Version: 1 01.08.2011





| Prüfbericht - Nr.:<br>Test Report No.:   | 17021048 001   | Attachment 1  | Seite 1 von 19<br>Page 1 of 19                               |
|--|--|---|--|
| Auftraggeber:<br>Client:   | GlobTek, Inc.  |   |  |
| Gegenstand der Prüfung:<br>Test item:  | Rechargeable Lithiu  | Im Ion Cell   |  |
| Bezeichnung:<br>Identification:  | SR703880F  | Serien-Nr.:<br>Serial No.:  | N/A  |
| Wareneingangs-Nr.:<br>Receipt No.:   | 153176330  | Eingangsdatum:<br>Date of receipt:  | 2011-10-18   |
| Zustand des Prüfgegenstandes bei<br>Anlieferung:<br>Condition of test item at delivery:  | Sample is OK for test  | ting.   |  |
| Prüfort:TÜV Rheinland (Shenzhen) Co., Ltd.Testing location:1 F, Cybio Technology Building No. 1, Langshan No. 2 Road South,<br>Industrial Area, High-Tech Industry Park North, Nanshan District,<br>518057 Shenzhen, P. R. China             |  |   | gshan No. 2 Road South, 5th<br>Iorth, Nanshan District,      |
| Prüfgrundlage:UL 1642:2005 (revisions dated November 25, 2009)Test specification:  |  |   | er 25, 2009)   |
| <b>Prüfergebnis:</b><br>Test Result:   | Der Prüfgegenstand<br>The test item passed   | d entspricht oben go<br>the test specification  | enannter Prüfgrundlage(n).<br>n(s).                          |
| <b>Prüflaboratorium:</b><br>Testing Laboratory:  | <b>TÜV Rheinland (Sh</b><br>3&4 F, Cybio Techn<br>5th Industrial Area,<br>518057 Shenzhen, | <b>nenzhen) Co., Ltd.</b><br>ology Building No. 1,<br>High-Tech Industry P<br>P. R. China | Langshan No. 2 Road South,<br>ark North, Nanshan District,   |
| geprüft/ tested by:  | kontrollie   | <b>rt/</b> reviewed by:   | <u>^</u>   |
| 2012-08-14 Charles Cao / PE CHAR   | 85 CAD 2012-08-1   | 4 Sean Pan / Rev  | viewer Standers  |
| DatumName/StellungUnterDateName/PositionSign   | ature Date   | m Name/Stell<br>Name/Posit  | ung Unterschrift<br>ion Signature                            |
| Sonstiges/ Other Aspects:  |  |   |  |
| The complete test report includes the  | following documents:-  | Test report (19 pages   | \$).   |
| Abkürzungen:P(ass) =entspricht PrüfgrundlageAbbreviations:P(ass) =passedF(ail) =entspricht nicht PrüfgrundlageF(ail) =failedN/A =nicht anwendbarN/A =not applicableN/T =nicht getestetN/T =not tested  |  |   | = passed<br>= failed<br>= not applicable<br>= not tested     |
| Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.                            |  |   | migung der Prüfstelle nicht<br>dung eines Prüfzeichens.      |
| This test report relates to the a.m. test sample. Without permission of the test center this test report is not permitted to duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products. |  |   | test report is not permitted to be this or similar products. |
| TÜV Rheinland LGA Products · Tillystrasse 2 · D-90431 Nürnberg · Tel.: +49 911 655 5225 · Fax +49 911 655 5226<br>Mail: service@de.tuv.com · Web: <u>www.tuv.com</u>   |  |   |  |



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| Test item particulars:   |   |
|--|---|
| Information about the product needed to establish a correct test program, such as product mobility, type of power connections and similar. | (Test item particulars are selected by the TRF Originator base on the requirements in the standard) |
| Designation:   | SR703880F   |
| Nominal voltage  | 3.3V  |
| Rated capacity:  | 1600mAh   |
| Maximum charge voltage   | 3.85V   |
| End discharge voltage:   | 2.0V  |
| Manufacturer's charge method:  | Charge the cell at 0.5C CC to 3.65V, then CV until charging current reaches 0.03C                   |
| Chemistry:   | LiFePo <sub>4</sub>   |
| Utilization Type   | Technician-replaceable cell   |
| 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(ail)  |
| Testing:   |   |
| Date of receipt of test item   | 2011-10-18  |
| Date(s) of performance of tests  | 2011-10-31 to 2011-11-11  |
| General remarks:   |   |
| This report shall not be reproduced, except in full, with  | nout the written approval of the testing laboratory.  |
| The test results presented in this report relate only to   | the object tested.  |
| "(see remark #)" refers to a remark appended to the r  | eport.  |
| "(see appended table)" refers to a table appended to t   | he report.  |
| Throughout this report a point is used as the decimal  | separator.  |
| Copy of marking plate:   |   |
| GLO<br>Rechargeab<br>SR<br>1600mA<br>20  | OBTEK<br>le Lithium Ion Cell<br>703880F<br>h 3.3V 5.28WH<br>11.10.10                                |

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Report No.: 17021048 001 Attachment 1

### Summary of testing:

#### Test items:

cl.10 Short-Circuit Test; cl.11 Abnormal Charging Test; cl.13 CrushTest; cl.14 ImpactTest; cl.15 Shock Test; cl.16 Vibration Test; cl.17 Heating Test; cl.18 Temperature Cycling Test; cl.19 Low Pressure (Altitude Simulation) Test; cl.20 Projectile Test; cl.21 General

## **Description of the product:**

This tested sample is constructed with only one single Li-ion cell and doesn't have any over current and shortcircuits proof circuit.

1) These tested cells have not been evaluated in combination with charger(s) or host product(s). Additional evaluation to determine compliance may be required on the combination(s) in the end product evaluation.

2) The tested cells were evaluated for a maximum charge current and maximum voltage limit outlined in the Table above. The end product evaluation shall ensure that current and voltage limits noted are maintained.

3) The tested cell shall be fixed in a case with sufficient protective strength as mechanical enclosure and fire enclosure. The end product shall be kept away from fire and high temperature area.

