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

- **Which organizations and regulations govern the transport of lithium, lithium ion and polymer cells and batteries?**

The regulations that govern the transport of primary lithium (non-rechargeable) and rechargeable lithium ion (including polymer) cells and batteries include the International Civil Aviation Organization (ICAO) Technical Instructions and corresponding International Air Transport Association (IATA) Dangerous Goods Regulations, and the International Maritime Dangerous Goods (IMDG) Code. In addition, lithium and lithium ion cells and batteries are regulated in the US in accordance with Part 49 of the Code of Federal Regulations, (49 CFR Sections 100-185) of the US Hazardous Materials Regulations (HMR). Section 173.185 provides specifications on exceptions and packaging for shipping based on details of weights, tests and classifications. The hazardous materials table in Section 172.101 also provides related shipping information. The Office of Hazardous Materials Safety, which is within the US Department of Transportation’s (DOT) Research and Special Programs Administration (RSPA), is responsible for coordinating the transportation of hazardous materials (also known as dangerous goods) by air, rail, highway and water and drafting the regulations that govern such materials. These regulations are based on the UN Recommendations on the Transport of Dangerous Goods Model Regulations and the UN Manual of Tests and Criteria.

- **What transportation regulations are currently in effect in the U.S.?**

Based on lithium weight (for primary cells and batteries) and equivalent lithium content (for lithium ion cells and batteries), the following shipping regulations currently are in effect. **See pages 2 and 3 for additional U.S. requirements on shipping primary lithium cells and batteries.**

<table>
<thead>
<tr>
<th>Primary Cell / Battery Max. Lithium Content</th>
<th>Lithium Ion &amp; Polymer Cell / Battery Max. Lithium Content</th>
<th>Shipping Classification/Testing</th>
<th>Special Packaging/Markings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 gram / 2.0 grams (1)</td>
<td>1.5 grams / 8.0 grams</td>
<td>Excepted (2)</td>
<td>No (2)</td>
</tr>
<tr>
<td>5.0 grams / 25 grams</td>
<td>5.0 grams / 25 grams</td>
<td>Excepted / T1-T8 (3)(6)(7)</td>
<td>No (4)</td>
</tr>
<tr>
<td>&gt;5.0 grams / &gt;25 grams</td>
<td>&gt;5.0 grams / &gt;25 grams</td>
<td>Class 9 / T1-T8 (5)(6)(7)</td>
<td>Yes (8)</td>
</tr>
</tbody>
</table>

(1) Applies to cells and batteries with solid cathodes. The maximum lithium content for cells and batteries with liquid cathodes is 0.5 grams / 1.0 gram.

(2) Excepted from regulations. No testing, Class 9 markings, specification packaging, or Class 9 label required. However, due to December 15, 2004 US DOT Interim Final Rule there are certain marking requirements that apply to excepted primary lithium cells and batteries.

(3) Excepted from regulations only if pass the UN T1-T8 Tests.

(4) If pass UN Tests, no Class 9 markings, specification packaging, or Class 9 label required. However, due to December 15, 2004 US DOT Interim Final Rule there are certain marking requirements that apply to excepted primary lithium cells and batteries.

(5) Must pass UN T1-T8 Tests and be shipped as a Class 9 hazardous material.

(6) Cells and batteries that fail to meet requirements of UN Tests can only be shipped if shipper secures an Approval from the US DOT. (See page 4 regarding Exemptions and Approvals for shipping and testing.)

(7) 49 CFR 173.185(d) does allow for cells and batteries and equipment containing cells and batteries that were first transported prior to Jan. 1, 1995, and were assigned to Class 9 on the basis of the requirements of the U.S. HMR in effect on Oct. 1, 1993, to be transported in accordance with the applicable requirements in effect on Oct. 1, 1993.

(8) Requires Class 9 markings, label, specification packaging, and shipping papers.
How is equivalent lithium content calculated for lithium ion cells and batteries?

Equivalent lithium content for lithium ion and lithium polymer cells and batteries in grams on a per cell basis is calculated as 0.3 times the rated capacity in ampere-hours. The equivalent lithium content for a battery or battery pack is the rated capacity in ampere-hours for a single cell multiplied by 0.3 and then multiplied by the number of cells in the battery.

What international transportation regulations currently are in effect?

