

**TEST REPORT**

ST/SG/AC,10/11 Rev.5/Amend.1 Section 38.3

**AMENDMENTS TO THE FIFTH REVISED EDITION OF THE RECOMMENDATIONS ON THE
TRANSPORT OF DANGEROUS GOODS, MANUAL OF TEST AND CRITERIA**

(Section 38.3: Lithium batteries)

Report reference No.: STR13018297S

Tested by (name+ signature): Anne Ma

Anne Ma

Approved by (+ signature): Ailis Ma

Ailis Ma

Date of issue: Jan. 30, 2013

Testing laboratory: SEM.Test Compliance Service Co., Ltd.

Address: 3/F, Jinbao Commerce Building, Xin'an Fanshen Road, Bao'an
District, Shenzhen, P.R.C. (518101)

Testing location: As above

Standard: ST/SG/AC,10/11 Rev.5/Amend.1 Section 38.3

Test procedure: Type approved

Procedure deviation: N.A.

Non-standard test method: N.A.

**This test report is specially limited to the above client company and product model only, it may not
be duplicated without prior written consent of SEM. Test.**

Product Name: Rechargeable Li-ion Battery

Trademark

Model/type reference

Ratings: 14.8V, 230Wh (15.6Ah)

Max. charge voltage: 17.0V

Max. charge current: 7.0A

Standard charge current: 3.12A



Max. discharge current	7.0A
Standard discharge current	3.12A
Overcharge protection voltage	17.0V
Over discharge protection voltage ..	11.0V
Shape of cell	<input type="checkbox"/> Cylindrical cell (greater than 20mm in diameter) <input type="checkbox"/> Cylindrical cell (not more than 20mm in diameter) <input checked="" type="checkbox"/> Prismatic cell <input type="checkbox"/> Coin cell/Button cell <input type="checkbox"/> Pouch cell
Particulars: test item vs. test requirements	
Classification	<input type="checkbox"/> Lithium metal batteries <input type="checkbox"/> Lithium metal cells <input checked="" type="checkbox"/> Lithium ion batteries <input type="checkbox"/> Lithium ion cells
Samples Type	<input type="checkbox"/> Large battery <input type="checkbox"/> Large cell <input checked="" type="checkbox"/> Small battery <input type="checkbox"/> Small cell <input type="checkbox"/> Single cell battery
Dimension	L : 153.0mm W: 101.8mm T : 63.0mm
Mass of apparatus	1307g
Possible test case verdicts:	
- test case does not apply to the test object	N(.A.)
- test object does meet the requirement	P(ass)
- test object does not meet the requirement	F(all)
Testing:	
Date of receipt of test item	Jan. 15, 2013
Date(s) of performance of test	Jan. 15, 2013 to Jan. 30, 2013
Test Conclusion:	
The Rechargeable Li-ion Battery is tested according to Section 38.3 of Amendments to the Fifth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Test and Criteria (ST/SG/AC.10/11/Rev.5/Amend.1).	
Test Result: Pass.	



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Clause	Requirement – Test	Result - Remark	Verdict
38.3.4	Procedure		P
	Test 1 to 5 must be conducted in sequence on the same cell or battery.		P
	Test 6 and 8 should be conducted using not otherwise tested cells or batteries.		P
	Test 7 may be conducted using undamaged batteries previously used in tests 1 to 5 for purposes of testing on cycled batteries.		P
38.3.4.1	Test 1: Altitude Simulation		P
38.3.4.1.1	Purpose		P
	This test simulates air transport under low-pressure conditions.		-
38.3.4.1.2	Test procedure		P
	stored at a pressure	11.6 kPa	-
	ambient temperature (20 ± 5°C)	24°C	-
	Stored times(≥ 6 hours)	8 hours	-
38.3.4.1.3	Requirement		P
	Cells and batteries meet this requirement if there is 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.	No leakage, no venting, no disassembly, no rupture and no fire. Battery after testing is not less than 90% of its voltage immediately prior to this procedure.	P

