



WORKING PAPER

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

Rio de Janeiro, Brazil, 20 to 24 October 2014

**Agenda Item 5: Review of provisions for the safe transport of lithium batteries
5.1: Improved hazard communication for energy storage devices**

**TRANSPORTING DAMAGED OR DEFECTIVE LITHIUM BATTERIES AND LITHIUM
BATTERIES CONTAINED IN EQUIPMENT**

(Presented by PRBA — Rechargeable Battery Association)

SUMMARY

This working paper contains revisions to Special Provision A154 of the Technical Instructions and a new packing instruction for incorporation into the Supplement to provide for the transport of damaged or defective lithium ion and lithium metal cells and batteries and equipment containing them under approvals issued by the State of Origin. The proposed packing instruction includes a thermal packaging test for lithium batteries.

Action by the DGP: The DGP is invited to:

- a) amend Special Provision A154 of the Technical Instructions; and
- b) add a new packing instruction to the Supplement to the Technical Instructions that includes the thermal packaging test for lithium batteries

as shown in the appendices to this working paper.

1. INTRODUCTION

1.1 The Dangerous Goods Panel (DGP) and UN Sub-Committee of Experts have discussed the issue of transporting damaged or defective lithium batteries numerous times over the last several years. The Sub-Committee adopted packing instructions and special provisions that are part of the 18th Revised Edition of the Model Regulations and IMDG Code, 2014 Edition, which are authorized for use starting 1 January 2015. In addition, the United States Department of Transportation recently issued a special permit that authorizes the transport by cargo aircraft of damaged or defective lithium ion batteries and equipment containing them. A copy of that special permit is provided in Appendix C to this working paper.

1.2 PRBA — Rechargeable Battery Association is aware of several competent authorities who have been approached by industry over the last two years regarding the need to transport damaged or defective lithium ion batteries by air for immediate failure analysis due to the time-sensitive nature of having such an analysis conducted as quickly as possible. Under such a scenario, transportation by road, rail or vessel is not practical. To facilitate the transport of these batteries (and equipment containing them) by air, we have prepared a proposal to authorize such shipments.

1.3 Special Provision A154 of the Technical Instructions prohibits the transport of lithium 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. Currently the transport of such damaged or defective lithium batteries by air can only be carried out under an exemption.

1.4 At DGP-WG/13, DGP members indicated that additional requirements would need to be added to the new packing instructions from the 18th Revised Edition of the Model Regulations in order to transport damaged or defective lithium batteries by air.

1.5 This paper proposes amendments to Special Provision A154 and the addition of a new packing instruction for incorporation into the Supplement to the Technical Instructions based on the 18th Revised Edition of the UN Model Regulation which includes a requirement for thermal resistant packaging or overpack and performance criteria and test method for the packaging or overpack that can be used as a basis for issuing approvals. The proposed performance criteria and test method — listed in the proposed packing instruction and identified as a thermal packaging test for lithium batteries — will ensure that any packaging used to transport damaged or defective lithium batteries or equipment containing them is capable of containing a potential thermal event.

1.6 The thermal packaging test for lithium batteries would be conducted with the lithium cells, batteries or equipment, or with cells, batteries or equipment that simulate the intended contents to be transported in the packaging or overpack. Cells or batteries would be tested at 100% state of charge. The test requires that no flames or sparks escape from any part of the container throughout the test period although smoke may vent from the container. The container must maintain its integrity until the end of the test. No projectiles may puncture the container and the container must be capable of withstanding a pressure pulse from the thermal event either by being fitted with a venting device or through design of the packaging without loss of integrity or containment functions.

2. ACTION BY THE DGP-WG

2.1 The DGP-WG is invited to:

- a) amend Special Provision A154 of the Technical Instructions; and
- b) add a new packing instruction to the Supplement to the Technical Instructions that includes the thermal packaging test for lithium batteries

as shown in the appendices to this working paper.

APPENDIX A

PROPOSED AMENDMENT TO PART 3 OF THE TECHNICAL INSTRUCTIONS

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Part 3

DANGEROUS GOODS LIST,
SPECIAL PROVISIONS AND
LIMITED AND EXCEPTED QUANTITIES

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Chapter 3

SPECIAL PROVISIONS

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Table 3-2. Special provisions

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A154	Lithium 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)- <u>unless approved by the State of Origin and the State of the Operator and transported in packaging that is capable of meeting the performance requirements of the thermal packaging test for lithium batteries identified in Packing Instruction 9XX of the Supplement to these Instructions.</u>
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APPENDIX B

PROPOSED AMENDMENT TO PART S-4 OF THE SUPPLEMENT TO THE TECHNICAL
INSTRUCTIONS

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Part S-4

PACKING INSTRUCTIONS

(ADDITIONAL INFORMATION
FOR PART 4 OF THE
TECHNICAL INSTRUCTIONS)

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Packing Instruction 9XX

Cargo aircraft only for UN Nos. 3090, 3091, 3480 and 3481 that are damaged or defective

This packing instruction applies to damaged or defective lithium ion batteries (UN 3480), lithium metal batteries (UN 3090), lithium ion batteries contained in equipment (UN 3481), and lithium metal batteries contained in equipment (UN 3091) (see Special Provision A154 of the Technical Instructions).

