

UN38.3 Test Summary

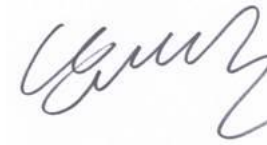
The following product has been evaluated according to the 6th revised edition of the UN Manual of Tests and Criteria.
We, LG Chem, Ltd., hereby certify that this battery meets the requirements of the regulation for transportation of lithium-ion cells, batteries and single cell batteries.

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| Description | | List of Test Completed | | |
| Test Report Number | QDI-180806-B-RESU13 | UN 38.3 Tests | Test 1. Altitude Simulation | Pass |
| Date of test report | 2018. 08. 06 | | Test 2. Thermal Test | Pass |
| Item / Cell Type | Lithium ion Battery / Pouch | | Test 3. Vibration | Pass |
| Model name | RESU13 | | Test 4. Shock | Pass |
| Nominal voltage | 51.8 V | | Test 5. External Short Circuit | Pass |
| Capacity / Energy | 252.0 Ah / 13.0 kWh | | Test 6. Impact or Crush | Pass |
| Weight | Max 98.5 kg | | Test 7. Overcharge | Pass |
| Dimensions | 626(L)*452(W)*227(H) mm | | Test 8. Forced Discharge | Pass |

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CERTIFICATE OF COMPLIANCE

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.

| | |
|--|----------|
| <input type="checkbox"/> Lithium-ion cell <input checked="" type="checkbox"/> Lithium-ion battery <input type="checkbox"/> Lithium-ion single cell battery | |
| Model name | RESU13 |
| Cell Model name | JH3 |
| Nominal voltage | 51.8 V |
| Electric power capacity | 252.0 Ah |

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| Approved | DaeHo Nam | <i>[Signature]</i> |

UN38.3 Test Report

- RESU13 (252.0 Ah, 51.8 V) -

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2018. 08. 06



1. UN38.3 Large Battery Test Condition

Rev.6

| Test item | Test Condition | Requirements | Etc. |
|--------------------------------|--|--|---|
| Test 1. Altitude Simulation | Storing at (low pressure)11.6kPa for 6hr at 20+/-5°C | | T1~T5 : Sequence Tests <pre> graph TD T1[Test 1 Altitude Simulation] --> T2[Test 2 Thermal Test] T2 --> T3[Test 3 Vibration] T3 --> T4[Test 4 Shock] T4 --> T5[Test 5 Ext. Short Circuit] </pre> |
| Test 2. Thermal Test | [72±2°C,12hr ↔ -40±2°C, 12hr,interval max. 30min] x 10cycle , Storing at 20±5°C for 24h | | |
| Test 3. Vibration | [7Hz↔200Hz↔7Hz, in 15min] x 12 times x 3 direction 1) sinusoidal waveform with a logarithmic sweep 2) 7Hz~18Hz (maintaining 1gn) app. 50Hz (until 2gn) 200Hz (maintaining 2gn), 1.6mm total excursion | - After OCV (%) ≥ 90% - No leakage, no venting, no disassembly, no rupture, no fire - Mass loss limit (leakage) 1) If M < 1g, less than 0.5%, 2) If 1g ≤ M ≤ 75g, less than 0.2%, 3) If M > 75g, less than 0.1% | |
| Test 4. Shock | Half sine shock 1) Peak acceleration - For batteries (whichever is smaller) : 150gn or $\sqrt{\frac{30000}{Mass(kg)}}gn$ 2) Pulse duration : 6msec 3) 6 direction (±x, y, z) x 3 cycle | | |
| Test 5. External Short Circuit | 1) Samples to be heated to 57±4°C in chamber (Measured on external case) 2) Less than 0.1Ω, ext. short-circuit at 57±4°C 3) 1hr continue after returning to 57±4°C or "has decreased by half of the maximum temperature increase observed during the test and remains below that value" If this assessment is not feasible, the exposure time shall be at least 12hours | - No disassembly, no rupture, no fire within 6 hours after the test - Max. Temp ≤ 170°C | |
| Test 6. Impact | Φ=15.8±0.1mm bar, 9.1±0.1kg mass, 61±2.5cm height | | for cylindrical cells (not less than 18mm diameter) |
| Test 6. Crush | Crushing rate : 1.5cm/s, until 13kN±0.78kN or 100mV drop or 50% deformation | - No disassembly, no fire within 6 hours after the test - Max. Temp ≤ 170°C | for cylindrical cells (less than 18mm diameter) for prismatic, pouch, coin/button cells |
| Test 7. Overcharge | Current = Manufacturer's recommended max. continuous charge current X 2 Voltage 1.If charge voltage ≤ 18V, V (min.) = 2 x (max. charge voltage) or 22V. 2.If charge voltage > 18V, V (min.) = 1.2 x (max. charge voltage) | - No disassembly, no fire within 7 days after the test | Batteries not equipped with overcharge protection that are designed for use only in a battery assembly, which affords such protection, are not subject to the requirements of this test |
| Test 8. Forced Discharge | Discharge at max. discharge current (connecting in series with 12V DC power supply), Duration time = rated capacity/initial test current | - No disassembly, no fire within 7 days after the test | Resistance of Electric Loader 1/Ω = (max. discharge current) / (12 + Initial OCV) |