The international transportation regulations require battery and cell manufacturers or companies that ship equipment packed with or containing these cells and batteries to meet UN testing, marking, packaging, labeling and shipping paper specifications. These regulations are incorporated into the ICAO Technical Instructions, IATA Dangerous Goods Regulations, and IMDG Code.

Based on lithium content (for primary cells and batteries) and equivalent lithium content (for lithium ion cells and batteries), the following international shipping regulations apply:

<table>
<thead>
<tr>
<th>Primary Cell / Battery Max. Lithium Content</th>
<th>Lithium Ion &amp; Polymer Cell / Battery Max. Equiv. Lithium Content</th>
<th>Shipping Classification/Testing</th>
<th>Special Packaging/Markings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 gram / 2.0 grams</td>
<td>1.5 grams / 8.0 grams</td>
<td>Exempted / T1-T8</td>
<td>Yes (4)</td>
</tr>
<tr>
<td>&gt;1.0 gram / &gt;2.0 grams</td>
<td>&gt;1.5 grams / &gt;8.0 grams</td>
<td>Class 9 / T1-T8</td>
<td>Yes (4)</td>
</tr>
</tbody>
</table>

(1) Starting January 1, 2005 all cells and batteries shipped by air must pass UN T1-T8 Tests. Cells and batteries that pass UN Tests are excepted from regulation. The IMDG Code contains a grandfather clause for testing “small” cells and batteries until December 31, 2013.

(2) If shipping from the U.S. under the ICAO Technical Instructions and cells or batteries fail to pass the required UN Tests, shipper must secure an Approval from the U.S. DOT prior to offering products for shipment. (See page 4 regarding Exemptions and Approvals for shipping and testing.)

(3) Must pass UN T1-T8 Tests and be shipped as a Class 9 hazardous material

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

(5) Requires Class 9 markings, label, specification packaging, and shipping papers.

The U.S. DOT issued an “Interim Final Rule” on December 15, 2004 pertaining to the transport of primary lithium cells and batteries by passenger aircraft into, out of, or within the United States. What are the implications of that rule on shipments of lithium and lithium ion cells and batteries?

The rule imposes a prohibition on the offering for transportation and transportation of primary lithium cells and batteries as cargo aboard passenger-carrying aircraft into, out of, or within the United States. However, primary lithium cells with no more than 5 g of lithium content and batteries with an aggregate lithium content of no more than 25 g THAT ARE PACKED WITH OR INSTALLED IN EQUIPMENT are not subject to this prohibition.

The rule also requires the following statement (marking) be placed on packages containing only primary lithium cells with no more than 5 g of lithium content and batteries with an aggregate lithium content of no more than 25 g that are excepted from regulation under the U.S. HMR: “PRIMARY LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT.” The marking must be on a background of contrasting color in letters at 12 mm (0.5 inch) in height on packages having a gross mass of more than 30 kg (66 pounds); or at least 6 mm (0.25 inch) on packages having a gross mass of 30 kg (66 pounds) or less. Packages containing primary lithium cells with more than 5 g of lithium content and batteries with an aggregate lithium content of more than 25 g should contain the “Cargo Aircraft Only” label.
As noted previously, the prohibition does not apply to primary lithium cells with no more than 5 g of lithium content and batteries with an aggregate lithium content of no more than 25 g THAT ARE PACKED WITH OR INSTALLED IN EQUIPMENT. Packages containing such equipment, however, are subject to packaging weight limitations. When these “small” cells and batteries are packed with equipment and offered for transport on passenger-carrying aircraft the gross weight of the package must not exceed 5 kg. When these “small” cells and batteries are installed in equipment and offered for transport on passenger-carrying aircraft the net weight of the cells or batteries in a package must not exceed 5 kg.

Lithium primary cells with more than 5 g of lithium content or batteries with an aggregate lithium content of more than 25 g that are packed with or installed in equipment are subject to the passenger-carrying aircraft prohibition. Packages containing such equipment should now carry the “Cargo Aircraft Only” label.

**Recommended label for use on packages containing primary lithium cells with no more than 5 g of lithium content and batteries with an aggregate lithium content of no more than 25 g that are excepted from regulation under the U.S. HMR:**

![PRIMARY LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT](image)

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**What are the UN “T” tests required by the UN regulatory scheme?**

The UN Manual of Tests and Criteria, Fourth Revised Edition (2003), contain the UN T1-T8 Tests that are listed below. These tests only have to be performed once for each cell and battery of a given design, and must be completed prior to shipment. Lithium cells or batteries, which differ from a tested type by:

1. A change of more than 0.1 g or 20% by mass, whichever is greater, to the cathode, to the anode, or to the electrolyte; or
2. A change that would materially affect the test results,

shall be considered a new design type and shall be subjected to the required tests. Cells and batteries of identical design only have to be tested one time.

