

PERFORMANCE TEST REPORT

| | |
|--------------------|--|
| ■ APPARATUS | Lithium Primary Battery (Li/SOCl ₂) |
| ■ DESIGNATION | DD CELL |
| ■ VOLTAGE RATINGS | 3.6V |
| ■ APPLIED STANDARD | IEC62281 (FIRST EDITION-05,2004) UN Manual (ST/SG/AC.10/27/Add. 2, 2001) |
| ■ MANUFACTURER | VITZROCELL Co., Ltd. 256-41, Dugok-Li, Shinam-Myon, Yesan-Gun, Chung-Nam, KOREA |
| ■ DATE OF TESTS | March 13. 2006 ~ March 27. 2006 |
| ■ DATE OF ISSUE | April 04. 2006 |

The tests have been carried out in accordance with the IEC62281(Safety of primary and secondary lithium cells and batteries during transport) and UN Manual.

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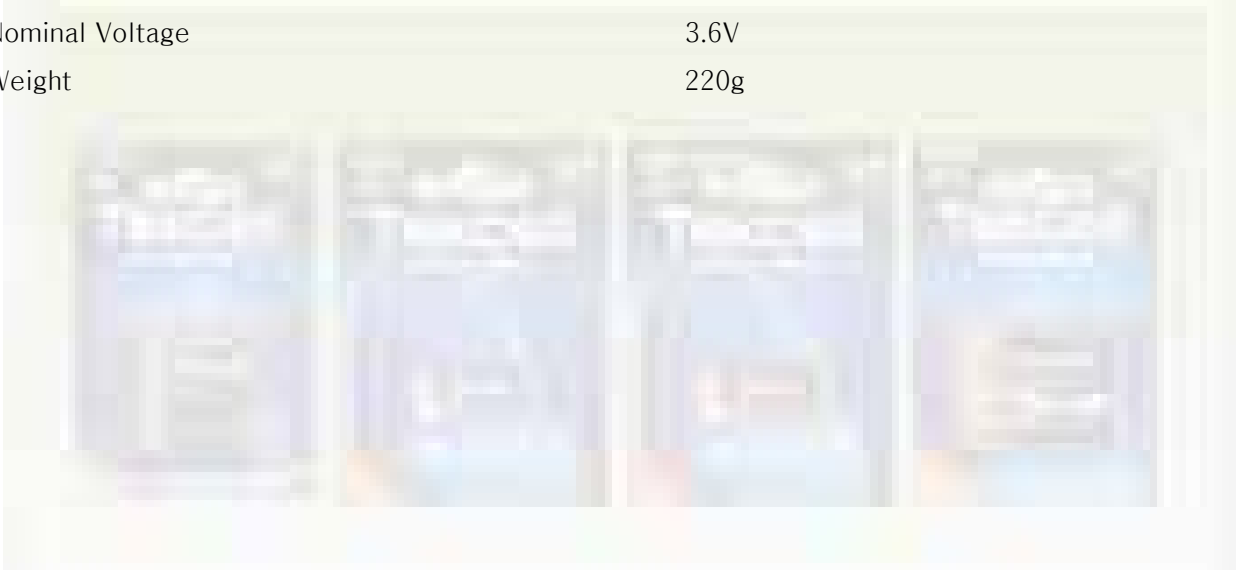
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Rating

Lithium Primary Battery (Li/SOCI2)

| | |
|------------------|--|
| Applied Standard | IEC62281 (FIRST EDITION – 05, 2004) UN Manual (ST/SG/AC.10/27/Add. 2, 2001) |
| Manufacturer | VITZROCELL Co., Ltd. |
| Type | DD CELL |
| Nominal Voltage | 3.6V |
| Weight | 220g |