- Tests through T1-T5 shall be conducted in sequence with the same battery.
- Large battery means a lithium metal battery or lithium ion battery with a gross mass of more than 12 kg.

2. General Information

1. Standard charge / discharge Condition

| | Mode | Condition | End Condition |
|-----------|---------|--------------------------------------|------------------|
| Charge | CC / CV | Current = 75.6 A Voltage = 58.8 V | Current = 12.6 A |
| Discharge | CC | Current = 75.6 A | Voltage = 42.0 V |

2. Test Condition

| | Mode | Condition |
|--------------------------|------|--|
| Test 8. Forced Discharge | CC | Max. Discharge Current = 157.5 A Duration Time = 24 min |

3-1. T1-T4 Test Result

| Before | | | Altitude (T1) | | | | | Thermal (T2) | | | | | Vibration (T3) | | | | | Shock (T4) | | | | |
|--------|-----|-----------|---------------|-----------|--------------|--------------|--------|---------------|-----------|--------------|--------------|--------|----------------|-----------|--------------|--------------|--------|---------------|-----------|--------------|--------------|--------|
| NO. | OCV | Mass (kg) | After OCV (V) | Mass (kg) | After OCV(%) | Mass Loss(%) | Result | After OCV (V) | Mass (kg) | After OCV(%) | Mass Loss(%) | Result | After OCV (V) | Mass (kg) | After OCV(%) | Mass Loss(%) | Result | After OCV (V) | Mass (kg) | After OCV(%) | Mass Loss(%) | Result |

A. 1st cycle fully charged state

| | | | | | | | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|-------|-------|------|--------|--------|-------|-------|------|--------|--------|-------|-------|------|--------|--------|--------|-------|------|
| 1 | 58.252 | 97.860 | 58.222 | 97.860 | 99.95 | 0.000 | Pass | 57.683 | 97.860 | 99.07 | 0.000 | Pass | 57.659 | 97.860 | 99.96 | 0.000 | Pass | 57.658 | 97.860 | 100.00 | 0.000 | Pass |
| 2 | 58.251 | 97.980 | 58.217 | 97.980 | 99.94 | 0.000 | Pass | 57.716 | 97.980 | 99.14 | 0.000 | Pass | 57.690 | 97.980 | 99.95 | 0.000 | Pass | 57.690 | 97.980 | 100.00 | 0.000 | Pass |

