Type Examination Certificate

Certificate Number 20160630-4787109638
Issue Date 2016-06-30

Test results apply only to the sample(s) actually tested by UL LLC ("UL").

Product: Rechargeable Li-Ion Battery Pack

Tests Requested By:
3M Company
3M Center
Saint Paul, MN 55144, United States

Manufacturer:
3M Company
3M Center
Saint Paul, MN 55144, United States

Model/Type/Serial Ref: Model TR-830, rated 11.25Vdc, 4.8Ah, 3S/1P

UL has determined that the samples tested conform with the requirements of the Standard indicated on this Certificate.

Standard(s): UN Manual of Tests & Criteria, Transport of Dangerous Goods, Sixth Edition

The client provided all of the test samples for testing by UL. UL did not select the samples or determine whether the samples provided were representative of other manufactured products. UL has not established Follow-Up Service or other surveillance of the product. UL's name and marks shall not be used on or in connection with the product. The client and or manufacturer are solely and fully responsible for conformity of all products to all applicable standards, specifications or requirements. The test results may not be used, in whole or in part, in any other document without UL's prior written approval.

Issued By: LaTanya Schwalb

Reviewed by: Jessica Rowland

LaTanya Schwalb
UL LLC

Jessica Rowland
UL LLC

2016-06-30

3M Company
Mr. Steven Hedberg
CRL SEMS Lab – Hardgoods Regulatory Engineering (HRE)
3M Center, 235-BE-03
St. Paul, MN 55144-1000,United States

Reference:	File: E76959 Project : 4787109638.1.1
Product:	UN 38.3, 6TH Edition, Transport of Dangerous Goods, Testing for Model TR-830 Li-ion Rechargeable Battery (54Wh, 4.8Ah, 11.25Vdc, 3S/1P, using SAFT MP174565 cells)

Dear Mr. Hedberg,

Project 4787109638.1.1 was opened, in accordance with 3M's request for the evaluation of the above-referenced battery model. The requested test protocol for this project was to determine compliance with the UN Manual of Test Criteria, Sixth Edition, Transport of Dangerous Goods, Tests T.1through T.5 (in sequence) and T.7.

A copy of the test data sheets has been included as an appendix to this report. The battery test results are summarized below.

Model: TR-830

Sixteen samples were received by UL Northbrook (and tested by UL Poland) of Model TR-830 having been subjected to charge and discharge cycles, eight (8) of the samples were cycled one (1) time and eight (8) were cycled fifty (50) times in accordance with the requirements of the UN Manual of Tests and Criteria Clause 38.3.3 (b) & (d) prior to being shipped to UL Northbrook.

UN 38.3 Tests	1st cycle, Fully Charged	50th Cycle, Fully Charged
T.1 - Altitude Simulation	Compliant	Compliant
T.2 - Thermal	Compliant	Compliant
T.3 - Vibration	Compliant	Compliant
T.4 - Shock	Compliant	Compliant
T.5 - External Short Circuit	Compliant	Compliant
T.7 - Overcharge	Compliant	Compliant

UL LLC did not select the samples, determine whether the samples were representative of production samples, witness the production of the test samples, nor were we provided with information relative to the formulation or identification of component materials used in the test samples. The test results apply only to the actual samples tested.

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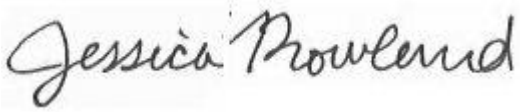
This letter will serve to report that all tests on the subject product have been completed. This concludes all work associated with this project and we are therefore closing this portion of the project.

Thank you for the opportunity to provide your company with these services. Please do not hesitate to contact us if you should have any questions or comments.

Sincerely,

LaTanya Schwalb
Senior Project Engineer
Tel: 847.664.2979
E-mail: LaTanya.Schwalb@ul.com

Reviewed by:



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GENERAL

CELL SAFETY TESTING PRACTICES

Follow all battery SOPs when handling, testing, storing or disposing of battery samples. Follow appropriate procedures to prevent inadvertent shorting of battery and cell terminals during handling, storage and disposal of batteries. Follow MSDS sheets and battery SOPs when handling batteries where there is evidence of electrolyte leakage.

Some lithium batteries are capable of exploding when subjected to battery tests. It is important that personnel be protected from the flying fragments, explosive force, fire and sudden release of heat and noise that results from such explosions.

