

## EM CX Fact Sheet FY 08-01

### Transportation of Lithium Batteries

<b>Purpose</b>	This factsheet has been prepared to address compliance issues associated with the transportation of lithium batteries, lithium batteries packed with equipment and lithium batteries contained in equipment. This factsheet focuses primarily on the Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations but also discusses the current and pending International Civilian Aviation Organization (ICAO) and International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).
<b>Rule/ Regulation Identification</b>	<ul style="list-style-type: none"><li>• <b>Title: Hazardous Materials: Transportation of Lithium Batteries</b></li><li>• Status: Final Rule</li><li>• Date: August 9, 2007</li><li>• Reference: 72 FR 44930</li><li>• Affected regulations: 49 CFR 171 - 178</li></ul> <p>Link:<a href="http://a257.g.akamaitech.net/7/257/2422/01jan20071800/edocket.access.gpo.gov/2007/pdf/E7-15213.pdf">http://a257.g.akamaitech.net/7/257/2422/01jan20071800/edocket.access.gpo.gov/2007/pdf/E7-15213.pdf</a></p>
<b>Deadline</b>	Effective Date: January 1, 2008
<b>Executive Summary</b>	<p>Consumer electronic devices continue to be provided an exemption under PHMSA regulations and ICAO technical instructions provided they meet the definition of a small battery and spare batteries are properly secured and carried in <i>carry-on-baggage only</i>. The limitation is 2 lithium ion batteries not to exceed a total of 25 grams ELC (160 Whr).</p> <p><i>Lithium metal batteries</i> are generally <i>forbidden</i> on passenger aircraft <i>unless</i> they meet the carry-on provisions of domestic and international provisions (i.e. small cell/battery) <i>or the marking, documentation, and limitations provided by SP 188, 189, and/or 190.</i></p> <p>Beginning January 1, 2009, ICAO Technical Instructions will be adding additional PSNs for lithium battery entries clarifying the distinction between lithium metal and lithium ion batteries.</p> <p>For the PSNs <i>Lithium batteries contained in equipment, Lithium batteries, packed with equipment</i> and <i>Lithium battery</i> that are used to describe <b><u>Lithium ion battery</u></b> scenarios and are not covered by carry-on provisions; the lading is subject to hazardous materials regulations unless the cell/battery does not meet the definition of a Class 9 material (i.e. &lt; 1.5 grams ELC/cell [20 Whr]; &lt; 8 gram ELC/battery [100 Whr]). Effective January 1, 2009 additional communication requirements (labeling, documentation, and training) will be applicable to small, excepted batteries.</p>
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US Army Corps  
Of Engineers  
EM CX Factsheet  
08-01

DEPARTMENT OF TRANSPORTATION  
Pipeline and Hazardous Materials  
Safety Administration

Hazardous Materials: Transportation of Lithium Batteries

Action: Final Rule

72 FR 44930; August 9, 2007

**I. Purpose.** This factsheet has been prepared to address compliance issues associated with the transportation of lithium batteries, lithium batteries packed with equipment and lithium batteries contained in equipment. This factsheet focuses primarily on the Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations but also discusses the current and pending International Civilian Aviation Organization (ICAO) and International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).

**II. Background.** Over the last several years, PHMSA has published several rulemakings addressing the transportation of lithium batteries. The rulemaking activities were driven in large part by transportation related incidents associated with the movement of lithium batteries in commerce. The most recent rulemaking was published in the *Federal Register* on August 9, 2007 (72 FR 44930). PHMSA worked closely with the Federal Aviation Administration (FAA) to address recommendations made by the National Transportation Safety Board (NTSB) which resulted from investigations into the Los Angeles International Airport incident where two pallets of lithium batteries caught on fire. PHMSA discussed several other incidents and industry recalls of lithium batteries in the preamble to the rule. Those discussions can be found in Section I. C. of the preamble to the August 9, 2007 final rule.

**III. Summary.** PHMSA has clarified terminology used for the description of lithium batteries. PHMSA is following battery size standards as defined under the United Nations recommendations and international regulatory bodies such as the International Civilian Aviation Organization (ICAO) and the International Maritime Organization's International Maritime Dangerous Goods (IMDG) Code. A cell is a single electro-chemical unit; a battery consists of one or more connected cells. For the purposes of the rule, PHMSA defines "primary" as a non-rechargeable battery containing lithium metal as opposed to a "secondary" battery which contains an ionic form of lithium (lithium-ion). PHMSA has divided batteries along these standardized categories into two "classes" and three subcategories as detailed in Table 1. While battery technologies are continuing to advance, PHMSA considers the use of this terminology appropriate at this time. While the rule's main focus is on primary lithium batteries due to safety concerns, the rule also addresses lithium-ion batteries. The primary focus of this factsheet will be requirements associated with secondary batteries (i.e. lithium-ion batteries). Lithium-ion batteries and electronic equipment containing them are potentially regulated in the various modes of

transportation and have some more specific requirements in the air mode. While USACE does not typically ship primary batteries, the requirements and prohibitions associated with them are substantial and they will be discussed in some detail. The factsheet is broken out into two main topics, the PHMSA rulemaking in August of 2007 and the pending changes under ICAO slated to become effective on January 1, 2009.

A brief synopsis of current and pending rulemaking includes:

- Consumer electronic devices continue to be provided an exemption under PHMSA regulations and ICAO technical instructions provided they meet the definition of a small battery and spare batteries are properly secured and carried in *carry-on-baggage only*. The limitation is 2 grams of lithium metal per battery or 8 grams equivalent lithium content (ELC) for lithium ion batteries. The exception is that up to two spare batteries may be carried in carry-on baggage provided an aggregate of 25 grams ELC (160 Whr) is not exceeded.
- *Lithium metal batteries* are generally *forbidden* on passenger aircraft *unless* they meet the carry-on provisions of domestic and international provisions (i.e. small cell/battery) *or the marking, documentation, and limitations provided by Special Provisions (see SP 188, 189, and/or 190)*.
- Beginning January 1, 2009, ICAO Technical Instructions will be adding additional PSNs for lithium battery entries clarifying the distinction between lithium metal and lithium ion batteries. PHMSA will likely begin the rulemaking process to adopt these changes shortly.
- For the proper shipping names (PSNs), *Lithium batteries contained in equipment, Lithium batteries, packed with equipment* and *Lithium battery* that are used to describe ***Lithium ion battery*** scenarios and are not covered by carry-on provisions; the lading is not subject to hazardous materials regulations provided the cell/battery does not meet the definition of a Class 9 material (i.e. < 1.5 grams ELC/cell [20 Whr]; < 8 gram ELC/battery [100 Whr]). *However, effective January 1, 2009 additional communication requirements (labeling, documentation, and training) may be applicable to small, excepted batteries in international shipments.* Those provisions could very likely be adopted domestically.