List of the tests

| Description of tests | Test circuit | Sheet NO. |
|--------------------------|--------------|-----------|
| Altitude simulation test | - | 5/10 |
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1. Altitude simulation test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|---|-------|------------|--------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Test cells were stored at a pressure of 11.6kPa for 6hours at ambient temperature (20±5℃) [Requirement] -NM / NL / NV / NC / NE / NR / NF -Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.654 | 3.655 | 217.29 | 217.30 | * NM NL NV NC NE NR NF (PASS) | Ph.01 |
| #02 | | | 3.654 | 3.655 | 216.91 | 216.91 | | Ph.01 |
| #03 | | | 3.654 | 3.655 | 217.46 | 217.46 | | Ph.01 |
| #04 | | | 3.653 | 3.655 | 214.72 | 124.71 | | Ph.01 |
| #05 | | | 3.658 | 3.659 | 216.70 | 216.69 | | Ph.01 |
| #06 | | | 3.654 | 3.656 | 215.64 | 215.64 | | Ph.01 |
| #07 | | | 3.654 | 3.655 | 216.21 | 216.21 | | Ph.01 |
| #08 | | | 3.654 | 3.655 | 216.61 | 216.61 | | Ph.01 |
| #09 | | | 3.654 | 3.655 | 214.93 | 214.93 | | Ph.01 |
| #10 | | | 3.654 | 3.655 | 214.86 | 214.86 | | Ph.01 |
| #16 | Fully Discharged Cells | [Test Procedure] Test cells were stored at a pressure of 11.6kPa for 6hours at ambient temperature (20±5℃) [Requirement] -NM / NL / NV / NC / NE / NR / NF | - | - | 219.18 | 219.18 | * NM NL NV NC NE NR NF (PASS) | Ph.02 |
| #17 | | | - | - | 218.74 | 218.74 | | Ph.02 |
| #18 | | | - | - | 216.75 | 216.75 | | Ph.02 |
| #19 | | | - | - | 217.00 | 217.00 | | Ph.02 |
| #20 | | | - | - | 217.00 | 217.00 | | Ph.02 |
| #21 | | | - | - | 213.22 | 213.22 | | Ph.02 |
| #22 | | | - | - | 216.18 | 216.18 | | Ph.02 |
| #23 | | | - | - | 216.63 | 216.63 | | Ph.02 |
| #24 | | | - | - | 216.88 | 216.88 | | Ph.02 |
| #25 | | | - | - | 216.42 | 216.42 | | Ph.02 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

2. Thermal test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|---|--------|------------|--------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Test cells were stored for 6hours at $75 \pm 2^\circ\text{C}$, followed by storage for 6hours at $-40 \pm 2^\circ\text{C}$. The maximum time interval between test temperature extreme was 30minutes. This procedure was repeated 10times, after which all test cells were stored for 24hours at ambient temperature ($20 \pm 5^\circ\text{C}$) [Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.655 | 3.668 | 217.30 | 217.31 | * NM NL NV NC NE NR NF (PASS) | Ph.03 |
| #02 | | | 3.655 | 3.666 | 216.91 | 216.90 | | Ph.03 |
| #03 | | | 3.655 | 3.665 | 217.46 | 217.46 | | Ph.03 |
| #04 | | | 3.655 | 3.667 | 214.71 | 214.72 | | Ph.03 |
| #05 | | | 3.659 | 3.669 | 216.69 | 216.69 | | Ph.03 |
| #06 | | | 3.656 | 3.667 | 215.64 | 215.64 | | Ph.03 |
| #07 | | | 3.655 | 3.667 | 216.21 | 216.20 | | Ph.03 |
| #08 | | | 3.655 | 3.668 | 216.61 | 216.61 | | Ph.03 |
| #09 | | | 3.655 | 3.667 | 214.93 | 214.94 | | Ph.03 |
| #10 | | | 3.655 | 3.666 | 214.86 | 214.87 | | Ph.03 |
| #16 | Fully Discharged Cells | [Test Procedure] Test cells were stored for 6hours at $75 \pm 2^\circ\text{C}$, followed by storage for 6hours at $-40 \pm 2^\circ\text{C}$. The maximum time interval between test temperature extreme was 30minutes. This procedure was repeated 10times, after which all test cells were stored for 24hours at ambient temperature ($20 \pm 5^\circ\text{C}$) [Requirement] -NM / NL / NV / NC / NE / NR / NF | - | - | 219.18 | 219.18 | * NM NL NV NC NE NR NF (PASS) | Ph.04 |
| #17 | | | - | - | 218.74 | 218.75 | | Ph.04 |
| #18 | | | - | - | 216.75 | 216.75 | | Ph.04 |
| #19 | | | - | - | 217.00 | 216.99 | | Ph.04 |
| #20 | | | - | - | 217.00 | 216.99 | | Ph.04 |
| #21 | | | - | - | 213.22 | 213.22 | | Ph.04 |
| #22 | | | - | - | 216.18 | 216.18 | | Ph.04 |
| #23 | | | - | - | 216.63 | 216.62 | | Ph.04 |
| #24 | | | - | - | 216.88 | 216.35 | | Ph.04 |
| #25 | - | - | 216.42 | 216.41 | Ph.04 | | | |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