Max. Nominal Nominal Max. Max. End Nominal Nominal discharge Model Charge discharge charge discharge charge capacity voltage current current current current voltage voltage SR70388 2.0V 1600mAh 3.3V 800mA 800mA 1600mA 24A 3.85V 0F

#### - Table 1: Electrical parameters

### **Construction:**



| Item项目 | Specific参数    |
|--------|---------------|
| Т      | 6.7 ± 0.3 mm  |
| W      | 37.0 ± 1.0 mm |
| L      | 79.0 ± 1.0 mm |
| L2     | 1.5 ± 1.0 mm  |
| L3     | 10.0 ± 2.0 mm |
| w      | 14.0 ± 1.5 mm |
| d      | 5.0 ± 0.2 mm  |



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Clause

Requirement + Test

Result - Remark

Verdict

| INTRODUC | TION   |   |     |
|----------|--|---|-----|
| 1        | Scope  |   | Р   |
| 2        | General  |   | Р   |
| 3        | Glossary   |   | Р   |
| CONSTRUC | CTION  |   |     |
| 4        | General  |   | Р   |
| 4.1      | Casing   |   | Р   |
| 4.1.1    | The casing of a lithium battery shall have the<br>strength and rigidity necessary to resist the abuses<br>to which it may be subjected, without resulting in a<br>risk of fire. The casing of a user-replaceable lithium<br>battery shall have the strength and rigidity necessary<br>to resist the abuses to which it may be subjected<br>without resulting in a risk of injury to persons.   | The casing of the lithium cell can meet the strength and rigidity requirements.                                       | Ρ   |
| 4.1.2    | A cell of a user-replaceable battery shall be in a rigid<br>casing of sufficient strength to prevent flexing. A tool<br>providing the mechanical advantage of a pliers,<br>screwdriver, or hacksaw shall be the minimum<br>capable of opening the user-replaceable cell casing,<br>if opening of the casing will expose metallic lithium.  | Technician-replaceable cell.<br>The casing of the lithium<br>cell can meet the strength<br>and rigidity requirements. | N/A |
| 4.2      | Electrolyte  |   | Р   |
| 4.2.1    | A user-replaceable battery shall not contain<br>pressurized vapor or liquid that could spray materials<br>into the eyes or leak more than 5 milliliters of liquid<br>when the battery casing is punctured under normal<br>laboratory conditions, $23 \pm 2^{\circ}$ (73 $\pm 3.6^{\circ}$ ).   | Technician-replaceable cell.  | N/A |
| 4.3      | Use  |   | N/A |
| 4.3.1    | A lithium battery shall be protected from abnormal charging currents during use. A battery tested and found acceptable for the charging current, $I_C$ (see Section 11), under fault conditions specified by the manufacturer, shall be protected from larger charging currents in the end product application by: a) Two blocking components, such as diodes, or b) One blocking component and one current limiting component, such as a resistor or a fuse. The current limiting component shall limit the charging current to one-third the value used in the Abnormal Charging Test, Section 11. |   | N/A |
| PERFORM  | ANCE   |   |     |
| 5        | General  |   | Р   |
| 5.1      | Technician-replaceable Batteries   |   | Р   |



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|        | UL1042:2005   |                                 |         |
|--------|---|---------------------------------|---------|
| Clause | Requirement + Test  | Result - Remark                 | Verdict |
|        |   | ·                               |         |
| 5.1.1  | Technician-replaceable lithium cells or batteries are<br>to be tested as described in Sections 10—20.<br>Section 12, Forced Discharge Test, is applicable<br>only to cells intended to be used in multicell<br>applications such as battery packs. For multicell<br>installations, also see 5.3.1. No fire or explosion shall<br>occur as a result of the Short-Circuit Test, Section<br>10, the Shock Test, Section 15, the Vibration Test,<br>Section 16, the Temperature Cycling Test, Section<br>18 or the Altitude Simulation Test, Section 19. Also,<br>the temperature of an exterior cell or battery casing<br>shall not exceed 150°C (302°F) when tested in<br>accordance with the Short-Circuit Test. When a fire<br>or explosion occurs as a result of the Abnormal<br>Charging Test, Section 11; Crush Test, Section 13;<br>Impact Test, Section 14; or Heating Test, Section 17;<br>the use of the technician replaceable cell or battery<br>shall be restricted to applications in which it is not<br>exposed to, or is protected from, any conditions<br>shown to cause a fire or explosion. Cells and<br>batteries subjected to the Shock Test, Section 15,<br>Vibration Test, Section 16, Temperature Cycling<br>Test, Section 18, and Altitude Simulation Test,<br>Section 19 shall also not leak or vent. For these<br>tests, unacceptable leakage is determined to have<br>occurred when the resulting mass loss exceeds the<br>values shown in Table 5.1, Venting and Leakage<br>Mass Loss Criteria. | See appended table for testing. | P       |
| 5.2    | User-replaceable Batteries  |                                 | N/A     |
| 5.2.1  | User-replaceable lithium cells or batteries are to be tested as described in Sections 10-20. Section 12, Forced Discharge Test, is applicable only to cells intended to be used in multicell applications such as battery packs. In addition to complying with the requirements for a technician replaceable cell or battery as specified in 5.1.1, a user-replaceable cell or battery shall not explode or ignite when subjected to the Crush Test, Section 13, or the Impact Test, Section14.   | Technical-replaceable cell.     | N/A     |
| 5.2.2  | Sets of five specimens each are to be used for the<br>Projectile Test, Section 20.3; see Table 6.3. When<br>only one specimen from a set of five does not<br>comply with the requirements, another set of five<br>specimens is to be tested. All specimens from this<br>second set shall comply with the requirements.  |                                 | N/A     |
| 5.3    | Multi-cell Installation   |                                 | N/A     |



