



WORKING PAPER

DANGEROUS GOODS PANEL (DGP)

TWENTY-FOURTH MEETING

Montréal, 28 October to 8 November 2013

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 2015-2016 Edition

SECONDARY LITHIUM BATTERIES

(Presented by H. Brockhaus)

SUMMARY

This paper proposes either a new Special Provision Axxx or amendments to Packing Instruction 965 in order to enable the safe transport of lithium batteries larger than 35 kg gross mass. This proposal enhances a previous one made at the 2013 Meeting of the DGP Working Group of the Whole (DGP-WG/13, Montréal, 15 to 19 April 2013 (DGP-WG/13-WP/60)). This working paper is presented to provide additional information and an amended proposal in response to the feedback received during and after DG-WG/13 (see paragraph 3.5.1 of the DGP-WG/13 Report (DGP/24-WP/3)).

Action by the DGP: The DGP is invited to consider the implementation of a new Special Provision Axxx as shown in Appendix A to this working paper or to amend Packing Instruction 965 by the addition of a new section IC as shown in Appendix B.

1. INTRODUCTION

1.1 Transport regulations for large lithium ion batteries have been discussed since the last biennium.

1.2 A new special provision to allow for the transport of lithium ion batteries larger than 35 kg on cargo aircraft was proposed at the 2013 Meeting of the DGP Working Group of the Whole (DGP-WG/13, 15 to 19 April 2013) (see paragraph 3.5.1 of the DGP-WG/13 Report (DGP/24-WP/3)). There was general agreement that provisions needed to be developed for these batteries on the basis that they were currently being shipped under approval and there was no guarantee that every approval

provided for sufficient safety features. It was felt, however, that more work was needed before anything could be introduced into the Instructions. The working group felt that:

- a) the provisions would be more appropriate in the packing instructions rather than a special provision;
- b) the larger the battery, the larger the risk. These risks needed to be mitigated. It was difficult to mitigate the chemical hazard of lithium batteries, but limiting the state of charge could mitigate the energy density risk; and
- c) packaging needed to be considered so that if an incident occurred it could be contained. Research was being done in one State on packaging that could withstand pressure build up if the batteries self-ignited, the results of which were encouraging.

1.3 This working paper addresses these issues so as to enable the panel to finally discuss necessary provisions for the transport of single large lithium-ion batteries.

1.4 Based on the discussion at DGP/WG13 and discussions outside that meeting, two alternative proposals are presented in this working paper:

- a) a new Special Provision SP Axxx; and
- b) enhancements to Packing Instruction 965.

1.5 Terms used in this and previous working papers intended to describe technical parameters of the battery, the packaging or other regulatory details, are already widely used throughout the *Technical Instructions* and in the lithium battery provisions. These include:

- a) **Strong, impact resistant outer casing.** This term is used in Packing Instruction 965 to describe the quality of the battery outer casing when there are provisions for the battery to be shipped in a non-type approved packaging;
- b) **Fire and flame resistance.** This term is already widely used to describe packaging material properties in approvals in accordance with Special Provisions A99 and A88. Within these approval documents, no further specification has been added for, e.g. the minimum time material must resist a certain temperature before showing adverse reactions etc. Therefore we feel that there is already a sufficient level of common sense about the meaning;
- c) **Non-combustible, non-flammable.** These terms are commonly used within the Technical Instructions and other modal regulations to describe the non-flammable nature of packaging material. Only a few materials used for inner dangerous goods packagings are prone to provide these properties in combination with other features like absorbency for liquids. Flammability is defined in e.g. 2.4.1 of the UN Model Regulations or Part 2;4.2.2.1 of the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) and can serve as classification criteria for non-flammability; and
- d) **Non-conductive.** Packaging material must not be electrically conductive and Ohm resistance must be high enough to prevent from current and voltage. Special Provision A88 already uses that wording.

1.6 Should the panel have persistent objections with the above terms not being precise and clear enough to allow for consistent handling of dangerous goods, it is recommended that appropriate initiatives to define them be taken to the UNECE.

1.7 The guiding principles and requirements of these two proposals are:

- a) Packing Group II performance level outer packaging for lithium battery;
- b) one single battery per package only;
- c) strong outer casing for battery required;
- d) inner packaging, leak proof, required; and
- e) non-combustible, non-conductive cushioning material.

1.8 Those requirements are usually applied for Special Provision A99 approvals issued by various authorities. Until now no issues, safety concerns or accidents have been reported for consignments in line with Special Provisions A99 or A88 approvals provided. In consequence, it is recommended to accept the special provisions as proposed to be sufficient for lithium ion battery transportation.

1.9 State of Charge (SOC) safety impact during transport of lithium ion batteries and cells is subject to on-going discussions. Types of cells and batteries which were successfully tested according to the UN Manual of Test and Criteria, Part III, subsection 38.3 have shown adequate safety under various transport relevant stress also at 100% SOC (i.e. fully charged). Furthermore, a specific SOC is not generally required when prototype, non-tested batteries are shipped in accordance with Special Provision A88.

