

## LITHIUM ION BATTERY SAFETY TESTING REPORT

<b>Applicant:</b>	CHANGZHOU SOARING TECHNOLOGY CO., LTD Building 25, Xinke Road, Xinbei District, Changzhou, Jiangsu Province, China
<b>Product:</b>	Rechargeable Li-Polymer Battery
<b>Model:</b>	BAT-H11
<b>Rating:</b>	3.85VDC, 2790mAh, 10.74Wh
<b>Test method &amp; Criterion</b>	UNITED NATIONS "Recommendations on the TRANSPORT OF DANGEROUS GOODS" Manual of Tests and Criteria ST/SG/AC.10/11/Rev.5/Amend.1+Amend.2 38.3
<b>Appearance</b>	Black Tape Film
<b>Verification Issuing Office Name</b>	AnTek Certification Inc. 7F., No. 351, Yangguang St., Neihu District, Taipei City, Taiwan
<b>Test Performed Date:</b>	Sep. 24 <sup>th</sup> , 2015 – Oct. 13 <sup>th</sup> , 2015
<b>Test Items:</b>	See Page 2 for details.
<b>Conclusion:</b>	The sample has passed the test items of UN 38.3
<b>Date of Issued:</b>	Oct. 15 <sup>th</sup> , 2015
<b>Comment::</b>	Internal cell source: LISHEN / SP395682SF Trade Mark: acer

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## TEST ITEMS

No.	Name of Test Items	Conclusion	Remark
T1.	Altitude Simulation	Passed	--
T2.	Thermal Test	Passed	--
T3.	Vibration	Passed	--
T4.	Shock	Passed	--
T5.	External Short Circuit	Passed	--
T6.	Impact	N/A	--
	Crush	Passed	--
T7.	Overcharge	Passed	--
T8.	Forced Discharge	Passed	--
Test Environment Condition		Ambient Temperature: 21.2°C ~ 23.1°C Ambient Humidity: 50% ~ 63%	

## SAMPLES FOR TYPE TESTS:

Test Number	Cell / Battery Type	Test Samples
T1 ~ T5	<input type="checkbox"/> Primary Cells	Ten cells in undischarged states Ten cells in fully discharged states
	<input type="checkbox"/> Primary Batteries (Small Type)	Four batteries in undischarged states Four batteries in fully discharged states
	<input type="checkbox"/> Primary Batteries (Large Type)	Four batteries in undischarged states Four batteries in fully discharged states
	<input type="checkbox"/> Rechargeable Cells	Ten cells at first cycle, in fully charged states
	<input checked="" type="checkbox"/> Single Cell type battery	Ten cells at first cycle, in fully charged states
	<input type="checkbox"/> Rechargeable Batteries (Small Type)	Four batteries at first cycle, in fully charged states Four batteries after 50 cycles ending in fully charged states
	<input type="checkbox"/> Rechargeable Batteries (Large Type)	Two batteries at first cycle, in fully charged states Two batteries after 25 cycles ending in fully charged states
T6	<input type="checkbox"/> Primary cells	Five cells in undischarged states Five cells in fully discharged states
	<input type="checkbox"/> Component cells of primary batteries	Five cells in undischarged states Five cells in fully discharged states
	<input type="checkbox"/> Rechargeable cells	Five cells at first cycle at 50% of the design rated capacity
	<input checked="" type="checkbox"/> Component cells of rechargeable batteries	Five cells at first cycle at 50% of the design rated capacity
	<input type="checkbox"/> For prismatic cells, ten test cells are required instead of the five described above	
T7	<input checked="" type="checkbox"/> Rechargeable Batteries (Small Type)	Four batteries at first cycle, in fully charged states Four batteries after 50 cycles ending in fully charged states
	<input type="checkbox"/> Rechargeable Batteries (Large Type)	Two batteries at first cycle, in fully charged states Two batteries after 25 cycles ending in fully charged states
T8	<input type="checkbox"/> Primary cells	Ten cells in fully discharged states
	<input type="checkbox"/> Primary component cells	Ten cells in fully discharged states
	<input type="checkbox"/> Rechargeable cells	Ten cells, at first cycle in fully discharged states Ten cells after 50 cycles ending in fully discharged states
	<input checked="" type="checkbox"/> Rechargeable component cells	Ten cells, at first cycle in fully discharged states Ten cells after 50 cycles ending in fully discharged states

## T1: Altitude Simulation

### Purpose

This test simulates air transport under low-pressure conditions.