Group	No.	Mass M of Test Battery (g)			OCV (V)		
		M1 (before the test)	M2 (after the test)	Mass Loss limit (0.2%)	OCV1 (before the test)	OCV2 (after the test)	OCV (≥90%)
Group A (at first cycle, in fully charged states)	01	1307.025	1307.020	0.000%	16.785	16.784	99.994%
	02	1307.125	1307.120	0.000%	16.781	16.778	99.982%
	03	1306.023	1306.018	0.000%	16.788	16.785	99.982%
	04	1307.088	1307.080	0.001%	16.785	16.750	99.791%
Group B (after fifty cycles ending in fully charged states)	05	1307.114	1307.110	0.000%	16.798	16.792	99.964%
	06	1307.485	1307.479	0.000%	16.751	16.745	99.964%
	07	1306.036	1306.030	0.000%	16.786	16.781	99.970%
	08	1308.255	1308.251	0.000%	16.789	16.785	99.976%

Remark

1. Mass loss (%)=(M1-M2)/M1*100% (Where M₁ is the mass before the test and M₂ is the mass after the test).
2. Leakage means the visible escape of electrolyte or other material from a cell or battery or the loss of material (except battery casing, handling devices or labels) from a cell or battery such that the loss of mass exceeds the values in Table.
3. The OCV of each test cell after testing is not less than 90% of its voltage immediately prior to this procedure.
4. Ambient temperature: 24°C

Conclusion:

Rechargeable Li-ion Battery had passed altitude simulation test.



ST/SG/AC.10/11 Rev.5/Amend.1 Section 38.3

Clause	Requirement – Test	Result - Remark	Verdict				
38.3.4.2	Test 2: Thermal Test		P				
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		P				
	Test temperature and stored hours	1) 72±2°C, ≥6h 2) -40±2°C, ≥6h	-				
	The maximum time interval	Between test temperature extremes is 30 minutes.	-				
	Test times	repeated 10 times	-				
	After which all test cells and batteries are to be stored for 24 hours at ambient temperature (20±5°C)	24°C	-				
	For large cells and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.	Small battery	N				
38.3.4.2.3	Requirement		P				
	Cells and batteries meet this requirement if there is 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.	No leakage, no venting, no disassembly, no rupture and no fire. Battery after testing is not less than 90% of its voltage immediately prior to this procedure.	P				
Group	No.	Mass M of Test Battery (g)			OCV (V)		
		M1 (before the test)	M2 (after the test)	Mass Loss limit (0.2%)	OCV1 (before the test)	OCV2 (after the test)	OCV (≥90%)
Group A (at first cycle, in fully charged states)	01	1307.020	1306.058	0.074%	16.784	16.751	99.803%
	02	1307.120	1306.256	0.066%	16.778	16.752	99.845%
	03	1306.018	1305.258	0.058%	16.785	16.745	99.762%
	04	1307.080	1306.233	0.065%	16.750	16.732	99.893%
Group B (after fifty cycles ending in fully charged states)	05	1307.110	1306.122	0.076%	16.792	16.752	99.762%
	06	1307.479	1306.555	0.071%	16.745	16.721	99.857%
	07	1306.030	1305.110	0.070%	16.781	16.745	99.785%
	08	1308.251	1307.222	0.079%	16.785	16.751	99.797%
Remark							
1. Mass loss (%)=(M1-M2)/M1*100% (Where M ₁ is the mass before the test and M ₂ is the mass after the test).							
2. Leakage means the visible escape of electrolyte or other material from a cell or battery or the loss of material (except battery casing, handling devices or labels) from a cell or battery such that the loss of mass exceeds the values in Table.							
3. The OCV of each test cell after testing is not less than 90% of its voltage immediately prior to this procedure.							
4. Ambient temperature: 24°C							

Conclusion:

Rechargeable Li-ion Battery had passed thermal test.