1.10 Nevertheless, the last working group of the whole discussions revealed that a state of charge limitation is seen as an appropriate measure to reduce the risk for an adverse reaction of lithium ion batteries as cargo.

1.11 Consequently, a SOC limitation of 60% has been added to the proposals. As this will result in more complex preparation of packagings and, in accordance with opinions given, will establish a higher safety level, other previously-offered safety measures are no longer considered.

APPENDIX A

PROPOSED AMENDMENT TO THE 2015-2016 EDITION OF THE TECHNICAL
INSTRUCTIONS

Part 3

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

*Parts of this Chapter are affected by State Variations AU 1, AU 2, CA 7,
HR 3, IR 3, JM 1, KP 2, NL 1, US 11, ZA 1; see Table A-1*

Table 3-2 lists the special provisions referred to in column 7 of Table 3-1 and the information contained in them is additional to that shown for the relevant entry. Where the wording of the special provision is equivalent to that in the UN Model Regulations, the UN special provision number is shown in parentheses.

Table 3-2. Special provisions

| <i>TIs</i> | <i>UN</i> |
|-------------|--|
| ... | |
| <u>AXXX</u> | <p><u>Irrespective of the quantity limits for cargo aircraft specified in column 13 of Table 3-1 and in Section I of Packing Instruction 965, a lithium ion or lithium polymer battery (UN 3480) with a mass exceeding 35 kg that meets the requirements of this special provision may be offered for transport on cargo aircraft only, if the following requirements are met:</u></p> <p><u>a) Requirements for batteries:</u></p> <ol style="list-style-type: none"><u>1) Each cell and each battery is of the type proven to meet the requirements of 2:9.3.1 of these Instructions;</u><u>2) Each battery must have a strong, impact-resistant outer casing; and</u><u>3) Battery state of charge must be not more than 60 per cent.</u> <p><u>b) Packing requirements:</u></p> <ol style="list-style-type: none"><u>1) Lithium ion or lithium polymer batteries must be protected against short circuits;</u><u>2) The outer packaging must meet the requirements of Packing Group II;</u><u>3) The battery must be individually packed in inner packaging and placed inside an outer packaging. The inner packaging must be leak-proof;</u><u>4) The battery must be surrounded by cushioning material that is non-combustible and non-conductive and must be secured to prevent inadvertent movement during transport;</u><u>5) In addition to 5:2 of these Instructions, the packaging has to be marked with the words "Single battery per package, transport in accordance with SP Axxx". Letters and numerals must be at least 12 mm high. This marking must be reproduced on an overpack, if used; and</u><u>6) Only one battery per packaging is permitted.</u> |

TIs UN

c) Documentation and handling requirements:

The use of SP AXXX must be documented in the shipper's declaration in the field 'Additional Handling Information' with the following sentence: "Single battery per package, transport in accordance with SP Axxx".

All other requirements of these Instructions regarding marking, labelling, documentation and handling must apply.

Part 3

DANGEROUS GOODS LIST, SPECIAL PROVISIONS AND LIMITED AND EXCEPTED QUANTITIES

...

Chapter 2

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

...

Table 3-1. Dangerous Goods List

| Name | UN No. | Class or division | Sub-sidiary 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 |
| Lithium ion batteries (including lithium ion polymer batteries) | 3480 | 9 | | Miscellaneous | US 3 | A51 A88 A99 A154 A164 A183 AXXX | II | E0 | See | 965 | See | 965 |

...

APPENDIX B

**PROPOSED AMENDMENT TO THE 2015-2016 EDITION OF
THE TECHNICAL INSTRUCTIONS**

Part 4

PACKING INSTRUCTIONS

Packing Instruction 965

Passenger and cargo aircraft for UN 3480

1. Introduction

This entry applies to lithium ion or lithium polymer batteries. This packing instruction is structured as follows:

- Section IA applies to lithium ion cells with a Watt-hour rating in excess of 20 Wh and lithium ion batteries with a Watt-hour rating in excess of 100 Wh, which must be assigned to Class 9 and are subject to all of the applicable requirements of these Instructions;
- Section IB applies to lithium ion cells with a Watt-hour rating not exceeding 20 Wh and lithium ion batteries with a Watt-hour rating not exceeding 100 Wh packed in quantities that exceed the allowance permitted in Section II, Table 965-II; **and**
- **Section IC applies to lithium ion batteries with gross weights not exceeding 400 kg, which must be assigned to Class 9 and are subject to all of the applicable requirements of these Instructions; and**
- Section II applies to lithium ion cells with a Watt-hour rating not exceeding 20 Wh and lithium ion batteries with a Watt-hour rating not exceeding 100 Wh packed in quantities not exceeding the allowance permitted in Section II, Table 965-II.

2. Lithium batteries forbidden from transport

The following applies to all lithium ion 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 ion cells with a Watt-hour rating in excess of 20 Wh and lithium ion batteries with a Watt-hour rating in excess of 100 Wh 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).