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|        | UL1642:2005   |   |         |
|--------|---|---|---------|
| Clause | Requirement + Test  | Result - Remark                                 | Verdict |
| 5.3.1  | A technician-replaceable or user-replaceable cell<br>intended for use in multicell installations or battery<br>packs shall also be tested as described in 10.3 and<br>Section 12. No fire or explosion shall occur as a<br>result of these tests. In addition, batteries subjected<br>to the test described in 10.3 shall meet the<br>requirements as described in 5.1.1 and 5.2.1 for a<br>cell or battery subjected to the Short-Circuit Test,<br>Section10.  | One single cell                                 | N/A     |
| 6      | Samples   |   | Р       |
| 6.1    | Fully charged primary cells or batteries and primary<br>cells or batteries that have been conditioned by<br>partial or complete discharge, or both, are to be used<br>for the tests described in Sections 10-20. The<br>number of samples to be used in each test for a<br>primary technician-replaceable cell or battery is<br>shown in Table 6.1. The number of samples to be<br>used in each test for a primary user-replaceable cell<br>or battery is shown in Table 6.3. When a group of<br>cells or batteries of different sizes, but similar<br>chemistries is involved, selected sizes representative<br>of the range are to be tested. | The samples are secondary<br>lithium-ion cells. | N/A     |
| 6.2    | Fully charged secondary cells or batteries and<br>secondary cells or batteries that have been<br>conditioned by charge-discharge cycling are to be<br>used for the tests described in Sections 10 — 20.<br>The number of samples to be used in each test for a<br>secondary technician-replaceable cell or battery is<br>shown in Table 6.2. The number of samples to be<br>used in each test for a secondary user-replaceable<br>cell or battery is shown in Table 6.4. When a group<br>of cells or batteries of different sizes, and similar<br>chemistries is involved, selected sizes representative<br>of the range are to be tested.      | Prepared as required.                           | Ρ       |
| 7      | Conditioning of Samples   |   | Р       |
| 7.1    | Discharge   |   | N/A     |
| 7.1.1  | Primary batteries are to be completely discharged by<br>connecting their terminals through resistors that<br>provide the desired level of discharge within 60 days.<br>Completely discharged is considered to be the state<br>in which the closed-circuit voltage has been reduced<br>to less than 0.2 volts and the short-circuit current to<br>less than 1.0 milliamperes. Batteries are to be<br>discharged at room temperature. Cells with a liquid<br>cathode such as thionyl chloride or sulfur dioxide,<br>shall also be conditioned by one-half discharge   | The samples are secondary<br>lithium-ion cells. | N/A     |



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|        | UL1642:2005  |   |         |
|--------|--|---|---------|
| Clause | Requirement + Test   | Result - Remark   | Verdict |
| 7.1.2  | For solid electrolyte and other types of primary<br>lithium batteries that cannot be discharged within 60<br>days because of the small currents they inherently<br>produce, longer discharge times plus discharge at<br>higher temperatures may be used to obtain the<br>desired level of discharge. The manufacturer's<br>recommended discharge procedures are to be<br>followed so as to obtain the required discharge level<br>in the minimum time.   | The samples are secondary lithium-ion cells.  | N/A     |
| 7.2    | Charge-discharge cycling   |   | Р       |
| 7.2.1  | Secondary cells are to be conditioned at 25°C (77°F). Cells are continuously cycled as per the manufacturer's specifications. The specification shall be such that the full rated capacity of the cell is utilized and the number of cycles accumulated shall be at least equal to 25 percent of the advertised cycle life of the cell or cycled continuously for 90 days, whichever is shorter. Cycling is to be done either individually or in groups. Cells are to be recharged prior to testing as indicated in Table 6.2 and Table 6.4. | The samples are cycled at<br>manufacturer's factory<br>before they were sent to be<br>tested. | Ρ       |
| 8      | Important test considerations  |   | Р       |
| 8.1    | Some lithium batteries are capable of exploding<br>when the tests described in Sections 10-20 are<br>conducted. It is important that personnel be<br>protected from the flying fragments, explosive force,<br>sudden release of heat, and noise that results from<br>such explosions. The test area is to be well<br>ventilated to protect personnel from possible harmful<br>fumes or gases.  | Prepared the tests as required.   | Р       |
| 8.2    | As an additional precaution, the temperatures on the surface of the battery casings shall be monitored during the tests described in Sections 10, 12, 13, and 14. All personnel involved in the testing of lithium batteries are to be instructed never to approach a lithium battery while the surface temperature exceeds $90^{\circ}C$ ( $194^{\circ}F$ ).  | Prepared the tests as required.   | Р       |
| 8.3    | For protection, the Projectile Test, Section 20 is to be conducted in a room separate from the observer.   | Prepared the tests as required.   | Р       |
| 9      | Temperature measurements   |   | Р       |
| 9.1    | Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm2) and not smaller than 30 AWG (0.05 mm2) and a potentiometer-type instrument.   | Prepared the tests as required.   | Р       |
| 9.2    | The temperature measurements on the batteries are<br>to be made with the measuring junction of the<br>thermocouple held tightly against the metal casing of<br>the battery.  | Prepared the tests as required.   | Р       |