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Clause	Requirement – Test	Result - Remark	Verdict				
38.3.4.3	Test 3: Vibration		P				
38.3.4.3.1	Purpose		P				
	This test simulates vibration during transport.		-				
38.3.4.3.2	Test procedure		P				
	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.		P				
	Duration	15min	-				
	Frequency range	7Hz.....200Hz.....7Hz	-				
	Amplitude	0.8mm	-				
	This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the cell.		-				
38.3.4.3.3	Requirement		P				
	Cells and batteries meet this requirement if there is 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.	There is no leakage, no venting, no disassembly, no rupture and no fire.	P				
Group	No.	Mass M of Test Battery (g)			OCV (V)		
		M1 (before the test)	M2 (after the test)	Mass Loss limit (0.2%)	OCV1 (before the test)	OCV2 (after the test)	OCV (≥90%)
Group A (at first cycle, in fully charged states)	01	1306.058	1306.050	0.001%	16.751	16.748	99.982%
	02	1306.256	1306.250	0.000%	16.752	16.750	99.988%
	03	1305.258	1305.250	0.001%	16.745	16.741	99.976%
	04	1306.233	1306.230	0.000%	16.732	16.728	99.976%
Group B (after fifty cycles ending in fully charged states)	05	1306.122	1306.118	0.000%	16.752	16.748	99.976%
	06	1306.555	1306.550	0.000%	16.721	16.718	99.982%
	07	1305.110	1305.058	0.004%	16.745	16.740	99.970%
	08	1307.222	1307.220	0.000%	16.751	16.748	99.982%
Remark							
<ol style="list-style-type: none"> Mass loss (%)=(M1-M2)/M1*100% (Where M₁ is the mass before the test and M₂ is the mass after the test). Leakage means the visible escape of electrolyte or other material from a cell or battery or the loss of material (except battery casing, handling devices or labels) from a cell or battery such that the loss of mass exceeds the values in Table. The OCV of each test cell after testing is not less than 90% of its voltage immediately prior to this procedure. Ambient temperature: 24°C 							

Conclusion:

Rechargeable Li-ion Battery had passed vibration test.



ST/SG/AC.10/11 Rev.5/Amend.1 Section 38.3

Clause	Requirement – Test	Result - Remark	Verdict
38.3.4.4	Test 4: Shock		P
38.3.4.4.1	Purpose		P
	This test simulates possible impacts during transport.		-
38.3.4.4.2	Test procedure		P
	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.	This is small batteries.	-
	a half-sine shock of peak acceleration	150 g _n	-
	Pulse duration	6ms	-
	the positive direction followed	three times shocks	-
	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.		-
38.3.4.4.3	Requirement		P
	Cells and batteries meet this requirement if there is 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.	There is no leakage, no venting, no disassembly, no rupture and no fire.	P

Group	No.	Mass M of Test Battery (g)			OCV (V)		
		M1 (before the test)	M2 (after the test)	Mass Loss limit (0.2%)	OCV1 (before the test)	OCV2 (after the test)	OCV (≥90%)
Group A (at first cycle, in fully charged states)	01	1306.050	1306.048	0.000%	16.748	16.745	99.982%
	02	1306.250	1306.241	0.001%	16.750	16.748	99.988%
	03	1305.250	1305.215	0.003%	16.741	16.735	99.964%
	04	1306.230	1306.210	0.002%	16.728	16.726	99.988%
Group B (after fifty cycles ending in fully charged states)	05	1306.118	1306.110	0.001%	16.748	16.746	99.988%
	06	1306.550	1306.542	0.001%	16.718	16.716	99.988%
	07	1305.058	1305.051	0.001%	16.740	16.738	99.988%
	08	1307.220	1307.218	0.000%	16.748	16.746	99.988%

Remark

- Mass loss (%)=(M1-M2)/M1*100% (Where M₁ is the mass before the test and M₂ is the mass after the test).
- Leakage means the visible escape of electrolyte or other material from a cell or battery or the loss of material (except battery casing, handling devices or labels) from a cell or battery such that the loss of mass exceeds the values in Table.
- The OCV of each test cell after testing is not less than 90% of its voltage immediately prior to this procedure.
- Ambient temperature: 24°C

Conclusion:

Rechargeable Li-ion Battery had passed shock test.