The test area is to be well ventilated to protect personnel from possible harmful fumes or gases that may be emitted during battery testing.

All personnel involved in the testing of lithium batteries are to be instructed never to approach a lithium battery while the surface temperature exceeds 90°C (194°F).

GENERAL (CONT'D):

DEFINITIONS

Battery - Two or more cells or batteries which are electrically connected together and fitted with devices necessary for use, for example, case, terminals, marking or protective devices. Units which have two or more cells that are commonly referred to as "battery packs", "modules" or "battery assemblies" having the primary function of providing a source of power to another piece of equipment are treated as batteries.

Cell - A single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across its two terminals, and may contain protective devices.

Component Cell - A cell contained in a battery. A component cell is not to be considered a single cell battery.

Cycle - One sequence of fully charging and fully discharging a rechargeable cell or battery.

Disassembly (Explosion) – A vent or rupture where solid matter from any part of a cell or a battery penetrates a wire mesh screen (annealed aluminum wire with a diameter of 0.25 mm and grid density of 6 to 7 wires per cm) placed 25 cm away from the cells or battery.

Fire - Flames are emitted from the test cell or battery.

First Cycle - The initial cycle following completion of all manufacturing processes.

Fully Charged – A rechargeable cell or battery, which has been electrically charged to its design rated capacity.

Fully Discharged - Either

- Primary cell or battery – Electrically discharged to remove 100% of its rated capacity.
- Rechargeable cell or battery – Electrically discharged to its endpoint voltage as specified by the manufacturer.

Large Battery – A lithium metal battery or lithium ion battery with a gross mass of more than 12 kg.

Large Cell – A cell with a gross mass of more than 500 g.

GENERAL (CONT'D):

Leakage – 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 mass loss exceeds the values in Table 1 below.

In order to quantity the mass loss the following procedure is provided:

$$\text{Mass Loss (\%)} = (M_1 - M_2) / M_1 \times 100$$

Where M_1 is the mass before the test and M_2 is the mass after the test. When mass loss does not exceed the values in the Table 1, it shall be considered as "no mass loss".

Table 1: Mass Loss Limit

MASS M OF CELL OR BATTERY	Mass Loss Limit
~~M < 1 g~~	~~0.5%~~
~~1 g ≤ M ≤ 75 g~~	~~0.2%~~
M > 75 g	0.1%

Rupture – The mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage but not ejection of solid materials.

Single cell battery - A cell externally fitted with devices necessary for use in equipment or another battery which it is designed to power, for example protective devices.

Small Battery – A lithium metal battery or lithium ion battery with a gross mass of not more than 12 kg.

Small Cell – A cell with a gross mass of not more than 500 g.

Undischarged – A primary cell or battery that has not been wholly or partly discharged.

Venting – The release of excessive internal pressure from a cell or battery in a manner intended by design to preclude rupture or disassembly.

GENERAL (CONT'D):

Rechargeable Cell and Batteries –

Tests T.1 – T.5 are to be conducted on the same test samples in sequence.

Number of Cells / Component Cells Transported Separately from Battery	Tests	Conditioning	State of Charge (SOC)
10	T.1 - T.5	First cycle	Fully Charged
5	T.6	First cycle	50% of Rated Capacity
10	T.8	First cycle	Fully discharged
10	T.8	50 cycles	Fully discharged

Number of Component Cells not Transported Separately from Battery	Tests	Conditioning	State of Charge (SOC)
5	T.6	First cycle	50% of Rated Capacity
10	T.8	First cycle	Fully discharged
10	T.8	50 cycles	Fully discharged

Number of Small Batteries	Tests	Conditioning	State of Charge (SOC)
4	T.1 - T.5	First cycle	Fully Charged
4	T.1 - T.5	50 cycles	Fully Charged
4	T.7	First cycle	Fully Charged
4	T.7	50 cycles	Fully Charged

Number of Large Batteries	Tests	Conditioning	State of Charge (SOC)
2	T.1 - T.5	First cycle	Fully Charged
2	T.1 - T.5	25 cycles	Fully Charged
2	T.7	First cycle	Fully Charged
2	T.7	25 cycles	Fully Charged

T.1: ALTITUDE SIMULATION

METHOD

The samples were subjected to this test in accordance with Sec. 38.3.4.1, Test T.1 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

The samples were stored for 6 hours at an absolute pressure of 11.6 kPa (1.68 psi) and a temperature of 20 ± 5°C (68 ± 9°F). The samples were weighed before and after the exposure. The cell/battery voltage was also determined before and after the test.

