**DOT Lithium Battery Regulations**

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| The Office of Hazardous Materials Safety, which is a part of the United States Department of Transportations (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), published their final ruling regarding the transportation and handling of lithium batteries. Their ruling follows closely to the UN Recommendations on the Transport of Dangerous Goods and Materials Regulations. These regulations have been put into effect as of January 1st, 2008.  All lithium batteries and cells are to be grouped by their size. The size of a battery is determined from the amount of lithium in the battery (see table below). Depending on the size classification of a battery, it has to adhere to a specific set of conditions when being transported.   |  |  |  |  | | --- | --- | --- | --- | |  | **Small** | **Medium** | **Large** | | **Primary Cells** | Lithium content in cell must be less than 1 gram. | Lithium content in between 1 gram and 5 grams. | Lithium content of greater than 5 grams. | | **Primary Batteries** | Lithium content must be less than 2 grams. | Lithium content in between 2 grams and 25 grams. | Lithium content of greater than 25 grams. | | **Secondary Cells** | Equivalent Lithium Content (ELC) of less than 1.5 grams. | ELC in between 1.5 grams and 5 grams. | ELC of greater than 5 grams. | | **Secondary Batteries** | ELC of less than 8 grams. | ELC in between 8 grams and 25 grams. | ELC of greater than 25 grams. |   The equivalent lithium content (ELC) of a battery is a function of the number of cells in the battery and the rated capacity of the battery in ampere-hours.  ELC = 0.3 \* (# of Cells) \* (Capacity (in ampere-hours))   Small lithium cells or batteries can be transported as a non-restricted material by any means of transportation provided they successfully complete the UN ST/SG/AC.10/aa/Rev. 4 Recommendations on the Transport of Dangerous Goods Manual of Tests and Criteria T1-T8 tests (altitude simulation, thermal test, vibration, shock, external short circuit, impact, overcharge, forced discharge). This part of the ruling will not be enforced until October 1st, 2009. However, it is strongly recommended that these tests be run on lithium batteries of all sizes to avoid accidents during shipments.  Medium lithium cells or batteries need to successfully complete the UN T1-T8 tests before they can be transported by any means. If they pass these tests, they can be transported as a non-restricted material by rail car or highway only. In order to ship by air, they have to pass the UN tests and also be classified as a Class 9 Hazardous Material.   Large lithium cells or batteries need to be classified as a Class 9 Hazardous Material and pass the UN T1-T8 tests to be shipped by any means of transportation. All untested batteries may be shipped to a test facility by highway only, and need to be classified as a Class 9 Hazardous Material.  **How often does a battery need to be tested?**  The UN T1-T8 tests need to be run at least once, for every battery or cell design. The ruling states a cell or battery that differs from a tested type by:   **A change of more that 0.1g or 20% by mass to the cathode, anode, or the electrolyte, or a change that would materially affect the results, shall be subjected to the required tests. Even if a battery is made from cells that have previously successfully completed the UN tests, it is required to pass the tests again.**  ***Test T.1: Altitude simulation***  ***Test T.2: Thermal test***  ***Test T.3: Vibration***  ***Test T.4: Shock***  ***Test T.5: External short circuit***  ***Test T.6: Impact***  ***Test T.7: Overcharge***  ***Test T.8: Forced discharge***  ***Test Details:***  38.3.4.1 ***Test T.1: Altitude simulation***  38.3.4.1.1 Purpose: This test simulates air transport under low-pressure conditions.  38.3.4.1.2 Test procedure: Test cells and batteries shall be stored at a pressure of 11.6 kPa or less for at least six hours at ambient temperature (20 5 °C).  38.3.4.1.3 Requirement: Cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.  38.3.4.2 ***Test T.2: Thermal test***  38.3.4.2.1 Purpose: This test assesses cell and battery seal integrity and internal electrical connections. The test is conducted using rapid and extreme temperature changes.  38.3.4.2.2 Test procedure: Test cells and batteries are to be stored for at least six hours at a test temperature equal to 75 ± 2 °C, followed by storage for at least six hours at a test temperature equal to –40 ± 2 °C. The maximum time interval between test temperature extremes is 30 minutes. This procedure is to be repeated 10 times, after which all test cells and batteries are to be stored for 24 hours at ambient temperature (20 ± 5 °C). For large cells and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.  38.3.4.2.3 Requirement: Cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.  38.3.4.3 ***Test T.3: Vibration***  38.3.4.3.1 Purpose: This test simulates vibration during transport.  38.3.4.3.2 Test procedure Cells and batteries are firmly secured to the platform of the vibration machine without distorting the cells in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the cell. One of the directions of vibration must be perpendicular to the terminal face.  