

Lithium Battery Testing Under UN/DOT 38.3

8 tests required according to the United Nations Manual of Tests and Criteria

Abstract

Lithium batteries provide a reliable and cost-effective power source for a wide range of electrical and electronic products. However, safety concerns still exist, especially in instances where battery inventories are transported via aircraft. These concerns have led to increased attention to the potential dangers of transporting lithium batteries, and new requirements for manufacturers of lithium batteries and devices powered by lithium batteries. This white paper reviews the testing required under UN/DOT 38.3.

Required Tests According to UN/DOT 38.3

According to the requirements of UN/DOT 38.3, lithium cells and batteries are subject to as many as eight separate tests designed to assess their ability to withstand the anticipated rigors incurred during transport. The eight tests evaluate samples for risks from electrical, mechanical and environmental conditions, as follows:

REQUIRED TESTS TEST DESCRIPTION
<p>Test 1: Altitude Simulation</p> <p>Also known as the low-pressure test, the altitude simulation test simulates the transportation of cells and batteries under low pressure conditions, such as those experienced in an aircraft cargo hold, or in an aircraft cabin that experiences a sudden loss of pressure. During the test, a sample is stored at a specified pressure and at ambient temperature for at least six hours. To pass this test, the sample must not leak, vent, disassemble, rupture or ignite. In addition, the open circuit voltage of the tested sample must be at least 90% of the sample's voltage as measured before the test.</p>
<p>Test 2: Thermal Test</p> <p>The thermal test assesses the seal integrity and internal electrical connections of a cell or battery after exposure to rapid and extreme temperature variations. During the test, a sample is cycled 10 times through extended periods of exposure to extreme heat and cold conditions, after which it is stored for 24 hours at ambient temperature. To pass this test, the sample must not leak, vent, disassemble, rupture or ignite. In addition, the open circuit voltage of the tested sample must be at least 90% of the sample's voltage as measured before the test.</p>
<p>Test 3: Vibration Test</p> <p>The vibration test simulates the effect of the kind of vibration that could be applied to a cell or battery during transport. During the test, a sample is secured to a vibration machine and subjected to vibrations of varying amplitudes (dependent upon the size and weight of the sample being tested) over a three-hour period in each of three mutually perpendicular mounting positions. To pass this test, the sample must not leak, vent, disassemble, rupture or ignite. In addition, upon completion of testing of a cell in its third perpendicular mounting position, the open circuit voltage of the tested sample must be at least 90% of the sample's voltage as measured immediately prior to this procedure.</p>

Test 4: Shock Test

The Shock test is intended to assess the robustness of cells or batteries against cumulative shocks, such as those that might be encountered during transport. During the test, a sample is secured to a testing device and subjected to three calibrated shocks of varying intensity (again, dependent upon the size and weight of the sample being tested) in both a positive and negative direction in each of three different mounting positions, for a total of 18 separate shocks. To pass this test, the sample must not leak, vent, disassemble, rupture or ignite. In addition, the open circuit voltage of the tested sample must be at least 90% of the sample's voltage as measured before the test.

Test 5: External Short Circuit

As the name implies, the external short circuit test simulates an external short circuit to determine the ability of a cell or battery to withstand a maximum current flow without adverse consequences. During the test, a sample that has been heated to a specified temperature is then subjected to a specified short circuit condition for at least one hour after the sample's external case temperature has reverted pre-test specified temperature (small cells or batteries), or (in the case of large batteries) has decreased by half of the maximum temperature increase observed during the test. To pass this test, the external temperature of the sample must not exceed 170°C, and the sample must not disassemble, vent or ignite during the test, or within the six-hour period following the test.

Test 6: Impact/Crush Test

The impact/crush test determines the ability of a cell or battery to withstand an impact or crush that may result in an internal short circuit. During the impact test (applicable to cylindrical cells equal to or greater than 18 mm in diameter), a sample is subjected to a single impact from a mass of a specified weight dropped from a specified height. During the crush test (applicable to prismatic, pouch, coin/button cells and cylindrical cells less than 18 mm in diameter), a sample is crushed between two flat surfaces at a defined speed until either the applied force reaches a calculated limit, the voltage of the cell drops by at least 100 mV, or the cell is deformed by 50%. To pass this test, the external temperature of the sample must not exceed 170°C, and the sample must not disassemble or ignite during the test, or within the six-hour period following the test.

Test 7: Overcharge Test

The Overcharge test evaluates the ability of a rechargeable cell or battery to withstand an overcharge condition without adverse consequences. During the test, a sample is subjected to a current charge equal to twice that of the manufacturer's maximum recommended continuous charge current at ambient temperature for a period of 24 hours. To pass this test, the sample must not disassemble or ignite during the test, or within the seven-day period following the test.

Test 8: Forced Discharge Test

The forced discharge test assesses the ability of a cell or battery to withstand a forced discharge condition. During the test, a sample is forced discharged at ambient temperature at an initial current equal to the maximum discharge current specified by the manufacturer and for a calculated time interval. To pass the test, the sample must not disassemble or ignite during the test, or within the seven-day period following the test.