RESULTS

Battery Model	TR-830

Sample No.	Sample Condition	Weight Before Test in Grams	Weight After Test In Grams	Percentage of Weight Loss	Voltage Before Test	Voltage After Test	Percentage of Voltage Remain	Comments
1	C	676.65	676.59	0.008868	12.365	12.359	99.951476	1,2,7,8
2	C	676.25	676.22	0.004436	12.356	12.351	99.959534	1,2,7,8
3	C	674.75	674.71	0.005928	12.342	12.336	99.951386	1,2,7,8
4	C	676.08	676.04	0.005916	12.366	12.361	99.959567	1,2,7,8
9	D	676.62	676.58	0.005912	12.385	12.379	99.951554	1,2,7,8
10	D	674.01	673.96	0.007418	12.368	12.362	99.951488	1,2,7,8
11	D	675.53	675.48	0.007402	12.201	12.195	99.950824	1,2,7,8
12	D	675.91	675.86	0.007398	12.403	12.397	99.951625	1,2,7,8

T.1: ALTITUDE SIMULATION (CONT'D):

Comments:	
(1)	Sample remained intact.
(2)	Integrity of protective devices **[**was**] [**~~was not~~**]** maintained.
(3)	Sample vented.
(4)	Sample opened and leaked electrolyte.
(5)	Sample exploded.
(6)	Sample caught on fire.
(7)	There was no mass loss, no leakage, no venting, no disassembly, no rupture and no fire.
(8)	The open circuit voltage of each cell after testing was greater than 90%.
Condition	
(A)	Fully discharged state.
(B)	Undischarged state.
(C)	First cycle in fully charged state.
(D)	After 50 cycles ending in fully charged state.
(E)	After 25 cycles ending in fully charged state.

[X] The samples **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]**.

[X] The sample **[**~~vented or leaked~~**] [**did not vent or leak**]** more than **[**~~0.5 percent~~**] [**~~0.2 percent~~**] [**0.1 percent**]**.

[X] The samples **[**~~ruptured or disassembled~~**] [**did not rupture or disassemble**]**.

[X] The fully charged samples open circuit voltage after testing is **[**not less than**] [**~~less than~~**]** 90% of its voltage prior to testing.

Ambient Temperature, C	20.9	Relative Humidity, %	45.6	Barometric Pressure, mBar	1007.5

T.2: THERMAL TEST

METHOD

The samples were subjected to this test in accordance with Sec. 38.3.4.2, Test T.2 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

The samples were subjected to temperature cycling consisting of the following. The samples were weighed before and after the exposure. The cell/battery voltage was also determined before and after the test.

Samples In: 2016-06-10	The chamber temperature was raised to 72 ± 2°C (162 ± 4°F) within 30 minutes and maintained at this temperature for **[**6**] [**~~12~~**]** hours.
	The chamber temperature was reduced to -40 ± 2°C (-40 ± 4°F) within 30 minutes and maintained at this temperature for **[**6**] [**~~12~~**]** hours.
	Repeat the sequence for 9 additional cycles (total of 10 cycles).
Samples Out: 2016-06-17	After the 10th cycle, store the batteries at ambient temperature 20 ± 5°C (68 ± 9°F) for 24 hours prior to examination.

Note: The duration of exposure to the test temperature extremes was determined as below:

- Small cells and small batteries: 6 hours;
- ~~Large cells and large batteries: 12 hours~~.

T.2: THERMAL TEST (CONT'D):

RESULTS

Battery Model	TR-830

Sample No.	Sample Condition	Weight Before Test in Grams	Weight After Test In Grams	Percentage of Weight Loss	Voltage Before Test	Voltage After Test	Percentage of Voltage Remain	Comments
1	C	676.59	676.13	0.0680343	12.359	12.201	98.721579	1,2,7,8
2	C	676.22	675.79	0.0636292	12.351	12.194	98.728848	1,2,7,8
3	C	674.71	674.24	0.0697081	12.336	12.185	98.77594	1,2,7,8
4	C	676.04	675.56	0.0710522	12.361	12.193	98.640887	1,2,7,8
9	D	676.58	676.07	0.075436	12.379	12.216	98.683254	1,2,7,8
10	D	673.96	673.44	0.0772155	12.362	12.206	98.738068	1,2,7,8
11	D	675.48	675.02	0.0681461	12.195	12.084	99.089791	1,2,7,8
12	D	675.86	675.39	0.0695894	12.397	12.227	98.62870	1,2,7,8

