U.S. Department
of Transportation

**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

June 20, 2023

Bob Keller
Avionics Design Group Director
Northrop Grumman Corporation
1575 South Price Road
Chandler, AZ 85286

Reference No. 23-0029

Dear Mr. Keller:

This letter is in response to your March 15, 2023, email requesting clarification of the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) applicable to testing requirements for lithium ion battery packs in accordance with the United Nations (UN) Manual of Tests and Criteria in sub-section 38.3. You state that your company uses commercially available lithium ion cells for low-power battery packs where you have two basic battery configurations that are both enclosed in an aluminum housing. Configuration #1 is an 8-cell battery pack with a 100 Wh rating, and Configuration #2 is a 16-cell battery pack with an approximate 200 Wh rating. You seek confirmation of your understanding that you must test two units of each configuration in accordance with the requirements of sub-section 38.3.3(b), (d), and (f)—specifically, sub-section 38.3.3(b)(iii), (b)(iv), (d)(i), (d)(ii), and (f)—of the UN Manual of Tests and Criteria.

Based on the information you provided, your understanding is incorrect. In accordance with sub-section 38.3.3(b)(iii) and (b)(iv), an 8-cell battery pack with a 100 Wh rating must be tested under tests T.1 through T.5 in the quantity indicated:

- four small batteries at first cycle, in fully charged states; and
- four small batteries after 25 cycles ending in fully charged states.

Additionally, in accordance with sub-section 38.3.3(d)(i) and (d)(ii), an 8-cell battery pack with a 100 Wh rating must be tested under test T.7 in the quantity indicated:

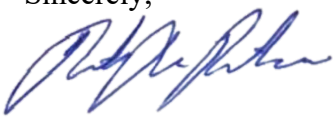
- four small batteries at first cycle, in fully charged states; and
- four small batteries after 25 cycles ending in fully charged state.

In accordance with sub-section 38.3.3(f), if a 16-cell battery pack with a 200 Wh rating is assembled from two 8-cell battery packs that have passed all applicable tests, one assembled 16-cell battery pack in a fully charged state shall be tested under tests T.3, T.4, T.5, and T.7. Alternatively, the 16-cell battery pack may be tested in accordance with sub-section 38.3.3(b)(iii)

and (b)(iv) using quantities indicated in the sub-section. Please note that small batteries not equipped with battery overcharge protection that are designed for use only as a component in another battery or in equipment—which affords such protection—are not subject to the requirements of the T.7 testing requirements.

I hope this information is helpful. Please contact us if we can be of further assistance.

Sincerely,



Dirk Der Kinderen
Chief, Standards Development Branch
Standards and Rulemaking Division

Baker

23-0029

From: INFOCNTR (PHMSA)
To: Dodd, Alice (PHMSA)
Cc: Hazmat Interps
Subject: FW: Letter of Interpretation Request Attn: Brianna
Date: Friday, March 24, 2023 1:28:16 PM
Attachments: image005.png
image006.png
LG-Energy-Solution-RESU-16H-Prime-UN38.8-Test-Report.pdf
150526-[UL1642] ICR18650MJ1, INR18650MJ1 NoA.pdf
Specification INR18650MJ1 22.08.2014.pdf

Hi Alice,

Please see the below interpretation request as well as the attachments.

