TEST REPORT

TEST REPORT
IEC 62660-3

Secondary lithium-ion cells for the propulsion of electric road vehicles

Part 3: Safety requirements

Report Number. :	PNS220224158 01001
Date of issue :	2022-03-18
Total number of pages	13

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Applicant's name :	EVE Power Co., Ltd.
Address :	No. 68, Jingnan Avenue, Duodao Zone, Jingmen, Hubei, China
Manufacturer's name……:	EVE Power Co., Ltd.
Address :	No. 68, Jingnan Avenue, Duodao Zone, Jingmen, Hubei, China
Factory's name……..…:	EVE Power Co., Ltd.
Address :	No. 68, Jingnan Avenue, Duodao Zone, Jingmen, Hubei, China

Test specification:

Standard :	IEC 62660-3:2016
Test procedure :	N/A
Non-standard test method :	N/A

Test item description :	Lithium-ion Power Cell
Trade Mark :	EVE
Model/Type reference :	LF280K
Ratings :	3.2V, 280Ah

List of Attachments (including a total number of pages in each attachment):

- Photos documentation (1 page)

Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
cl. 5.2 Capacity cl. 6.2.1 Vibration cl. 6.2.2 Mechanical shock cl. 6.2.3 Crush cl. 6.3.1 High temperature endurance cl. 6.3.2 Temperature cycling cl. 6.4.1 External short circuit cl. 6.4.2 Overcharge cl. 6.4.3 Forced discharge cl. 6.4.4 Internal short circuit test	**GUANGDONG UTL CO., LTD.** Lianding Testing Building, No.18 Center Road of Yayuan Industrial Zone, Nancheng District, Dongguan, Guangdong, China

Summary of compliance with National Differences (List of countries addressed):

N/A

☒ The product fulfils the requirements of EN 62660-3:2016.

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

Note: Cells used in the manufacture of a battery need not be marked.

Test item particulars..... :	
Classification of installation and use..... :	☒ BEV application ☐ HEV application
Recommend charging voltage..... :	3.65V
Recommend charging current..... :	140A
Recommend charging method declared by the manufacturer..... :	Charging the cell with 140A constant current and 3.65V constant voltage until the current reduces to 14A at ambient 25°C±2°C
Discharge current (1/3 I_t A) for BEV ..... :	93.333A
Discharge current (1 I_t A) for HEV ..... :	N/A
Specified end of discharge voltage ..... :	0°C<T≤65°C: 2.5V; -20°C<T≤0°C: 2.0V
Charging temperature range..... :	0~65°C
Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement..... :	P (Pass)
- test object does not meet the requirement..... :	F (Fail)
Testing..... :	
Date of receipt of test item ..... :	2022-02-23
Date (s) of performance of tests ..... :	2022-03-02 to 2022-03-17

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

The test results presented in this report relate only to the object tested.
This report shall not be reproduced except in full without the written approval of the testing laboratory.
Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

General product information:

The cell consists of the positive electrode plate, negative electrode plate, separator, electrolyte and case. The positive and negative electrode plates are housed in the case in the state being separated by the separator.

The main features of the cell are shown as below:

Product name	Lithium ion cell
Model	LF280K
Capacity	280Ah
Nominal voltage	3.2V
Rated charge current	140A
Standard discharge current	140A
Maximum charge current	280A
Maximum discharge current	280A
Rated charge voltage	3.65V
Maximum Charge voltage	3.65V
Final discharge voltage	0°C<T≤65°C: 2.5V; -20°C<T≤0°C: 2.0V
Charging temperature upper limit	0°C ~ 65°C
Discharge temperature range	-20°C ~ 65°C
Weight (g)	5400±300g
External dimensions (mm)	Approx. L 173.7±0.5mm x T 72.0±1.0mm x H 207.2±0.5mm

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Clause	Requirement + Test	Result - Remark	Verdict

