Transportation Regulations for Lithium, Lithium Ion and Lithium Ion Polymer Cells and Batteries

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This document explains the changes in regulation that have come into effect from the 1st of January 2003 which concern the transport of Lithium and Lithium Ion Batteries.

Note: The regulations that apply to lithium-ion batteries and cells also apply to lithium-Ion-polymer, better known as the Li-Po batteries used in model aircraft.

Which Transport Regulations came into Effect on January 1st 2003?

New regulations controlling the transportation of all lithium and lithium ion cells became effective on January 1st 2003. The new regulations require that battery and cell manufacturers or companies that ship equipment containing these cells and batteries meet new testing, marking, packaging, labeling and shipping paper specifications. These new regulations are incorporated into the ICAO Technical Instructions (2003-2004 Edition), IATA Dangerous Good Regulations 44th Ed, the IMDG Code (2002 Edition), and the US HMR pursuant to a final rule issued by the RSPA.

Based on lithium content (for primary cells and batteries) and equivalent lithium content (for lithium ion and lithium ion polymer cells and batteries), the following shipping regulations went into effect on January 1st 2003:

Maximum Lithium Content				Shipping Class	Testing	Special Packaging and Marking
Primary		Secondary				
Cell	Battery	Cell	Battery			
1.0g	2.0g	1.5g	8.0g	Exempted	T1-T8(1,2)	Yes(3)
>1.0g	>2.0g	>1.5g	>8.0g	Class 9	T1-T8(4)	Yes(5)

Notes:

(1) Cell and battery types manufactured prior to January 1st 2003 were exempt from T1-T8 testing until December 31st 2004.

(2) As from January 1st 2005, all cells and batteries must be tested. Cells and batteries that meet the requirements of all the UN T1-T8 tests are exempt from regulation

(3) Packages containing more than 24 cells or 12 batteries must meet new packaging, marking and shipping paper requirements

(4) Must pass UN T1-T8 tests and be shipped at class 9 hazardous material

(5) Requires class nine markings, label, specification packaging and shipping Papers.

What are the UN T1-T8 Tests required by the UN Regulatory scheme?

The UN regulatory scheme requires that all lithium ion cells and batteries manufactured after January 1st 2003 pass the UN T1-T8 tests prior to being transported. These tests only have to be performed once for each cell and battery of a given design, and must be completed prior to shipment of cells and batteries. The tests are briefly described as follows:

T1 - Altitude simulation, This test simulates air transport under low-pressure

conditions.
T2 - Thermal test, This test assesses cell and battery seal integrity and internal electrical connections. The test is conducted using rapid and extreme temperature changes.
T3 - Vibration, This test simulates vibration during transport.
T4 - Shock, This test simulates possible impacts during transport.
T5 - External short circuit, This test simulates an external short circuit.
T6 - Impact, This test simulates an impact.
T7 - Overcharge, This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.
T8 - Forced discharge, This test evaluates the ability of a primary or a rechargeable cell to withstand a forced discharge condition.

From where can a copy of the UN testing requirements be obtained?
A copy of the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria is available from the UN website.

What is 'Lithium Content' or 'Equivalent Lithium Content':
As used above and elsewhere in the regulations, "lithium content" means the mass of lithium in the anode of a lithium metal or lithium metal alloy cell, except in the case of a lithium ion cell the "lithium-equivalent" in grams is calculated to be 0.3 times the rated capacity of each cell in Ampere-hours (Ah) multiplied by the number of cells. For example, a nine cell lithium ion battery, where each cell has a rated capacity of 2.2Ah, has an equivalent lithium content of 5.94g.

Has the testing deadline been extended for small cells and batteries?
As noted above, lithium cells not exceeding 1g and batteries not exceeding 2g of lithium metal, and lithium ion cells not exceeding 1.5g, and batteries not exceeding 8g of equivalent lithium content, that were manufactured prior to January 2003, were exempt from the UN T1-T8 testing requirements until December 31st 2004 if shipped within the US. In Europe, the testing deadline for small cells and batteries was June 30th 2003. After these dates, all lithium and lithium ion cells and batteries, regardless of their lithium weight, must be tested prior to transport.