3. Vibration test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|---|-------|------------|--------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Cells were firmly secured to the platform of the vibration machine. The vibration was a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15minutes. This cycle was repeated 12times for a total of 3hours for each of 3mutually perpendicular mounting positions of the cells. •Frequency,Acceleration and amplitude - 7~18Hz : 1G - 18~50Hz : 1~8G(1.6mm p-p) - 50~200Hz : 8G [Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.668 | 3.668 | 217.31 | 217.31 | * NM NL NV NC NE NR NF (PASS) | Ph.05 |
| #02 | | | 3.666 | 3.666 | 216.90 | 216.90 | | Ph.05 |
| #03 | | | 3.665 | 3.666 | 217.46 | 217.46 | | Ph.05 |
| #04 | | | 3.667 | 3.667 | 214.72 | 214.73 | | Ph.05 |
| #05 | | | 3.669 | 3.669 | 216.69 | 216.69 | | Ph.05 |
| #06 | | | 3.667 | 3.668 | 215.64 | 215.64 | | Ph.05 |
| #07 | | | 3.667 | 3.667 | 216.20 | 216.19 | | Ph.05 |
| #08 | | | 3.668 | 3.668 | 216.61 | 216.61 | | Ph.05 |
| #09 | | | 3.667 | 3.667 | 214.94 | 214.94 | | Ph.05 |
| #10 | | | 3.666 | 3.666 | 214.87 | 214.87 | | Ph.05 |
| #16 | Fully Discharged Cells | [Test Procedure] Cells were firmly secured to the platform of the vibration machine. The vibration was a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15minutes. This cycle was repeated 12times for a total of 3hours for each of 3mutually perpendicular mounting positions of the cells. •Frequency,Acceleration and amplitude - 7~18Hz : 1G - 18~50Hz : 1~8G(1.6mm p-p) - 50~200Hz : 8G [Requirement] - NM / NL / NV / NC / NE / NR / NF | - | - | 219.18 | 219.18 | * NM NL NV NC NE NR NF (PASS) | Ph.06 |
| #17 | | | - | - | 218.75 | 218.75 | | Ph.06 |
| #18 | | | - | - | 216.75 | 216.75 | | Ph.06 |
| #19 | | | - | - | 216.99 | 217.00 | | Ph.06 |
| #20 | | | - | - | 216.99 | 216.99 | | Ph.06 |
| #21 | | | - | - | 213.22 | 213.22 | | Ph.06 |
| #22 | | | - | - | 216.18 | 216.17 | | Ph.06 |
| #23 | | | - | - | 216.62 | 216.62 | | Ph.06 |
| #24 | | | - | - | 216.35 | 216.35 | | Ph.06 |
| #25 | | | - | - | 216.41 | 216.41 | | Ph.06 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