The following is a more detailed outline discussion of the major provisions of the PHMSA rule.

#### A. Definitions.

PHMSA has added three definitions to help clarify the rule.

*Aggregate lithium content* means the sum of the grams of lithium content or equivalent lithium content contained by the cells comprising a battery.

*Equivalent lithium content* means, for a lithium-ion cell, the product of the rated capacity, in ampere-hours, of a lithium-ion cell times 0.3, with the result expressed in grams. The equivalent lithium content of a battery equals the sum of the grams of equivalent lithium content contained in the component cells of the battery.

*Lithium content* means the mass of lithium in the anode of a lithium metal or lithium alloy cell. The lithium content of a battery equals the sum of the grams of lithium content contained in the component cells of the battery. For a lithium-ion cell see the definition for “equivalent lithium content.”

**B. Example**

In order to comply with the regulations one must be able to determine the lithium content of the cell or battery in question and classify the cell or battery as small, medium or large (see Table 1). Once a determination is made, the regulations can be evaluated to determine if the battery is eligible for any exemption from the regulations or if the cell/battery is subject to regulation as a Class 9 hazardous material/dangerous good.

Table 1  
Battery and Cell Category Definitions

Type	Small (no more than)	Medium (between)	Large (more than)
Cells:			
Primary.....	1 g Li	1 g and 5 g Li	5 g Li
Secondary.....	1.5 g ELC* (20 Whr**)	1.5 g and 5 g ELC	5 g ELC
Batteries			
Primary.....	2 g Li	2 g and 25 g Li	25 g Li
Secondary.....	8 g ELC (100 Whr**)	8 g and 25 g ELC (100 – 160 Whr**)	25 g ELC

\*ELC (Equivalent Lithium Content)

\*\*Effective 1/1/09 ICAO/IATA will use Watt-hour (Whr) instead of ELC

An example scenario is useful to explain the relationship of these terms to every day items such as a laptop computer battery.

Consider a standard laptop battery with the following markings (Attachment 1; Photo 1A):

Rechargeable Li-ion Battery  
Rating: 14.8V = 4460 mAh

Type: 66Whr  
Capacity: 66Whr

Given this information there is no direct correlation to the masses identified in Table 1. However, we do know some important criteria by which we can make a determination.

We know the equivalent lithium content (ELC) is the rated capacity ampere-hour (Ah) X (0.3) which equals a result expressed in grams of Li (49 CFR 173.185). Therefore;

$$(4.46) \text{ Ah X } (0.3) = 1.338 \text{ grams of ELC.}$$

However, the definition of ELC is for a lithium-ion *cell* so the calculation is not entirely correct. We would expect, intuitively that the battery is composed of more than one cell, but that *may not* be indicated as a marking on a typical battery under historic marking practices by industry. Based on discussions with the Portable Rechargeable Battery Association ([PRBA](#)) we know that the number of *cells* can be calculated if we are given the voltage and capacity of the battery.

1. Voltage: Number of cells in series. For the laptop industry, the nominal discharge voltage is ~ 3.6 – 3.7V/cell so the battery pack voltage will be divisible by one of these numbers. In our case  $14.8\text{V}/3.7\text{V} = 4$  or 4 cells in series (i.e. a 4S)

2. Capacity: Number of parallel strings of series cells. Capacity should be divisible by the increments of the nominal capacities of the typical 18650 cylindrical cells (i.e. 2.0, 2.1, 2.2, 2.3, 2.4, 2.5 or 2.6Ah) common to the laptop industry. We have a capacity of ~ 4400mAh.  $4400\text{mAh}/2200\text{mAh} = 2$  or a 2P

That tells us we have a 4S2P (2 parallel strings of 4-series cells) or 8 total cells with an inferred capacity per cell of 2.2Ah.

Our true *aggregate lithium content* (in ELC) is calculated as  $(2.2\text{Ah}) \text{ X } (0.3) \text{ X } (8) = 5.28$  grams ELC. Looking at Table 1, we would classify our battery as a “small secondary battery.”

As it turns out, this is a common configuration for laptop battery packs and in fact a 3S2P is the most common of all.

There are currently situations where laptop batteries (or other types) may not have all the described markings (Attachment 1; Photo 1B). This example shows a voltage of 10.8V and a 4500 mAh rating. Using the same logic presented above we can deduce  $10.8\text{V}/3.6\text{V} = 3$  cells in series or a 3S. For capacity, we can evaluate the 4500 mAh to determine the parallel cell configuration. With a little trial and error  $4.5 \text{ Ah}/2.2 \text{ Ah} \sim 2$ .

We then know we have a 3S2P lithium-ion battery pack and we can determine ELC.  $(2.2 \text{ Ah}) \text{ X } (0.3) \text{ X } (6) = 3.96$  grams ELC; again a small battery per PHMSA definitions.

As awkward as this process is currently, relief is in the works. Industry is moving to mark batteries with watt-hour (Whr). The International Air Transportation Association (IATA) has a set of instructions that will become effective in January 2009 following ICAO Technical Instruction amendments (see Section F. Pending Regulations). The cut off for Class 9 lithium batteries will be set at 100Whr making determinations in the future much

easier. Under United Nations testing protocols, batteries will be required to be marked in Whr starting January 1, 2009.

Currently, if the information is provided, as in the example above (i.e. 66 Whr), the user can easily determine if the battery is regulated as a Class 9 dangerous good/hazardous material. Otherwise, a calculation needs to be made to determine ELC and whether the battery is a small, medium or large battery. Based on a small sample size of laptop batteries readily available, it appears it would be atypical for this type of battery to be classified as other than small.

Primary batteries (lithium metal) are subject to the same evaluation and classification criteria; however, as we will see, they are regulated much more stringently in the air mode. However, as stated before, it would be an unusual situation for USACE personnel to be shipping lithium metal batteries.

### C. Battery entries and the PHMSA Hazardous Materials Table (HMT).

A review of the current HMT shows several entries of lithium batteries, specifically:

1. UN3091, Lithium batteries, contained in equipment, 9, II
2. UN3091, Lithium batteries packed with equipment, 9, II
3. UN3090, Lithium battery, 9, II

All entries have multiple special provisions (SP) identified in Column 7. Prior to the 8/7/2007 rule, SP 29, A54, A55 were common to all. A102 and A104 were specific to the first entry, A101 and A103 for the second, and A100 for the third.

