



**WORKING PAPER**

**DANGEROUS GOODS PANEL (DGP)**

**TWENTY-SECOND MEETING**

**Montréal, 5 to 16 October 2009**

**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 2011-2012 Edition**

**FUEL CELL VEHICLES – CONSEQUENTIAL CHANGES**

(Presented by USFCC)

**SUMMARY**

Fuel cell vehicles, fuel cell engines, and fuel cell powered equipment have been added to UN 3166 by the UNSCETDG. Consequential amendments are necessary. This paper addresses those consequential amendments.

**Action by the DGP:** The DGP is invited to consider the proposed amendments as presented in the appendix.

**1. INTRODUCTION**

1.1 The entry UN 3171, **Battery powered vehicle** or **Battery powered equipment** applies to vehicles and equipment powered by wet batteries, sodium batteries or lithium batteries and transported with these batteries installed. Examples of such vehicles and equipment are electrically-powered cars, lawnmowers, wheelchairs and other mobility aids. Hybrid electric vehicles powered by both an internal combustion engine and wet batteries, sodium batteries or lithium batteries, transported with the battery(ies) installed are consigned under the UN 3166 entries **Vehicle, flammable gas powered** or **Vehicle, flammable liquid powered** as appropriate.

1.2 Fuel cell powered vehicles have been developed as another alternative to internal combustion engine powered vehicles for some applications including cars, buses, fork lifts, wheelchairs, mobility devices and other self propelled equipment. A fuel cell is an electrochemical device that converts the chemical energy of a fuel and an oxidant to electrical energy (DC power), heat and reaction products (Definition from IEC 62282-6-1). A fuel cell is essentially an electrical generator operating by a chemical reaction without combustion. The electrical power generated by the fuel cell is used in a vehicle to power the electric motors that drive the vehicle or to recharge the installed batteries.

1.3 Since the hazard involved in transporting and handling vehicles using a fuel cell are the same as the hazards involved in transporting and handling vehicles or equipment using an internal combustion engine, at its 34th Session of the UNSCETDG held in December 2008, the UN Sub-Committee agreed to revise the dangerous goods list as follows:

3166	ENGINE, INTERNAL COMBUSTION or VEHICLE, FLAMMABLE GAS POWERED or VEHICLE, FLAMMABLE LIQUID POWERED <u>or ENGINE, FUEL CELL, FLAMMABLE GAS POWERED or ENGINE, FUEL CELL, FLAMMABLE LIQUID POWERED or VEHICLE, FUEL CELL, FLAMMABLE GAS POWERED or VEHICLE, FUEL CELL, FLAMMABLE LIQUID POWERED</u>	9			106 312	0	E0	NONE			
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1.4 The DGP considered the definition of fuel cell at its working group meeting in November of 2008 (DGP-WG08, The Hague, 3 to 7 November 2008) and accepted provisionally, subject to final approval at DGP/22, the following definition:

“**FUEL CELL.** A fuel cell is an electrochemical device that converts the chemical energy of a fuel to electrical energy, heat and reaction products.”

1.5 The UN SCETDG reached a decision in December of 2008 to add the following definitions to Part 1, Chapter 1.2, Definitions and Units of Measurement, sub-paragraph 1.2.1, Definitions:

- a) “Fuel Cell means an electrochemical device that converts the chemical energy of a fuel to electrical energy, heat and reaction products.”
- b) “A fuel cell engine is a device used to power equipment and consists of a fuel cell and its fuel supply, whether integrated with or separate from the fuel cell, and includes all appurtenances necessary to fulfill its function.”

## 2. DISCUSSION

2.1 These proposed consequential amendments are intended to be consistent with the decisions made at the UNSCETDG.

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APPENDIX

AMENDMENTS TO THE TECHNICAL INSTRUCTIONS

Attachment 1

LISTS OF PROPER SHIPPING NAMES

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- 3166 Engines, internal combustion, flammable gas powered  
or Engines, internal combustion, flammable liquid powered  
or Vehicle, flammable gas powered  
or Vehicle, flammable liquid powered  
or Engines, fuel cell, flammable gas powered  
or Engines, fuel cell, flammable liquid powered  
or Vehicle, fuel cell, flammable liquid powered  
or Vehicle, fuel cell, flammable gas powered

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Attachment 2

GLOSSARY OF TERMS

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Already approved provisionally in DGP-WG08: (see DGP/22-WP/2, paragraph 3.2.1):