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Clause	Requirement – Test	Result - Remark	Verdict	
38.3.4.5	Test 5: External Short Circuit		P	
38.3.4.5.1	Purpose		P	
	This test simulates an external short circuit.		P	
38.3.4.5.2	Test procedure		P	
	The cell or battery to be tested shall be temperature stabilized so that its external case temperature reaches $55 \pm 2^\circ\text{C}$.		-	
	Short circuit condition with a total External resistance of less than 0.1ohm.		-	
	This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to $55 \pm 2^\circ\text{C}$.		-	
38.3.4.5.3	Requirement		P	
	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 during the test and within six hours after this test.	Battery external temperature does not exceed 170°C , and there is no disassembly, no fire during the test and within six hours after this test.	P	
Group	No.	External Highest Temperature ($^\circ\text{C}$)	Criteria	Result
Group A (at first cycle, in fully charged states)	01	55.5	Battery external temperature does not exceed 170°C , and there is no disassembly, no rupture and no fire during the test and within six hours after this test.	P
	02	55.2		P
	03	55.1		P
	04	55.3		P
Group B (after fifty cycles ending in fully charged states)	05	55.2		P
	06	55.3		P
	07	55.4		P
	08	55.5		P
Ambient temperature: 23°C				

Conclusion:

Rechargeable Li-ion Battery had passed external short circuit test.



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Clause	Requirement – Test	Result - Remark	Verdict	
38.3.4.6	Test 6: Impact / Crush	The test sample Component cell of rechargeable batteries.	P	
38.3.4.6.1	Purpose		P	
	These tests simulate mechanical abuse from an impact or crush that may result in an internal short circuit.		P	
38.3.4.6.2	Test procedure – Impact (applicable to cylindrical cells greater than 20 mm in diameter)		N	
	The sample cell or component cell is to be placed on a flat smooth surface. A 15.8 mm ± 0.1mm diameter, at least 6 cm long, or the longest dimension of the cell, whichever is greater, Type 316 stainless steel bar is to be placed across the centre of the sample. A 9.1 kg ± 0.1 kg mass is to be dropped from a height of 61 ± 2.5 cm at the intersection of the bar and sample in a controlled manner using a near frictionless, vertical sliding track or channel with minimal drag on the falling mass. The vertical track or channel used to guide the falling mass shall be oriented 90 degrees from the horizontal supporting surface.		N	
	The test sample is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8 mm ± 0.1mm diameter curved surface lying across the centre of the test sample. Each sample is to be subjected to only a single impact.		N	
38.3.4.6.3	Test Procedure – Crush (applicable to prismatic, pouch, coin/button cells and cylindrical cells not more than 20 mm in diameter)		P	
	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.		P	
	The applied force reaches 13 kN ± 0.78 kN;	<input checked="" type="checkbox"/> Reach this condition	P	
	The voltage of the cell drops by at least 100 mV;	<input type="checkbox"/> Reach this condition	P	
	The cell is deformed by 50% or more of its original thickness.	<input type="checkbox"/> Reach this condition	P	
38.3.4.6.4	Requirement		P	
	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.	After the test, The, component Cells 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.	P	
Group	No.	Component cells external temperature (°C)	Criteria	Result
Group C at first cycle at 50% of the design rated capacity	09	31.3	The component Cells 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.	P
	10	31.0		P
	11	33.1		P



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	12	32.3		P
	13	33.9		P

Ambient temperature: 24.0°C

Conclusion:

Rechargeable Li-ion Battery had passed Crush test.



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Clause	Requirement – Test	Result - Remark	Verdict
38.3.4.7	Test 7: Overcharge		P
38.3.4.7.1	Purpose		P
	This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.		-
38.3.4.7.2	Test procedure		P
	The charge current	2×15.6A=31.2A, Twice the manufacturer's recommended maximum continuous charge current.	P
	The minimum voltage of the test:		P
	a) The minimum voltage of the test (The manufacturer's recommended charge voltage is not more than 18V).	2×17V=34V, the lesser of two times the maximum charge voltage of the battery or 22V,	P
	b) The minimum voltage of the test (The manufacturer's recommended charge voltage is more than 18V).		N
	Ambient temperature.	24°C	-
	The duration of the test.	24 hours	-
38.3.4.7.3	Requirement		P
	Rechargeable batteries meet this requirement if there is no disassembly and no fire during the test and within seven days after the test.	There is no disassembly and no fire during the test and within seven days after the test.	P
Group	No.	Criteria	Result
Group A (at first cycle, in fully charged states)	14	There is no disassembly and no fire during the test and within seven days after the test.	P
	15		P
	16		P
	17		P
Group B (after fifty cycles ending in fully charged states)	18		P
	19		P
	20		P
	21		P
Ambient temperature: 24°C			

Conclusion:

Rechargeable Li-ion Battery had passed overcharge test.