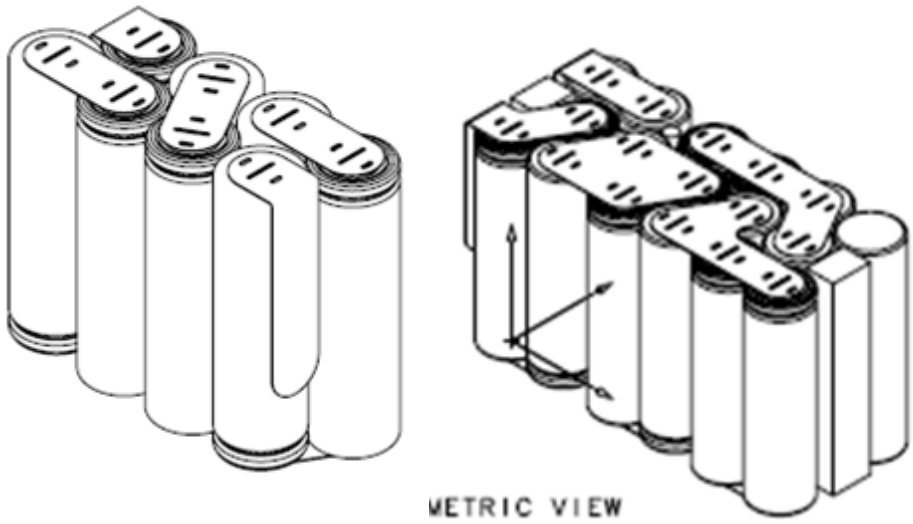
Let us know if you need anything.

Regards,

-Breanna

From: Keller, Robert J [US] (SP) <robert.j.keller@ngc.com>
Sent: Wednesday, March 15, 2023 1:25 PM
To: INFOCNTR (PHMSA) <INFOCNTR.INFOCNTR@dot.gov>
Subject: Letter of Interpretation Request Attn: Brianna

I would like to get clarification on a requirement for testing Li-Ion battery packs per the UN testing requirements outlined in section 38.3. Our company, Northrop Grumman, is a defense contractor that uses a commercially available cell for relatively low power battery assemblies. The cells are LG INR18650MJ1 cells. I have attached the cell specification, UN and UL test documents. In our applications we have 2 basic configurations, an 8Sx1P and an 8Sx2P configuration.



Both are enclosed in aluminum housings. The 8 cell pack is a 100Whr pack. The 16 cell pack is about 200Whr.

My question involves section 38.3.3 (b), (d) and (f). The way the document is written it implies that for rechargeable battery assemblies, you need to test 4 to 38.3.3 (b)(iii) , 4 to (b)(iv), 4 to (d)(i) and 4 to (d)(ii) for each configuration. This assumes that the cells used have not been tested to the UN requirements. Section (f) seems to clarify that if the cells used have been through UN testing, then the quantities required for testing at the battery assembly level is a quantity of 1 for short circuit and a quantity of 1 subjected to overcharge testing. This assumes that the battery assemblies are less than 6200Wh and have less than 500 g of lithium content. Both of my battery assemblies meet these conditions and the cells have been tested through the entire suite of UN and UL tests.

For my circumstance, am I correct in understanding that I need to test 2 units of each configuration in order to be compliant? One in short circuit testing and one subjected to the overcharge test. Table 38.3.2 seems to confirm this but footnote c seems contradict this depending on how you read it.

Thank you in advance for clarification regarding this matter. Our current volumes of these batteries fall below the 100 per year threshold but I anticipate the volume may exceed the 100 unit exemption in the future.

Regards,

Bob Keller | Avionics Design Group Director
Northrop Grumman Corporation | Space Systems Sector
O: 480-722-3553 | Robert.J.Keller@ngc.com

NORTHROP GRUMMAN

Prepared		*Document No.*	*Date*	*Rev*
LGC MBD/MBDC	Oh, Kyung Su	LRB-PS-CY3450_MJ1	2014-08-22	1

Approved		*Description*
LGC MBD/MBDC	Kim, Dong Myung	Lithium Ion INR18650 MJ1 3500mAh

PRODUCT SPECIFICATION

Rechargeable Lithium Ion Battery
Model : INR18650 MJ1 3500mAh

LG Chem

20 YOIDO-DONG YOUNGDUNGPO-GU,

SEOUL 150-721, KOREA

http://www.lgchem.com

Revision History

Revision	Date	Originator	Description
0	2014-04-28	Oh, Kyung Su	- Draft
1	2014-08-22	Oh, Kyung Su	-2.2. Nominal Voltage - 3.63V → 3.635V

Contents

1. General Information

1.1 Scope

This product specification defines the requirements of the rechargeable lithium ion battery of LG Chem.

