



WORKING PAPER

**DANGEROUS GOODS PANEL (DGP)
MEETING OF THE WORKING GROUP OF THE WHOLE**

Beijing, China, 25 October to 3 November 2006

- 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 2009/2010 Edition**
- 2.3: Part 3 — Dangerous Goods List and Limited Quantities Exceptions**
 - 2.4: Part 4 — Packing Instructions**

**PROHIBITION OF CERTAIN PRIMARY LITHIUM BATTERIES FROM
TRANSPORT BY PASSENGER AIRCRAFT**

(Presented by R. Richard)

SUMMARY

This paper proposes to forbid the transport of certain primary lithium batteries on passenger aircraft on the basis of their risk and the inability of standard aircraft fire suppression systems to extinguish a fire involving such batteries. Exceptions are proposed for small primary lithium batteries contained in or packed with equipment.

Action by the DGP-WG is in paragraph 2.

1. INTRODUCTION

1.1 In recent years a number of incidents involving lithium batteries have occurred during or in connection with transportation by aircraft. A list and description of incidents of which the U.S. competent authority has been made aware is attached (See Appendix C). Because primary lithium batteries contain lithium metal they pose a significant hazard in the event of an in-flight cargo compartment fire. Fire tests conducted by the U.S. Department of Transportation's Federal Aviation Administration concluded that the presence of primary lithium batteries can significantly increase the severity of an in-flight cargo compartment fire. In this study, a series of tests were conducted to assess the flammability characteristics of primary lithium batteries, both individually and when packaged and shipped as cargo onboard cargo and passenger aircraft. The tests were designed to determine the conditions necessary for battery ignition, the characteristics of the battery fire, the potential hazard to the aircraft as a result of the fire, and the effectiveness of the standard Halon 1301 fire suppression systems in extinguishing the fire. The report presented significant findings related to the risk posed to passengers or crew aboard aircraft containing shipments of primary lithium batteries. A copy of the relevant technical report published in June 2004 (DOT/FAA/AR/-04/ 26) was previously provided as DGP-WG/04-WP/11 and is available via the internet at <http://www.tc.faa.gov/its/worldpac/techrpt/ar04-26.pdf>.

1.2 The tests performed show that Halon 1301, the fire suppression agent installed in many transport category aircraft, is ineffective in suppressing or extinguishing a primary lithium battery fire. A relatively small fire source was sufficient to start a primary lithium battery fire. The outer plastic coating easily melted and fused adjacent batteries together and then ignited, contributing to the fire intensity. This helped to raise the battery temperature to the self-ignition temperature of lithium. Once the lithium in a single battery began to burn, it released enough energy to ignite adjacent batteries. This propagation continued until all batteries were consumed. The report further concluded that the air temperature in a cargo compartment that had a fire suppressed by Halon 1301 could still be above the auto-ignition temperature of lithium. Because of this, batteries that were not involved in the initial fire could still ignite and propagate.

1.3 The ignition of a primary lithium battery released burning electrolyte and a molten lithium spray. The cargo liner material may be vulnerable to perforation by molten lithium, depending on its thickness. This could allow the Halon 1301 fire suppressant agent to leak out of the compartment, reducing the concentration within the cargo compartment and the effectiveness of the agent. Holes in the cargo liner may also allow flames to spread outside the compartment. The ignition of primary lithium batteries released a pressure pulse that raised the air pressure within the cargo compartment. The ignition of only a few batteries was sufficient to increase the air pressure by more than 1-psi in an airtight 10-meter-cubed pressure vessel. Cargo compartments are only designed to withstand approximately a 1-psi pressure differential. The ignition of a bulk-packed lithium battery shipment could compromise the integrity of the compartment by activating the pressure relief panels. This would have the same effect as perforations in the cargo liner, allowing the Halon 1301 fire suppressant to leak out, reducing its effectiveness.

1.4 On the basis of the risk posed by primary lithium batteries, their potential to damage the cargo liner, and the inability of standard aircraft fire suppression systems to extinguish a fire involving such batteries, it is proposed that the ICAO Technical Instructions be amended to prohibit their carriage as cargo on passenger carrying aircraft.

