

In order to ship as normal cargo, the cells and batteries must pass a series of tests. If engineering models and prototypes need to be shipped prior to completion of the tests then they must be shipped as Hazardous Class 9 Materials.

- ✧ Battery Safety Test: Totally 15 items, according to UL2054 & IEC62133 standard;
- ✧ Battery Reliability Test : Totally 8 items, according to IEC61951 standard;
- ✧ Battery Application Test: Considering consumer's demand and habit; understanding the design of Electronics products; Proceed all kinds of application performance tests, gives improvement suggestions. Also provides our customers with a best cost control solution.

Battery Reliability Test

- ✧ T1: Altitude Simulation: Simulates air transport under low pressure conditions.
- ✧ T2: Thermal: Assesses the integrity of the cell's seal and the internal electrical connections of the battery.
- ✧ T3: Vibration: Simulates vibration during transport.
- ✧ T4: Shock: Simulates possible impacts during transport.
- ✧ T5: External Short Circuit: Simulates an external short circuit condition.
- ✧ T6: Impact: Simulates an in-transit impact.
- ✧ T7: Overcharge: Simulates an in-transit impact.
- ✧ T8: Forced Discharge: Evaluates the ability of a rechargeable battery to withstand a forced discharge condition.

***Note: the above tests need to be carried out on both the bare cells and assembled battery packs except tests 6 & 8 which only apply to the cells and test 7 which only applies to the assembled battery pack.

Temperature Test



Crush Test



Vibration Test



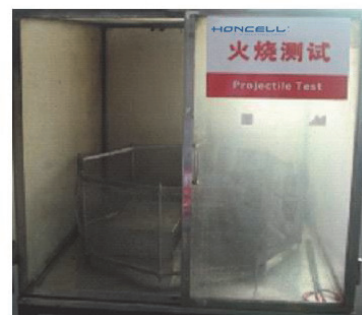
Heating Test



Impact Test



Projectile Test



Lithium-ion Polymer Battery Safety Test- UN38.3 Transportation Test

| UN-Tests | | | |
|---|---|---|--|
| Test Title | Procedure | Test Sample Size | Pass Requirement |
| T1: Altitude Simulation | Store @ $\leq 11.6\text{kPa}$ or less for $\geq 6\text{hrs}$ @ $20\pm 5^\circ\text{C}$ | 4 batteries, cycle 1 fully charged | No mass loss, leakage, venting, rupture, disassembly, or fire & OCV after test $\geq 90\%$ OCV before test |
| | | 4 batteries, cycle 50 fully charged | |
| T2: Thermal Shock (follows T1) | Store for $\geq 6\text{hrs}$ @ $75\pm 2^\circ\text{C}$, Store for $\geq 6\text{hrs}$ @ $-40\pm 2^\circ\text{C}$. Interval between extremes $\leq 30\text{mins}$. Repeat 10 times. | Same 8 batteries from T1 | As above |
| T3: Vibration (follows T2) | Sinusoidal vibration, logarithmic sweep of 7Hz-200Hz-7Hz in 15minutes. Repeat 12 times in each of 3 perpendicular axes | Same 8 batteries from T2 | As above |
| T4: Shock (follows T3) | 1/2 sine shock, peak acceleration of 150G for 6ms. 3 shocks in positive direction & 3 in negative direction in 3 perpendicular axes: A total of 18 | Same 8 batteries from T3 | As above |
| T5: Short Circuit (follows T4) | Stabilize the battery @ $55\pm 2^\circ\text{C}$. Short circuit it with $< 0.1\Omega$ for $\geq 1\text{hr}$ or until 1hr after the battery case has returned to $55\pm 2^\circ\text{C}$. | Same 8 batteries from T4 | External temp $\leq 170^\circ\text{C}$, no disassembly, no rupture, no fire within 6hrs of test. |
| T6: Impact Cell level test - done by Cell mfr. | 15.8mm Φ bar placed on the cell & 9.1kg mass dropped onto bar from a height of $61\pm 2.5\text{cm}$ | 5 Cylindrical cells, cycle 1, 50% charged | External temp $\leq 170^\circ\text{C}$, no disassembly, no rupture, no fire within 6hrs of test. |
| | As above. Test repeated on two axes | 10 Prismatic cells, cycle 1, 50% charged | |
| T7: Overcharge Can follow T5 if undamaged | Charge @ $20^\circ\text{C}\pm 5^\circ\text{C}$ @ twice the manufacturers recommended charge current. | 4 new or undamaged batteries from T5, cycle 1 fully charged | No disassembly & no fire within 7 days of the test |
| | | 4 new or undamaged batteries from T5, cycle 50 fully charged | |
| T8: Forced Discharge Cell level test - done by Cell mfr | @ $20^\circ\text{C}\pm 5^\circ\text{C}$, connect each cell in series with a 12V DC power supply at an initial current equal to the manufacturers max rated discharge current for a time equal to the rated capacity divided by the initial test current. | Ten cells, Cycle 1, fully discharged Ten cells cycle 50 fully discharged | No Disassembly & No Fire within 7 days of the test |