International Civil Aviation Organization

DGP/24-WP/9
3/9/13

WORKING PAPER

DANGEROUS GOODS PANEL (DGP)

TWENTY-FOURTH MEETING

Montréal, 28 October to 8 November 2013

Agenda Item 5: Resolution, where possible, of the non-recurrent work items identified by the Air Navigation Commission or the panel:
5.1: Review of provisions for the transport of lithium batteries

LITHIUM METAL BATTERIES

(Presented by the Secretary)

SUMMARY

This working paper proposes forbidding lithium metal batteries on passenger and cargo aircraft. It suggests that reports of counterfeit batteries and non-compliant shipments being transported, the fire risk these batteries present and the fact that current fire suppression systems and procedures for fire suppression controls in cargo holds have no effect on lithium metal fires make the risk in transporting them unacceptable and difficult to justify.

Action by the DGP: In the absence of mitigation measures which can contain a lithium metal fire and the absence of an effective fire suppressant system for such batteries, the DGP is invited to consider forbidding UN 3090 — **Lithium metal batteries** from passenger and cargo aircraft as presented in the appendix to this working paper.

1. INTRODUCTION

1.1 The risks related to lithium batteries have been well documented by the Dangerous Goods Panel (DGP). Much has been done to improve measures to address these risks, including the changes to the 2013-2014 Edition of the Technical Instructions which eliminated exceptions for bulk shipments of lithium batteries. At that time the panel recognized that although the changes enhanced safety, regulations could not, on their own, eliminate all risks related to transporting lithium batteries. It was acknowledged that inadvertent errors in applying the regulations were possible, and intentional violations were a reality. It was believed that non-compliance had been a factor in a number of reported incidents. The panel also recommended ways to address these risks, including increased outreach, training, oversight and appropriate enforcement activities.

1.2 A basic foundation of safety management systems is that layered defenses against safety risks are necessary. A multi-layered system helps ensure that single-point failures are rarely consequential. In the context of safely transporting dangerous goods, these could include properly identifying dangerous goods, properly packaging them and preparing them for transport, ensuring that they are not damaged upon acceptance, and safely loading/unloading/storing them on the aircraft. Although these layers of defence may be adequate for batteries manufactured, classified and prepared for shipment in compliance with the regulations, they are less effective for batteries not manufactured to standard or for batteries which are not prepared for transport in compliance with the Technical Instructions. If an incident does occur because of non-compliant batteries, the last layers of defence would be the packaging and fire suppression capabilities. Tests suggest, however, that required packaging for lithium metal batteries do not sufficiently contain the effects of a lithium metal battery ignition and are not designed to withstand a lithium metal cell fire. Tests have also shown that Halon is ineffective as a fire suppressant on a lithium metal fire, leaving no other layer of defence.

1.3 The panel has acknowledged that non-compliant battery shipments, including those which contain counterfeit batteries not manufactured and tested in compliance with the Instructions, are a reality. The panel has also acknowledged that many if not all reported incidents related to lithium batteries have involved non-compliant shipments. The substantial increase of batteries being transported, the increase in energy densities, and the expected future upward trend for both makes non-compliant shipments an even greater threat to safety. While increased outreach, training, oversight and appropriate enforcement activities can help reduce the number of non-compliant consignments in the transport chain, the fact remains that these activities cannot eliminate non-compliance. Effectively regulating compliance is also difficult since it is impossible to distinguish between counterfeit lithium metal batteries and those which have been manufactured to standard. If transport risk was based solely on compliant shipments, many other dangerous goods currently forbidden for transport — such as explosives and toxic gases — would arguably be permitted.

1.4 The risks involved with transporting lithium batteries, reports of counterfeit batteries and non-compliant shipments being transported coupled with the fact that current fire suppression systems in cargo holds have no effect on lithium metal fires make it difficult to justify allowing them as cargo. It is noted that one State and several airlines already forbid lithium metal on their passenger aircraft through State and operator variations. It is further noted that the lithium battery industry have indicated an increasing amount of lithium metal batteries are transported by sea.

2. ACTION BY THE DGP

2.1 In the absence of packaging which can contain a lithium metal fire or an effective fire suppressant system, the panel is invited to consider forbidding the transport of UN 3090 — **Lithium metal batteries** on both passenger and cargo aircraft.