2. ACTION BY THE DGP-WG

2.1 The DGP-WG is invited to agree in principle to prohibit the transport of primary lithium batteries on passenger-carrying aircraft, and that exceptions be provided for small primary lithium batteries contained in or packed with equipment.

2.2 The DGP-WG is invited to consider how best to implement the prohibition if adopted. Two possible approaches to amend the TI to incorporate these requirements are presented in Appendices A and B of this document to facilitate discussion. These suggested amendments are based on current ICAO TI text and do not include changes that may be adopted in the 15th Revised Edition of the UN Model Regulations. Appendix A provides the prohibition and applicable requirements in a new Special Provision that would be assigned to the lithium battery entries. This proposal only includes provisions specific to the prohibition of primary lithium batteries on passenger-carrying aircraft and does not include consequential amendments (such as those necessary to A45) that may be required. Appendix B provides the prohibition and applicable requirements in a consolidated packing instruction based on the proposed packing instruction for lithium batteries introduced in the packing instruction reformatting initiative.

APPENDIX A

NEW SPECIAL PROVISION

- AXX I. Primary lithium batteries and cells are forbidden for transportation aboard passenger-carrying aircraft, unless contained in or packed with equipment and complying with the provisions specified in this Special Provision. Primary lithium batteries and cells excepted from the requirements of these Technical Instructions by Special Provision A45 must be marked “PRIMARY LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT”.
- II. When contained in or packed with equipment, primary lithium batteries and cells are forbidden from transport aboard passenger-carrying aircraft unless the following conditions are met:
- a) for a cell, the lithium content is not more than 1 g;
 - b) for a battery, the aggregate lithium content is not more than 2 g;
 - c) each cell or battery is of the type proved to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;
 - d) the package contains no more than the number of lithium batteries or cells necessary to power the intended piece of equipment;
 - e) the equipment and the battery or cell are packed in a strong outer packaging that is constructed of suitable material of adequate strength and design in relation to the packaging’s capacity and its intended use; and
 - f) the net weight of lithium batteries within a package does not exceed 5 kg.

Primary lithium batteries or cells contained in or packed with equipment conforming to the above conditions a)-f) are excepted from all other requirements of these Instructions.

As used above and elsewhere in the Instructions, “lithium content” means the mass of lithium in the anode of a lithium metal or lithium alloy cell.

APPENDIX B

NEW PACKING INSTRUCTION

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PACKING INSTRUCTION 9xx

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All requirements in this packing instruction apply only to cells or battery types that have been determined to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3 including any reclassification exceptions. The requirements for the following classifications and any applicable reclassification exceptions are included in this packing instruction.

- I. LITHIUM BATTERIES UN3090
- II. LITHIUM BATTERIES PACKED WITH EQUIPMENT UN3091
- III. LITHIUM BATTERIES CONTAINED IN EQUIPMENT UN3091
 - The general packing requirements of Part 4, Chapter 1 must be met other than I B and II
 - Substances must be compatible with their packagings as required by 4;1.1.

I. LITHIUM BATTERIES UN3090

Lithium metal or lithium alloy (primary, nonrechargeable) cells or batteries are forbidden from transport aboard passenger aircraft

- A. Lithium metal or lithium alloy (permitted on cargo aircraft) or lithium ion cells and batteries must meet the following requirements:
 - a) each cell or battery is of the type proved to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, sub-section 38.3;
 - b) each cell and battery must incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport;
 - c) each cell and battery must be equipped with an effective means of preventing external short circuits;
 - d) each battery containing cells or series of cells connected in parallel must be equipped with an effective means as necessary to prevent dangerous reverse current flow (e.g. diodes, fuses, etc.);
 - e) cells and batteries must be packed in the inner packagings to effectively prevent short circuits and to prevent movement which could lead to short circuits;
 - f) cells and batteries must be packed in steel drums (1A2), aluminium drums (1B2), plywood drums (1D) or fibre drums (1G), plastic drums (1H2), plastic jerricans (3H2), steel jerricans (3A2), wooden boxes (4C1, 4C2), plywood boxes (4D), reconstituted wood boxes (4F), fibreboard boxes (4G), solid plastic boxes (4H2), steel or aluminium boxes (4A, 4B) of Packing Group II;
 - g) irrespective of the requirements in e) and f) above, lithium batteries with a mass of 12 kg or greater and having a strong, impact-resistant outer casing, or assemblies of such batteries, may be transported when packed in strong outer packagings and protective enclosures not subject to the requirements of Part 6 of these instructions, if approved

by the appropriate authority of the State of Origin. A copy of the document of approval must accompany the consignment.