Comments	
(1)	Sample remained intact.
(2)	Integrity of protective devices **[**was**] [**~~was not~~**]** maintained.
(3)	Sample vented.
(4)	Sample opened and leaked electrolyte.
(5)	Sample exploded.
(6)	Sample caught on fire.
(7)	There was no mass loss, no leakage, no venting, no disassembly, no rupture and no fire.
(8)	The open circuit voltage of each cell after testing was greater than 90%.

T.2: THERMAL TEST (CONT'D):

Condition	
(A)	Fully discharged state.
(B)	Undischarged state.
(C)	First cycle in fully charged state.
(D)	After 50 cycles ending in fully charged state.
(E)	After 25 cycles ending in fully charged state.

[X] The samples **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]**.

[X] The sample **[**~~vented or leaked~~**] [**did not vent or leak**]** more than **[**~~0.5 percent~~**] [**~~0.2 percent~~**] [**0.1 percent**]**.

[X] The samples **[**~~ruptured or disassembled~~**] [**did not rupture or disassemble**]**.

[X] The fully charged samples open circuit voltage after testing is **[**not less than**] [**~~less than~~**]** 90% of its voltage prior to testing.

Ambient Temperature, C	21.4	Relative Humidity, %	45.8	Barometric Pressure, mBar	1006.9

T.3: VIBRATION

METHOD

The samples were subjected to this test in accordance with Sec. 38.3.4.3, Test T.3 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

The samples were subjected to vibration tests consisting of the following. The samples were weighed before and after the exposure. The cell/battery voltage was also determined before and after the test.

The samples were 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 was a sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz traversed in 15 minutes. This cycle was 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 was perpendicular to the terminal face.

The logarithmic frequency sweep was as follows:

[X] For cells and small batteries: From 7 Hz a peak acceleration of 1 g_n was maintained until 18 Hz is reached. The amplitude was then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8 g_n occurred (approximately 50 Hz). A peak acceleration of 8 g_n was then maintained until the frequency was increase to 200 Hz.

[ ] For large batteries: From 7 Hz a peak acceleration of 1 g_n was maintained until 18 Hz is reached. The amplitude was then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 2 g_n occurred (approximately 25 Hz). A peak acceleration of 2 g_n was then maintained until the frequency was increase to 200 Hz.

T.3: VIBRATION (CONT'D):

RESULTS

Cell/Battery Model	TR-830

Sample No.	Sample Condition	Weight Before Test in Grams	Weight After Test In Grams	Percentage of Weight Loss	Voltage Before Test	Voltage After Test	Percent of Voltage Remain	Comments
1	C	676.13	676.43	0.0	12.201	12.180	99.827883	1,2,7,8
2	C	675.79	676.06	0.0	12.194	12.174	99.835985	1,2,7,8
3	C	674.24	674.55	0.0	12.185	12.164	99.827657	1,2,7,8
4	C	675.56	675.87	0.0	12.193	12.169	99.803166	1,2,7,8
9	D	676.07	676.40	0.0	12.216	12.195	99.828094	1,2,7,8
10	D	673.44	673.76	0.0	12.206	12.185	99.827953	1,2,7,8
11	D	675.02	675.30	0.0	12.084	12.063	99.826216	1,2,7,8
12	D	675.39	675.69	0.0	12.227	12.206	99.828249	1,2,7,8

Comments	
(1)	Sample remained intact.
(2)	Integrity of protective devices **[**was**] [**~~was not~~**]** maintained.
(3)	Sample vented.
(4)	Sample opened and leaked electrolyte.
(5)	Sample exploded.
(6)	Sample caught on fire.
(7)	There was no mass loss, no leakage, no venting, no disassembly, no rupture and no fire.
(8)	The open circuit voltage of each cell after testing was greater than 90%.

T.3: VIBRATION (CONT'D):

Condition	
(A)	Fully discharged state.
(B)	Undischarged state.
(C)	First cycle in fully charged state.
(D)	After 50 cycles ending in fully charged state.
(E)	After 25 cycles ending in fully charged state.