The following tests must be performed on all primary lithium, rechargeable lithium ion and lithium polymer cells or batteries. See the table below to determine quantities required for testing.

**Test T1:** **Altitude Simulation** – Simulates air transport under low-pressure conditions. Store at 11.6 kPa or less for 6 hours at 20°C.

**Test T2:** **Thermal Test** – Assesses cell and battery seal integrity and internal electrical connections using thermal cycling to simulate rapid and extreme temperature changes. Perform 10 cycles between 75°C and –40°C, 6 hours per cycle with no more than 30 minutes between cycles, and then observe for 24 hours.

**Test T3:** **Vibration** – Simulates vibration during transport. Sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz in 15 minutes. This cycle must be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the cell or battery.
**Test T4:** **Shock** – Simulates possible impacts during transport. Half-sine shock of peak acceleration of 150g and pulse duration of 6 milliseconds. Each cell or battery must be subjected to 3 shocks in the positive direction and 3 shocks in the negative direction of three mutually perpendicular mounting positions for a total of 18 shocks.

**Test T5:** **External Short Circuit** – Simulates an external short circuit. After stabilizing at 55°C, apply an external resistance of less than 0.1 ohm for 1 hour and then observe for 6 hours.

**Test T6:** **Impact** – Simulates an impact. Place a 15.8 mm diameter bar across the sample and then drop a 9.1 kg mass from a height of 61 cm on to the bar, and then observe for 6 hours.

**Test T7:** **Overcharge** – Evaluates the ability of a rechargeable battery to withstand overcharge. Charge at twice the manufacturer’s recommended maximum continuous charge current for 24 hours, and then observe for 7 days.

**Test T8:** **Forced Discharge** – Evaluates the ability of a primary or a rechargeable cell to withstand forced discharge. Force discharge at an initial current equal to the maximum discharge current specified by the manufacturer, and then observe for 7 days.

- **How many primary and rechargeable cells or batteries are required for testing, and which tests are performed for each?**

Tests are performed sequentially on the same group of cells or batteries as shown below:

<table>
<thead>
<tr>
<th>T-Tests</th>
<th>Primary Cells</th>
<th>Primary Batteries</th>
<th>Rechargeable Cells</th>
<th>Rechargeable Batteries</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 – T5</td>
<td>20</td>
<td>8</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>T6</td>
<td>10</td>
<td>—</td>
<td>10 or 20 (1)</td>
<td>—</td>
</tr>
<tr>
<td>T7</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>8</td>
</tr>
<tr>
<td>T8</td>
<td>10</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>8</strong></td>
<td><strong>50 or 60</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

(1) 20 = prismatic cells

- **Where can I obtain a copy of the complete UN testing requirements?**


- **If my cells or batteries must be tested prior to shipping, how am I supposed to ship these products to a testing facility without violating the hazardous materials regulations?**

Under 49 CFR 173.185(j) of the US HMR, when not contained in equipment, cells and batteries shipped for testing purposes may be shipped only by highway and as Class 9 hazardous materials.

- **Has the testing deadline been extended for small cells and batteries?**

Yes, but only for cells and batteries shipped by sea pursuant to the IMDG Code. Therefore, lithium cells not exceeding 1 gram and batteries not exceeding 2 grams of lithium metal, and lithium ion cells not exceeding 1.5 grams and batteries not exceeding 8 grams of equivalent lithium content that were designed and manufactured prior to January 1, 2003, are excepted from the UN T1-T8 testing requirements until December 31, 2013 ONLY if shipped by sea pursuant to the IMDG Code.
What does Class 9 mean?

Class 9 is one of nine hazardous materials 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 hazardous materials, which include lithium and lithium ion cells and batteries, among other materials. See Exhibit A for packaging, marking, labeling, and shipping paper requirements. Additional information on shipping hazardous materials can be found on the US DOT website at: http://hazmat.dot.gov or at IATA’s website at: http://www1.iata.org/dangerousgoods/index.

What are the Class 9 shipping requirements for cells and batteries that exceed a certain lithium content?