- h) Primary (non-rechargeable) lithium metal or alloy batteries and cells must be labeled with a CAO label.

B. Exceptions for UN 3090 Lithium batteries:

Lithium batteries are excepted from other provisions of these Instructions, except incident reporting 7;4.4, if they meet the following requirements:

- 1) Primary (non-rechargeable) lithium batteries and cells:
 - a) are forbidden on passenger aircraft and must be marked “PRIMARY LITHIUM BATTERIES-FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT”;
 - b) For CAO lithium content for lithium metal or lithium alloy is not more than:
 - i) 1g for cells; and
 - ii) 2g for batteries;
- 2) Secondary (rechargeable) lithium ion cells and batteries:
 - a) are permitted on passenger and cargo aircraft
 - b) lithium content for lithium ion is not more than:
 - i) 1.5g for cells; and
 - ii) 8g for batteries;
- 3) Each cell or battery has successfully passed each test in the UN Manual of Tests and Criteria, Part III, sub-section 38.3;
- 4) Cells and batteries are separated so as to prevent short circuits and are packed in strong packagings;
- 5) The words “Not Restricted lithium batteries” must be included in the description of the substance on the Airwaybill;
- 6) Each package containing more than 24 lithium cells or 12 lithium batteries must meet the following requirements with primary lithium metal or alloy batteries marked “PRIMARY LITHIUM BATTERIES-FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT”.
 - a) Each package must be marked indicating that it contains lithium batteries and that special procedures should be followed in the event that the package is damaged;
 - b) Each shipment must be accompanied with documentation indicating that packages contain lithium batteries and that special procedures should be followed in the event a package is damaged;
 - c) Each package is capable of withstanding a 1.2m drop test in any orientation without damage to cells or batteries contained therein, without shifting of the contents so as to allow battery to battery (cell to cell) contact and without release of contents; and
 - d) Packages may not exceed 30 kg gross mass.

II. LITHIUM BATTERIES PACKED WITH OR CONTAINED IN EQUIPMENT UN3091

Lithium metal or lithium alloy (primary, nonrechargeable) cells or batteries are forbidden from transport aboard passenger aircraft.

A. UN 3091 Lithium batteries packed with equipment

Lithium cells and batteries must meet the following requirements:

- a) each cell or battery is of the type proved to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, sub-section 38.3;
- b) each cell and battery must incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport;
- c) each cell and battery must be equipped with an effective means of preventing external short circuits;
- d) each battery containing cells or series of cells connected in parallel must be equipped with an effective means as necessary to prevent dangerous reverse current flow (e.g. diodes, fuses, etc.);
- e) cells and batteries must be packed in fiber drums (1G) or fiberboard boxes (4G) of Packing Group II and in such a manner to effectively c)prevent short circuits and to prevent movement which could lead to short circuits;
- f) packages must not exceed 5 kg gross mass for passenger aircraft or 35 kg gross mass for cargo aircraft; and
- g) the equipment and the packages of lithium cells or batteries must be overpacked.

B. UN 3091 Lithium batteries contained in equipment

Lithium cells and batteries must meet the following requirements:

- a) each cell or battery is of the type proved to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, sub-section 38.3;
- b) each cell and battery must incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport;
- c) each cell and battery must be equipped with an effective means of preventing external short circuits;
- d) each battery containing cells or series of cells connected in parallel must be equipped with an effective means as necessary to prevent dangerous reverse current flow (e.g. diodes, fuses, etc.);
- e) equipment containing lithium batteries must be contained in strong outer packaging. The outer packaging must be waterproof or made waterproof through the use of a liner, such as a plastic bag unless the equipment is made waterproof by the nature of the construction;
- f) the equipment must be secured against movement within the outer packaging and be packed so as to prevent accidental operation during air transport;
- g) the quantity of lithium metal contained in any piece of equipment must not exceed 12 g per cell and 500 g per battery; and
- h) not more than 5 kg of lithium batteries may be contained in any piece of equipment.