Table 2 below summarizes SP changes PHMSA made in the 8/9/2007 final rule. Roman type indicates existing SPs, italics and strikethroughs are editions and deletions. The biggest change is the addition of United Nations SPs 188, 189, and 190 to associated column 7 entries. The rule also deleted SP A102 from column 9A.

The proper shipping name (PSN) entry for #1 above now has SPs: 29, 188, 189, 190, A54, A55, A102, A104. Column 9A (passenger aircraft/rail) has been revised to read "See A101, A104."

PSN #2 now has SPs 29, 188, 189, 190, A54, A55, A101, A103 and Column 9A has been revised to read "See A101, A103."

PSN#3 now has SPs 29, 188, 189, 190, A54, A55, and A100.

For convenience all special provisions referenced in this factsheet can be found in Attachment 2 and are cross referenced to PSNs in Table 2.

**Table 2**

PSNs and associated Special Provisions		
1. Lithium batteries, contained in equipment	2. Lithium batteries packed with equipment	3. Lithium battery
Pre 8/9/2007 Final Rule		
29, A54, A55 A102 and A104	29, A54, A55 A101 and A103	29, A54, A55 A100
Post 8/9/2007 Final Rule		
29, 188, 189, 190 A54, A55 A102 A101 and A104	29, 188, 189, 190 A54, A55 A101 and A103	29, 188, 189, 190 A54, A55 A100
IATA SPs (49 <sup>th</sup> edition)		
A45, A48	A45	A45, A88, A99

D. Current Regulations.

As discussed above, PHMSA added three definitions associated with lithium batteries under §171.8. PHMSA also added language directed at lithium batteries under §171.12 *North American Shipments*, §171.24 *Additional requirements for the use of the ICAO Technical Instructions*, and §171.25 *Additional requirements for the use of the IMDG Code*. The provisions basically prohibit primary lithium batteries from transportation on passenger aircraft unless packages contain  $\leq 5$  kg (11 lb) net weight primary lithium batteries or cells contained in or packaged with equipment. Packaging instructions for Class 9 regulated batteries and cells can be found at §173.185 (Attachment 3).

*Exceptions and Consumer Electronics*

PHMSA regulations have specific exceptions for passengers, crewmembers, and air operators. Those general provisions are found at 49 CFR 175.10. They except certain hazardous materials from regulation in the air mode provided certain conditions are met. 175.10(a)(17) addresses lithium batteries specifically and provides an exception from the hazardous materials regulations. 49 CFR 175.10(a)(17) states:

*Except as provided in §173.21 of this subchapter, consumer electronic and medical devices (watches, calculating machines, cameras, cellular phones, lap-top and notebook computers, camcorders, etc.) containing lithium cells or batteries and spare lithium batteries and cells for these devices, when carried by passengers or crew members for personal use. Each spare battery must be individually protected so as to prevent short circuits (by placement in original retail packaging or by otherwise insulating terminals, e.g., by taping over exposed terminals or placing each battery in a separate plastic bag or protective pouch) **and carried in carry-on baggage only**. In addition, each installed or spare battery must not exceed the following:*

*(i) For a lithium metal battery, a lithium content of not more than 2 grams per battery; or*

*(ii) For a lithium-ion battery, an aggregate equivalent lithium content of not more than 8 grams per battery, except that up to two batteries with an aggregate equivalent lithium content of more than 8 grams but not more than 25 grams may be carried.*

Note: 175.10(b) states: *The exceptions provided in paragraph (a) of this section also apply to aircraft operators when transporting passenger or crewmember baggage that has been separated from the passenger or crewmember, including transfer to another carrier for transport to its final destination.* Given the new language in 175.10(a)(17), this provision exposes a potential weakness regarding lithium batteries in carry-on baggage. This issue is further complicated by the “jet-way” tagging of carry-on baggage on small regional aircraft. It appears lithium batteries and devices containing them could inadvertently be placed in aircraft cargo holds by aircraft operators. It would appear prudent to remove electronic devices from those bags if such a scenario arises or pack them in a backpack or similar piece of luggage that will fit in authorized locations in the cabin on these smaller aircraft.

#### E. Summary of PHMSA Regulations (effective date January 1, 2008)

- Generally speaking, primary lithium cells and batteries are prohibited from transport of passenger aircraft unless:

i. The provisions of 49 CFR 175.10(a)(17) are met or

ii. The cell or battery meets the definition of a small battery and the requirements of Special Provision 188 a.(2). Specifically, the passenger aircraft prohibition is waived if the package contains 5 kg (11 lbs) net weight or less of primary lithium batteries or cells that are contained in or packed with equipment and the package contains no more than the number of lithium batteries or cells necessary to power the piece of equipment. (see SP 188; Attachment 2).

- Primary lithium batteries transported by any means other than passenger aircraft must be marked “PRIMARY LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT.”
- Large lithium batteries (> 25 grams) remain fully regulated as Class 9.
- 49 CFR 175.10(a)(17) revised the interim final rule (12/15/2004) stipulating that consumer electronics containing batteries and spares *must* be in carry-on baggage. These items can no longer be in checked baggage.
- Exceptions for medium batteries in other than surface modes have been eliminated and have been moved from 49 CFR 173.185 to SP 189.
- The small battery exception from UN testing requirements is eliminated. (With few exceptions, *all* lithium batteries are now subject to UN testing).
- Marking and paperwork requirements have been added for medium batteries shipped as excepted in the surface mode.
- Effective October 1, 2009, the cell or battery must be of a type meeting UN Manual of Tests and Criteria.

- Effective October 1, 2008, marking and paperwork requirements have been added for packages of small batteries containing more than 24 lithium cells or 12 lithium batteries.

#### F. Pending ICAO Regulatory Changes (2009 – 2010)

The ICAO Dangerous Goods Panel (DGP) recently completed their work on amending the lithium battery provisions in ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air. As mentioned earlier, the ICAO changes go into effect on January 1, 2009 for international air shipments.

As noted in Table 1, the United Nations is transitioning to a Whr rating for lithium ion batteries and relying on manufacturing marking to help the regulated community classify these batteries. Specifically, a 20 Whr rating will equate to small *secondary cell* and a rating of 100 Whr will equate to a *small secondary battery*.