[X] The sample **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]**.

[X] The sample **[**~~vented or leaked~~**] [**did not vent or leak**]** more than
[~~0.5 percent~~**] [**~~0.2 percent~~**] [**0.1 percent**]**.

[X] The samples **[**~~ruptured or disassembled~~**] [**did not rupture or disassemble**]**.

[ ] The fully charged samples open circuit voltage after testing is **[**not less than**] [**~~less than~~**]** 90% of its voltage prior to testing.

Ambient Temperature, C	21.6	Relative Humidity, %	61.1	Barometric Pressure, mBar	1024.8

T.4: SHOCK

METHOD

The samples were subjected to this test in accordance with Sec. 38.3.4.4, Test T.4 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

The samples were subjected to shock. The samples were weighed before and after the exposure. The cell/battery voltage was also determined before and after the test. The sample cell was secured to the testing machine by means of a rigid mount, which supports all mounting surfaces of the sample. Each sample was subjected to a half-sine shock as below:

[ ] For cells: Peak acceleration of 150 g_n and pulse duration of 6 milliseconds.

[ ] For large cells: Peak acceleration of 50 g_n and pulse duration of 11 milliseconds.

[X] For small batteries: Peak acceleration of the smaller of the following, and pulse duration of 6 milliseconds:

- 150 g_n.
- ~~√(100850 / mass of the battery in kg)~~

[ ] For large batteries: Peak acceleration of the smaller of the following, and pulse duration of 11 milliseconds:

- 50 g_n.
- √(30000 / mass of the battery in kg)

Each sample was 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 for a total of 18 shocks.

T.4: SHOCK (CONT'D):

RESULTS

Cell/Battery Model	TR-830
[X] Weight of Battery in kg	0.676
[X] Target Peak Acceleration for Battery in g_n	150

Sample No.	Sample Condition	Weight Before Test in Grams	Weight After Test In Grams	Percentage of Weight Loss	Voltage Before Test	Voltage After Test	Percent of Voltage Remain	Comments
1	C	676.43	676.43	0.0	12.180	12.179	99.99179	1,2,7,8
2	C	676.06	676.06	0.0	12.174	12.172	99.983572	1,2,7,8
3	C	674.55	674.54	0.0014825	12.164	12.163	99.991779	1,2,7,8
4	C	675.87	675.86	0.0014796	12.169	12.167	99.983565	1,2,7,8
9	D	676.40	676.39	0.0014784	12.195	12.193	99.9836	1,2,7,8
10	D	673.76	673.75	0.0014842	12.185	12.184	99.991793	1,2,7,8
11	D	675.30	675.29	0.0014808	12.063	12.061	99.98342	1,2,7,8
12	D	675.69	675.69	0.0	12.206	12.204	99.983615	1,2,7,8

T.4: SHOCK (CONT'D):

Comments	
(1)	Sample remained intact.
(2)	Integrity of protective devices **[**was**] [**~~was not~~**]** maintained.
(3)	Sample vented.
(4)	Sample opened and leaked electrolyte.
(5)	Sample exploded.
(6)	Sample caught on fire.
(7)	There was no mass loss, no leakage, no venting, no disassembly, no rupture and no fire.
(8)	The open circuit voltage of each cell after testing was greater than 90%.
Condition	
(A)	Fully discharged state.
(B)	Undischarged state.
(C)	First cycle in fully charged state.
(D)	After 50 cycles ending in fully charged state.
(E)	After 25 cycles ending in fully charged state.

[X] The sample **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]**.

[X] The sample **[**~~vented or leaked~~**] [**did not vent or leak**]** more than
[~~0.5 percent~~**] [**~~0.2 percent~~**] [**0.1 percent**]**.

[X] The samples **[**~~ruptured or disassembled~~**] [**did not rupture or disassemble**]**.

[X] The fully charged samples open circuit voltage after testing is **[**not less than**] [**~~less than~~**]** 90% of its voltage prior to testing.