1.2 Product classification

Cylindrical rechargeable lithium ion battery

1.3 Model name

INR18650 MJ1

2. Nominal Specification

Item	Condition / Note	Specification
2.1 Energy	Std. charge / discharge	Nominal 3500 mAh Minimum 3400 mAh
2.2 Nominal Voltage	Average	3.635V
2.3 Standard Charge (Refer to 4.1.1)	Constant current Constant voltage End current(Cut off)	0.5C (1700mA) 4.2V 50mA
2.4 Max. Charge Voltage		4.2 ± 0.05V
2.5 Max. Charge Current		1.0 C (3400mA)
2.6 Standard Discharge (Refer to 4.1.2)	Constant current End voltage(Cut off)	0.2C (680mA) 2.5V
2.7 Max. Discharge Current		10A
2.8 Weight	Approx.	Max. 49.0 g
2.9 Operating Temperature	Charge Discharge	0 ~ 45℃ -20 ~ 60℃
2.10 Storage Temperature (for shipping state)	1 month 3 month 1 year	-20 ~ 60℃ -20 ~ 45℃ -20 ~ 20℃

3. Appearance and Dimension

3.1 Appearance

There shall be no such defects as deep scratch, crack, rust, discoloration or leakage, which may adversely affect the commercial value of the cell.

3.2 Dimension

Diameter: 18.4 +0.1 / -0.3 mm (Max. 18.5mm)

Height: 65.0 ±0.2mm (Max. 65.2mm)

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4. Performance Specification

4.1 Standard test condition

4.1.1 Standard Charge

Unless otherwise specified, “Standard Charge” shall consist of charging at constant current of 0.5C. The cell shall then be charged at constant voltage of 4.20V while tapering the charge current. Charging shall be terminated when the charging current has tapered to 50mA. For test purposes, charging shall be performed at 23ºC ± 2ºC.

4.1.2 Standard Discharge

“Standard Discharge” shall consist of discharging at a constant current of 0.2C to 2.50V. Discharging is to be performed at 23 ºC ± 2 ºC unless otherwise noted (such as capacity versus temperature).

4.1.3 High Drain rate Charge/discharge condition

Cells shall be charged at constant current of 1,500mA to 4.20V with end current of 100mA. Cells shall be discharged at constant current of 4,000mA to 2.50V. Cells are to rest 10 minutes after charge and 20 minutes after discharge.

4.2 Electrical Specification

Item	Condition	Specification
4.2.1 Initial AC Impedance	Cell shall be measured at 1kHz after charge per 4.1.1.	≤ 40 mΩ, without PTC
4.2.2 Initial Capacity	Cells shall be charged per 4.1.1 and discharged per 4.1.2 within 1h after full charge.	≥ 3400 mAh
4.2.3 Cycle Life	Cells shall be charged and discharged per 4.1.3 400 cycles. A cycle is defined as one charge and one discharge. 401st discharge power shall be measured per 4.1.1 and 4.1.2	≥ 80 % (of C_{min} in 2.1)

4.3 Environmental specification.

Item	Condition		Specification
4.3.1 Storage Characteristics	Cells shall be charged per 4.1.1 and stored in a temperature-controlled environment at 23ºC ± 2ºC for 30 days. After storage, cells shall be discharged per 4.1.2 to obtain the remaining power*.		Power remaining rate ≥ 90% (P_{min} in 2.1)
4.3.2 High Temperature Storage Test	Cells shall be charged per 4.1.1 and stored in a temperature-controlled environment at 60ºC for 1 week. After storage, cells shall be discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered power**.		No leakage, Power recovery rate ≥ 80%
4.3.3 High Temperature and High Humidity Test	Cells are charged per 4.1.1 and stored at 60ºC (95% RH) for 168 hours. After test, cells are discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered power.		No leakage, No rust Power recovery rate ≥ 80%
4.3.4 Thermal Shock Test	65ºC (8h) ← 3hrs → -20ºC (8h) for 8 cycles with cells charged per 4.1.1 After test, cells are discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered power.		No leakage Power recovery rate ≥ 80%
4.3.5 Temperature Dependency of Capacity	Cells shall be charged per 4.1.1 at 23ºC ± 2ºC and discharged per 4.1.2 at the following temperatures.		
	Charge	Discharge	Capacity
	23℃	-10℃	70% of P_{ini}
		0℃	80% of P_{ini}
		23℃	100% of P_{ini}
		60℃	95% of P_{ini}