Based on the ICAO DGP meeting, several changes will occur in the packaging instruction content and format for lithium battery entries in the Table of Dangerous Goods. Further, documentation and labeling requirements have been modified and new weight limits were adopted. There is also a new battery handling label. Attachment 4, developed by Wiley Rein LLP for PRBA members, contains an example of the handling label and a summary table of the 2009 – 2010 ICAO Technical Instruction Requirements for shipping small, excepted lithium batteries in the air mode. ICAO has also adopted the following requirement for shippers of small, excepted cells and batteries: “*Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.*” This is new language. Once IATA incorporates the ICAO language into their DGRs, the scope of this training requirement may be a bit clearer. At this point, it is clear some sort of function specific training documentation may be necessary.

Effective January 1, 2009, the following new UN numbers and shipping names will go into effect under the ICAO Technical Instructions:

(UN3480) Lithium ion batteries

(UN3481) Lithium ion batteries packed with equipment

(UN3481) Lithium ion batteries contained in equipment

(UN3090) Lithium metal batteries

(UN3091) Lithium metal batteries packed with equipment

(UN3091) Lithium metal batteries contained in equipment

## 1. Requirements for UN3480, UN3480 (packed with) and UN3481 (contained in)

For the first three PSNs listed above *lithium ion batteries (UN3480)*, *lithium ion batteries packed with equipment (UN3481)*, and *lithium ion batteries contained in equipment (UN3481)* that meet the definition of fully regulated Class 9 dangerous goods, there are no changes to the ICAO Technical Instructions other than packaging instruction reformatting.

### *Exceptions for UN3480*

For shippers of small, excepted *lithium ion* cells and batteries (UN3840)) major changes include packaging weight limitation reduction from 30 kg to 10 kg on passenger and cargo aircraft, the new battery labeling requirement for outer packages and the previously mentioned change from ELC to Watt-hours (1.5 g is now 20 watt-hours; 8 g is now 100 watt-hours). SP A45 will be incorporated directly into the packaging instruction and a requirement that “*Any person preparing or offering cells or batteries for transport must received adequate instruction on these requirements commensurate with their responsibilities.*”

The following new packaging and documentation requirements will apply:

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery.
- Cells and batteries must be protected to avoid short circuits.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
  1. damage to cells or batteries contained within the packaging;
  2. shifting of the contents allowing battery to battery contact; and
  3. release of contents.
- Each consignment must be accompanied with a document such as an air way bill indicating:
  1. the package contains lithium metal cells or batteries;
  2. the package must be handled with care and that a flammability hazard exists if the package is damaged;
  3. special procedures should be followed in the event the package is damaged, to include inspection and repacking if necessary; and
  4. a telephone number for additional information.

Each package must be labeled with the lithium battery handling label (See Attachment 4) and “*Any person preparing or offering cells or batteries for transport must received adequate instruction on these requirements commensurate with their responsibilities.*”

### *Exceptions for UN3481*

For shippers of small, excepted lithium ion cells and batteries *packed with equipment* (UN3481) the maximum number of batteries in each package is now limited to the minimum number required to power the equipment plus two spares. The new labeling requirement for outer packages applies, the Whr exception levels are adopted as above, SP A45 is incorporated into the packaging instruction (PI) and the “adequate instruction” provision applies.

The packaging provisions for these excepted items are similar to those outlined above for *lithium ion* cells and/or batteries. There is no weight limit for this provision.

### *Exceptions for UN3481*

For shippers of small, excepted lithium ion cells and batteries *contained in equipment* (UN3481), the labeling requirement for outer packages applies, the Whr thresholds are incorporated (i.e. 20 Whr/cell or 100 Whr/battery), the SP A45 is incorporated into the PI and the “adequate instruction” provision is applicable. The labeling and documentation (battery hazard label and airway bill communication) are applicable *unless* a single package contains no more than four (4) cells or no more than two (2) batteries in equipment, then *neither* the labeling or documentation requirements apply. There is no weight limitation under this provision.

Applicable packaging requirements are similar to those under the *lithium ion* cell or battery entry above unless the 4 cell/2 battery criteria are exceeded.

## 2. Requirements for UN3090

For shippers of fully –regulated, Class 9 *lithium metal* cells/batteries (UN3090), the revised ICAO Technical Instructions include the following requirements:

- When offered for transport on passenger aircraft, cells/batteries must be packed in intermediate or outer rigid metal packaging. Cells and batteries must be surrounded by cushioning material that is non-combustible and non-conductive, and placed inside an outer packaging.
- Packages offered for transport on passenger aircraft cannot exceed 2.5 kg (gross weight). The weight reflects a reduction from the current 5 kg weight limitation.

### *Exceptions for UN3090*

For shippers of small, excepted *lithium metal* cells and batteries (UN3090) major changes include packaging weight limitation reduction from 30 kg to 2.5 kg on passenger and cargo aircraft, the new battery labeling requirement for outer packages, and the previously mentioned change from ELC to Watt-hours (i.5 g is now 20 watt-hours; 8 g is now 100 watt-hours). SP A45 will be incorporated directly into the packaging instruction and the *adequate instruction* for shipper’s provisional language has been added to the PI.

The following new packaging and documentation requirements will apply:

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery.
- Cells and batteries must be protected to avoid short circuits.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
  1. damage to cells or batteries contained within the packaging;
  2. shifting of the contents allowing battery to battery contact; and
  3. release of contents.
- Each consignment must be accompanied with a document such as an air way bill indicating:
  1. the package contains lithium metal cells or batteries;
  2. the package must be handled with care and that a flammability hazard exists if the package is damaged;
  3. special procedures should be followed in the event the package is damaged, to include inspection and repacking if necessary; and
  4. a telephone number for additional information.

Each package must be labeled with the lithium battery handling label (see Attachment 4) and the “*Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities*” provision is added.

### 3. Requirements for UN3091

For *lithium metal batteries packed with equipment* that are fully regulated, Class 9 materials, changes to the ICAO Technical instructions include:

- Cells/batteries offered for transport on passenger aircraft must be packed in intermediate or outer rigid metal packaging and surrounded by cushioning material that is non-combustible and non-conductive. The intermediate packaging must be placed inside an outer packaging (strong outer packaging).

#### *Exceptions for UN3091*

For shippers of small, excepted *lithium metal* cells/batteries packed with in equipment the major change is directed at the maximum number of batteries in each package. That is limited to the minimum number required to power the equipment plus two spares. The new battery labeling requirement applies to outer packagings (See Attachment 4). The amended SP A45 is now incorporated into the packaging instruction and the training provision stating “*Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.*” has been added.

#### 4. Requirements for UN3091

For *lithium metal batteries contained in equipment* that are fully regulated, Class 9 materials the only change to the ICAO Technical Instructions is an increase in the weight restriction from 5 kg to 35 kg for shipments on cargo aircraft. The associated packaging instruction has been reformatted.