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Clause

Requirement + Test

Result - Remark

Verdict

| ELECTF |   |   |     |
|--------|---|---|-----|
| 10     | Short-Circuit Test  |   | Р   |
| 10.1   | Each test sample battery, in turn, is to be short-<br>circuited by connecting the positive and negative<br>terminals of the battery with a circuit load having a<br>maximum resistance load of 0.1 ohm. The battery is<br>to discharge until a fire or explosion is obtained, or<br>until it has reached a completely discharged state of<br>less than 0.1 volts and the battery case temperature<br>has returned to $\pm 10^{\circ}$ ( $\pm 18^{\circ}$ ) of ambient<br>temperature. | Tested as required. See appended table.   | Ρ   |
| 10.2   | Tests are to be conducted at $20 \pm 5^{\circ} (68 \pm 9^{\circ})$ and<br>at $55 \pm 5^{\circ} (131 \pm 9^{\circ})$ . The batteries are to reach<br>equilibrium at $20 \pm 5^{\circ}$ or $55 \pm 5^{\circ}$ , as applicable,<br>before the terminals are connected.   | Tested as required.   | Ρ   |
| 10.3   | A battery is to be tested individually unless the<br>manufacturer indicates that it is intended for use in<br>series or parallel. For series or parallel use,<br>additional tests on five sets of batteries are to be<br>conducted using the maximum number of batteries<br>to be covered for each configuration.   | Tested as required.   | Ρ   |
| 10.4   | When an overcurrent or thermal protective device<br>that has been investigated for the purpose actuates<br>during the test, the test shall be repeated with the<br>battery supply connected to the maximum load that<br>does not cause the protective device to open. A<br>protective device that has not been investigated for<br>the purpose shall be short-circuited.  | Only one single lithium-ion<br>cell, no over-current or<br>thermal protective device<br>was integrated into the cell. | N/A |
| 10.5   | The samples shall not explode or catch fire. The temperature of the exterior cell or battery casing shall not exceed $150^{\circ}$ ( $302^{\circ}$ ).   | The test results meet the requirements.   | Ρ   |
| 11     | Abnormal Charging Test  |   | Р   |
| 11.1   | Primary cells or batteries shall comply with 11.2—<br>11.7.   | Secondary cell  | N/A |
| 11.2   | Cells or batteries conditioned in accordance with Tables 6.1 or 6.3, as applicable, are to be used for this test. The batteries are to be tested in an ambient temperature of $20 \pm 5^{\circ}$ (68 $\pm 9^{\circ}$ F).  | Secondary cell  | N/A |



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|-------------|--|---------------------|---------|
| Clause      | Requirement + Test   | Result - Remark     | Verdict |
| L           |  | 1                   |         |
| 11.3        | Each test sample battery is to be subjected to a charging current of three times the current I, specified by the manufacturer by connecting it in opposition to a dc-power supply. The specified charging current is to be obtained by connecting a resistor of the specified size and rating in series with the battery. The test charging time is to be calculated using the formula:  | Secondary cell      | N/A     |
|             | $t_c = \frac{2.5C}{3(l_c)}$ , in which   |                     |         |
|             | $t_c$ is the charging time in hour   |                     |         |
|             | <b>C</b> is the capacity of the cell/batteiy in ampere-hours, and  |                     |         |
|             | <i>I<sub>c</sub></i> is the maximum charging current, in amperes, specified by the manufacturer.   |                     |         |
|             | The minimum charging time is to be 7 hours.  |                     |         |
| 11.4        | When a non-resettable overcurrent or thermal<br>protective device that has been investigated for the<br>purpose operates during the test, the test is to be<br>repeated at a charge current below the level that the<br>protective device operates. When a resettable<br>protective device operates during the test, the<br>protector is allowed to reset to a total of 10 cycles; or<br>until the appropriate charging time has been<br>completed, but not less than 7 hours. A protective<br>device that has not been investigated for the purpose<br>is to be short-circuited. See 2.3.2. | Secondary cell      | N/A     |
| 11.5        | The samples shall not explode or catch fire.   | Secondary cell      | N/A     |
| 11.6        | Secondary cells or batteries shall comply with 11.7—<br>11.10.   | See table 11        | Р       |
| 11.7        | Cells or batteries conditioned in accordance with<br>Tables 6.2 or 6.4, as applicable, are to be used for<br>this test. The batteries are to be tested in an ambient<br>temperature of $20 \pm 5$ °C (68 $\pm 9$ °F).  | Tested as required. | Р       |
| 11.8        | Each test sample battery is to be discharged at a constant current of 0.2c/lhour, to a manufacturer specified discharge endpoint voltage. The cell or battery is then to be charged with a constant maximum specified output voltage and a current limit of three times the maximum charging current, I, specified by the manufacturer. Charging duration is to be 7 hours or the time required to reach the manufacturer's specified end-of-charge condition, whichever is greater.   | Tested as required. | Р       |



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| UL1642:2005 |        |
|-------------|--------|
|             | Desult |

| Clause           | Requirement + Test   | Result - Remark   | Verdict |
|------------------|--|---|---------|
| 11.9             | The cell/battery is to be tested without the assistance  | The samples are to be   | Р       |
|                  | of overcurrent or thermal protective devices, unless<br>such protective devices have been investigated for<br>the purpose. When a non-resettable overcurrent or<br>thermal protective device operates during the test,<br>the test shall be repeated at an overcharging current<br>below the level that the protection device operates.<br>When a resettable protective device operates during<br>the test, the protector is to be allowed to reset to a<br>total of 10 cycles; or until the appropriate charging<br>time has been completed, but not less than 7 hours.<br>A protective device that has not been investigated for<br>the purpose is to be short-circuited. See 2.3.2. | tested without any<br>assistance of over-current<br>or thermal protective<br>devices. |         |
| 11.10            | The samples shall not explode or catch fire.   | No explosion or catch fire during and after the test                                  | Р       |
| 12               | Forced-Discharged Test   |   | N/A     |
| 12.1             | This test is intended for cells that are to be used in series-connected, multicell applications, such as battery packs.  | One single cell   | N/A     |
| 12.2             | A completely discharged cell is to be force-<br>discharged by connecting it in series with fully<br>charged cells of the same kind. The number of fully<br>charged cells to be connected in series with the<br>discharged cell is to equal the maximum number<br>less one of the cells to be covered for series use.<br>Five cells are to be completely discharged, at room<br>temperature.  |   | N/A     |
| 12.3             | Once the completely discharged cell is connected in<br>series with the specified number of fully charged<br>cells the resultant battery pack is to be short<br>circuited.  |   | N/A     |
| 12.4             | The positive and negative terminals of the sample<br>are to be connected with a copper wire with a<br>maximum resistance load of 0.1 ohm. The sample is<br>to discharge until a fire or explosion is obtained, or<br>until it has reached a completely discharged state of<br>less than 0.2 volts and the battery case temperature<br>has returned to $\pm 10^{\circ}$ (18F) of ambient<br>temperature.  |   | N/A     |
| 12.5             | When an overcurrent or thermal protective device<br>that has been investigated for the purpose operates<br>during the test, the test shall be repeated with the<br>battery supply connected to the maximum load that<br>does not cause the protective device to open. A<br>protective device that has not been investigated for<br>the purpose shall be short-circuited.   |   | N/A     |
| 12.6             | The samples shall not explode or catch fire.   |   | N/A     |
| MECHANICAL TESTS |  |   |         |
| 13               | Crush Test   |   | Р       |