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APPENDIX

PROPOSED AMENDMENTS TO THE TECHNICAL INSTRUCTIONS

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)

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Table 3-1. Dangerous Goods List

Name	*UN No.*	*Class or division*	*Subsidiary risk*	*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*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Lithium metal batteries (including lithium alloy batteries)†	3090	9		US 2 US 3	A88 A99 A154 A164 A183	~~II~~	E0	~~See~~ FORB	~~968~~ DDEN	~~See~~ FORB	~~968~~ DDEN
Lithium metal batteries contained in equipment (including lithium alloy batteries) †	3091	9		US 2 US 3	A48 A99 A154 A164 A181 A185	~~II~~	E0	970	5 kg	970	35 kg
Lithium metal batteries packed with equipment (including lithium alloy batteries) †	3091	9		US 2 US 3	A99 A154 A164 A181 A185	~~II~~	E0	969	5 kg	969	35 kg

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Part 4

PACKING INSTRUCTIONS

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Chapter 11

CLASS 9 — MISCELLANEOUS DANGEROUS GOODS

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Packing Instruction 968

Passenger and cargo aircraft for UN 3090

1. **Introduction**

This entry applies to lithium metal or lithium alloy batteries. This packing instruction is structured as follows:

- Section IA applies to lithium metal cells with a lithium metal content in excess of 1 g and lithium metal batteries with a lithium metal content in excess of 2 g, which must be assigned to Class 9 and are subject to all of the applicable requirements of these Instructions;
- Section IB applies to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities that exceed the allowance permitted in Section II, Table 968-II; and
- Section II applies to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities not exceeding the allowance permitted in Section II, Table 968-II.

2. **Lithium batteries forbidden from transport**

The following applies to all lithium metal cells and batteries in this packing instruction:

Cells and batteries, identified by the manufacturer as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport (e.g. those being returned to the manufacturer for safety reasons).

Waste lithium batteries and lithium batteries being shipped for recycling or disposal are forbidden from air transport unless approved by the appropriate national authority of the State of Origin and the State of the Operator.

IA. **SECTION IA**

Section IA requirements apply to lithium metal cells with a lithium metal content in excess of 1 g and lithium metal batteries with a lithium metal content in excess of 2 g that have been determined to meet the criteria for assignment to Class 9.

Each cell or battery must:

1) be of the type proven to meet the requirements of each test in the UN *Manual of Tests and Criteria*, Part III, subsection 38.3;

Note 1. Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.

Note 2. Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.

2) incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport and be equipped with an effective means of preventing external short circuits; and

3) be manufactured under a quality management programme as described in 2;9.3.1 e).

Each battery containing cells or a 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).

IA.1 **General requirements**

Part 4;1 requirements must be met.

Table 968-IA

UN number and proper shipping name	*Net quantity per package*	
	Passenger	*Cargo*
UN 3090 **Lithium metal batteries**	2.5 kg	35 kg

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Packing Instruction 968

IA.2 **Additional requirements**

- Lithium metal cells and batteries must be protected against short circuits.
- Lithium metal cells and batteries must be placed in inner packagings that completely enclose the cell or battery, then placed in an outer packaging. The completed package for the cells or batteries must meet the Packing Group II performance requirements.
- Lithium metal 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 or protective enclosures (e.g. in fully enclosed or wooden slatted crates) 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.
- For lithium metal cells and batteries prepared for transport on passenger aircraft as Class 9:
  - cells and batteries offered for transport on passenger aircraft must be packed in intermediate or outer rigid metal packaging; and
  - cells and batteries must be surrounded by cushioning material that is non-combustible and non-conductive, and placed inside an outer packaging.

IA.3 **Outer packagings**

Boxes	*Drums*	*Jerricans*
Aluminium (4B)	Aluminium (1B2)	Aluminium (3B2)
Fibreboard (4G)	Fibre (1G)	Plastics (3H2)
Natural wood (4C1, 4C2)	Other metal (1N2)	Steel (3A2)
Other metal (4N)	Plastics (1H2)	
Plastics (4H1, 4H2)	Plywood (1D)	
Plywood (4D)	Steel (1A2)	
Reconstituted wood (4F)		
Steel (4A)		

IB. **SECTION IB**

Section IB requirements apply to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities that exceed the allowance permitted in Section II, Table 968-II.