If shipping internationally, the following cells and batteries must pass the UN Tests and be shipped as Class 9 hazardous materials:

- A lithium metal or lithium alloy cell with a lithium content of more than 1.0 gram
- A lithium metal or lithium alloy battery with an aggregate lithium content of more than 2 grams
- A lithium ion cell with an equivalent lithium content of more than 1.5 grams
- A lithium ion battery with an aggregate equivalent lithium content of more than 8 grams

Are there any marking, packaging, and shipping paper requirements for excepted cells and batteries?

Yes. Except for batteries contained in equipment, 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, lithium ion or lithium polymer cells or batteries and that special procedures should be followed in the event that the package is damaged (see recommended labels below);
- Be accompanied with a document indicating that packages contain lithium batteries and that special procedures should be followed in the event a package is damaged;
- Be capable of withstanding a 1.2 meter (3.9 ft.) 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
- Not exceed 30 kg (66.1 lbs.) gross mass. (Does not apply to batteries packed with equipment.)

Recommended labels for use on packages containing more than 24 Excepted cells or 12 Excepted batteries:

Label for use with Excepted primary lithium cells or batteries:
Transportation Regulations for Lithium, Lithium Ion and Lithium Polymer Cells and Batteries

Label for use with Excepted lithium ion and lithium ion polymer cells or batteries:

![CAUTION]

**Important note regarding use of CHEMTREC telephone numbers:** Companies that list CHEMTREC's emergency number on their packaging must be registered with CHEMTREC, and pay an annual fee. This includes the "shipper of record," who must also be registered in order to comply with Federal DOT regulations. This regulation (49CFR §172.604) states that the shipper of record must have a 24-hour emergency telephone number. Although the shipper may not be the manufacturer of the product, being able to reach the shipper to provide disposition instructions or other assistance is often required. Any technical information about the product can be obtained from the MSDS provided by the shipper, from CHEMTREC's database of technical information, or through CHEMTREC's contacts with the manufacturer.

- **How do the regulations apply to Class 9 lithium or lithium ion cells and batteries packed with or contained in equipment?**

  If cells or batteries that are classified as Class 9 are packed with or contained in equipment the equipment also must be shipped as Class 9 hazardous material. (Different Class 9 markings and weight limitations may apply to packages containing batteries packed with or contained in equipment.)

- **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 cells and batteries with a liquid cathode containing sulfur dioxide, sulfuryl chloride or thionyl chloride if any cell has been discharged to the extent that the open circuit voltage is less than two volts, or is less than two-thirds of the voltage of the fully charged cell, whichever is less. It is Ultralife Batteries’ policy to ship discharged or depleted lithium cells and batteries by ground only.

- **Are there any training requirements for employees of companies that ship lithium cells and batteries?**

  Yes. The international and U.S. transportation regulations require employees involved in the packaging or shipment of Class 9 lithium or lithium ion cells and batteries to complete a hazardous materials training course. Employees must renew their certification training every three years in the U.S. and every two years under the international regulations. It is strongly recommended that employees also complete an “IATA training” course.

- **Can exemptions to the shipping regulations be requested?**

  Yes. Exemptions to the regulations for shipments of a specific cell or battery type may be requested from the countries of origin and destination, and cleared with the carrier. An “Approval” from the U.S. DOT serves a similar purpose and there are several provisions in the U.S. and international regulations that specify when a shipper of lithium batteries should secure an Approval from an “appropriate authority.” Sufficient product information should be provided in the request and include cell and battery lithium content, safety test data (if available), and the application in which the cells or batteries will be used. If granted, an Approval can take from 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: Under 49 CFR 173.185(j) of the US HMR, when not contained in equipment, cells and batteries shipped for testing purposes may be shipped by highway as Class 9 hazardous materials without an Approval.  The cells or batteries must be individually packed in an inner packaging, surrounded by cushioning material that is non-combustible and nonconductive.

- **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 one time.  Assembly company employees involved in the packaging or shipment of Class 9 batteries must complete a certified hazardous materials shipping training course.