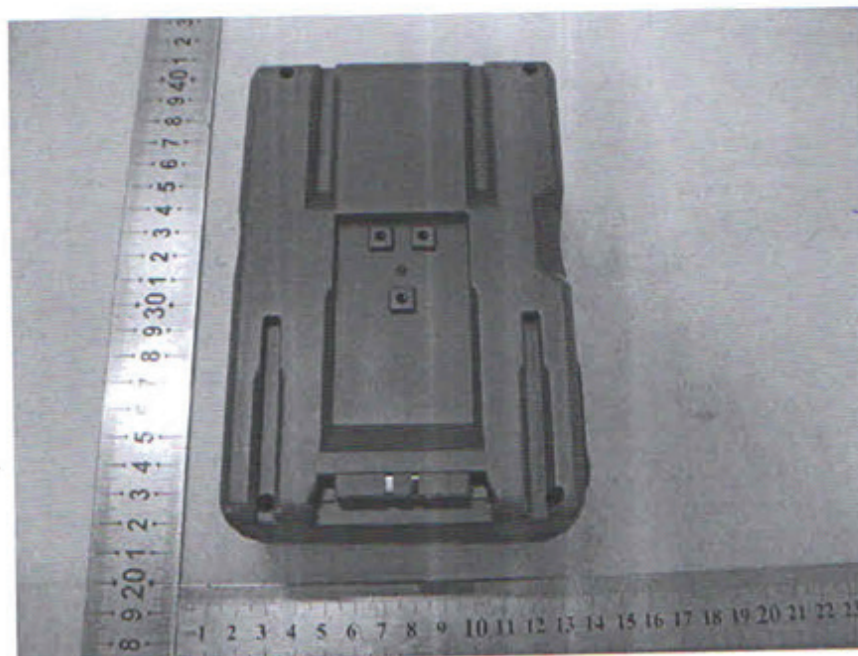
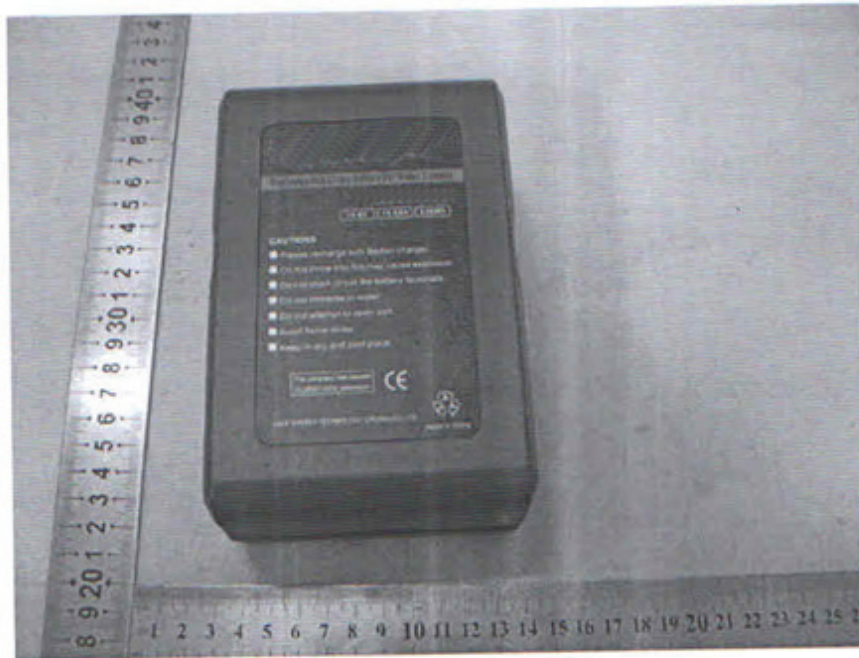
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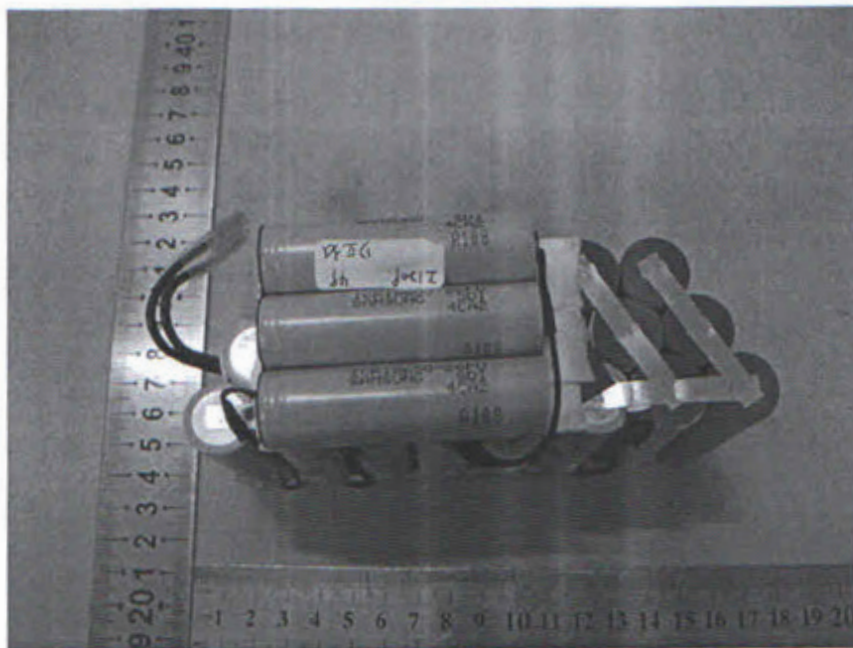
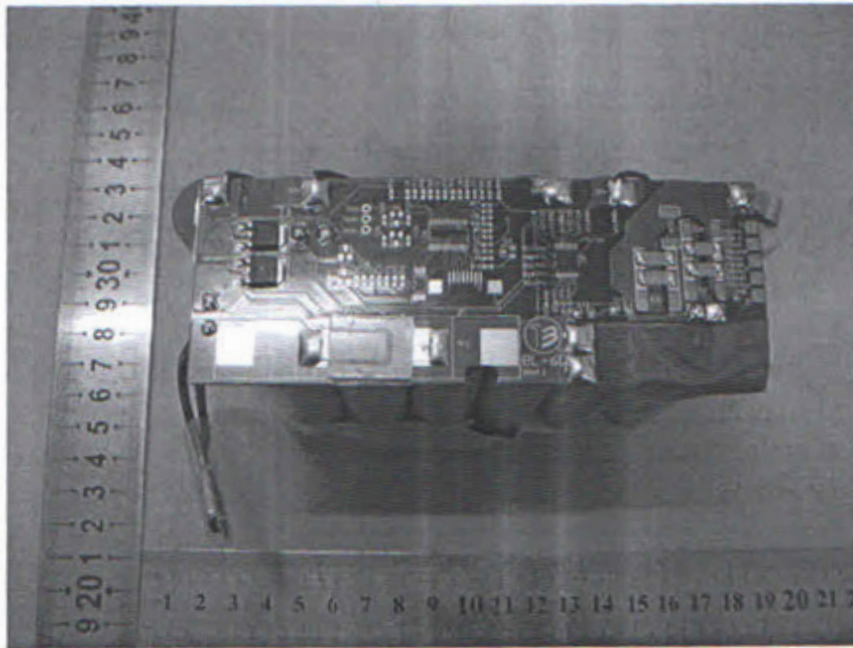
Clause	Requirement – Test	Result - Remark	Verdict
38.3.4.8	Test 8: Forced discharge		P
38.3.4.8.1	Purpose		P
	This test evaluates the ability of a primary or a rechargeable cell to withstand a forced discharge condition.		P
38.3.4.8.2	Test procedure		P
	Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12 V DC, power supply at an initial current equal to the maximum discharge current specified by the manufacturer.		P
	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).		P
38.3.4.8.3	Requirement		P
	Primary or rechargeable cells meet this requirement if there is no disassembly and no fire during the test within seven days after the test.	There is no disassembly and no fire during the test within seven days after the test.	P
Group	No.	Status	Criteria
Group E (at first cycle in fully discharged states)	22	OK	There is no disassembly and no fire during the test within seven days after the test.
	23	OK	
	24	OK	
	25	OK	
	26	OK	
	27	OK	
	28	OK	
	29	OK	
	30	OK	
	31	OK	
Group F (after 50 cycles ending in fully discharged states)	32	OK	
	33	OK	
	34	OK	
	35	OK	
	36	OK	
	37	OK	
	38	OK	
	39	OK	
	40	OK	
	41	OK	
Ambient temperature: 24.0°C			