### 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 ( $20 \pm 5$  °C).

### 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.

### Results:

Sample No	Sample State	Before Test		After Test		Mass Loss (%)	Voltage Loss (%)	Phenomenon
		Mass (g)	Open-Circuit Voltage (V)	Mass (g)	Open-Circuit Voltage (V)			
01	A	41.173	4.348	41.173	4.346	0.00	0.05	O
02	A	40.572	4.384	40.572	4.384	0.00	0.00	O
03	A	40.801	4.337	40.801	4.336	0.00	0.02	O
04	A	41.031	4.342	41.031	4.340	0.00	0.05	O
05	A	40.339	4.377	40.339	4.376	0.00	0.02	O
06	A	40.854	4.349	40.854	4.348	0.00	0.02	O
07	A	41.173	4.374	41.173	4.374	0.00	0.00	O
08	A	40.367	4.372	40.367	4.370	0.00	0.05	O
09	A	40.857	4.351	40.857	4.351	0.00	0.00	O
10	A	40.342	4.364	40.342	4.363	0.00	0.02	O

#### Sample state:

A – Pack at first cycle, in fully charged states.

#### Phenomenon:

L – Leakage; V – Venting; D – Disassembly; R – Rupture; F – Fire.

O - No leakage, no venting, no disassembly, no rupture and no fire.

## **T2: Thermal Test**

### **Purpose**

This test assesses cell and battery seal integrity and internal electrical connections. The test is conducted using rapid and extreme temperature changes.

### **Test procedure:**

Test cells and batteries are to be stored for at least six hours at a test temperature equal to  $75 \pm 2$  °C, followed by storage for at least six hours at a test temperature equal to  $-40 \pm 2$  °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 ( $20 \pm 5$  °C). For large cells and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.

### **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.

### **Results:**

Sample No	Sample State	Before Test		After Test		Mass Loss (%)	Voltage Loss (%)	Phenomenon
		Mass (g)	Open-Circuit Voltage (V)	Mass (g)	Open-Circuit Voltage (V)			
01	A	41.173	4.346	41.172	4.338	0.00	0.18	O
02	A	40.572	4.384	40.571	4.375	0.00	0.21	O
03	A	40.801	4.336	40.800	4.328	0.00	0.18	O
04	A	41.031	4.340	41.031	4.330	0.00	0.23	O
05	A	40.339	4.376	40.338	4.365	0.00	0.25	O
06	A	40.854	4.348	40.854	4.336	0.00	0.28	O
07	A	41.173	4.374	41.172	4.369	0.00	0.11	O
08	A	40.367	4.370	40.367	4.359	0.00	0.25	O
09	A	40.857	4.351	40.856	4.339	0.00	0.28	O
10	A	40.342	4.363	40.341	4.352	0.00	0.25	O

#### **Sample state:**

A – Pack at first cycle, in fully charged states.

#### **Phenomenon:**

L – Leakage; V – Venting; D – Disassembly; R – Rupture; F – Fire.

O - No leakage, no venting, no disassembly, no rupture and no fire.

## **T3: Vibration**

### **Purpose**

This test simulates vibration during transport.