90 degrees around its

will be subjected to the

crushing force.

longitudinal axis so that both

the wide and narrow sides

Not a coin or button battery

No explosion or catch fire

during and after the test. Max temp at case: 103.27C. N/A

Ρ

Ρ

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|--------|---|--|--------------|
|        | UL1642:2005   |  |              |
| Clause | Requirement + Test  | Result - Remark  | Verdict      |
| 13.1   | A battery is to be crushed between two flat surfaces.<br>The force for the crushing is to be applied by<br>a hydraulic ram with a 1.25 inch (32 mm) diameter<br>piston. The crushing is to be continued until a<br>pressure reading of 2500 psig (17.2 MPa) is reached<br>on the hydraulic ram, applied force of 3000 pounds<br>(13 kN). Once the maximum pressure has been<br>obtained it is to be released.   | Tested as required.  | Ρ            |
| 13.2   | A cylindrical or prismatic battery is to be crushed with<br>its longitudinal axis parallel to the flat surfaces of the<br>crushing apparatus. A prismatic battery is also to be<br>rotated 90 degrees around its longitudinal axis so<br>that both the wide and narrow sides will be subjected<br>to the crushing force. Each sample battery is to be<br>subjected to a crushing force in only one direction.<br>Separate samples are to be used for each test. | The samples are prismatic<br>cells, test imposed on<br>longitudinal axis of the cell<br>surface, also to be rotated<br>90 degrees around its<br>longitudinal axis so that both<br>the wide and narrow sides<br>will be subjected to the<br>crushing force. | Ρ            |
| 13.3   | A coin or button battery is to be crushed with the flat<br>surface of the battery parallel with the flat surfaces of<br>the crushing apparatus.   | Not a coin or button battery   | N/A          |
| 13.4   | The samples shall not explode or catch fire.  | No explosion or catch fire<br>during and after the test.<br>Max temp at case: 52.3C.   | Р            |
| 14     | Impact Test   |  | Р            |
| 14.1   | A test sample battery is to be placed on a flat<br>surface. A 5/8 inch (15.8 mm) diameter bar is to be<br>placed across the center of the sample. A 20 pound<br>(9.1 kg) weight is to be dropped from a height of 24<br>$\pm$ 1 inch (610 $\pm$ 25 mm) onto the sample.   | Prepared the test as required.   | Ρ            |
| 14.2   | A cylindrical or prismatic battery is to be impacted<br>with its longitudinal axis parallel to the flat surface<br>and perpendicular to the longitudinal axis of the 5/8<br>inch (15.8 mm) diameter curved surface lying across   | The samples are prismatic<br>cells, test imposed on<br>longitudinal axis of the cell<br>surface, also to be rotated  | Р            |

the center of the test sample. A prismatic battery is

also to be rotated 90 degrees around its longitudinal

subjected to the impact. Each sample battery is to be

subjected to only a single impact. Separate samples

A coin or button battery is to be impacted with the flat

surface of the test sample parallel to the flat surface and the 5/8 inch (15.8 mm) diameter curved surface

The samples shall not explode or catch fire.

axis so that both the wide and narrow sides are

are to be used for each test.

lying across its center.

Shock Test

14.3

14.4

15



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#### UI 1642-2005

|         | 011042.2003   |  |         |
|---------|---|--|---------|
| Clause  | Requirement + Test  | Result - Remark  | Verdict |
| 15.1    | The cell is to be secured to the testing machine by means of a rigid mount which supports all mounting surfaces of the cell. Each cell shall be subjected to a total of three shocks of equal magnitUde. The shocks are to be applied in each of three mutually perpendicular directions unless it has only two axes of symmetry in which case only two directions shall be tested. Each shock is to be applied in a direction normal to the face of the cell. For each shock the cell is to be accelerated in such a manner that during the initial 3 milliseconds the minimum average acceleration is 75 g (where g is the local acceleration due to gravity). The peak acceleration shall be tested at a temperature of $20 \pm 5^{\circ}$ ( $68 \pm 9^{\circ}$ ). | Prepared the test as<br>required. See table 15             | Ρ       |
| 15.2    | The samples shall not explode or catch fire. In addition, the sample shall not vent or leak as described in 5.1.1.  | No explosion or catch fire,<br>the sample not vent or leak | Р       |
| 16      | Vibration Test  |  | Р       |
| 16.1    | A battery is to be subjected to simple harmonic motion with an amplitude of 0.8 mm (0.03 inch) [1.6 mm (0.06 required. See table 10 inch) total maximum excursion].   |  | Р       |
| 16.2    | The frequency is to be varied at the rate of 1 hertz per<br>minute between 10 and 55 hertz, and return in not less<br>than 90 nor more than 100 minutes. The battery is to<br>be tested in three mutually perpendicular directions.<br>For a battery that has only two axes of symmetry, the<br>battery is to be tested perpendicular to each axis.   | Tested as required.  | Ρ       |
| 16.3    | The samples shall not explode or catch fire. In addition the sample shall not vent or leak as described in 5.1.1.   | The test results meet the requirements.                    | Р       |
| ENVIRON | MENTAL TESTS  |  |         |
| 17      | Heating Test  |  | Р       |
| 17.1    | A battery is to be heated in a gravity convection or<br>circulating air oven with an initial temperature of<br>$20 \pm 5^{\circ} (68 \pm 9^{\circ})$ . The temperature of the oven is t o<br>be raised at a rate of $5 \pm 2^{\circ} (9 \pm 3.6^{\circ})$ per minute<br>to a temperature of $130 \pm 2^{\circ} (302 \pm 3.6^{\circ})$ and<br>remain for 10 minutes. The sample shall return to<br>room temperature ( $20 \pm 5^{\circ}$ ) and then be examined.   | Tested as required.  | Ρ       |
| 17.2    | The samples shall not explode or catch fire.  | The test results meet the requirements.                    | Р       |
| 18      | Temperature Cycling Test  |  | Р       |