4. Shock test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|---|-------|------------|--------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Each test cell was subjected to a halfsine shock of peak acceleration of 150g _n and pulse duration of 6ms. Each cell was subjected to 3shocks in the positive direction followed by 3 shocks in the negative direction of 3mutually perpendicular mounting positions of the cell for a total of 18 shock. [Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.668 | 3.668 | 217.31 | 217.31 | * NM NL NV NC NE NR NF (PASS) | Ph.07 |
| #02 | | | 3.666 | 3.666 | 216.90 | 216.90 | | Ph.07 |
| #03 | | | 3.666 | 3.666 | 217.46 | 217.46 | | Ph.07 |
| #04 | | | 3.667 | 3.666 | 214.73 | 214.73 | | Ph.07 |
| #05 | | | 3.669 | 3.669 | 216.69 | 216.70 | | Ph.07 |
| #06 | | | 3.668 | 3.668 | 215.64 | 215.64 | | Ph.07 |
| #07 | | | 3.667 | 3.667 | 216.19 | 216.19 | | Ph.07 |
| #08 | | | 3.668 | 3.667 | 216.61 | 216.62 | | Ph.07 |
| #09 | | | 3.667 | 3.667 | 214.94 | 214.94 | | Ph.07 |
| #10 | | | 3.666 | 3.666 | 214.87 | 214.87 | | Ph.07 |
| #16 | Fully Discharged Cells | [Test Procedure] Each test cell was subjected to a halfsine shock of peak acceleration of 150g _n and pulse duration of 6ms. Each cell was subjected to 3shocks in the positive direction followed by 3 shocks in the negative direction of 3mutually perpendicular mounting positions of the cell for a total of 18 shock. [Requirement] - NM / NL / NV / NC / NE / NR / NF | - | - | 219.18 | 219.18 | * NM NL NV NC NE NR NF (PASS) | Ph.08 |
| #17 | | | - | - | 218.75 | 218.75 | | Ph.08 |
| #18 | | | - | - | 216.75 | 216.75 | | Ph.08 |
| #19 | | | - | - | 217.00 | 217.01 | | Ph.08 |
| #20 | | | - | - | 216.99 | 216.99 | | Ph.08 |
| #21 | | | - | - | 213.22 | 213.22 | | Ph.08 |
| #22 | | | - | - | 216.17 | 216.16 | | Ph.08 |
| #23 | | | - | - | 216.62 | 216.62 | | Ph.08 |
| #24 | | | - | - | 216.35 | 216.35 | | Ph.08 |
| #25 | | | - | - | 216.41 | 216.41 | | Ph.08 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

5. External short circuit test

| Specimen No. | State of charge | Test procedure & requirement | Max. Temperature of during test(°C) | Result | Photo |
|--------------|------------------------|--|-------------------------------------|---|-------|
| #01 | Un-Discharged Cells | [Test Procedure] Test cells were subjected to a short circuit condition with a total external resistance of less than 0.1Ω at $55\pm 2^\circ\text{C}$. The test has been continued for 1hour after the cell external case temperature has returned to $55\pm 2^\circ\text{C}$. Test cell was observed for a further 6hours. [Requirement] - NE / NR / NF - External temperature of the cell $\leq 170^\circ\text{C}$ (NT) | 17.0 | * NT NE NR NF (PASS) | Ph.09 |
| #02 | | | 20.3 | | Ph.09 |
| #03 | | | 17.9 | | Ph.09 |
| #04 | | | 17.9 | | Ph.09 |
| #05 | | | 16.6 | | Ph.09 |
| #06 | | | 18.5 | | Ph.09 |
| #07 | | | 18.1 | | Ph.09 |
| #08 | | | 16.9 | | Ph.09 |
| #09 | | | 16.1 | | Ph.09 |
| #10 | | | 16.7 | | Ph.09 |
| #16 | Fully Discharged Cells | [Test Procedure] Test cells were subjected to a short circuit condition with a total external resistance of less than 0.1Ω at $55\pm 2^\circ\text{C}$. The test has been continued for 1hour after the cell external case temperature has returned to $55\pm 2^\circ\text{C}$. Test cell was observed for a further 6hours. [Requirement] - NE / NR / NF - External temperature of the cell $\leq 170^\circ\text{C}$ (NT) | 16.0 | * NT NE NR NF (PASS) | Ph.10 |
| #17 | | | 15.9 | | Ph.10 |
| #18 | | | 15.6 | | Ph.10 |
| #19 | | | 15.8 | | Ph.10 |
| #20 | | | 16.1 | | Ph.10 |
| #21 | | | 16.1 | | Ph.10 |
| #22 | | | 18.1 | | Ph.10 |
| #23 | | | 16.0 | | Ph.10 |
| #24 | | | 15.8 | | Ph.10 |
| #25 | | | 16.1 | | Ph.10 |

* NT : No excessive temperature rise, NE : No explosion, NR : No Rupture, NF : No Fire