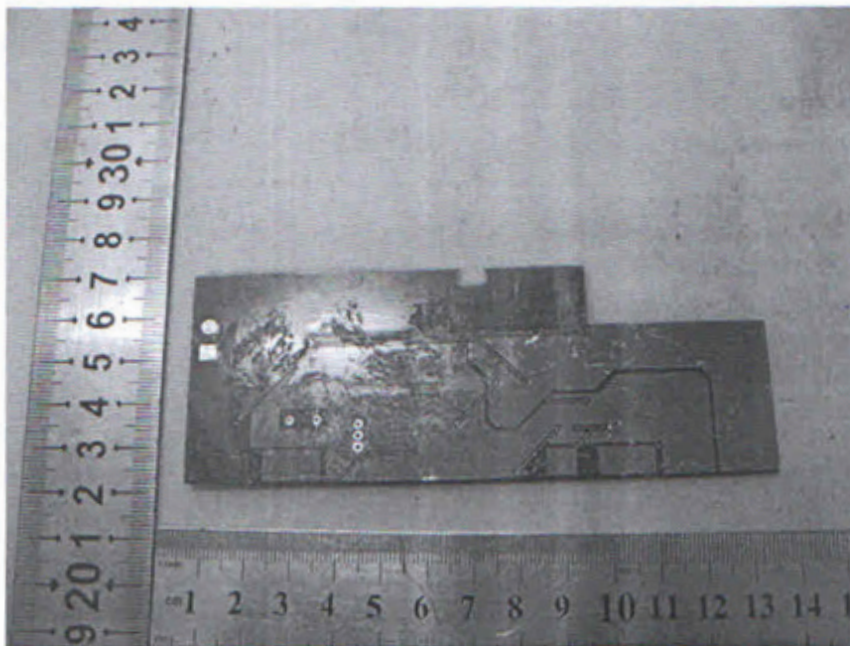
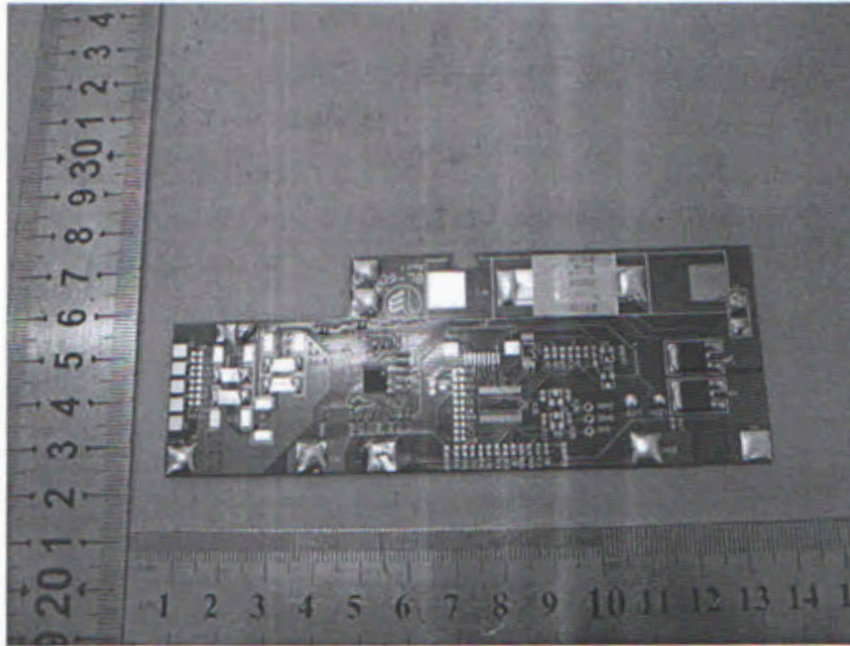
Conclusion:

Rechargeable Li-ion Battery had passed Forced discharge test.

Photos







*** End of Report ***