C. Exceptions for UN 3091 Lithium batteries packed with or contained in equipment

Excepted batteries are not subject to other provisions of these instructions (including the prohibition for transport of primary lithium batteries aboard passenger aircraft) except 7;4.4 if they meet the following requirements:

- 1) Primary (non-rechargeable) lithium batteries and cells
 - a) are permitted on passenger and cargo aircraft;
 - b) the lithium content for lithium metal or alloy batteries is not more than:
 - i) 1g for cells; and
 - ii) 2g for batteries;
 - c) for passenger aircraft:
 - i) the package contains no more than the number of lithium batteries or cells necessary to power the intended piece of equipment; and
 - ii) the gross weight of the package does not exceed 5 kg;
- 2) Secondary (rechargeable) lithium ion cells and batteries:
 - a) are permitted on passenger and cargo aircraft ;
 - b) lithium content for lithium ion is not more than:
 - i) 1.5g for cells; and
 - ii) 8g for batteries;
- 3) for batteries packed with equipment the requirements of Paragraph I.B.6 must be met if applicable.

III. FORBIDDEN FOR AIR TRANSPORT

Cells or batteries containing one or more cells with a liquid cathode containing sulphur dioxide, sulphuryl chloride or thionyl chloride are forbidden for transport if discharged to the extent that the open circuit voltage is less than the lower of:

- a) 2 volts; or
- b) two-thirds of the voltage of the undischarged cell.

For the purposes of this packing instruction, "equipment" means apparatus requiring the lithium batteries with which it is packed for its operation. "Lithium content" means the mass of lithium in the anode of a lithium metal or lithium alloy cell, except in the case of a lithium ion cell the "lithium equivalent content" in grams is calculated to be 0.3 times the rated capacity in ampere-hours. Incidents regarding batteries must be reported in accordance with 4.4.

APPENDIX C

**LITHIUM BATTERY & BATTERY-POWERED DEVICES
SUMMARY OF INCIDENTS**

DATE	TYPE OF BATTERY	DEVICE (if applicable)	INCIDENT SUMMARY
17-Jul-2006	EaglePicher-Kokam Lithium ion/polymer (used for remote control models), 122 batteries of various sizes		The unlabeled/marked package was discovered to have caught fire while being held in bond for customs clearance in Korea. Package had traveled to Korea in FedEx system from Vienna via Paris and Subic Bay.
15-May-2006	Lithium-ion (VGP-BPL2/VGP-BPS2 or equivalent)	Laptop with spare battery	Shortly before flight departure, a burning smell was detected in the first-class cabin of a Lufthansa ORD-MUC flight. Maintenance personnel were called to check and found it was coming from hand luggage inside an overhead luggage bin above seat 2A. The flight attendants evacuated the passengers in first class and first 2 rows of coach class. Crew used extinguishers to prevent setting off what was seen as the beginning of a slow fire. Maintenance immediately brought the bag outside the aircraft onto the ramp where it started to catch fire. Fire dept was called to assist. Fire was eventually put out after reigniting once. Fire apparently started from the extra battery pack for a laptop (not known if loose or attached to laptop). Flight departed 1 hour 18 minutes late.
03-MAR-2006	Lithium ion button cells, mfr. by Lixing		US-bound package was noticed to be smoking at outbound FedEx station in Shenzhen, China. Upon inspection, the package of lithium ion batteries was discovered to be on fire.