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<i>Term and explanation</i>	<i>UN Number(s), when relevant</i>
<u>FUEL CELL. A fuel cell is an electrochemical device that converts the chemical energy of a fuel to electrical energy, heat and reaction products.</u>	<u>0503, 3268</u>

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Based on definition approved at 33<sup>rd</sup> Session of  
UNSCETDG:

*Term and explanation* *UN Number(s),  
when relevant*

**FUEL CELL ENGINE.** A device used to power equipment consisting of a fuel cell and its fuel supply, whether integrated with or separate from the fuel cell, and includes all appurtenances necessary to fulfill its function. 3166

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### Part 3

## DANGEROUS GOODS LIST, SPECIAL PROVISIONS AND LIMITED AND EXCEPTED QUANTITIES

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### Chapter 2

#### ARRANGEMENT OF THE DANGEROUS GOODS LIST (TABLE 3-1)

Parts of this Chapter are affected by State Variations AU 1, AU 2, AU 3, BE 3, CA 7, CA 8, CA 10, CA 11, CA 13, GB 3, IR 3, JP 21, NL 1, US 2, US 3, US 6, US 15, ZA 1; see Table A-1

#### 2.1 ARRANGEMENT OF THE DANGEROUS GOODS LIST (TABLE 3-1)

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Name	UN No.	Class or division	Subsidiary risk	Labels	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
									Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	5	6	7	8	9	10	11	12	13
<b>Engines, fuel cell, flammable gas powered</b>	3166	9		Miscellaneous		A67 A70 A87 A134		E0	FORBI	DDEN	951	No limit
<b>Engines, fuel cell, flammable liquid powered</b>	3166	9		Miscellaneous		A67 A70 A87 A134		E0	950	No limit	950	No limit
<b>Vehicle, fuel cell, flammable gas powered</b>	3166	9		Miscellaneous		A67 A70 A87 A118 A120 A134		E0	FORBI	DDEN	951	No limit
<b>Vehicle, fuel cell, flammable liquid powered</b>	3166	9		Miscellaneous		A67 A70 A87 A118 A120 A134		E0	950	No limit	950	No limit

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## Part 3

## DANGEROUS GOODS LIST, SPECIAL PROVISIONS AND LIMITED AND EXCEPTED QUANTITIES

Table 3-2. Special provisions

<i>TI</i> s	<i>UN</i>
A21	<p>This entry only applies to vehicles and equipment which are powered by wet batteries, sodium batteries or lithium batteries and which are transported with these batteries installed. Examples of such vehicles and equipment are electrically-powered cars, lawn mowers, wheelchairs and other mobility aids. Vehicles that also contain an internal combustion engine must be consigned under the entry Vehicle (flammable gas powered) or Vehicle (flammable liquid powered), as appropriate. Hybrid electric vehicles powered by both an internal combustion engine and wet batteries, sodium batteries or lithium batteries, transported with the battery(ies) installed, must be consigned under the entries UN 3166 <b>Vehicle, flammable gas powered</b> or UN 3166 <b>Vehicle, flammable liquid powered</b>, as appropriate.</p> <p><u>Vehicles or machinery powered by a fuel cell engine must be consigned under the entries <b>Vehicle, fuel cell, flammable gas powered</b> or <b>Vehicle, fuel cell, flammable liquid powered</b>, or <b>Engine, fuel cell, flammable gas powered</b> or <b>Engine, fuel cell, flammable liquid powered</b> as appropriate. These entries include hybrid electric vehicles containing both a fuel cell and an internal combustion engine and wet batteries, sodium batteries or lithium batteries, transported with the battery(ies) installed.</u></p>
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≠ A70	<p>Internal combustion <u>or fuel cell</u> engines being shipped either separately or incorporated into a <u>vehicle</u>, machine or other apparatus, the fuel tank of which has never contained any fuel and the fuel system of which is completely empty of fuel, or that are powered by a fuel that does not meet the classification criteria for any class or division, and without batteries or other dangerous goods, are not subject to these Instructions. The words "not restricted" and the special provision number A70 must be provided on the air waybill when an air waybill is issued.</p>
A134 (312)	<p>Vehicles which contain an internal combustion engine must be consigned under the entries UN 3166 <b>Vehicle, flammable gas powered</b> or UN 3166 <b>Vehicle, flammable liquid powered</b>, as appropriate. These entries include hybrid electric vehicles powered by both an internal combustion engine and wet batteries, sodium batteries or lithium batteries, transported with the battery(ies) installed.</p> <p><u>Vehicles or machinery powered by a fuel cell engine must be consigned under the entries <b>Vehicle, fuel cell, flammable gas powered</b> or <b>Vehicle, fuel cell, flammable liquid powered</b>, or <b>Engine, fuel cell, flammable gas powered</b> or <b>Engine, fuel cell, flammable liquid powered</b> as appropriate. These entries include hybrid electric vehicles containing both a fuel cell and an internal combustion engine and wet batteries, sodium batteries or lithium batteries, transported with the battery(ies) installed.</u></p>