What are the new Class 9 shipping requirements that went into effect on January 1st 2003 for cells and batteries that exceed a certain lithium content?
This change in regulation effects larger lithium ion cells and batteries. The following cells and batteries must pass UN tests T1-T8 and be shipped a Class 9 hazardous materials:
• A lithium cell with a lithium content of more than 1.0g
• A lithium battery with an aggregate Lithium content of more than 2.0g
• A lithium ion cell with an equivalent lithium content of more than 1.5g
• A lithium ion battery with an equivalent lithium content of more than 8g

What is Class 9?
Class 9 (Miscellaneous Dangerous Goods) is one of the nine hazardous material shipping classifications defined by the US HMR and other transportation regulations. Class 9 defines the specification packaging, markings, labeling and shipping paper requirements for miscellaneous materials, which include lithium and lithium ion cells and batteries, along with other materials. Additional information on shipping hazardous materials can be found on IATA's website at www.iata.org/dangerousgoods/index

Are there any new marking and packaging requirements for exempt cells

and batteries?
Yes, effective from January 1st 2003, even if cells or batteries are exempt from class 9, packages containing more than 24 lithium or lithium ion cells, or 12 lithium or lithium ion batteries must:
• Be marked to indicate that they contain lithium or lithium ion cells or batteries and that special procedures should be followed in the event that the package is damaged
• Be capable of withstanding a 1.2m drop test in any orientation without damage to cells or batteries contained din the package, without shifting of the contents that would allow short circuiting to occur.
• Not exceed 30Kg
• A note should be included with each shipment explaining that the cells or batteries are exempt from ICAO, IATA and DOT regulations.

Do the Class 9 shipping regulations apply to lithium or lithium ion cells and batteries packed in equipment?
Yes, If cells or batteries that are classified as being Class 9 are packed with or contained in equipment, the equipment also must be shipped as Class 9 hazardous material. Please refer to UN ID 3091 for relevant packing and marking requirements.

What regulations apply to the shipment of discharged lithium cells and batteries?
Except when shipped for disposal, the US HMR prohibits the shipping of any cell that has been discharged to the extent that the open circuit voltage is less than 2V or is less than 2/3rds of the voltage of the fully charged cell, whichever is less.

Are there any training requirements for employees that ship Class 9 Lithium / lithium ion cells and batteries?
Yes, in the US, employees involved in the packaging or shipment of class 9 lithium or lithium ion cells and batteries must complete a “49 CFR” certified hazardous materials training course. Employees must renew their certification training every three years. It is strongly recommended that employees complete an IATA training Course.

Can exemptions to the shipping regulations be requested?
Yes, Exemptions to the regulations for a specific cell or battery type can be requested from the countries of origin and destination, and cleared with the carrier. An approval from the DOT serves a similar purpose. Sufficient product information must be provided in the request and should include the cell and battery lithium content, any safety test data available, and details of the application in which the cells or batteries will be used.

If granted, an approval can take 12 to 16 weeks to secure from the DOT. Approvals are transferable, so if a cell or battery manufacturer obtains an approval it may be transferred to their customer(s) who would receive and subsequently re-ship the product.
Note: Lithium or lithium ion cells or batteries are excepted from the UN T1-T8 tests or DOT approval when transported by motor vehicle for the purposes of testing. The cells or batteries must be individually packed in an inner packaging, surrounded by cushioning material that is non-combustible and non conductive.

Do batteries that are manufactured by battery assembly companies have to be tested even if they use cells that have already been tested by the cell manufacturers?
Yes, unless shipped with DOT approval, tests must be performed by the battery

assembly company any time a battery design is created, or changed in a manner that would materially affect the test results. Cells and batteries of identical design only have to be tested once, even if they are manufactured in and shipped from multiple locations. Assembly company employees involved in the packaging or shipment of Class 9 batteries must complete a certified hazardous materials shipping training course.