##### *Exceptions for UN3091*

For shippers of small, excepted lithium metal cells/batteries contained in equipment, the primary changes are the new battery labeling requirement for outer packages (Attachment 4) and incorporation of SP A45 into the packaging instruction. The training requirement “*Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.*”

Each package containing more than four cells or more than two batteries installed in equipment must be labeled with the lithium battery handling label (Attachment 4). If the label is applied to the package then the documentation (i.e. air waybill) and communication requirements are required as follows:

1. the package contains lithium metal cells or batteries;
2. the package must be handled with care and that a flammability hazard exists if the package is damaged;
3. special procedures should be followed in the event the package is damaged, to include inspection and repacking if necessary; and
4. a telephone number for additional information.

#### 5. Carry-on provisions for lithium ion batteries.

ICAO still acknowledges that passengers are authorized to carry consumer electronic and medical devices including spare lithium ion batteries onboard passenger aircraft. *Each spare lithium ion battery* must be individually protected from short circuits and *carried in carry-on baggage only*. Further, each installed battery or spare *must not exceed 8 grams per battery (100 Whr)*. A total of *two* batteries may be carried provided the aggregate ELC *does not exceed 25 grams ELC*.

- For international travel, effective January 1, 2009, ICAO has adopted new carry-on provisions. The 8 gram ELC limitation will be changed to 100 Whr and the 8 – 25 grams ELC will be eliminated and replaced with 100 – 160 Whr. *Approval from the airline/operator must be secured by passengers prior to carrying these larger batteries onboard passenger aircraft.* [see IATA editorial note below]

Since IATA adopts the ICAO technical instructions it is important to note their recent activities relative to lithium batteries:

IATA regulations have a pending amendment under the newly developed Appendix I of the DGRs (49<sup>th</sup> Edition) – Impending Changes. That section states:

- ***Dangerous Goods Carried by Passengers and Crew.*** Amendments to dangerous goods permitted in passenger or crew baggage include the following language:

.....

***Consumer electronic equipment powered by lithium batteries.*** Reference to lithium equivalent content for lithium batteries has been revised to reflect a maximum Watt/hour rating of 100 Whr. The watt/hour rating is already marked on consumer type lithium ion batteries. This change reflects the amendments to SP A45.

Appendix I of the IATA DGRs (49<sup>th</sup> Edition) Section I.2.3.5.10 has an editorial note stating: “The provision permitting passengers and crew members to carry lithium ion batteries larger than 8 g but not more than 25 g has been removed.”

.....

These pending amendments track directly with the ICAO Technical Instructions previously discussed with the exception that IATA The effective date is January 1, 2009.

#### G. Summary and Conclusions

Regulations addressing the transportation of lithium batteries are currently rather unwieldy. Once the battery type is identified in the context of existing classifications a systematic progression through the HMT and associated special provisions allows the regulated community to determine specific requirements.

Generally speaking, consumer electronics as carry-on items on passenger aircraft are fairly straightforward; however shipping electronic equipment with lithium metal or lithium ion cells or batteries requires an additional level of investigation.

In summary, consumer electronic devices continue to be provided an exemption under PHMSA regulations and ICAO technical instructions provided they meet the definition of a small battery and spare batteries are properly secured and carried in *carry-on-baggage only*. The limitation is 2 lithium ion batteries not to exceed a total of 25 grams ELC (160 Whr).

*Lithium metal batteries* are generally *forbidden* on passenger aircraft *unless* they meet the carry-on provisions of domestic and international provisions (i.e. small cell/battery) *or the marking, documentation, and limitations provided by SP 188, 189, and/or 190.*

Beginning January 1, 2009, ICAO Technical Instructions will be adding additional PSNs for lithium battery entries clarifying the distinction between lithium metal and lithium ion batteries.

For the PSNs *Lithium batteries contained in equipment*, *Lithium batteries, packed with equipment* and *Lithium battery* that are used to describe **Lithium ion battery** scenarios and are not covered by carry-on provisions; the lading is not subject to hazardous materials regulations provided the cell/battery does not meet the definition of a Class 9 material (i.e. < 1.5 grams ELC/cell [20 Whr]; < 8 gram ELC/battery [100 Whr]). Effective January 1, 2009 additional communication requirements (labeling, documentation, and training) will be applicable to small, excepted batteries.

Until industry standardizes marking requirements (i.e. ratings in Whr), the regulated community may need to determine ELC by the methods presented in this factsheet.