* Remaining Capacity: After storage, cells shall be discharged with Std. condition (4.1.2) to measure the remaining capacity.
** Recovery Capacity: After storage, cells shall be discharged with fast discharge condition (4.1.3), and then cells shall be charged with std. charge condition (4.1.1), and then discharged with Std. condition (4.1.2). This charge / discharge cycle shall be repeated three times to measure the recovery capacity.

4.4 Mechanical Specification

Item	Condition	Specification
4.4.1 Drop Test	Cells charged per 4.1.1 are dropped onto an wooden floor from 1.0 meter height for 1 cycle, 2 drops from each cell terminal and 1drop from the side of cell can (Total number of drops = 3).	No leakage No temperature rising
4.4.2 Vibration Test	Cells charged per 4.1.1 are vibrated for 90 minutes per each of the three mutually perpendicular axis (x, y, z) with total excursion of 0.8mm, frequency of 10Hz to 55Hz and sweep of 1Hz change per minute	No leakage

4.5 Safety Specification

Item	Condition	Specification
4.5.1 Overcharge Test	Cells are discharged per 4.1.2, and then charged at constant current of 3 times the max. charge condition and constant voltage of 4.2V while tapering the charge current. Charging is continued for 7 hours (Per UL1642).	: No explode, No fire
4.5.2 External Short - Circuiting Test	Cells are charged per 4.1.1, and the positive and negative terminal is connected by a 100mΩ-wire for 1 hour (Per UL1642).	: No explode, No fire
4,5.3 Overdischarge Test	Cells are discharged at constant current of 0.2C to 250% of the minimum capacity.	: No explode, No fire
4.5.4 Heating Test	Cells are charged per 4.1.1 and heated in a circulating air oven at a rate of 5ºC per minute to 130ºC. At 130ºC, oven is to remain for 10 minutes before test is discontinued (Per UL1642).	: No explode, No fire
4.5.5 Impact Test	Cells charged per 4.1.1 are impacted with their longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8mm diameter bar (Per UL1642).	: No explode, No fire
4.5.6 Crush Test	Cells charged per 4.1.1 are crushed with their longitudinal axis parallel to the flat surface of the crushing apparatus (Per UL1642).	: No explode, No fire

5. Caution

Warning: Using the lithium ion rechargeable battery, mishandling of the battery may cause heat, fire and deterioration in performance. Be sure to observe the following.

5.1 Cautions for Using and Handling

- When using the application equipped with the battery, refer to the user's manual before usage.
- Please read the specific charger manual before charging.
- Charge time should not be longer than specified in the manual.
- When the cell is not charged after long exposure to the charger, discontinue charging.
- Battery must be charged at operating temperature range 0 ~ 45℃.
- Battery must be discharged at operating temperature range -20 ~ 60℃.
- Please check the positive(+) and negative(-) direction before packing.
- When a lead plate or wire is connected to the cell for packing, check out insulation not to short-circuit.
- Battery must be stored separately.
- Battery must be stored in a dry area with low temperature for long-term storage.
- Do not place the battery in direct sunlight or heat.
- Do not use the battery in high static energy environment where the protection device can be damaged.
- When rust or smell is detected on first use, please return the product to the seller immediately.
- The battery must be away from children or pets
- When cell life span shortens after long usage, please exchange to new cells.