1. General requirements

Part 4:1 requirements must be met.

2. Outer Packagings

For cells and batteries and equipment containing cells and batteries:

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)

3. Additional requirements

Packagings must conform to the Packing Group II performance level.

The packaging or overpack, if applicable, must be capable of successfully meeting the thermal packaging test for lithium batteries in Section 4 of this packing instruction.

In addition each cell or battery or equipment containing such cells or batteries:

- a) must be individually packed in inner packaging and placed inside an outer packaging. The inner packaging or outer packaging must be leak-proof to prevent the potential release of electrolyte.
- b) each inner packaging must be surrounded by sufficient non-combustible and non-conductive thermal insulation material to protect against a dangerous evolution of heat.

- c) sealed packagings must be fitted with a venting device when appropriate.
- d) appropriate measures must be taken to minimize the effects of vibrations and shocks, prevent movement of the cells or batteries within the package that may lead to further damage during transport.
- e) for leaking cells or batteries, sufficient inert absorbent material must be added to the inner or outer packaging to absorb any release of electrolyte.
- f) a cell or battery with a net mass of more than 35 kg must be limited to one cell or battery per outer packaging.

4. Thermal packaging test for lithium batteries

a) Scope

This test method evaluates the thermal containment capabilities of a packaging or overpack, if applicable, intended for the transport of damaged or defective lithium cells and batteries and equipment containing them. The test must be conducted with cells, batteries or equipment, or utilize those that simulate the intended contents to be transported in the packaging. A larger number of cells or batteries or cells or batteries contained in equipment with a higher Watt-hour rating may be tested to validate that the packaging or overpack are capable of containing a smaller number of cells or batteries with a lower Watt-hour rating or lithium content, as applicable. Cells and batteries must be tested at 100 per cent state of charge.

b) Apparatus

- i) Test Area. The test area must be large enough in size to fully house the testing apparatus and the outer package or overpack with sufficient clearance and provide adequate safety for the test operator(s).
- ii) Heating Element(s). Appropriate heater(s) must be used that have the capacity to force cells or batteries into thermal runaway within the outer package or overpack. Various types of heater cartridges or thermal tape may be appropriate for certain applications depending on the lithium chemistries and cell and battery form factors.
- iii) Thermal runaway refers to a situation where an increase in temperature changes the conditions in a way that causes a further increase in temperature, often leading to a destructive result.
- iv) Instrumentation (optional). A calibrated recording device or a computerized data acquisition system with an appropriate range may be utilized to measure and record the outputs of the thermocouples. Instrumentation is optional, but can be useful in determining whether the cells have vented or were forced into thermal runaway as well as indicating when it is safe to open the tested outer packaging or overpack.

c) Test specimen

Specimen configuration. Each outer package or overpack material type and design must be tested, including any features such as handles, latches or fastening systems that may compromise the ability of the outer package or overpack to provide thermal protection.

d) Preparation for testing

- i) Position the heating element in the package or overpack so that the test cells, batteries or cells or batteries contained in equipment can be positioned directly in contact with or attached to the heating element (e.g. thermal tape).
- ii) Insulate the terminals and leads from the heating element from short circuit during the test and configure the leads to exit the package with as little effect on the package closure as possible.
- iii) Ensure that the position of loose cells, batteries, or equipment is maintained on or attached to the heating element. This may be accomplished using other packaging, housings, steel banding, etc.
- iv) Close the package or overpack in accordance with the closure instructions.
- v) Position the package or overpack in the test area and connect the heating element leads to a switched power source.

e) Test procedure

- i) Prepare data collection equipment (if used) and check for proper reading on thermocouples, as applicable.

- ii) Turn on power to heating element(s) and increase temperature until thermal runaway occurs (a forced external short circuit, use of a spark ignitor or similar device may be used to force a thermal runaway event). Thermal runaway can typically be determined by the sounds emitted from the tested package or overpack and by the observation of temperature spikes when thermocouples are used.
- iii) Maintain power to the heating element for a minimum of thirty minutes after thermal runaway occurs.
- iv) Turn off power to heating element(s).
- v) Allow the package or overpack and contents to cool naturally for a minimum of one hour and until a safe inner temperature has been reached before concluding the test.
- vi) Once the contents have reached a safe temperature, inspect the outer package or overpack to the requirements listed below.

f) Recordkeeping

- i) Record a complete description of the package or overpack and contents being tested.
- ii) Record any observations regarding the behaviour of the test specimen during the test, such as smoke production, structural changes, and time of occurrence of each event.
- iii) If thermocouples were used, record the temperature and time history. Record the maximum temperatures achieved at all thermocouple locations and the corresponding time.

g) Requirements

No flames or sparks may escape from any part of the outer packaging although smoke may vent from the outer packaging or overpack. The outer packaging or overpack must maintain its integrity until the end of the test. No projectiles may puncture the outer packaging or overpack.