- **Do the shipping regulations apply to any company that ships batteries, even if they are not the original cell or battery pack manufacturer?**

All Ultralife OEM customers, distributors, battery assemblers, etc., are responsible for adhering to the packaging and marking requirements when re-shipping cells or batteries, and must ensure that the proper packaging and labeling is used when using packaging or labels other than the original materials in which the product was received.  All Ultralife OEM customers, distributors and battery assemblers are responsible for obtaining new UN testing if they combine, reconfigure or assemble cells or batteries such that they differ from the original tested version (e.g., building cells into a battery pack).  As previously described, new tests must be performed on a cell or battery if the cell or battery differ from the original tested type by:

(a) A change of more than 0.1 g or 20% by mass, whichever is greater, to the cathode, to the anode, or to the electrolyte; or

(b) A change that would materially affect the test results.

- **Are there any fines if shipping regulations are violated?**

Yes!  Each violation of the US DOT HMR is subject to a fine of up to $32,500.  Fines are additive 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 on to airplanes?**

Yes.  There are provisions in the ICAO Technical Instructions that enable passengers to carry on consumer electronic devices (watches, calculators, cameras, cellular phones, laptop computers, PDA’s, games, camcorders, etc.) that utilize lithium batteries containing no more than 2 grams of lithium content or lithium ion batteries containing no more than 8 grams of equivalent lithium content.  These provisions also allow an unlimited number of spare batteries that contain no more than these quantities (2 grams / 8 grams).

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 2 grams of lithium content and lithium ion batteries containing more than 25 grams of equivalent lithium content.

*All spare batteries must be individually protected so as to prevent short circuits and placed in carry-on baggage only.*
Where can I find information on the transportation regulations that apply to Ultralife’s lithium, lithium ion and polymer cells and batteries?

You can obtain a list of Ultralife’s cells and batteries, which includes lithium weights and transportation classifications, from Ultralife’s web site at: http://www.ultralifebatteries.com/whitepapers/Ultralife_Batteries_Lithium_Weights_and_Transportation_Classifications.pdf.

Who can I contact if I have more questions about battery transportation?

Please contact Ultralife Batteries, Inc. for answers to questions regarding the transportation of Ultralife lithium, lithium ion or polymer cells and batteries at: 800-332-5000 (US & Canada); 315-332-7100; or 44-1235-542600 (Europe); or visit Ultralife’s web site at: http://www.ultralifebatteries.com.

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Exhibit A - Packaging, Marking, Labeling, and Shipping Paper Requirements for Class 9 Lithium and Lithium ion Cells and Batteries

1. **PACKAGING** – Use only packaging that meets “Packing Group II” performance standards. Refer to the appropriate hazardous materials transportation regulations for the list of approved Packing Group II packaging and Performance - Oriented Packaging Standards.
   - Packages must not exceed 5 kg (gross weight) for passenger aircraft
   - Packages must not exceed 35 kg (gross weight) for cargo aircraft

2. **MARKING** – The following markings must be applied to the packaging:
   - Shipping name: Lithium batteries
   - Identification number: UN 3090
   - Shippers name and address
   - Name and address of company or individual receiving batteries (also known as the “consignee”)
   - UN packaging specifications

3. **LABELING** – The following Class 9 label must be used:

4. **SHIPPING PAPERS** – The following information must be included on shipping papers:
   - Proper shipping name, hazard class, identification number, and packing group in the following order (Example: Lithium batteries, 9, UN 3090, II)
     - The following alternative sequence for the basic shipping description elements is preferred effective January 1, 2005 under the IATA Dangerous Goods Regulations and permitted under the U.S. hazardous materials regulations: UN 3090, Lithium batteries, 9, II
   - Number of and type of packages (Example: 12 fiberboard boxes)
   - Weight
   - Page number and total number of pages (Example: Page 1 of 2 Pages)
   - Emergency telephone number (Ultralife uses Chemtrec in the US: 1-800-424-9300)
   - Shipper’s certification (Example: This is to certify that the above-named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation (by air, if applicable) according to the applicable international and national governmental regulations.)
   - Signature of shipper

**NOTE:** If SHIPPING BY AIR, the following additional information is required for hazardous materials:
- Air Waybill Number
- Proper certification (I declare that all of the applicable air transport requirements have been met.)
- Indication of whether “Passenger and Cargo Aircraft” or “Cargo Aircraft Only”
- Airport of Departure
- Airport of Destination
- Shipment Type: Non-radioactive or radioactive
- Place and date of signing of shippers certification

* An additional marking and/or “Cargo Aircraft Only” label are required if shipping primary lithium cells or batteries into, out of, or within the U.S. See pages 2 and 3 for more information.