6. Impact test

| Specimen No. | State of charge | Test procedure & requirement | Max. Temperature of during test(°C) | Result | Photo |
|--------------|------------------------|--|-------------------------------------|-----------------------------------|-------|
| #11 | Un-Discharged Cells | [Test Procedure] A 15.8mm diameter bar was placed across the center of the fully charged cells. Then 9.1kg weight was dropped from a height of 61cm onto cells. [Requirement] - NE / NF - External temperature of the cell ≤ 170°C (NT) | 15.1 | * NT NE NF (PASS) | Ph.11 |
| #12 | | | 14.8 | | Ph.11 |
| #13 | | | 15.6 | | Ph.11 |
| #14 | | | 15.0 | | Ph.11 |
| #15 | | | 14.9 | | Ph.11 |
| #26 | Fully Discharged Cells | [Test Procedure] A 15.8mm diameter bar was placed across the center of the fully discharged cells. Then 9.1kg weight was dropped from a height of 61cm onto cells. [Requirement] - NE / NF - External temperature of the cell ≤ 170°C (NT) | 14.1 | * NT NE NF (PASS) | Ph.12 |
| #27 | | | 14.5 | | Ph.12 |
| #28 | | | 15.8 | | Ph.12 |
| #29 | | | 15.3 | | Ph.12 |
| #30 | | | 14.7 | | Ph.12 |

7. f

| Specimen No. | State of charge | Test procedure & requirement | Result | Reference |
|--------------|------------------------|--|-----------------------------|-----------|
| #31 | Fully Discharged Cells | [Test Procedure] Test cells were discharged by constant current of 550mA during 6hours. [Requirement] - NE / NF | * NE NF (PASS) | Ph.13 |
| #32 | | | | Ph.13 |
| #33 | | | | Ph.13 |
| #34 | | | | Ph.13 |
| #35 | | | | Ph.13 |
| #36 | | | | Ph.13 |
| #37 | | | | Ph.13 |
| #38 | | | | Ph.13 |
| #39 | | | | Ph.13 |
| #40 | | | | Ph.13 |

* NT : No excessive temperature rise, NE : No explosion, NF : No Fire

Photographs



#01 ~ #05



#06 ~ #10

Photographs of specimen before test



#01 ~ #05



#06 ~ #10

Photographs of specimen after test

Photo.01 – Photographs of specimen before & after Altitude simulation test (Undischarged cells)

Photographs



#16 ~ #20



#21 ~ #25

Photographs of specimen before test



#16 ~ #20



#21 ~ #25

Photographs of specimen after test

Photo.02 – Photographs of specimen before & after Altitude simulation test (Fully discharged cells)

Photographs



#01 ~ #05



#06 ~ #10

Photographs of specimen before test



#01 ~ #05



#06 ~ #10

Photographs of specimen after test

Photo.03 – Photographs of specimen before & after Thermal test (Undischarged cells)

Photographs



#16 ~ #20



#21 ~ #25

Photographs of specimen before test



#16 ~ #20



#21 ~ #25

Photographs of specimen after test

Photo.04 – Photographs of specimen before & after Thermal test (Fully discharged cells)

Photographs



#01 ~ #05



#06 ~ #10

Photographs of specimen before test



#01 ~ #05



#06 ~ #10

Photographs of specimen after test

Photo.05 – Photographs of specimen before & after Vibration test (Undischarged cells)

Photographs



#16 ~ #20



#21 ~ #25

Photographs of specimen before test



#16 ~ #20



#21 ~ #25

Photographs of specimen after test

Photo.06 – Photographs of specimen before & after Vibration test (Fully discharged cells)

Photographs



#01 ~ #05



#06 ~ #10

Photographs of specimen before test



#01 ~ #05



#06 ~ #10

Photographs of specimen after test

Photo.07 – Photographs of specimen before & after Shock test (Undischarged cells)

Photographs



#16 ~ #20



#21 ~ #25

Photographs of specimen before test



#16 ~ #20



#21 ~ #25

Photographs of specimen after test

Photo.08 – Photographs of specimen before & after Shock test (Fully discharged cells)

Photographs



#01 ~ #05



#06 ~ #10

Photographs of specimen before test



#01 ~ #05



#06 ~ #10

Photographs of specimen after test

Photo.09 – Photographs of specimen before & after External short circuit test (Undischarged cells)

Photographs



#16 ~ #20



#21 ~ #25

Photographs of specimen before test



#16 ~ #20



#21 ~ #25

Photographs of specimen after test

Photo.10 – Photographs of specimen before & after External short circuit test (Fully discharged cells)