APPENDIX C
U.S. DOT SPECIAL PERMIT

September 10, 2014



U.S. Department
of Transportation

East Building, PHH - 30
1200 New Jersey Avenue, Southeast
Washington, D.C. 20590

**Pipeline and Hazardous
Materials Safety Administration**

DOT-SP 16011

EXPIRATION DATE: May 31, 2016

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Americase
Waxahache, TX
2. PURPOSE AND LIMITATIONS:
 - a. This special permit authorizes the manufacture, mark, sale and use of two specially designed packagings intended for the transport of certain lithium ion cells and batteries that may be damaged or defective and may be contained in equipment. This special permit provides no relief from the Hazardous Materials Regulations (HMR), International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO TI), or the International Maritime Dangerous Goods (IMDG) Code other than as specifically stated herein. The most recent revision supersedes all previous revisions.
 - b. The safety analyses performed in development of this special permit only considered the hazards and risks associated with transportation in commerce. The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.
 - c. This special permit serves as an approval under § 173.185(g), as an "exemption" as defined in 1;3.1.1 of the ICAO TI and Chapter 7.9, Section 7.9.1 of the IMDG Code (see IMO MSC/Circ. 1075-Granting Exemptions from the Provisions of the IMDG Code), and as a "Competent Authority Approval" as defined under 49 CFR § 107.1.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180, the ICAO TI, and the IMDG Code.

September 10, 2014

4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR § 173.185(f) in that alternative packaging is authorized; Chapter 2.9, Section 2.9.4 of the IMDG Code; Special Provision A154 and Paragraph 2. (specifically, damaged or defective lithium batteries forbidden for transport) of Packing Instructions 965 and 967 of Part 4, Chapter 11 of the ICAO TI in that damaged or defective cells and batteries may be transported as provided herein.
5. BASIS: This special permit is based on the application of Americase dated October 2, 2013 submitted in accordance with § 107.105 and the public proceeding thereon, and additional information dated April 25, 2014.
6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Material Description			
Proper Shipping Name	Hazard Class/ Division	Identification Number	Packing Group
Lithium ion batteries*	9	UN3480	II
Lithium ion batteries contained in equipment*	9	UN3481	II

*Only Damaged or defective lithium ion cells or batteries or equipment containing such cells or batteries may be transported under the terms of this special permit: These are batteries that met all requirements of § 173.185(a) prior to being damaged or defective.

7. SAFETY CONTROL MEASURES:
- a. Each cell and battery must be protected against short-circuits.
 - b. Each cell and battery contained in equipment must be protected from short-circuits.
 - c. Lithium metal cells, batteries, or equipment containing such cells or batteries are not authorized under the terms of this special permit.

September 10, 2014

d. PACKAGING - UN standard packaging is required. Thermally insulated UN 4G fiberboard and UN 4B aluminum boxes identified as Model Numbers ENG-FBLIB-9100 and ENG-ATLIB-9100, respectively, may be used as outer packagings for transporting damaged and defective cells and batteries, including those contained in equipment, provided that other applicable packaging requirements are met including:

1. For Model Number ENG-FBLIB-9100, cells and batteries, including those contained in equipment, may not be rated to more than 1,500 Watt-hours (Wh) (or 120 grams total equivalent lithium content);
 2. For Model Number ENG-ATLIB-9100, cells and batteries, including those contained in equipment, may not be rated to more than 5,700 Wh (or 456 grams total equivalent lithium content);
 3. For transportation via cargo aircraft, each lithium ion cell may not be rated to more than 20 Wh and batteries and batteries contained in equipment cannot exceed 100 Wh;
 4. Each cell and battery, including those contained in equipment, must be surrounded by cushioning material that is non-combustible, and non-conductive;
 5. The outer packaging must meet Packing Group I performance criteria; and
 6. Persons offering packages for transportation must comply with the closure instructions accompanying the packaging. A copy of the closure instructions must be provided to persons offering the shipment.
8. OPERATIONAL CONTROLS:
- a. MARKING - When used to transport damaged or defective lithium ion cells and batteries, including those contained in equipment, each package shipped under the terms of this special permit must be marked "Damaged/Defective Lithium-ion Batteries" on a contrasting background in proximity to the markings and labels required by the HMR, the ICAO TI, and the IMDG Code.