Attachment 1

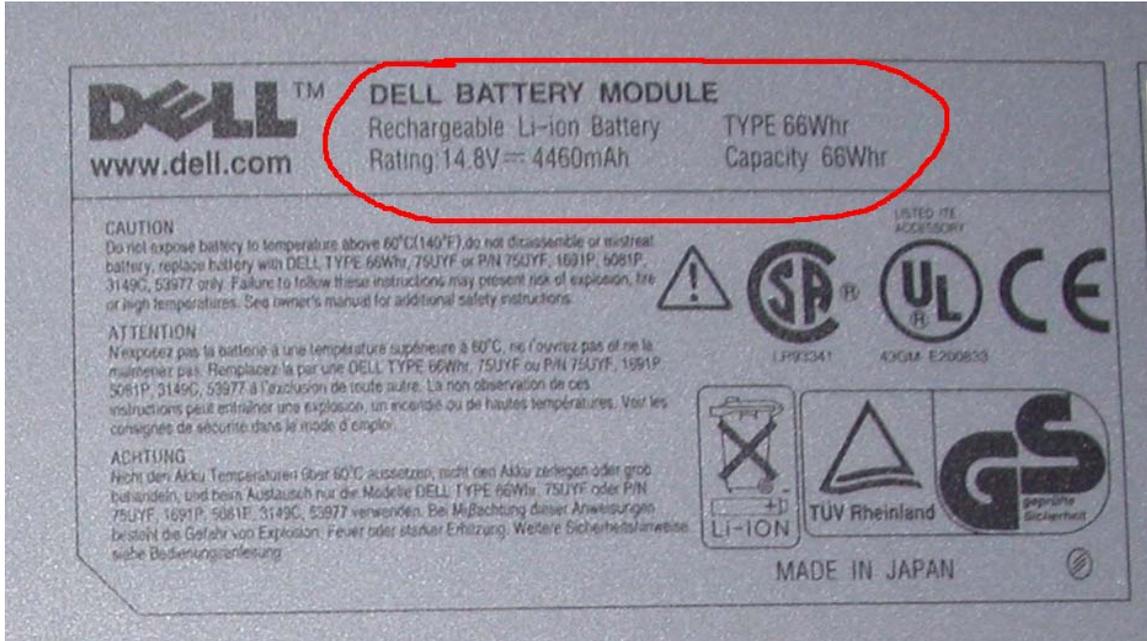


Photo 1A

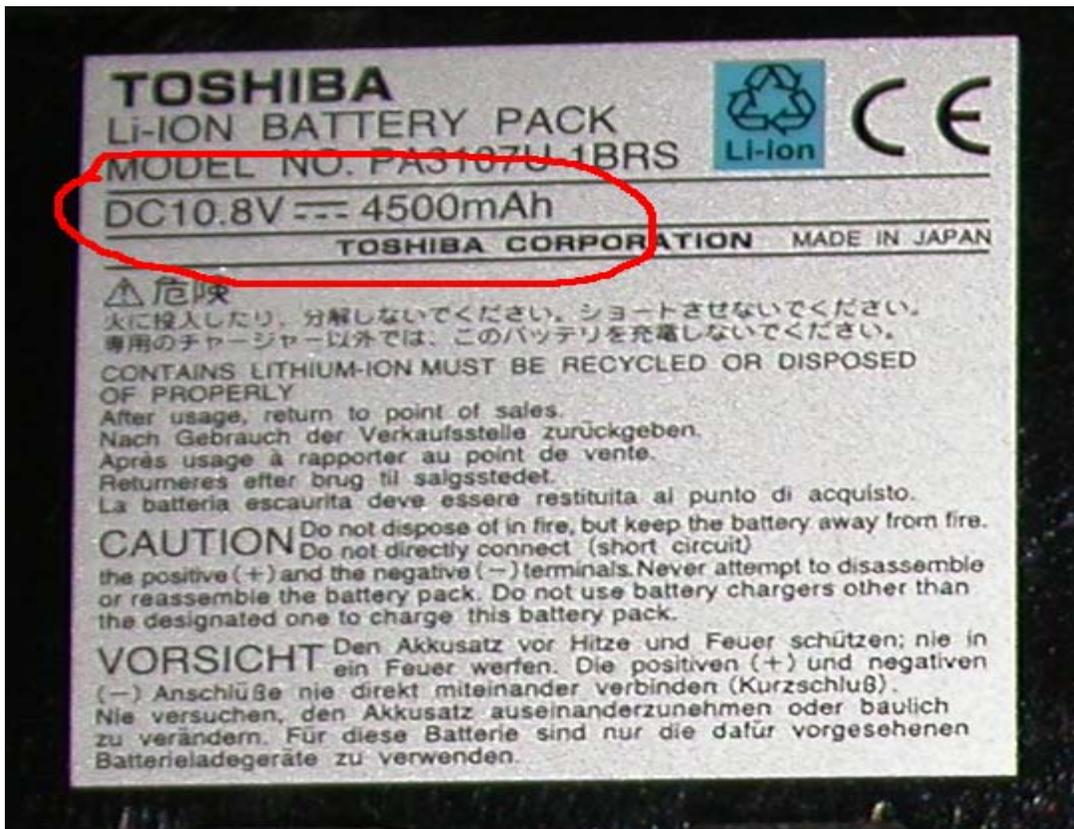


Photo 1B

**Attachment 2**  
**Lithium Battery Special Provisions**  
**(Emphasis added)**

**29** For transportation by motor vehicle, rail car or vessel, production runs (exceptions for prototypes can be found in §173.185(e)) of not more than 100 lithium cells or batteries are excepted from the testing requirements of §173.185(a)(1) if—

- a. For a lithium metal cell or battery, the lithium content is not more than 1.0 g per cell and the aggregate lithium content is not more than 2.0 g per battery, and, for a lithium-ion cell or battery, the equivalent lithium content is not more than 1.5 g per cell and the aggregate equivalent lithium content is not more than 8 g per battery;
- b. The cells and batteries are transported in an outer packaging that is a metal, plastic or plywood drum or metal, plastic or wooden box that meets the criteria for Packing Group I packagings; and
- c. Each cell and battery is individually packed in an inner packaging inside an outer packaging and is surrounded by cushioning material that is non-combustible, and non-conductive.

**188** *Small lithium cells and batteries.* **Lithium cells or batteries, including cells or batteries packed with or contained in equipment, are not subject to any other requirements of this subchapter if they meet all of the following:**

a. *Primary lithium batteries and cells.* (1) Primary lithium batteries and cells are forbidden for transport aboard passenger-carrying aircraft. The outside of each package that contains primary (nonrechargeable) lithium batteries or cells must be marked “PRIMARY LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT” or “LITHIUM METAL BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT” on a background of contrasting color. The letters in the marking must be:

- (i) At least 12 mm (0.5 inch) in height on packages having a gross weight of more than 30 kg (66 pounds); or
- (ii) At least 6 mm (0.25 inch) on packages having a gross weight of 30 kg (66 pounds) or less, except that smaller font may be used as necessary to fit package dimensions; and

**(2) The provisions of paragraph (a)(1) do not apply to packages that contain 5 kg (11 pounds) net weight or less of primary lithium batteries or cells that are contained in or packed with equipment and the package contains no more than the number of lithium batteries or cells necessary to power the piece of equipment;**

- b. For a lithium metal or lithium alloy cell, the lithium content is not more than 1.0 g. For a lithium-ion cell, the equivalent lithium content is not more than 1.5 g;
- c. For a lithium metal or lithium alloy battery, the aggregate lithium content is not more than 2.0 g. **For a lithium-ion battery, the aggregate equivalent lithium content is not more than 8 g;**
- d. Effective October 1, 2009, the cell or battery must be of a type proven to meet the requirements of each test in the UN Manual of Tests and Criteria (IBR; see §171.7 of this subchapter);

e. Cells or batteries are separated so as to prevent short circuits and are packed in a strong outer packaging or are contained in equipment;

f. Effective October 1, 2008, except when contained in equipment, each package containing more than 24 lithium cells or 12 lithium batteries must be:

(1) Marked to indicate that it contains lithium batteries, and special procedures should be followed in the event that the package is damaged;

(2) Accompanied by a document indicating that the package contains lithium batteries and special procedures should be followed in the event that the package is damaged;

(3) Capable of withstanding a 1.2 meter drop test in any orientation without damage to cells or batteries contained in the package, without shifting of the contents that would allow short circuiting and without release of package contents; and