### **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.

### **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.

### **Results:**

Sample No	Sample State	Before Test		After Test		Mass Loss (%)	Voltage Loss (%)	Phenomenon
		Mass (g)	Open-Circuit Voltage (V)	Mass (g)	Open-Circuit Voltage (V)			
01	A	41.172	4.338	41.171	4.334	0.00	0.09	O
02	A	40.571	4.375	40.571	4.371	0.00	0.09	O
03	A	40.800	4.328	40.799	4.323	0.00	0.12	O
04	A	41.031	4.330	41.031	4.327	0.00	0.07	O
05	A	40.338	4.365	40.337	4.361	0.00	0.09	O
06	A	40.854	4.336	40.854	4.332	0.00	0.09	O
07	A	41.172	4.369	41.170	4.363	0.00	0.14	O
08	A	40.367	4.359	40.367	4.355	0.00	0.09	O
09	A	40.856	4.339	40.856	4.334	0.00	0.12	O
10	A	40.341	4.352	40.340	4.349	0.00	0.07	O

#### **Sample state:**

A – Pack at first cycle, in fully charged states.

#### **Phenomenon:**

L – Leakage; V – Venting; D – Disassembly; R – Rupture; F – Fire.

O – No leakage, no venting, no disassembly, no rupture and no fire.

## T4: Shock

### Purpose

This test simulates possible impacts during transport.

### 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.

### 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.

### Results:

Sample No	Sample State	Before Test		After Test		Mass Loss (%)	Voltage Loss (%)	Phenomenon
		Mass (g)	Open-Circuit Voltage (V)	Mass (g)	Open-Circuit Voltage (V)			
01	A	41.171	4.334	41.170	4.332	0.00	0.05	O
02	A	40.571	4.371	40.571	4.370	0.00	0.02	O
03	A	40.799	4.323	40.799	4.321	0.00	0.05	O
04	A	41.031	4.327	41.031	4.327	0.00	0.00	O
05	A	40.337	4.361	40.337	4.359	0.00	0.05	O
06	A	40.854	4.332	40.853	4.331	0.00	0.02	O
07	A	41.170	4.363	41.170	4.362	0.00	0.02	O
08	A	40.367	4.355	40.367	4.355	0.00	0.00	O
09	A	40.856	4.334	40.855	4.333	0.00	0.02	O
10	A	40.340	4.349	40.339	4.347	0.00	0.05	O

Sample No	Sample State	Before Test		After Test		Mass Loss (%)	Voltage Loss (%)	Phenomenon
		Mass (g)	Open-Circuit Voltage (V)	Mass (g)	Open-Circuit Voltage (V)			

**Sample state:**

A – Pack at first cycle, in fully charged states.

**Phenomenon:**

L – Leakage; V – Venting; D – Disassembly; R – Rupture; F – Fire.

O - No leakage, no venting, no disassembly, no rupture and no fire. O - No leakage, no venting, no disassembly, no rupture and no fire.

## T5: External Short Circuit

### Purpose

This test simulates an external short circuit.

### Test procedure:

The cell or battery to be tested shall be temperature stabilized so that its external case temperature reaches  $55 \pm 2$  °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  $55 \pm 2$  °C. This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to  $55 \pm 2$  °C. The cell or battery must be observed for a further six hours for the test to be concluded.

### 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.

### Results:

Sample No	Sample State	External Highest Temperature (°C)	Initial Voltage(V)	External resistance(mΩ)	Phenomenon
01	A	55.4	4.332	72.42	O
02	A	55.4	4.370	90.25	O
03	A	55.3	4.321	86.57	O
04	A	55.5	4.327	81.32	O
05	A	55.3	4.359	78.84	O
06	A	55.4	4.331	88.16	O
07	A	55.3	4.362	84.67	O
08	A	55.2	4.355	87.53	O
09	A	55.3	4.333	78.58	O
10	A	55.2	4.347	87.82	O

#### Sample state:

A – Pack at first cycle, in fully charged states.

#### Phenomenon:

D – Disassembly; R – Rupture; F – Fire; O - No disassembly, no rupture and no fire.

## Test T.6 –Crush

### Purpose

These tests simulate mechanical abuse from an impact or crush that may result in an internal short circuit.