September 10, 2014

b. In accordance with the provisions of Paragraph (b) of § 173.22a, persons may use the packaging authorized by this special permit for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this special permit.

c. A person who is not a holder of this special permit, but receives a package covered by this special permit, may reoffer it for transportation provided no modification or change is made to the package and it is offered for transportation in conformance with this special permit, the HMR, the ICAO TI, and the IMDG Code.

d. A current copy of this special permit must be maintained at each facility where the package is offered or reoffered for transportation.

e. Each packaging manufactured under the authority of this special permit must be either (1) marked with the name of the manufacturer and location (city and state) of the facility at which it is manufactured or (2) marked with a registration symbol designated by the Office of Hazardous Materials Special Permits and Approvals for a specific manufacturing facility.

f. A current copy of this special permit must be maintained at each facility where the packaging is manufactured under this special permit. It must be made available to a DOT representative upon request.

g. For purposes of transportation by cargo aircraft and cargo vessel, this special permit also constitutes an exemption to the ICAO TI in accordance with 1;1.1.3. and as an exemption to the IMDG Code in accordance with Chapter 7.9, Section 7.9.1.

h. Any package that is damaged is not authorized to be loaded and transported.

i. The damaged/defective lithium ion cells, batteries, or equipment containing such lithium ion cells or batteries authorized under this special permit may only be transported by cargo aircraft that is authorized as a "will-carry" operator in accordance with 14 CFR.

September 10, 2014

j. Aircraft operators must have an approved operations manual that permits the carriage of damaged/defective lithium ion cells, batteries, or equipment containing such lithium ion cells or batteries in accordance with this special permit. See 14CFR 121.35 or 135.23.

k. Authorized U.S. Air Carriers - the following U.S. air carriers are the only authorized air carriers to accept any shipment under the terms of this special permit:

1. FedEx, Inc.; and
2. United Parcel Service, Inc.

l. This special permit in no way affects the need to obtain any required authorizations from other agencies of the United States Government or from the competent authorities of the States of origin, transit, over flight, and destination of the consignment, as well as the State of the air operator.

m. A foreign aircraft operator may only carry damaged or defective lithium ion cells, batteries or equipment containing such lithium ion cells or batteries in accordance with this special permit with the approval of the competent authority of the foreign State responsible for certification of the aircraft.

n. DAMAGED OR DEFECTIVE LITHIUM ION CELLS, BATTERIES, OR EQUIPMENT CONTAINING SUCH LITHIUM ION CELLS OR BATTERIES AUTHORIZED UNDER THE TERMS OF THIS SPECIAL PERMIT MAY NOT BE TRANSPORTED INTERNATIONALLY BY AIR.

9. MODES OF TRANSPORTATION AUTHORIZED: Cargo Aircraft Only with restrictions (see Paragraph 8.k. and 8.n.), Motor Vehicle, Cargo Vessel, Rail Freight.
10. MODAL REQUIREMENTS: A current copy of this special permit must be carried aboard each cargo aircraft, cargo vessel or motor vehicle used to transport packages covered by this special permit. The shipper must furnish a current copy of this special permit to the air carrier before or at the time the shipment is tendered.

September 10, 2014

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this special permit and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

- o All terms and conditions prescribed in this special permit and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
- o Persons operating under the terms of this special permit must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- o Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this special permit must receive training on the requirements and conditions of this special permit in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this special permit, including display of its number, when this special permit has expired or is otherwise no longer in effect.

Under Title VII of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—"The Hazardous Materials Safety and Security Reauthorization Act of 2005" (Pub. L. 109-59), 119 Stat. 1144 (August 10, 2005), amended the Federal hazardous materials transportation law by changing the term "exemption" to "special permit" and authorizes a special permit to be granted up to two years for new special permits and up to four years for renewals.

12. REPORTING REQUIREMENTS: Shipments or operations conducted under this special permit are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR §§ 171.15 Immediate notice of certain hazardous materials incidents, and 171.16 Detailed hazardous materials

September 10, 2014

incident reports. In addition, the grantee(s) of this special permit must notify the Associate Administrator for Hazardous Materials Safety, in writing, of any incident involving a package, shipment or operation conducted under terms of this special permit.

Issued in Washington, D.C.:



for Dr. Magdy El-Sibaie
Associate Administrator for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Pipeline and Hazardous Material Safety Administration, U.S. Department of Transportation, East Building PHH-30, 1200 New Jersey Avenue, Southeast, Washington, D.C. 20590.

Copies of this special permit may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat.dot.gov/sp_app/special_permits/spec_perm_index.htm Photo reproductions and legible reductions of this special permit are permitted. Any alteration of this special permit is prohibited.

PO: Hwang/Nicklous