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## Attachment 4

# REFORMATTED PACKING INSTRUCTIONS (APPLICABLE FROM 1 JANUARY 2011)

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## CLASS 9 — MISCELLANEOUS DANGEROUS GOODS

### Packing Instruction 950

Passenger and cargo aircraft for UN 3166 only  
(See Packing Instruction 951 for flammable gas-powered vehicles and engines or  
Packing Instruction 952 for battery-powered equipment and vehicles)

#### General requirements

Part 4, Chapter 1 requirements must be met, including:

#### 4) Compatibility requirements

— Substances must be compatible with their packagings as required by 4;1.1.3.

#### ~~2) Closure requirements~~

~~— Closures must meet the requirements of 4;1.1.4.~~

<i>UN number and proper shipping name</i>	<i>Quantity — passenger</i>	<i>Quantity — cargo</i>
UN 3166 <b>Engines, internal combustion, flammable liquid powered or Vehicle, flammable liquid powered or Vehicle, fuel cell, flammable liquid powered or Engine, fuel cell, flammable liquid powered</b>	No limit	No limit

#### ADDITIONAL PACKING REQUIREMENTS

##### *Flammable liquid fuel tanks*

Except as otherwise provided for in this packing instruction, fuel tanks must be drained of fuel and tank caps fitted securely. Special precautions are necessary to ensure complete drainage of the fuel system of vehicles, machines or equipment incorporating internal combustion engines, such as lawn mowers and outboard motors, where such machines or equipment could possibly be handled in other than an upright position. When it is not possible to handle in other than an upright position, vehicles, except those with diesel engines, must be drained of fuel as far as practicable, and if any fuel remains, it must not exceed one-quarter of the tank capacity.

##### *Diesel engines*

Vehicles equipped with diesel engines are excepted from the requirement to drain the fuel tanks, provided that a sufficient ullage space has been left inside the tank to allow fuel expansion without leakage, and the tank caps are tightly closed. A careful check must be made to ensure there are no fuel leakages.

**Batteries**

All batteries must be installed and securely fastened in the battery holder of the vehicle, machine or equipment and must be protected in such a manner so as to prevent damage and short circuits. In addition:

- 1) if spillable batteries are installed, and it is possible for the vehicle, machine or equipment to be handled in such a way that batteries would not remain in their intended orientation, they must be removed and packed according to Packing Instruction 492 or 870 as applicable;
- 2) if lithium batteries are installed, they must be of a type that has successfully passed the tests specified in the *UN Manual of Tests and Criteria*, Part III, subsection 38.3, must be securely fastened in the vehicle, machinery or equipment and must be protected in such a manner so as to prevent damage and short circuits; and
- 3) if sodium batteries are installed they must conform to the requirements of Special Provision A94.

**Other operational equipment**

- 1) Dangerous goods required for the operation of the vehicle, machine or equipment, such as fire extinguishers, tire inflation canisters, safety devices, must be securely mounted in the vehicle, machine or equipment. Aircraft may also contain other articles and substances which would otherwise be classified as dangerous goods but which are installed in that aircraft in accordance with the pertinent airworthiness requirements and operating regulations. If fitted, life-rafts, emergency escape slides and other inflation devices must be protected such that they cannot be activated accidentally. Vehicles containing dangerous goods identified in Table 3-1 as forbidden on passenger aircraft may only be transported on cargo aircraft. Replacements for the dangerous goods permitted must not be carried under this packing instruction.
- 2) Vehicles equipped with theft-protection devices, installed radio communications equipment or navigational systems must have such devices, equipment or systems disabled.

**Internal combustion or fuel cell engine shipped separately (not installed)**

- 1) When internal combustion engines or fuel cell engines are being shipped separately, all fuel, coolant or hydraulic systems remaining in or on the engine must be drained as far as practicable and all disconnected fluid pipes must be sealed with leakproof caps, which are positively retained.
- 2) This requirement also applies to vehicles, machines or equipment containing internal combustion engines or fuel cell engines which are being shipped in a dismantled state such that fuel lines have been disconnected.