5.2 Prohibitions

- Do not use different charger. Do not use cigarette jacks (in cars) for charging.
- Do not charge with constant current more than maximum charge current.
- Do not disassemble or reconstruct the battery.
- Do not throw or cause impact.
- Do not pierce a hole in the battery with sharp things. (such as nail, knife, pencil, drill)
- Do not use with other batteries or cells.
- Do not solder on battery directly.
- Do not press the battery with overload in manufacturing process, especially ultrasonic welding.
- Do not use old and new cells together for packing.
- Do not expose the battery to high heat. (such as fire)
- Do not put the battery into a microwave or high pressure container.
- Do not use the battery reversed.
- Do not connect positive(+) and negative(-) with conductive materials (such as metal, wire)
- Do not allow the battery to be immerged in or wetted with water or sea-water.

5.3 Caution for the battery and the pack

Pack shall meet under condition to maintain battery safety and last long performance of the lithium rechargeable cells.

5.3.1 Installing the battery into the pack

-. The cell should be inspected visually before battery assembly into the pack.

-. Damaged cell should not be used. (Damaged surface, can-distortion, electrolyte-smell)

-. Different Lot Number cells should not be packaged into the same pack.

-. Different types of cells, or same types but different cell maker's should not be used together.

5.3.2 Design of battery pack

-. The battery pack should not be connected easily to any charger other than the dedicated charger.

-. The battery pack has function not to cause external short cut easily.

5.3.3 Charge

-. Charging method is Constant Current-Constant Voltage (CC/CV).

-. Charging should be operating under maximum charge voltage and current which is specified in the product specification. (Article. 2.4, 2.5)

-. The battery should be charged under operating temperature specified in the product specification. (Article. 2.9)

5.3.4 Discharge

-. Discharging method is Constant Current (CC).

(In case of using the battery for mobile equipment, discharging mode could be Constant Power.)

-. Discharging should be operating under maximum discharge current which is specified in the product specification. (Article. 2.7)

-. Discharging should be done by cut off voltage which is specified in the product specification. (Article. 2.6)

-. The battery should be discharged under operating temperature specified in the product specification. (Article. 2.9)

5.3.5 Protection Circuit

-. The protection circuit should be installed in the battery pack, charger.

-. Charger or pack should have voltage sensing system to control over charge or discharge in order to maintain the battery's normal operating mode and protect cell imbalance.

-. Charger or pack should have warning system for over temperature, over voltage and over current.

6. EXCLUSION OF LIABILITY

THE WARRANTY SHALL NOT COVER DEFECTS CAUSED BY NORMAL WEAR AND TEAR, INADEQUATE MAINTENANCE, HANDLING, STORAGER FAULTY REPAIR, MODIFICATION TO THE BATTERY OR PACK BY A THIRD PARTY OTHER THAN LGC OR LGC'S AGENT APPROVED BY LGC, FAILURE TO OBSERVE THE PRODUCT SPECIFICATION PROVIDED HEREIN OR IMPROPER USE OR INSTALLATION, INCLUDING BUT NOT LIMITED TO, THE FOLLOWING:

-. DAMAGE DURING TRANSPORT OR STORAGE
-. INCORRECT INSTALLATION OF BATTERY INTO PACK OR MAINTENANCE
-. USE OF BATTERY OR PACK IN INAPPROPRIATE ENVIRONMENT
-. IMPROPER, INADEQUATE, OR INCORRECT CHARGE, DISCHARGE OR PRODUCTION CIRCUIT OTHER THAN STIPULATED HEREIN
-. INCORRECT USE OR INAPPROPRIATE USE
-. INSUFFICIENT VENTILATION
-. IGNORING APPLICABLE SAFETY WARNINGS AND INSTRUCTIONS
-. ALTERING OR ATTEMPTED REPAIRS BY UNAUTHORIZED PERSONNEL
-. IN CASE OF FORCE MAJEURE (LIGHTENING, STORM, FLOOD, FIRE, EARTHQUAKE, ETC.)

THERE ARE NO WARRANTIES – IMPLIED OR EXPRESS – OTHER THAN THOSE STIPULATED HEREIN. LG CHEM SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL OR INDIRECT DAMAGES ARISING OR IN CONNECTION WITH THE PRODUCT SPECIFICATION, BATTERY OR PACK.