Ambient Temperature, C	20.9	Relative Humidity, %	53.0	Barometric Pressure, mBar	1014.5

T.5: EXTERNAL SHORT CIRCUIT

METHOD

The samples were subjected to this test in accordance with Sec. 38.3.4.5, Test T.5 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

The samples were shall be heated for a period of time noted below, to reach a homogeneous stabilized temperature of 57 ± 4 °C, measured on the external case:

- Small cells and small batteries: 6 hours.
- ~~Large cells and large batteries: 12 hours.~~
- ~~**[ ]** _____ hours, assessed depended on the size and design of the sample.~~

The samples were then subjected to a short circuit condition with a total external resistance of less than 0.1 ohm, until:

- Small cells, small batteries and large cells: 1 hour after the external case temperature of sample has returned to 57 ± 4 °C.
- Large batteries: 1 hour after the external case temperature of sample has decreased by half of the maximum temperature increase observed during the test and remains below that value.

T.5: EXTERNAL SHORT CIRCUIT (CONT'D):

RESULTS

Battery Model	TR-830

Sample No.	Condition	Voltage Before Test	Maximum Temperature, °C	Comments
1	C	12.163	58.9	1,8
2	C	12.156	57.2	1,8
3	C	12.147	56.1	1,8
4	C	12.149	55.6	1,8
9	D	12.177	55.3	1,8
10	D	12.168	55.7	1,8
11	D	12.046	59.2	1,8
12	D	12.189	57.5	1,8

T.5: EXTERNAL SHORT CIRCUIT (CONT'D):

Comments	Condition
(1) Sample remained intact.	(A) Fully discharged state.
(2) Sample bulged.	(B) Undischarged state.
(3) Sample vented.	(C) First cycle in fully charged state.
(4) Sample opened and leaked electrolyte.	(D) After 50 cycles ending in fully charged state.
(5) Sample exploded.	(E) After 25 cycles ending in fully charged state.
(6) Sample caught on fire.	-
(7) (Other)	-
(8) No disassembly and no fire within six hours of the test.	-

[X] The maximum temperature measured on the exterior surface of the **[**~~metal cell casings~~**]** or **[**plastic pack casings**]** are noted above.

[X] The maximum temperature **[**~~exceeded~~**] [**did not exceed**]** 170°C.

[X] The samples **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]** within six hours of test.

[X] The samples **[**~~ruptured or disassembled~~**] [**did not rupture or disassemble**]** within six hours of test.

Ambient Temperature, C	21.0	Relative Humidity, %	48.0	Barometric Pressure, mBar	1002.8

T.7: OVERCHARGE

METHOD

The rechargeable batteries were subjected to this test in accordance with Section 38.3.4.7, Test T.7 of the Sixth Revised Edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (Refer to ST/SG/AC.10/11/Rev.6).

Batteries were subjected to a charge current of twice the manufacturer's recommended maximum continuous charge current.

The minimum voltage of the test was as follows:

- When the manufacturer's recommended charge voltage is not more than 18 V, the minimum voltage of the test was the lesser of 2 times the maximum charge voltage of the battery or 22 V.
- When the manufacturer's recommended charge voltage is more than 18 V, the minimum voltage of the test was 1.2 times the maximum charge voltage.

Tests were conducted at ambient temperature. The duration of the test was 24 hours.

RESULTS

Battery Model	TR-830
Overcharge Current	2560mA (2x max charging current of 1280mA)
Overcharge Voltage	22Vdc

Sample No.	Condition	Test Voltage, V	Measured Overcharge Current, mA	Comments
5	A	22	99	1,2,7
6	A	22	105	1,2,7
7	A	22	106	1,2,7
8	A	22	95	1,2,7
13	B	22	109	1,2,7
14	B	22	103	1,2,7
15	B	22	102	1,2,7
16	B	22	98	1,2,7

T.7: OVERCHARGE (CONT'D):

Comments	Condition
(1) Sample remained intact.	(A) First cycle in fully charged state.
(2) The battery's protective circuitry activated and the current was reduced to about _0.007 A.	(B) After 50 cycles ending in fully charged state.
(3) Sample vented.	(C) After 25 cycles ending in fully charged state.
(4) Sample opened and leaked electrolyte.	-
(5) Sample exploded.	-
(6) Sample caught on fire.	-
(7) No disassembly and no fire within seven days of the test.	-

[X] The samples **[**~~exploded or caught fire~~**] [**did not explode or catch fire**]** within seven days of test.

[X] The samples **[**~~disassembled~~**] [**did not disassemble**]** within seven days of test.

Ambient Temperature, C	21.3	Relative Humidity, %	60.6	Barometric Pressure, mBar	1024.4

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