Are fines imposed if any shipping regulations are violated?
Yes, each violation of US DOT HMR is subject to a fine of up to $27,500. Fines are collective and multiple fines may be imposed for a single shipment of cells or batteries that may have a combination of testing, packaging, labeling or other Violations.

Are there any carry on provisions in the regulations that enable passengers to carry electronic devices containing lithium or lithium ion batteries or spare batteries onto aeroplanes?
Yes, There are provisions in the ICAO technical instructions and US HMR that enable passengers to carry on consumer electronics devices (watches, calculators, cameras, mobile phones, notebook computers, PDA, Games, Camcorders etc) that utilise lithium batteries containing less than 2g or lithium ion batteries of less than 8g of equivalent lithium content. These provisions also allow an unlimited number of spare batteries than contain these quantities (2g/8g).
Passengers can also carry no more than two spare lithium ion batteries that contain between 8 and 25 grams of equivalent lithium content.
Passengers are prohibited from carrying on lithium batteries containing more than 2g of lithium and lithium ion batteries containing more than 25g of equivalent lithium Content.

All spare batteries must be individually protected so as to prevent short circuits and carried in carry-on baggage only.

Appendices

IATA Dangerous Goods Regulations (44th Edition)
It is strongly recommend that any organisation involved in the supply, assembly and transport of lithium / lithium ion cells or batteries obtain a copy of this publication, however the following information highlights the special provisions relating to lithium and lithium ion cells / batteries on which your shipping policy and procedures should be based.

Appendix A Special Provisions
Special Provision A45 (extracted from page 299, IATA DGR 2003 44th ed)
Lithium cells and batteries offered for transport are not subject to other provisions of these regulations if they meet the following:
(a) For a lithium metal or lithium alloy cell, the lithium content is not more than 1g and for a lithium ion cell, the lithium equivalent content is not more than 1.5g
(b) For a lithium metal or lithium alloy battery, the aggregate lithium content is not more than 2g and for a lithium ion battery, the aggregate lithium equivalent content is not more than 8g
(c) Each cell or battery is of a type proved to meet the requirements of each test in the UN Manual of Tests and Criteria III, sub section 38.3;
(d) Cells and batteries are separated so as to prevent short circuits and are packed in strong packaging, except when installed in equipment; and
(e) Except when installed in equipment, each package containing more than 24 lithium cells or 12 lithium batteries must in addition meet the following requirements:

I. Each package must be marked indicating that it contains lithium batteries and that special procedures should be adopted in the event that the package is damaged.
II. Each shipment must be accompanied with a document indicating that the packages contain lithium batteries and that special procedures should be adopted in the event a package is damaged.
III. 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 (or cell to cell) contact and without release of contents; and
IV. Except in the case of lithium batteries packed with equipment, packages may not exceed 30kg gross mass.
(f) Lithium batteries and cells that were manufactured before 1st January 2003 that have not been tested in accordance with the testing requirements in chapter 38.3 of the UN Manual of Tests and Criteria may be transported until 31st December 2004 if all other applicable requirements of these regulations are met.
As used above and elsewhere in these regulations, “lithium content” means the mass of lithium in the anode of a lithium metal or lithium metal alloy cell, except in the case of a lithium ion cell the “lithium-equivalent” in grams is calculated to be 0.3 times the rated capacity in Ampere-hours (Ah).