1A.1 General requirements

Part 4;1 requirements must be met.

Table 965-IA

| UN number and proper shipping name | Net quantity per package | |
|---------------------------------------|--------------------------|-------|
| | Passenger | Cargo |
| UN 3480 Lithium ion batteries | 5 kg | 35 kg |

≠

Packing Instruction 965

IA.2 Additional requirements

- Lithium ion cells and batteries must be protected against short circuits.
- Lithium ion 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 ion 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.
- Batteries manufactured after 31 December 2011 must be marked with the Watt-hour rating on the outside case.

IA.3 Outer packagings

Boxes

Aluminium (4B)
Fibreboard (4G)
Natural wood (4C1, 4C2)
Other metal (4N)
Plastics (4H1, 4H2)
Plywood (4D)
Reconstituted wood (4F)
Steel (4A)

Drums

Aluminium (1B2)
Fibre (1G)
Other metal (1N2)
Plastics (1H2)
Plywood (1D)
Steel (1A2)

Jerricans

Aluminium (3B2)
Plastics (3H2)
Steel (3A2)

IB. SECTION IB

Section IB requirements apply to lithium ion cells with a Watt-hour rating not exceeding 20 Wh and lithium ion batteries with a Watt-hour rating not exceeding 100 Wh packed in quantities that exceed the allowance permitted in Section II, Table 965-II.

Quantities of lithium ion cells or batteries that exceed the allowance permitted in Section II, Table 965-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 3480;
 - 3) Lithium ion batteries PI 965 IB;
 - 4) the number of packages and the gross mass of each package.

Lithium ion cells and batteries may be offered for transport if they meet all of the following:

- 1) for lithium ion cells, the Watt-hour rating (see the Glossary of Terms in Attachment 2) is not more than 20 Wh;
- 2) for lithium ion batteries, the Watt-hour rating is not more than 100 Wh;
 - the Watt-hour rating must be marked on the outside of the battery case except for those batteries manufactured before 1 January 2009;
- 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).

≠

Packing Instruction 965

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 965-IB

| Contents | Package quantity | |
|---------------------------------|------------------|---------|
| | Passenger | Cargo |
| Lithium ion cells and batteries | 10 kg G | 10 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 ion 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

IC. SECTION IC

Section IC applies to lithium ion batteries with gross weights not exceeding 400 kg, which must be assigned to Class 9 and are subject to all of the applicable requirements of these Instructions

Each battery must:

- 1) Each battery must have a strong, impact-resistant outer casing; and
- 4)2) Battery state of charge (SOC) shall be not more than 60%.

1C.1 General requirements

Part 4;1 requirements must be met.

Table 965-IC

| <u>UN number and proper shipping name</u> | <u>Net quantity per package</u> | |
|---|---------------------------------|---------------|
| | <u>Passenger</u> | <u>Cargo</u> |
| <u>UN 3480 Lithium ion batteries</u> | <u>Forbidden</u> | <u>400 kg</u> |

IC.2 Additional requirements

- Only one battery per packaging is permitted;
- Lithium ion batteries must be protected against short circuits;
- Lithium ion batteries must be placed in inner packagings that completely enclose the battery then

placed in an outer packaging. The completed package for the cells or batteries must meet the Packing Group II performance requirements. The inner packaging shall be leak proof

- Batteries manufactured after 31 December 2011 must be marked with the Watt-hour rating on the outside case;
- The battery must be surrounded by cushioning material that is non-combustible and non-conductive and must be secured to prevent inadvertent movement during transport;
- In addition to 5:2 of these Instructions, the packaging has to be marked with the words "Single battery per package, transport in accordance with PI965 section IC". Letters and numerals must be at least 12 mm high. This marking must be reproduced on an overpack, if used; and
- The use of PI965, section IC shall be documented in the shipper's declaration in the field 'Additional Handling Information' with the following sentence: "Single battery per package, transport in accordance with PI965, section IC".

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 ion 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 ion cells and batteries may be offered for transport if they meet all of the following:

- 1) for lithium ion cells, the Watt-hour rating (see the Glossary of Terms in Attachment 2) is not more than 20 Wh;
- 2) for lithium ion batteries, the Watt-hour rating is not more than 100 Wh;
 - the Watt-hour rating must be marked on the outside of the battery case except for those batteries manufactured before 1 January 2009;
- 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).

≠

Packing Instruction 965

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).

Table 965-II

| <i>Contents</i> | <i>Lithium ion cells and/or batteries with a Watt-hour rating not more than 2.7 Wh</i> | <i>Lithium ion cells with a Watt-hour rating more than 2.7 Wh, but not more than 20 Wh</i> | <i>Lithium ion batteries with a Watt-hour rating more than 2.7 Wh, but not more than 100 Wh</i> |
|---|--|--|---|
| <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> |
| 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 965-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 ion 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 ion batteries, in compliance with Section II of PI965” 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”.