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| UL1642:2005 |   |   |         |  |  |  |  |
|-------------|---|---|---------|--|--|--|--|
| Clause      | Requirement + Test  | Result - Remark                         | Verdict |  |  |  |  |
|             |   |   |         |  |  |  |  |
| 18.1        | The batteries are to be placed in a test chamber and subjected to the following cycles:   | Tested as required. See table 18        | Р       |  |  |  |  |
|             | Raising the chamber-temperature to 70 $\pm$ 3°C (158 $\pm$ 5°F) within 30 minutes and maintaining this temperature for 4 hours.   |   |         |  |  |  |  |
|             | Reducing the chamber temperature to $20 \pm 3^{\circ} C$ (68 $\pm 5^{\circ} F$ ) within 30 minutes and maintaining this temperature for 2 hours.  |   |         |  |  |  |  |
|             | Reducing the chamber temperature to minus 40 $\pm 3$ °C (minus 40 $\pm 5$ °F) within 30 minutes and maintaining this temperature for 4 hours.   |   |         |  |  |  |  |
|             | Raising the chamber temperature to $20 \pm 3^{\circ}$ (68 $\pm 5^{\circ}$ ) within 30 minutes.  |   |         |  |  |  |  |
|             | Repeating the sequence for a further 9 cycles.  |   |         |  |  |  |  |
|             | After the 10th cycle, storing the batteries for a minimum of 24 hours, at a temperature of 20 $\pm 5^{\circ}$ (68 $\pm 9^{\circ}$ ) prior to examination.   |   |         |  |  |  |  |
| 18.2        | The samples shall not explode or catch fire. In addition, the samples shall not vent or leak as described in 5.1.1.   | The test results meet the requirements. | Р       |  |  |  |  |
| 19          | Low Pressure (Altitude Simulation) Test   |   | Р       |  |  |  |  |
| 19.1        | Sample batteries are to be stored for 6 hours at an absolute pressure of 11.6 kPa (1.68 psi) and a temperature of 20 $\pm$ 3°C (68 $\pm$ 5°F).  | Tested as required. See table 19        | Р       |  |  |  |  |
| 19.2        | The samples shall not explode or catch fire as a result<br>of the Altitude Simulation Test. In addition, the<br>samples shall not vent or leak as described in 5.1.1.   | The test results meet the requirements. | Р       |  |  |  |  |
| TESTS FOF   | SUSER-REPLACEABLE LITHIUM BATTERIES   |   |         |  |  |  |  |
| 20          | Projectile Test   |   | Р       |  |  |  |  |
| 20.1        | When subjected to the test described in 20.2 - 20.5 no part of an exploding cell or battery shall penetrate the wire screen such that some or all of the cell or battery protrudes through the screen.  | The test results meet the requirements. | Р       |  |  |  |  |
| 20.2        | Each test sample cell or battery is to be placed on a screen that covers a 102 mm (4 inch) diameter hole in the center of a platform table. The screen is to be constructed of steel wire mesh having 20 openings per inch (25.4 mm) and a wire diameter of 0.017 inch (0.43 mm). | Prepared the test as required.          | Ρ       |  |  |  |  |
| 20.3        | The screen is to be mounted 38 mm (1-1/2 inch)<br>above a burner. The fuel and air flow rates are to be<br>set to provide a bright blue flame that causes the<br>supporting screen to glow a bright red.  | Prepared the test as required.          | Р       |  |  |  |  |



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| UL1642:2005 |  |                                |         |  |  |  |  |
|-------------|--|--------------------------------|---------|--|--|--|--|
| Clause      | Requirement + Test   | Result - Remark                | Verdict |  |  |  |  |
| 20.4        | An eight-sided covered wire cage, 610 mm (2 feet) across and 305 mm (1 foot) high, made from metal screening is to be placed over the test sample. See Figure 20.1. The metal screening is to be constructed from 0.25 mm (0.010 inch) diameter aluminum wire with 16 — 18 wires per inch (25.4 mm) in each direction.   | Tested as required.            | Р       |  |  |  |  |
| 20.5        | The sample is to be heated and shall remain on the screen until it explodes or the cell or battery has ignited and burned out. It is not required to secure the sample in place unless it is at risk of falling off the screen before the test is completed. When required, the sample shall be secured to the screen with a single wire tied around the sample.   | Tested as required.            | Ρ       |  |  |  |  |
| MARKING     |  |                                |         |  |  |  |  |
| 21          | General  |                                | Р       |  |  |  |  |
| 21.1        | A battery shall be legibly and permanently marked<br>with:<br>a) The manufacturer's name, trade name, or<br>trademark or other descriptive marking by which the<br>organization responsible for the product may be<br>identified;<br>b) A distinctive ("catalog" or "model") number or   | See marking plate on page<br>2 | Ρ       |  |  |  |  |
|             | <ul><li>c) The date or other dating period of manufacture not exceeding any three consecutive months.</li></ul>  |                                |         |  |  |  |  |
| 21.2        | A battery shall be marked with the word "WARNING"<br>and the following or an equivalent statement:<br>"Risk of fire, explosion, and bums. Do not recharge,<br>disassemble, crush, heat above 100°C (212°F), or<br>incinerate."   | Deleted                        | N/A     |  |  |  |  |
| 21.3        | The packaging for a user-replaceable battery shall<br>be marked with the word "CAUTION" and the<br>following or equivalent statements:<br>"Risk of fire and burns. Do not recharge,<br>disassemble, heat above 100°C (212°F), or<br>incinerate. Keep battery out of reach of children and<br>in original package until ready to use. Dispose of<br>used batteries promptly according to local recycling<br>or waste regulations. Never put batteries in mouth. If<br>swallowed, contact your physician or local poison<br>control center." | Deleted                        | N/A     |  |  |  |  |
| 21.4        | The end product with a user-replaceable lithium<br>battery shall be permanently marked adjacent to the<br>battery:<br>"Replace battery with (battery manufacturers name or<br>end product manufacturer's name, part number) only.<br>Use of another battery may present a risk of fire or<br>explosion. See owners manual for instructions."   | Deleted                        | N/A     |  |  |  |  |