Special Provision A88 (extracted from page 302, IATA DGR 2003 44th ed)
Prototype lithium batteries and cells that are packaged with not more than 24 cells or 12 batteries per packaging that have not been tested to the requirements in sub section 38.3 of the UN Manual of Tests and Criteria may be transported, if approved by the appropriate authority of the state of origin and the following requirements are met:
(a) The cells and batteries must be transported in an outer packaging that is a metal, plastic or plywood drum or a metal, plastic or wooden box and that meets the criteria for packing group 1 packaging; and
(b) Each cell and battery must be individually packed in an inner packaging inside an outer packaging and surrounded by cushioning material that is non –combustible, and non conductive. Cells and batteries must be protected against short Circuiting.

Special Provision A99 (extracted from page 302, IATA DGR 2003 44th ed)
A99 Irrespective of the limit specified in column L of the List of Dangerous Goods (4.2) a lithium battery or battery assembly that has successfully passed the tests specified in the UN Manual of Tests and Criteria, Part III, sub section 38.3 and that meets the requirements of packing instruction 903 as prepared for transport may have a mass exceeding 35Kg, if approved by the appropriate authority of state of origin. A copy of the document of approval must accompany the consignment.

Appendix B Identification

Identification (extracted from page 205, IATA DGR 2003 44th ed)

UN/ID No.	Proper Shipping Name/Description	Class Or Div	Sub Risk	Hazard Labels	PG	Passenger and Cargo Aircraft				Cargo Aircraft Only		S.P. See 4.4	ERG Code
						Ltd Qty							
						Pkg Inst	Max Net Qty/Pkg	Pkg Inst	Max Net Qty/Pkg	Pkg Inst	Max Net Qty/Pkg		
A	B	C	D	E	F	G	H	I	J	K	L	M	N
3090	Lithium Batteries	9		Miscellaneous	II	-	-	903	5Kg G	903	35Kg G	A45 A88 A99	9W
3091	Lithium Batteries contained in equipment	9		Miscellaneous	II	-	-	See 912		See 912		A45 A48	9W
3091	Lithium Batteries Packed with equipment	9		Miscellaneous	II	-	-	See 918		See 918		A45	9W

Appendix C
PACKING INSTRUCTION 903
STATE VARIATIONS: USG-03/13
OPERATOR VARIATIONS: DL-02, FX-02, MX-09, NW-03, UA01, UX07
The general packing requirements of sub section 5.0.2 must also be met.
This entry applies to cells and batteries containing lithium in any form, lithium polymer and lithium ion cells and batteries.
Lithium cells and batteries may only be transported under this packing instruction if they meet the following requirements:
(a) Each cell or battery type has been determined to meet the criteria for assignment to class 9 on the basis of tests carried out in accordance with the united nations Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria (UN Document ST/SG/AC.10/11);
(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 a series of cells connected in parallel must be equipped with 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 packaging to effectively prevent short-circuits and to prevent movement which could lead to short circuits;
(f) Cells and batteries must be packed in one of the outer packaging below which meet packing group II performance standards
Cells assigned to class 9 which have been discharged to the extent that the open circuit voltage is less than the lower of 2 volts; or 2/3 of the voltage of the undischarged cell; or batteries containing one or more such cells, are forbidden from transport
(g) Irrespective of the requirements in paragraphs (e) and (f) above, lithium batteries with a mass of 12Kg or greater and having a strong, impact-resistant outer casing, or assemblies of such batteries, may be transported when packed in strong outer packaging and protective enclosures not subject to the requirements of section 6 of these regulations, if approved by the appropriate authority if the state of origin. A copy of the document of approval must accompany the consignment.

OUTER PACKAGINGS														
Type	Drums					Jericans		Boxes						
Desc	Steel	Aluminium	Ply-wood	Fibre	Plastic	Steel	Plastic	Steel	Aluminium	Wood	Ply-wood	Reconstituted wood	Fibre board	Plastic
Spec	1A2	1B2	1D	1G	1H2	3A2	3H2	4A	4B	4C1 4C2	4D	4F	4G	4H2

Glossary
IATA International Air Transport Association
ICAO International Civil Aviation Organisation
IMDG Intentional Maritime Dangerous Goods
RSPA Research and Special Programs Administration