### Test procedure

A cell or component cell is to be crushed between two flat surfaces. The crushing is to be gradual with a speed of approximately 1.5 cm/s at the first point of contact. The crushing is to be continued until the first of the three options below is reached.

(a) The applied force reaches 13 kN  $\pm$  0.78 kN;

Example: The force shall be applied by a hydraulic ram with a 32 mm diameter piston until a pressure of 17 MPa is reached on the hydraulic ram.

(b) The voltage of the cell drops by at least 100 mV; or

(c) The cell is deformed by 50% or more of its original thickness.

Once the maximum pressure has been obtained, the voltage drops by 100 mV or more, or the cell is deformed by at least 50% of its original thickness, the pressure shall be released.

A prismatic or pouch cell shall be crushed by applying the force to the widest side. A button/coin cell shall be crushed by applying the force on its flat surfaces. For cylindrical cells, the crush force shall be applied perpendicular to the longitudinal axis.

Each test cell or component cell is to be subjected to one crush only. The test sample shall be observed for a further 6 h. The test shall be conducted using test cells or component cells that have not previously been subjected to other tests.

### 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 during the test and within six hours after this test.

### Results:

Sample No	Sample State	External Hightest Temperature (°C)	Phenomenon
19	A	24.0	O
20	A	23.6	O
21	A	23.8	O
22	A	24.1	O
23	A	24.0	O

#### Sample state:

A – Cell at first cycle at 50% of the design rated capacity.

#### Phenomenon:

D – Disassembly; F – Fire; O - No disassembly and no fire.

## **T7: Overcharge**

### **Purpose**

This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.

### **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.

### **Requirement**

Rechargeable batteries meet this requirement if there is no disassembly and no fire during the test and within seven days after the test.

### **Results:**

Sample No	Sample State	During Test		Phenomenon
		Charge Current	Charge Voltage	
11	A	5.58A	8.8V	O
12	A	5.58A	8.8V	O
13	A	5.58A	8.8V	O
14	A	5.58A	8.8V	O
15	B	5.58A	8.8V	O
16	B	5.58A	8.8V	O
17	B	5.58A	8.8V	O
18	B	5.58A	8.8V	O

#### **Sample state:**

A – Pack at first cycles, in fully charged states.

B – Pack after 50 cycles ending in fully charged states

#### **Phenomenon:**

D – Disassembly; F – Fire; O - No disassembly and no fire.

## **T8: Forced Discharge**

### **Purpose**

This test evaluates the ability of a primary or a rechargeable cell to withstand a forced discharge condition.

### **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).

### **Requirement**

Primary or rechargeable cells meet this requirement if there is no disassembly and no fire within seven days of the test.

### **Results:**

Sample No	Sample State	Discharge Current	Discharge Duration	Phenomenon
24	A	4.185A	0.7 h	O
25	A	4.185A	0.7 h	O
26	A	4.185A	0.7 h	O
27	A	4.185A	0.7 h	O
28	A	4.185A	0.7 h	O
29	A	4.185A	0.7 h	O
30	A	4.185A	0.7 h	O
31	A	4.185A	0.7 h	O
32	A	4.185A	0.7 h	O
33	A	4.185A	0.7 h	O
34	B	4.185A	0.7 h	O
35	B	4.185A	0.7 h	O
36	B	4.185A	0.7 h	O
37	B	4.185A	0.7 h	O
38	B	4.185A	0.7 h	O
39	B	4.185A	0.7 h	O

Sample No	Sample State	Discharge Current	Discharge Duration	Phenomenon
40	B	4.185A	0.7 h	O
41	B	4.185A	0.7 h	O
42	B	4.185A	0.7 h	O
43	B	4.185A	0.7 h	O

**Sample state:**

A – Cell at first cycle in fully discharged states.

B – Cell after 50 cycles ending in fully discharged states.

**Phenomenon:**

D – Disassembly; F – Fire; O - No disassembly and no fire.

## Photographs

<Fig. #1>



<Fig. #2>