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## 111 1040-0005

| UL1642:2005 |                    |                 |         |  |  |
|-------------|--------------------|-----------------|---------|--|--|
| Clause      | Requirement + Test | Result - Remark | Verdict |  |  |
|             |                    | •               | •       |  |  |

| 21.5 | The operating or maintenance instructions shall<br>provide the user with complete instructions as to how<br>to replace and dispose of a used battery. This<br>information shall include the following:  | Deleted            | N/A |
|------|---|--------------------|-----|
|      | <ul> <li>a) A warning notice stating the following or the equivalent:</li> <li>"CAUTION — The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100°C (212°F), or incinerate. Replace battery with (batte ry manufacturers name or end product manufacturer's name and part number) only. Use of another battery may present a risk of fire or explosion."</li> </ul> |                    |     |
|      | <ul> <li>b) Complete instructions as to how to replace the battery ending with the statement:</li> <li>"Dispose of used battery promptly. Keep away from children. Do not disassemble and do not dispose of in fire."</li> </ul>  |                    |     |
| 21.6 | If a manufacturer produces a battery at more than one factory, each battery package shall have a distinctive marking to identify it as the product of a particular factory.   | One single factory | N/A |



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## **Critical Components**

Material: e.g. external enclosure, PCB, closed-end connector, sleeves, cord anchorage etc

Components with winding: e.g. motor, transformer, magnetic coil etc.

Other components: e.g. switch, thermostat, heater, plug, internal wire, capacitor, relay, varistor etc.

| Object/Part<br>No. | Manufacturer/trademark                               | Type/Model | Technical data                | Standard | Mark(s) of conformity |
|--------------------|--|------------|-------------------------------|----------|-----------------------|
| Cathode            | Shanghai Shanshan<br>Tech Co., Ltd.                  | MCP        | Tap Density:<br>≥1.32g/cm3,   |          |                       |
|                    |  |            | Surface Area: 1.0~1.6<br>m2/g |          |                       |
|                    |  |            | D50=13~15um,                  |          |                       |
|                    |  |            | D90≤25.0um,                   |          |                       |
|                    |  |            | Material: LIFEPO4             |          |                       |
| Alternative        | ChangSha HaiRong<br>Electronic Materials Co.,        | PRC30      | Tap Density:<br>≥0.9g/cm3,    |          |                       |
|                    | Ltd.   |            | Surface Area: ≤2.5<br>m2/g    |          |                       |
|                    |  |            | D10= 5~9um                    |          |                       |
|                    |  |            | D50= 13~17um                  |          |                       |
|                    |  |            | D90≤34.0um                    |          |                       |
|                    |  |            | Material: LIFEPO4             |          |                       |
| Anode              | Formasa Energy &<br>Material Technology Co.,<br>Ltd. | SFCM30050  | TAP<br>Density:1.2~1.5g/cm3,  |          |                       |
|                    |  |            | D50: 2~6um,                   |          |                       |
|                    |  |            | Surface area:6~9m2/g          |          |                       |
|                    |  |            | Material: C                   |          |                       |
| Alternative        | Advanced Lithium<br>Electrochemistry(China           | M121       | TAP<br>Density:0.8~1.2g/cm3,  |          |                       |
|                    | ShangHai)Co., Ltd.                                   |            | D50: 2~6um,                   |          |                       |
|                    |  |            | Surface<br>area:11~15m2/g     |          |                       |
|                    |  |            | Material: C                   |          |                       |
| Electrolyte        | Guangzhou Tinci<br>Materials Technology<br>Co., Ltd. | TCE808     | EC/DMC/EMC/LiPF6              |          |                       |
| Alternative        | Beijing institute of<br>chemical reagents            | BLE8153    | EC/DMC/EMC/LiPF6              |          |                       |
| Separator          | UBE Industries Co., Ltd                              | UP3074     | PP、PE;Size:20μm,<br>140C max. |          |                       |
| Alternative        | SHENZHEN SENIOR<br>TECHNOLOGY<br>MATERIAL Co., Ltd.  | SD2        | PP、PE;Size:20µm,<br>140C max. |          |                       |



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| 10                                  | TABLE: S                                    | hort-Circuit Test                                   |                                |                        |                   | Р                 |
|-------------------------------------|---|---|--------------------------------|------------------------|-------------------|-------------------|
| Fully Cha                           | rged Cell                                   |   |                                |                        |                   |                   |
| Ambient te                          | mperature: 2                                | <b>0</b> °C   |                                |                        |                   |                   |
| Sam                                 | ple No.                                     | 1#  | 2#                             | 3#                     | 4#                | 5#                |
| Tma                                 | Tmax(℃) 97.60 98.72 93.47 96.70 10          |   |                                |                        |                   | 106.00            |
| Failur                              | e Mode                                      | No  | No                             | No                     | No                | No                |
| Ambient te                          | mperature: 5                                | 5℃  |                                | 1                      |                   |                   |
| Sam                                 | ple No.                                     | 6#  | 7#                             | 8#                     | 9#                | 10#               |
| Tma                                 | ax(℃)                                       | 100.02  | 95.95                          | 104.30                 | 106.06            | 108.94            |
| Failur                              | e Mode                                      | No  | No                             | No                     | No                | No                |
| Cycled Ce                           | ell   |   |                                |                        | I                 |                   |
| Ambient te                          | mperature: 2                                | <b>0</b> °C   |                                |                        |                   |                   |
| Sam                                 | ple No.                                     | 11#   | 12#                            | 13#                    | 14#               | 15#               |
| Tma                                 | ax(℃)                                       | 94.90   | 101.61                         | 104.52                 | 103.25            | 101.00            |
| Failure Mode                        |   | No  | No                             | No                     | No                | No                |
| Ambient te                          | mperature: 5                                | 5℃  |                                |                        | I                 | 1                 |
| Sam                                 | ple No.                                     | 16#   | 17#                            | 18#                    | 19#               | 20#               |
| Tma                                 | ax(℃)                                       | 104.93  | 102.95                         | 110.46                 | 106.01            | 103.08            |
| Failur                              | e Mode                                      | No  | No                             | No                     | No                | No                |
| Supplemer<br>Tmax was<br>The tested | ntary informa<br>recorded on<br>samples dor | tion:<br>the centre of the o<br>i't have any proteo | outside case;<br>ctive device. |                        | ·                 | ·<br>             |
| 11                                  | TABLE: A                                    | bnormal Chargin                                     | g Test                         |                        |                   | Р                 |
| Ambient te                          | mperature: 2                                | <b>3</b> °C   |                                |                        |                   |                   |
|                                     | Id <u>0.32</u> A Ue <u>2.0</u> V            |   |                                |                        |                   |                   |
|                                     | lc  | 4.8   | A                              | Uc                     |                   | <u>3.85    </u> V |
| Supplemer<br>during and             | ntary informa<br>after the test             | tion: The tested s                                  | amples don't                   | have any protective of | device, no explos | ion or catch fire |
| 15                                  | TABLE: S                                    | hock Test   |                                |                        |                   | Р                 |
|                                     |   |   |                                |                        |                   |                   |