NOTICE OF COMPLETION
AND
AUTHORIZATION TO APPLY THE UL MARK

05/26/2015

Lg Chem, Ltd.
HAENA PARK
128 Yeoui-daero Yeongdeungpo-gu
Seoul 150-721, Kr

Our Reference:	MH19896, Vol. 1	Project Number	4786940399
Your Reference:	PARK, HAENA		
Project Scope:	USR, Secondary Lithium-ion Cylindrical Cell, Model INR18650MJ1 (Traceable Code : MJ1) in Vol. 1, Sec. 1, Addition of model name.		

Dear HAENA PARK:

Congratulations! UL's investigation of your product(s) has been completed under the above Reference Number and the product was determined to comply with the applicable requirements. This letter temporarily supplements the UL Follow-Up Services Procedure and serves as authorization to apply the UL Mark at authorized factories under UL's Follow-Up Service Program. To provide your manufacturer(s) with the intended authorization to use the UL Mark, you must send a copy of this notice to each manufacturing location currently authorized under MH19896, Vol. 1 and *including any special instructions as indicated in the addendum to this letter*.

Records in the Follow-Up Services Procedure covering the product are now being prepared and will be sent in the near future. Until then, this letter authorizes application of the UL Mark for 90 days from the date indicated above.

Additional requirements related to your responsibilities as the Applicant can be found in the document “Applicant responsibilities related to Early Authorizations” that can be found at the following web-site:
http://www.ul.com/EAResponsibilities

Any information and documentation provided to you involving UL Mark services are provided on behalf of UL LLC (UL) or any authorized licensee of UL.

We are excited you are now able to apply the UL Mark to your products and appreciate your business. Feel free to contact me or any of our Customer Service representatives if you have any questions.

Very truly yours,

Richard Jeon

Engineer Project Associate
Richard.Jeon@ul.com

Reviewed by:

Bruce A. Mahrenholz
847-664-3009
CPO Director
Bruce.A.Mahrenholz@ul.com

NWTF68A-00B5C8

UN38.3 Test Summary

The following product has been evaluated according to the 6th revised edition of the UN Manual of Tests and Criteria.
We, LG Chem, Ltd., hereby certify that this battery meets the requirements of the regulation for transportation of lithium-ion cells, batteries and single cell batteries.

Manufacturer's contact information	LG Chem, Ltd. Address : 128 Yeoui-Daero, Yeongdeungpo-gu, SEOUL, 150-721, REPUBLIC OF KOREA Telephone : +82-10-7742-5427 E-mail : kkammy@lgchem.com Website : www.lgchem.com
Test Laboratory information	LG Chem, Ltd. / RESEARCH PARK Address : 188 Munjiro, Yuseong-gu, Daejeon, 305-738, REPUBLIC OF KOREA Telephone : +82-10-4808-7362 E-mail : Milkis@lgchem.com Website : www.lgchem.com

Description		List of Test Completed		
Test Report Number	QDI-200908-B-SH128064P8S1	UN 38.3 Tests	Test 1. Altitude Simulation	Pass
Date of test report	2020. 09. 08		Test 2. Thermal Test	Pass
Item / Cell Type	Lithium ion Battery / Pouch		Test 3. Vibration	Pass
Model name	SH128064P8S1		Test 4. Shock	Pass
Nominal voltage	128.45 V		Test 5. External Short Circuit	Pass
Capacity / Energy	64.1 Ah / 8.225 kWh		Test 6. Impact or Crush	Pass
Weight	Max 66.0 kg		Test 7. Overcharge	N/A
Dimensions	147.0(L)*490.0(W)*798.4(H) mm		Test 8. Forced Discharge	Pass

Reviewed By: MinJe Woo
Professional
Global Standard Certification Team
LG Chem, Ltd.
E-mail: Milkis@lgchem.com

Approved By: DaeHo Nam
Team Leader
Global Standard Certification Team
LG Chem, Ltd.
E-mail: kkammy@lgchem.com