DATE	TYPE OF BATTERY	DEVICE (if applicable)	INCIDENT SUMMARY
29-JUN-2005	Lithium Ion	Battery-pack	At UPS in Ontario, Calif., during unloading of a ULD from Shanghai, it was discovered that a fire had taken place inside the ULD. A package containing a lithium-ion battery pack was identified as the source of the fire. Upon discovery, the burnt package and its contents were cool to the touch and there was no smoldering evident.
11-FEB-2005	Lithium battery, solid cathode, manufactured by Eagle Picher of Surrey, BC, Canada.	None	An undeclared package containing 18 lithium batteries caught fire while being unloaded from a conveyor belt at the FedEx facility in White Bear Lake, MN. FedEx cargo handlers report hearing a “pop” sound and then seeing the box “lifted” off the conveyor belt by the force. The shipment had flown from Los Angeles to Minneapolis and was to be trucked to Clear Lake, WI. Only one battery caught fire
29-OCT-2004	Ultralife 9-volt lithium (traditional 9-volt form: rectangular with two terminals on top)	Small electronic device (details to come)	Shortly after departure, the battery exploded in the hand of a cameraman traveling on the VP campaign plane of Sen. Edwards (the cameraman reportedly was in the process of changing batteries). It spewed shrapnel and ignited a fire in the seat which was extinguished by flight attendants and others. The flight crew declared an emergency and returned to Raleigh-Durham airport without further incident.
07-AUG-2004	Lithium-ion	Lithium-ion batteries assembled together in a plastic case	Prototype lithium batteries shipped under a competent authority approval from California to Europe apparently started a fire in a ULD during the loading process at the FedEx Memphis hub. The ULD had just been loaded for a transatlantic flight (Memphis-Paris). The ULD and many other packages in it were damaged/destroyed by fire. Shipment apparently was in violation of the DOT approval allowing the prototype battery to be shipped.

DATE	TYPE OF BATTERY	DEVICE (if applicable)	INCIDENT SUMMARY
01-APR-2004	CR123 lithium batteries	Flashlight	A flight attendant lent a passenger a flashlight which was recently purchased in Beijing. The passenger dropped the flashlight while it was on. Later the passenger put the flashlight in a seatback pocket. A few minutes later, the flashlight began to emit smoke and noxious fumes. The flashlight became so hot it could only be handled with oven mitts.
02-NOV-2003	Ni-Cad, Ni-Methyl Hydride, and/or Lithium (according to label on computer)	Notebook computer – Toshiba Satellite model # 815-S129	At security screening, a passenger's bag contained a computer bearing a warning label on the bottom near the battery compartment: "Warning: Hot base may cause burn. Avoid prolonged contact with bare skin." Battery compartment was hot. Screener had passenger turn off computer.
12-AUG-2002	Lithium battery (excepted)	Samsung mini computer (palm pilot)	Burning odor detected by handlers at the Los Angeles FedEx inbound package sort center. Battery apparently short-circuited causing the bubble wrap in the package to burn and melt onto the unit.
12-APR-2002	Lithium batteries	None	Lithium batteries shipped under exception by Abbott Labs did not have terminals protected from short circuit. Started fire inside package at FedEx Indy sort facility.
03-NOV-2000	Hawker lithium sulphur dioxide batteries	None	While in route by road to the FedEx Cargo facility in Portland, OR, a lithium battery shorted and ruptured, burning its packaging. The shorted battery had long flexible protruding positive and negative terminals. Two FedEx drivers were treated at a hospital after inhaling fumes from the incident.
28-APR-1999	Primary Lithium batteries (excepted)	None	After shipment (two pallets/120,000 batteries) transferred from passenger flight to cargo facility at LAX, a fire occurred. Cargo employee possibly mishandled one of the two pallets. One pallet caught on fire, was moved, the second pallet then caught fire. Initial attempts to extinguish the blaze using water/chemical fire extinguishers failed.

DATE	TYPE OF BATTERY	DEVICE (if applicable)	INCIDENT SUMMARY
26-SEP-1996	Lithium batteries	None	Eight lithium batteries were connected in a series and packed with bubble wrap inside a plastic express envelope. There were exposed connections on one end and loose wires on the other end. The batteries were not secured from movement within the package and a short-circuit resulted causing the packaging to burn. Burnt package discovered at Airborne sort center after first flight and prior to trans-Pacific cargo flight.
08-MAY-1994	Duracell lithium batteries (excepted from ICAO regulation by SP A45)	None	Consignment of lithium batteries found emitting smoke in ULD during truck transport to LHR. Fire damage. Batteries were smaller in diameter than a dime and about 5 mm high. They had been tossed loosely into a box. Positive and negative terminals had "tails" which were prone to short circuiting. The shipper was prosecuted by the UK CAA for failure to comply with Special Provision A45 of the ICAO Technical Instructions and fined £1200 with £300 costs.

— END —