The logarithmic frequency sweep is as follows: from 7 Hz a peak acceleration of 1 gn is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8 gn occurs (approximately 50 Hz). A peak acceleration of 8 gn is then maintained until the frequency is increased to 200 Hz. 38.3.4.3.3 Requirement  Cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.  38.3.4.4 ***Test T.4: Shock***  38.3.4.4.1 Purpose: This test simulates possible impacts during transport.  38.3.4.4.2 Test procedure Test cells and batteries shall be secured to the testing machine by means of a rigid mount which will support all mounting surfaces of each test battery. Each cell or battery shall be subjected to a halfsine  shock of peak acceleration of 150 gn and pulse duration of 6 milliseconds. Each cell or battery shall be subjected to three shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicular mounting positions of the cell or battery for a total of 18 shocks. However, large cells and large batteries shall be subjected to a half-sine shock of peak acceleration of 50 gn and pulse duration of 11 milliseconds. Each cell or battery is subjected to three shocks in the positive direction followed by three shocks in the negative direction of each of three mutually perpendicular mounting positions of the cell for a total of 18 shocks.  38.3.4.4.3 Requirement: Cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.  38.3.4.5 ***Test T.5: External short circuit***  38.3.4.5.1 Purpose: This test simulates an external short circuit.  38.3.4.5.2 Test procedure: The cell or battery to be tested shall be temperature stabilized so that its external case temperature reaches 55 ± 2°C and then the cell or battery shall be subjected to a short circuit condition with a total external resistance of less than 0.1 ohm at 55 ± 2 °C. This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to 55 ± 2°C. The cell or battery must be observed for a further six hours for the test to be concluded.  38.3.4.5.3 Requirement: Cells and batteries meet this requirement if their external temperature does not exceed 170 °C and there is no disassembly, no rupture and no fire within six hours of this test.  38.3.4.6 ***Test T.6: Impact***  38.3.4.6.1 Purpose: This test simulates an impact.  38.3.4.6.2 Test procedure: The test sample cell or component cell is to be placed on a flat surface. A 15.8 mm diameter bar is to be placed across the centre of the sample. A 9.1 kg mass is to be dropped from a height of 61 2.5 cm onto the sample. A cylindrical or prismatic cell is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8 mm diameter curved surface lying across the centre of the test sample. A prismatic cell is also to be rotated 90 degrees around its longitudinal axis so that both the wide and narrow sides will be subjected to the impact. Each sample is to be subjected to only a single impact. Separate samples are to be used for each impact.  A coin or button cell is to be impacted with the flat surface of the sample parallel to the flat surface and the 15.8 mm diameter curved surface lying across its centre.  38.3.4 6.3 Requirement : Cells and component cells meet this requirement if their external temperature does not exceed 170 °C and there is no disassembly and no fire within six hours of this test.  38.3.4.7 ***Test T.7: Overcharge***  38.3.4.7.1 Purpose: This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.  38.3.4.7.2 Test procedure: The charge current shall be twice the manufacturer's recommended maximum continuous charge current. The minimum voltage of the test shall be as follows:  (a) when the manufacturer's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V.  (b) when the manufacturer's recommended charge voltage is more than 18V, the  minimum voltage of the test shall be 1.2 times the maximum charge voltage.  Tests are to be conducted at ambient temperature. The duration of the test shall be 24 hours.  38.3.4.7.3 Requirement: Rechargeable batteries meet this requirement if there is no disassembly and no fire within seven days of the test.  38.3.4.8 ***Test T.8: Forced discharge***  38.3.4.8.1 Purpose: This test evaluates the ability of a primary or a rechargeable cell to withstand a forced discharge condition.  38.3.4.8.2 Test procedure: Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12V D.C. power supply at an initial current equal to the maximum discharge current specified by the manufacturer.  The specified discharge current is to be obtained by connecting a resistive load of the appropriate size and rating in series with the test cell. Each cell shall be forced discharged for a time interval (in hours) equal to its rated capacity divided by the initial test current (in Ampere).  38.3.4.8.3 Requirement: Primary or rechargeable cells meet this requirement if there is no disassembly and no fire within seven days of the test.  **What happens if the ruling is not complied with?  If the DOT audits you and finds out that the rulings are not being complied with, fines of up to $100,000 dollars can be assessed per infraction. With these new rulings recently put into effect, it is expected that the DOT will be actively enforcing these requirements. The only way to ensure that you are complying with the rulings is to have your product tested.   Please do not find yourself on the wrong side of a DOT audit! If you would like to learn more about the shipping regulations imposed by the DOT, visit their website at (**[**http://hazmat.dot.gov/regs/rules/final/72fr/docs/72fr-44929.pdf**](http://hazmat.dot.gov/regs/rules/final/72fr/docs/72fr-44929.pdf)**).** [**www.mgabatterytesting.com**](http://www.mgabatterytesting.com) |