.
8. The Dangerous Goods List descriptions and packaging in the proposal are consistent with existing requirements for similar items. However, the proposal presents conservative values for the quantity limits authorized for liquefied flammable gases and hydrogen in a metal hydride, while still addressing the fuel cell cartridge sizes envisioned for the near future. For liquefied flammable gas fuel cell cartridges a maximum quantity of 200 ml with a vapor pressure not exceeding 1000 kPa at 55 °C is proposed. For fuel cell cartridges containing hydrogen in a metal hydride, a maximum quantity of 100 g of hydrogen with a pressure not to exceed 5 MPa at 55 °C is proposed. Consistent with the current requirements for liquefied flammable gases such as UN 1011 (Butane) and UN 1075 (Liquefied Petroleum Gases); and for UN 1049 (Hydrogen) and UN 3468 (Hydrogen in a metal hydride storage system), no limited quantity is currently proposed. While these conservative values are being proposed, it is possible that larger amounts per cartridge and appropriate limited quantity provisions could be considered for the Division 2.1 entries if the required level of safety is included by addition of a relevant technical standard or the necessary technical aspects of that standard.

Proposals

9. As the commercialization phase of fuel cell development approaches, there is a need to transport fuel cell cartridges containing fuel for these cells. Accordingly, the Sub-Committee is invited to consider the proposals in this document which, if adopted, will provide for the safe and efficient transport of these fuel cells and cartridges, as well as consumer electronic devices containing or packed with these fuel cells or cartridges.

10. The following amendments to the UN Model Regulations are proposed:

- (a) New entries would be added to the Dangerous Goods List in Chapter 3.2 of the Model Regulations and the existing entry for UN 3473 would be amended as follows:

The following new entries would be added:

| -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 | -9 | -10 | -11 |
|------|---|-----|----|----|---------------------|--------------------|------|----|-----|-----|
| KKKK | FUEL CELL CARTRIDGE containing liquefied flammable gas | 2.1 | | | 3AA, 3BB | None | P004 | | | |
| MMMM | FUEL CELL CARTRIDGE containing liquefied gas CONTAINED IN EQUIPMENT or PACKED WITH EQUIPMENT | 2.1 | | | 3AA, 3BB, 3CC | None | P004 | | | |
| NNNN | FUEL CELL CARTRIDGE containing hydrogen in a metal hydride | 2.1 | | | 3AA, 3DD | None | P004 | | | |
| SSSS | FUEL CELL CARTRIDGE containing hydrogen in a metal hydride CONTAINED IN EQUIPMENT or PACKED WITH EQUIPMENT | 2.1 | | | 3AA, 3CC, 3DD | None | P004 | | | |
| QQQQ | FUEL CELL CARTRIDGE containing water- reactive substance | 4.3 | | | 3AA, 3EE | 500 ml or 500 g | P004 | | | |
| WWWW | FUEL CELL CARTRIDGE containing water- reactive substance CONTAINED IN EQUIPMENT or PACKED WITH EQUIPMENT | 4.3 | | | 3AA, 3CC, 3EE | 500 ml or 500 g | P004 | | | |
| XXXX | FUEL CELL CARTRIDGE containing corrosive substance | 8 | | | 3AA, 3EE | 1 L or 1 Kg | P004 | | | |

| | | | | | |
|------|--|---|---------------------|----------------|------|
| YYYY | FUEL CELL CARTRIDGE containing corrosive substance CONTAINED IN EQUIPMENT or PACKED WITH EQUIPMENT | 8 | 3AA, 3CC, 3EE | 1 L or 1 Kg | P004 |
| ZZZZ | FUEL CELL CARTRIDGE containing flammable liquids CONTAINED IN EQUIPMENT or PACKED WITH EQUIPMENT | 3 | 3AA, 3CC | 1 L | P004 |

The existing entry for UN 3473 would be amended as follows:

| | | | | | |
|------|---|---|-----|-----|------|
| 3473 | FUEL CELL CARTRIDGE containing flammable liquids | 3 | 3AA | 1 L | P004 |
|------|---|---|-----|-----|------|

- (b) Four new Special Provisions would be added in Chapter 3.3 of the Model Regulations to read:

SP 3AA: This entry applies to fuel cell cartridges, including a fuel cell cartridge installed in a fuel cell, containing dangerous goods. The fuel cell cartridge means a container 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 shall be designed and constructed to prevent fuel leakage under normal conditions of transport.

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.

Fuel cell cartridge design types that are designed for liquid fuels shall be shown to pass an internal pressure test at a pressure of 100 kPa (gauge).

When a limited quantity value is prescribed in Column 7 of the Dangerous Goods List the quantity limits apply to the content of the fuel cell cartridge.

SP 3BB: Fuel cell cartridges transported under this entry shall contain no

more than 200 ml of liquefied flammable gas with a vapor pressure not exceeding 1000 kPa at 55 °C.

Fuel cell cartridge design types that are designed for liquefied gases shall be capable of withstanding a pressure of at least 1.5 times the equilibrium pressure of the contents at 55 °C.

SP 3CC: This entry applies to fuel cell cartridge(s) that are contained in equipment or packed with equipment.

SP 3DD: Fuel cell cartridges transported under this entry shall be approved by the competent authority and shall contain no more than 100g of hydrogen in a metal hydride with a pressure not to exceed 5 MPa at 55 °C.

SP 3EE: Where the cartridge design requires an activator, it shall include two independent means of preventing uncontrolled functioning.

(c) Add the following new packing instruction in 4.1.4.1:

| | | |
|-------------|----------------------------|-------------|
| P004 | PACKING INSTRUCTION | P004 |
|-------------|----------------------------|-------------|

This instruction applies to fuel cell cartridges, and fuel cell cartridges contained in equipment or packed with equipment.

The following packagings are authorized provided the general provisions of 4.1.1. and 4.1.3. are met; except for the orientation requirement in 4.1.1.5 :

Packaging conforming to the packing group III performance level.

When fuel cell cartridges are contained in equipment or packed with equipment, they shall be packed in a strong outer packaging. Large robust equipment containing fuel cell cartridges may be transported unpackaged. When fuel cell cartridges are packed with equipment, they shall be packed in inner packagings or placed in the outer packaging with cushioning material or divider so that the fuel cell cartridges are protected against damage that may be caused by the movement or placement of the contents within the outer packaging.