Quantities of lithium metal cells or batteries that exceed the allowance permitted in Section II, Table 968-II, must be assigned to Class 9 and are subject to all of the applicable provisions of these Instructions (including the requirements in paragraph 2 of this packing instruction and of this section) except for the following:

- the provisions of Part 6; and
- the dangerous goods transport document requirements of 5;4, provided alternative written documentation is provided by the shipper describing the contents of the consignment. Where an agreement exists with the operator, the shipper may provide the information by electronic data processing (EDP) or electronic data interchange (EDI) techniques. The information required is as follows and should be shown in the following order:

1) the name and address of the shipper and consignee;
2) UN 3090;
3) Lithium metal batteries PI 968 IB;
4) the number of packages and the gross mass of each package.

Lithium metal or lithium alloy cells and batteries may be offered for transport if they meet all of the following:

1) for lithium metal cells, the lithium content is not more than 1 g;
2) for lithium metal or lithium alloy batteries, the aggregate lithium content is not more than 2 g;
3) each cell or battery is of the type proven to meet the requirements of each test in the UN *Manual of Tests and Criteria*, Part III, subsection 38.3;

Note 1.— Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.

Note 2.— Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, *Part III, subsection 38.3 may continue to be transported.*

4) cells and batteries must be manufactured under a quality management programme as described in 2;9.3.1 e).

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Packing Instruction 968

IB.1 **General requirements**

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

Table 968-IB

Contents	*Package quantity*	
	Passenger	*Cargo*
Lithium metal cells and batteries	2.5 kg G	2.5 kg G

IB.2 **Additional requirements**

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery then placed in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
  - damage to cells or batteries contained therein;
  - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
  - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31) in addition to the Class 9 hazard label.
- Each consignment must be accompanied with a document with an indication that:
  - the package contains lithium metal cells or batteries;
  - the package must be handled with care and that a flammability hazard exists if the package is damaged;
  - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
  - a telephone number for additional information.

IB.3 **Outer packagings**

Boxes *Drums* *Jerricans*

Strong outer packagings

II. **SECTION II**

With the exception of Part 1;2.3 (Transport of dangerous goods by post), 7;4.4 (Reporting of dangerous goods accidents and incidents), 8;1.1 (Dangerous goods carried by passengers or crew)and paragraph 2 of this packing instruction, lithium metal or lithium alloy cells and batteries offered for transport are not subject to other additional requirements of these Instructions if they meet the requirements of this section.

Lithium metal or lithium alloy cells and batteries may be offered for transport if they meet all of the following:

1) for a lithium metal cell, the lithium content is not more than 1 g;
2) for a lithium metal or lithium alloy battery, the aggregate lithium content is not more than 2 g;
3) each cell or battery is of the type proven to meet the requirements of each test in the UN *Manual of Tests and Criteria*, Part III, subsection 38.3;

Note 1.— Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.

Note 2.— Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria*, Part III, subsection 38.3 may continue to be transported.*

4) cells and batteries must be manufactured under a quality management programme as described in 2;9.3.1 e).

II.1 **General requirements**

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

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Packing Instruction 968

Table 968-II

Contents	*Lithium metal cells and/or batteries with a lithium content not more than 0.3 g*	*Lithium metal cells with a lithium content more than 0.3 g but not more than 1 g*	*Lithium metal batteries with a lithium content more than 0.3 g but not more than 2 g*
1	*2*	*3*	*4*
Maximum number of cells / batteries per package	No limit	8 cells	2 batteries
Maximum net quantity (mass) per package	2.5 kg	n/a	n/a

The limits specified in columns 2, 3 and 4 of Table 968-II must not be combined in the same package.

II.2 **Additional requirements**

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery, then placed in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
  - damage to cells or batteries contained therein;
  - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
  - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31).
- Each consignment must be accompanied with a document with an indication that:
  - the package contains lithium metal cells or batteries;
  - the package must be handled with care and that a flammability hazard exists if the package is damaged;
  - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
  - a telephone number for additional information.
- The words "lithium metal batteries, in compliance with Section II of PI968" must be placed on the air waybill, when an air waybill is used.
- Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.

II.3 **Outer packagings**

Boxes *Drums* *Jerricans*

Strong outer packagings

II.4 **Overpacks**

- When packages are placed in an overpack, the lithium battery handling label required by this packing instruction must either be clearly visible or the label must be affixed on the outside of the overpack and the overpack must be marked with the word "Overpack".

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