(4) Gross weight of the package may not exceed 30 kg (66 pounds). This requirement does not apply to lithium cells or batteries packed with equipment;

g. Electrical devices must conform to §173.21 of this subchapter; and

**h. Lithium batteries or cells are not authorized aboard an aircraft in checked or carry-on luggage except as provided in §175.10.**

**189** *Medium lithium cells and batteries.* Effective October 1, 2008, when transported by motor vehicle or rail car, lithium cells or batteries, including cells or batteries packed with or contained in equipment, are not subject to any other requirements of this subchapter if they meet all of the following:

a. The lithium content anode of each cell, when fully charged, is not more than 5 grams.

b. The aggregate lithium content of the anode of each battery, when fully charged, is not more than 25 grams.

c. The cells or batteries are of a type proven to meet the requirements of each test in the UN Manual of Tests and Criteria (IBR; see §171.7 of this subchapter). A cell or battery and equipment containing a cell or battery that was first transported prior to January 1, 2006 and is of a type proven to meet the criteria of Class 9 by testing in accordance with the tests in the UN Manual of Tests and Criteria, Third Revised Edition, 1999, need not be retested.

d. Cells or batteries are separated so as to prevent short circuits and are packed in a strong outer packaging or are contained in equipment.

e. The outside of each package must be marked "LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL" on a background of contrasting color, in letters:

(1) At least 12 mm (0.5 inch) in height on packages having a gross weight of more than 30 kg (66 pounds); or

(2) At least 6 mm (0.25 inch) on packages having a gross weight of 30 kg (66 pounds) or less, except that smaller font may be used as necessary to fit package dimensions.

f. Except when contained in equipment, each package containing more than 24 lithium cells or 12 lithium batteries must be:

(1) Marked to indicate that it contains lithium batteries, and that special procedures should be followed in the event that the package is damaged;

(2) Accompanied by a document indicating that the package contains lithium batteries and that special procedures should be followed in the event that the package is damaged;

(3) Capable of withstanding a 1.2 meter drop test in any orientation without damage to cells or batteries contained in the package, without shifting of the contents that would allow short circuiting and without release of package contents; and

(4) Gross weight of the package may not exceed 30 kg (66 pounds). This requirement does not apply to lithium cells or batteries packed with equipment.

g. Electrical devices must conform to §173.21 of this subchapter.

**190** Until the effective date of the standards set forth in Special Provision 189, medium lithium cells or batteries, including cells or batteries packed with or contained in equipment, are not subject to any other requirements of this subchapter if they meet all of the following:

a. *Primary lithium batteries and cells*. (1) Primary lithium batteries and cells are forbidden for transport aboard passenger-carrying aircraft. The outside of each package that contains primary (nonrechargeable) lithium batteries or cells must be marked "PRIMARY LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT" or "LITHIUM METAL BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT" on a background of contrasting color. The letters in the marking must be:

(i) At least 12 mm (0.5 inch) in height on packages having a gross weight of more than 30 kg (66 pounds); or

(ii) At least 6 mm (0.25 inch) on packages having a gross weight of 30 kg (66 pounds) or less, except that smaller font may be used as necessary to fit package dimensions; and

(2) The provisions of paragraph (a)(1) do not apply to packages that contain 5 kg (11 pounds) net weight or less of primary lithium batteries or cells that are contained in or packed with equipment and the package contains no more than the number of lithium batteries or cells necessary to power the piece of equipment.

b. The lithium content of each cell, when fully charged, is not more than 5 grams.

c. The aggregate lithium content of each battery, when fully charged, is not more than 25 grams.

d. The cells or batteries are of a type proven to meet the requirements of each test in the UN Manual of Tests and Criteria (IBR; see §171.7 of this subchapter). A cell or battery and equipment containing a cell or battery that was first transported prior to January 1, 2006 and is of a type proven to meet the criteria of Class 9 by testing in accordance with the tests in the UN Manual of Tests and Criteria, Third Revised Edition, 1999, need not be retested.

e. Cells or batteries are separated so as to prevent short circuits and are packed in a strong outer packaging or are contained in equipment.

f. Electrical devices must conform to §173.21 of this subchapter.

**A54** Lithium batteries or lithium batteries contained or packed with equipment that exceed the maximum gross weight allowed by Column (9B) of the §172.101 Table may only be transported on cargo aircraft if approved by the Associate Administrator.

**A55** Prototype lithium batteries and cells that are packed with not more than 24 cells or 12 batteries per packaging that have not completed the test requirements in Sub-section 38.3 of the UN Manual of Tests and Criteria (incorporated by reference; see §171.7 of this subchapter) may be transported by cargo aircraft if approved by the Associate Administrator and provided the following requirements are met:

- a. The cells and batteries must be transported in rigid outer packagings that conform to the requirements of Part 178 of this subchapter at the Packing Group I performance level; and
- b. Each cell and battery must be protected against short circuiting, must be surrounded by cushioning material that is non-combustible and non-conductive, and must be individually packed in an inner packaging that is placed inside an outer specification packaging.

**A100** Primary (non-rechargeable) lithium batteries and cells are forbidden for transport aboard passenger carrying aircraft. Secondary (rechargeable) lithium batteries and cells are authorized aboard passenger carrying aircraft in packages that do not exceed a gross weight of 5 kg.

**A101** A primary lithium battery or cell packed with or contained in equipment is forbidden for transport aboard a passenger carrying aircraft unless the equipment and the battery conform to the following provisions and the package contains no more than the number of lithium batteries or cells necessary to power the intended piece of equipment:

- (1) The lithium content of each cell, when fully charged, is not more than 5 grams.
- (2) The aggregate lithium content of the anode of each battery, when fully charged, is not more than 25 grams.
- (3) The net weight of lithium batteries does not exceed 5 kg (11 pounds).

**A103** Equipment is authorized aboard passenger carrying aircraft if the gross weight of the inner package of secondary lithium batteries or cells packed with the equipment does not exceed 5 kg (11 pounds).

**A104** The net weight of secondary lithium batteries or cells contained in equipment may not exceed 5 kg (11 pounds) in packages that are authorized aboard passenger carrying aircraft.

**Attachment 3**  
**Part 173-Shippers-General Requirements for Shipments and Packagings**  
**49 CFR 173.185 Lithium cells and batteries**

(a) *Cells and batteries.* A lithium cell or battery, including a lithium polymer cell or battery and a lithium-ion cell or battery, must conform to all of the following requirements:

(1) Be of a type proven to meet the requirements of each test in the UN Manual of Tests and Criteria (IBR; see §171.7 of this subchapter). A cell or battery and equipment containing a cell or battery that was first transported prior to January 1, 2006 and is of a type proven to meet the criteria of Class 9 by testing in accordance with the tests in the UN Manual of Tests and Criteria, Third Revised Edition, 1999, need not be retested.