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## Packing Instruction 951

Cargo aircraft only for UN 3166 only  
(See Packing Instruction 950 for flammable liquid-powered vehicles and engines or  
Packing Instruction 952 for battery-powered equipment and vehicles)

### General requirements

Part 4, Chapter 1 requirements must be met, including:

#### ~~1) Compatibility requirements~~

— Substances must be compatible with their packagings as required by 4;1.1.3.

#### ~~2) Closure requirements~~

— ~~Closures must meet the requirements of 4;1.1.4.~~

<i>UN number and proper shipping name</i>	<i>Quantity — passenger</i>	<i>Quantity — cargo</i>
UN 3166 <b>Engines, internal combustion, flammable gas powered or Vehicle, flammable gas powered or Vehicle, fuel cell, flammable gas powered, or Engine, fuel cell, flammable gas powered</b>	Forbidden	No limit

### ADDITIONAL PACKING REQUIREMENTS ~~FOR COMBINATION PACKAGINGS~~

#### *Flammable gas vessels*

- 1) for flammable gas-powered vehicles, machines or equipment, pressurized vessels containing the flammable gas must be completely emptied of flammable gas. Lines from vessels to gas regulators, and gas regulators themselves, must also be drained of all trace of flammable gas. To ensure that these conditions are met, gas shut-off valves must be left open and connections of lines to gas regulators must be left disconnected upon delivery of the vehicle to the operator. Shut-off valves must be closed and lines reconnected at gas regulators before loading the vehicle aboard the aircraft;

or alternatively,

- 2) flammable gas-powered vehicles, machines or equipment that have pressure receptacles (fuel tanks) equipped with electrically operated valves that close automatically in case the power is disconnected, or with manual shut-off valves, may be transported under the following conditions:
  - i) the tank shut-off valves must be in the closed position and in the case of electrically operated valves, power to those valves must be disconnected;
  - ii) after closing the tank shut-off valves, the vehicle, equipment or machinery must be operated until it stops from lack of fuel before being loaded aboard the aircraft;
  - iii) in no part of the closed system must the remaining pressure of compressed gases exceed 5 per cent of the maximum allowable working pressure of the pressure receptacle (fuel tank) system, or more than 2 000 kPa (20 bar), whichever is the lower.

#### *Batteries*

All batteries must be installed and securely fastened in the battery holder of the vehicle, machine or equipment and must be protected in such a manner so as to prevent damage and short circuits. In addition:

- 1) if spillable batteries are installed, and it is possible for the vehicle, machine or equipment to be handled in such a way that batteries would not remain in their intended orientation, they must be removed and packed according to Packing Instruction 492 or 870 as applicable;
- 2) if lithium batteries are installed, they must be of a type that has successfully passed the tests specified in the



UN *Manual of Tests and Criteria*, Part III, subsection 38.3, must be securely fastened in the vehicle, machinery or equipment and must be protected in such a manner so as to prevent damage and short circuits; and

- 3) if sodium batteries are installed they must conform to the requirements of Special Provision A94.

**Other operational equipment**

- 1) Dangerous goods required for the operation of the vehicle, machine or equipment, such as fire extinguishers, tire inflation canisters, safety devices, must be securely mounted in the vehicle, machine or equipment. Aircraft may also contain other articles and substances which would otherwise be classified as dangerous goods but which are installed in that aircraft in accordance with the pertinent airworthiness requirements and operating regulations. If fitted, life-rafts, emergency escape slides and other inflation devices must be protected such that they cannot be activated accidentally. Vehicles containing dangerous goods identified in Table 3-1 as forbidden on passenger aircraft may only be transported on cargo aircraft. Replacements for the dangerous goods permitted must not be carried under this packing instruction.
- 2) Vehicles equipped with theft-protection devices, installed radio communications equipment or navigational systems must have such devices, equipment or systems disabled.

**Internal combustion or fuel cell engine shipped separately (not installed)**

- 1) When internal combustion engines or fuel cell engines are being shipped separately, all fuel, coolant or hydraulic systems remaining in or on the engine must be drained as far as practicable and all disconnected fluid pipes must be sealed with leakproof caps, which are positively retained.
- 2) This requirement also applies to vehicles, machines or equipment containing internal combustion engines or fuel cell engines which are being shipped in a dismantled state such that fuel lines have been disconnected.