Ambient temperature: 21 °C

Fresh cell

| Sample No.           | 51#    | 52#    | 53#    | 54#    | 55#    |
|----------------------|--------|--------|--------|--------|--------|
| Mass before test (g) | 40.156 | 40.494 | 40.542 | 39.915 | 40.031 |
| Mass after test (g)  | 40.158 | 40.496 | 40.544 | 39.917 | 40.032 |



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| $\frown$ |     |     |
|----------|-----|-----|
| LVC      | rea | cen |
|          |     |     |

| Sample No.           | 56#    | 57#    | 58#    | 59#    | 60#    |  |
|----------------------|--------|--------|--------|--------|--------|--|
| Mass before test (g) | 40.950 | 40.452 | 40.452 | 40.597 | 40.551 |  |
| Mass after test (g)  | 40.952 | 40.454 | 40.454 | 40.599 | 40.553 |  |

Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss less than 0.1%

| 16                  | TABLE: S                  | ABLE: Shock Test |        |        |        |        |  |
|---------------------|---------------------------|------------------|--------|--------|--------|--------|--|
| Ambient terr        | Ambient temperature: 23°C |                  |        |        |        |        |  |
| Fresh cell          |                           |                  |        |        |        |        |  |
| Sampl               | e No.                     | 61#              | 62#    | 63#    | 64#    | 65#    |  |
| Mass befo           | re test (g)               | 40.180           | 40.346 | 40.053 | 40.112 | 40.560 |  |
| Mass after test (g) |                           | 40.180           | 40.345 | 40.053 | 40.111 | 40.560 |  |
| Cycled cell         |                           |                  |        |        |        |        |  |
| Sampl               | e No.                     | 66#              | 67#    | 68#    | 69#    | 70#    |  |
| Mass befo           | re test (g)               | 39.859           | 40.333 | 40.623 | 40.327 | 40.132 |  |
| Mass afte           | r test (g)                | 39.860           | 40.334 | 40.623 | 40.327 | 40.132 |  |
|                     |                           |                  |        |        |        |        |  |

Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss less than 0.1%

| 18          | TABLE: Te                   | ABLE: Temperature Cycling Test |        |        |        |        |  |
|-------------|-----------------------------|--------------------------------|--------|--------|--------|--------|--|
| Ambient ter | Ambient temperature: 24.5°C |                                |        |        |        |        |  |
| Fresh cell  |                             |                                |        |        |        |        |  |
| Samp        | le No.                      | 81#                            | 82#    | 83#    | 84#    | 85#    |  |
| Mass befo   | ore test (g)                | 40.151                         | 40.032 | 40.794 | 40.827 | 40.322 |  |
| Mass afte   | er test (g)                 | 40.150                         | 40.030 | 40.793 | 40.826 | 40.320 |  |
| Cycled cell |                             |                                | ·      |        | ·      |        |  |
| Samp        | le No.                      | 86#                            | 87#    | 88#    | 89#    | 90#    |  |
| Mass befo   | ore test (g)                | 40.554                         | 40.451 | 40.134 | 40.210 | 40.771 |  |
| Mass afte   | er test (g)                 | 40.552                         | 40.449 | 40.133 | 40.208 | 40.769 |  |
|             |                             |                                |        |        |        |        |  |

| 19                          | TABLE: Lo   | Р      |        |        |        |        |  |  |  |
|-----------------------------|-------------|--------|--------|--------|--------|--------|--|--|--|
| Ambient temperature: 24.5°C |             |        |        |        |        |        |  |  |  |
| Fresh cell                  |             |        |        |        |        |        |  |  |  |
| Sampl                       | e No.       | 91#    | 92#    | 93#    | 94#    | 95#    |  |  |  |
| Mass befo                   | re test (g) | 40.800 | 39.734 | 40.472 | 40.914 | 40.953 |  |  |  |
| Mass afte                   | er test (g) | 40.801 | 39.737 | 40.475 | 40.915 | 40.957 |  |  |  |



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| Cycled cell   |        |        |        |        |        |  |  |  |  |
|---|--------|--------|--------|--------|--------|--|--|--|--|
| Sample No.  | 96#    | 97#    | 98#    | 99#    | 100#   |  |  |  |  |
| Mass before test (g)  | 39.964 | 39.782 | 39.941 | 39.999 | 39.994 |  |  |  |  |
| Mass after test (g)   | 39.968 | 39.784 | 39.940 | 40.000 | 39.994 |  |  |  |  |
| Supplementary information: no explosion or catch fire, in addition the sample did not vent or leak. Max loss less than 0.1% |        |        |        |        |        |  |  |  |  |

## End of report