(2) Incorporate a safety venting device or otherwise be designed in a manner that will preclude a violent rupture under conditions normally incident to transportation.

(3) Be equipped with an effective means to prevent dangerous reverse current flow (e.g., diodes, fuses, etc.) if a battery contains cells or series of cells that are connected in parallel.

(4) Be packaged in combination packagings conforming to the requirements of part 178, subparts L and M, of this subchapter at the Packing Group II performance level. The lithium battery or cell must be packed in inner packagings in such a manner as to prevent short circuits, including movement which could lead to short circuits. The inner packaging must be packed within one of the following outer packagings: metal boxes (4A or 4B); wooden boxes (4C1, 4C2, 4D, or 4F); fiberboard boxes (4G); solid plastic boxes (4H2); fiber drums (1G); metal drums (1A2 or 1B2); plywood drums (1D); plastic jerricans (3H2); or metal jerricans (3A2 or 3B2).

(5) Be equipped with an effective means of preventing external short circuits.

(6) Except as provided in paragraph (d) of this section, cells and batteries with a liquid cathode containing sulfur dioxide, sulfuryl chloride or thionyl chloride may not be offered for transportation or transported if any cell has been discharged to the extent that the open circuit voltage is less than two volts or is less than 2/3 of the voltage of the fully charged cell, whichever is less.

(b) *Lithium cells or batteries packed with equipment.* Lithium cells or batteries packed with equipment may be transported as Class 9 materials if the batteries and cells meet all the requirements of paragraph (a) of this section. The equipment and the packages of cells or batteries must be further packed in a strong outer packaging. The cells or batteries must be packed in such a manner as to prevent short circuits, including movement that could lead to short circuits.

(c) *Lithium cells or batteries contained in equipment.* Lithium cells or batteries contained in equipment may be transported as Class 9 materials if the cells and batteries meet all the requirements of paragraph (a) of this section, except paragraph (a)(4) of this section, and the equipment is packed in a strong outer packaging that is waterproof or is made waterproof through the use of a liner unless the equipment is made waterproof by nature of its construction. The equipment and cells or batteries must be secured within the outer packaging and be packed so as to prevent movement, short circuits, and accidental operation during transport.

(d) *Cells and batteries, for disposal or recycling.* A lithium cell or battery offered for transportation or transported by motor vehicle to a permitted storage facility, disposal site or for purposes of recycling is excepted from the specification packaging requirements of paragraph (a)(4) of this section and the requirements of paragraphs (a)(1) and (a)(6) of this section when protected against short circuits and packed in a strong outer packaging conforming to the requirements of §§173.24 and 173.24a.

(e) *Shipments for testing (prototypes)*. A lithium cell or battery is excepted from the requirements of (a)(1) of this section when transported by motor vehicle for purposes of testing. The cell or battery must be individually packed in an inner packaging, surrounded by cushioning material that is non-combustible and nonconductive. The cell or battery must be transported as a Class 9 material.

(f) A lithium cell or battery that does not comply with the provisions of this subchapter may be transported only under conditions approved by the Associate Administrator.

(g) Batteries employing a strong, impact-resistant outer casing and exceeding a gross weight of 12 kg (26.5 lbs.), and assemblies of such batteries, may be packed in strong outer packagings, in protective enclosures (for example, in fully enclosed wooden slatted crates) or on pallets. Batteries must be secured to prevent inadvertent movement, and the terminals may not support the weight of other superimposed elements. Batteries packaged in this manner are not permitted for transportation by passenger aircraft, and may be transported by cargo aircraft only if approved by the Associate Administrator prior to transportation.

[72 FR 44949, Aug. 9, 2007]

**Attachment 4**  
**ICAO Summary Table &**  
**Lithium Battery Label**

**2009-2010 ICAO TECHNICAL INSTRUCTION REQUIREMENTS FOR SHIPPING SMALL, EXCEPTED  
LITHIUM METAL BATTERIES AND LITHIUM ION BATTERIES ON PASSENGER AND CARGO AIRCRAFT**

	WEIGHT LIMITATIONS		MARKING/LABELING		SHIPPING DOCUMENT	
	Current	January 1, 2009	Current	January 1, 2009	Current	January 1, 2009
<b>LITHIUM METAL BATTERIES</b>	30 kg	2.5 kg	Marking required for packages containing more than 12 batteries or 24 cells	New label required on all packages. (See label on page 2.)	Required for packages containing more than 12 batteries or 24 cells	Required for all shipments
<b>LITHIUM METAL BATTERIES PACKED WITH EQUIPMENT</b>	None	No weight limitations. Maximum number of batteries in each package is limited to the minimum number required to power the equipment plus two spares	Marking required for packages containing more than 12 batteries or 24 cells	New label required on all packages. (See label on page 2.)	Required for packages containing more than 12 batteries or 24 cells	Required for all shipments
<b>LITHIUM METAL BATTERIES CONTAINED IN EQUIPMENT</b>	None	None	None	New label required except when package contains no more than four cells installed in equipment or no more than two batteries installed in equipment. (See label on page 2.)	None	Required except when package contains no more than four cells installed in equipment or no more than two batteries installed in equipment
<b>LITHIUM ION BATTERIES</b>	30 kg	10 kg	Marking required for packages containing more than 12 batteries or 24 cells	New label required on all packages. (See label on page 2.)	Required for packages containing more than 12 batteries or 24 cells	Required for all shipments
<b>LITHIUM ION BATTERIES PACKED WITH EQUIPMENT</b>	None	No weight limitations. Maximum number of batteries in each package is limited to the minimum number required to power the equipment plus two spares	Marking required for packages containing more than 12 batteries or 24 cells	New label required on all packages. (See label on page 2.)	Required for packages containing more than 12 batteries or 24 cells	Required for all shipments
<b>LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT</b>	None	None	None	New label required except when package contains no more than four cells installed in equipment or no more than two batteries installed in equipment (See label on page 2.)	None	Required except when package contains no more than four cells installed in equipment or no more than two batteries installed in equipment

## Lithium Battery Handling Label



Dimensions: 120 x 110 mm (4.75 inches x 4.35 inches)

Border color: Red on a contrasting background

Pictogram colors: Glass, batteries, and flame can be black

\* Place for "Lithium metal battery" or "Lithium ion battery"