B. 25th cycle fully charged state

| | | | | | | | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|-------|-------|------|--------|--------|-------|-------|------|--------|--------|--------|-------|------|--------|--------|--------|-------|------|
| 3 | 58.296 | 97.950 | 58.282 | 97.950 | 99.98 | 0.000 | Pass | 57.892 | 97.950 | 99.33 | 0.000 | Pass | 57.866 | 97.950 | 99.96 | 0.000 | Pass | 57.866 | 97.950 | 100.00 | 0.000 | Pass |
| 4 | 58.291 | 97.960 | 58.267 | 97.960 | 99.96 | 0.000 | Pass | 57.982 | 97.960 | 99.51 | 0.000 | Pass | 57.982 | 97.960 | 100.00 | 0.000 | Pass | 57.976 | 97.960 | 99.99 | 0.000 | Pass |

3-2. T5/T7 Test Result

| EXT.Short Circuit (T5) | | | |
|------------------------|----------------|----------------|--------|
| NO. | Initial OCV(V) | Max. Temp (°C) | Result |

A. 1st cycle fully charged state

| | | | |
|---|--------|-------|------|
| 1 | 57.658 | 58.50 | Pass |
| 2 | 57.690 | 57.90 | Pass |

B. 25th cycle fully charged state

| | | | |
|---|--------|-------|------|
| 3 | 57.866 | 57.65 | Pass |
| 4 | 57.976 | 58.70 | Pass |

| Over Charge (T7) | | | |
|------------------|----------------|----------------|--------|
| NO. | Initial OCV(V) | Max. Temp (°C) | Result |

A. 1st cycle fully charged state

| | | | |
|---|--------|-------|------|
| 5 | 58.280 | 21.60 | Pass |
| 6 | 58.205 | 21.50 | Pass |

B. 25th cycle fully charged state

| | | | |
|---|--------|-------|------|
| 7 | 57.915 | 21.50 | Pass |
| 8 | 57.910 | 21.50 | Pass |

3-3. T6/T8 Test Result (JH3)

| Crush (T6) | | | |
|------------|----------------|----------------|--------|
| NO. | Initial OCV(V) | Max. Temp (°C) | Result |

A. 1st cycle 50% charged state

| | | | |
|-----|-------|-------|------|
| C-1 | 3.718 | 23.54 | Pass |
| C-2 | 3.720 | 23.96 | Pass |
| C-3 | 3.721 | 24.05 | Pass |
| C-4 | 3.720 | 25.08 | Pass |
| C-5 | 3.719 | 23.28 | Pass |

| Forced Discharge (T8) | | | | | | | |
|-----------------------|----------------|----------------|--------|-----|----------------|----------------|--------|
| NO. | Initial OCV(V) | Max. Temp (°C) | Result | NO. | Initial OCV(V) | Max. Temp (°C) | Result |

A. 1st cycle fully discharged state

| | | | |
|------|-------|-------|------|
| C-6 | 3.362 | 58.40 | Pass |
| C-7 | 3.368 | 61.20 | Pass |
| C-8 | 3.204 | 57.70 | Pass |
| C-9 | 3.392 | 59.60 | Pass |
| C-10 | 3.385 | 61.60 | Pass |
| C-11 | 3.373 | 61.70 | Pass |
| C-12 | 3.269 | 60.00 | Pass |
| C-13 | 3.390 | 57.70 | Pass |
| C-14 | 3.381 | 62.10 | Pass |
| C-15 | 3.389 | 60.60 | Pass |

B. 50th cycle fully discharged state

| | | | |
|------|-------|-------|------|
| C-16 | 3.196 | 64.30 | Pass |
| C-17 | 3.342 | 63.50 | Pass |
| C-18 | 3.367 | 61.90 | Pass |
| C-19 | 3.342 | 67.40 | Pass |
| C-20 | 3.162 | 67.60 | Pass |
| C-21 | 3.352 | 66.20 | Pass |
| C-22 | 3.354 | 60.40 | Pass |
| C-23 | 3.371 | 61.10 | Pass |
| C-24 | 3.163 | 60.30 | Pass |
| C-25 | 3.356 | 65.90 | Pass |

4. Sample Image