4	**TEST CONDITIONS**		**P**
4.1	**General**		P
	The details of the instrumentation used have been provided in any report of results		P
4.2	**Measuring instruments**		**P**
4.2.1	Range of measuring devices		P
	The instruments used enable the values of voltage and current measured. The range of these instruments and measuring methods chosen so as to ensure the accuracy specified for each test		P
	For analogue instruments, this implies that the readings taken in the last third of the graduated scale		P
	Any other measuring instruments may be used provided they give an equivalent accuracy		P
4.2.2	Voltage measurement		P
	The resistance of the voltmeters used at least 1 MΩ/V		P
4.2.3	Current measurement		P
	The entire assembly of ammeter, shunt and leads are of an accuracy class of 0,5 or better		P
4.2.4	Temperature measurements		P
	The cell temperature measured by use of a surface temperature measuring device capable of an equivalent scale definition and accuracy of calibration as specified in 4.2.1		P
	The temperature measured at location which most closely reflects the cell temperature		P
	The temperature may be measured at additional appropriate locations, if necessary		P
4.2.5	Other measurements		P
	Other values including capacity and power may be measured by use of a measuring device, provided that it complies with 4.3		P
4.3	**Tolerance**		**P**
	Parameter measurement tolerances		P
4.4	**Test temperature**		**P**
	If not otherwise defined, before each test the cell stabilized at the test temperature for a minimum of 12 h		P

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Clause	Requirement + Test	Result - Remark	Verdict
	This period can be reduced if thermal stabilization is reached. Thermal stabilization is considered reached if after one interval of 1 h, the change of cell temperature is lower than 1 K		P
	Unless otherwise stated in this standard, cells tested at room temperature using the method declared by the manufacturer		P
5	**ELECTRICAL MEASUREMENT**		**P**
5.1	**General charge conditions**		**P**
	Unless otherwise stated in this standard, prior to the electrical measurement test, the cell charged as follows		P
	Prior to charging, the cell discharged at room temperature at a constant current of 1/3 It(A) for BEV application and 1 It(A) for HEV application down to an end-of-discharge voltage specified by the manufacturer. Then, the cell charged according to the charging method declared by the manufacturer at room temperature	BEV application	P
5.2	**Capacity**		P
	Before the SOC adjustment in 5.3, the capacity of the test cell confirmed the rated value in accordance with the following steps. Step 1 – The cell charged in accordance with 5.1 Step 2 – The cell discharged at the room temperature at a constant current of 1/3 It(A) for BEV application and 1 It(A) for HEV application to the end-of-discharge voltage that is provided by the manufacturer Step 3 – Measure the discharge endurance duration until the specified end-of-discharge voltage is reached, and calculate the capacity of cell expressed in Ah up to three significant figures	(See appended table 5.2)	P
5.3	**SOC adjustment**		P
	The test cells charged as specified, and discharged at a constant current of 1/3 It(A) for BEV application and 1 It(A) for HEV application for (100 - n) / 100 x 3 h for BEV application and for (100 - n) / 100 x 1 h for HEV application	BEV application	P
6	**SAFETY TESTS**		
6.1	**General**		**P**

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Clause	Requirement + Test	Result - Remark	Verdict
	The tests performed on cells that are not more than six months old. The number of cells under each test can be determined according to the agreement between the manufacturer and the customer. A cell block may be used for testing in place of a single cell according to the agreement between the manufacturer and the customer. Each test is end with the one-hour observation period, unless otherwise specified in this standard		P
6.2	**Mechanical tests**		**P**
6.2.1	Vibration		P
	The test performed in accordance with 6.1.1.1 of IEC62660-2:2010		P
	During the test, the cell is exhibit no evidence of leakage, venting, rupture, fire or explosion	(See appended table 6.2.1)	P
6.2.2	Mechanical shock		P
	The test performed in accordance with 6.1.2.1 of IEC62660-2:2010		P
	During the test, the cell is exhibit no evidence of leakage, venting, rupture, fire or explosion	(See appended table 6.2.2)	P
6.2.3	Crush		P
	Adjust the SOC of cell to100 % for BEV application and 80 % for HEV application		P
	The cell placed on an insulated rigid flat supporting surface, and applied a force with a crushing tool made of a solid material in the shape of a round or semicircular bar, or in the shape of a sphere or hemisphere with a 150 mm diameter. It is recommended to use the round bar to crush a cylindrical cell, and the sphere for a prismatic cell, including a flat or pouch cell. The force for the crushing applied in a direction nearly perpendicular to the layered face of the positive and negative electrodes inside cell. The force applied to the approximate centre of cell. The crush speed less than or equal to 6 mm/min		P
	The force released when an abrupt voltage drop of one-third of the original cell voltage occurs, or a deformation of 15 % or more of the initial cell dimension occurs, or a force of 1000 times of the weight of the cell is applied, whichever comes first. The cell under observation for 24 h or until the cell temperature declines 80 % of the maximum temperature rise, whichever is sooner		P
	During the test, the cell is exhibit no evidence of fire or explosion	(See appended table 6.2.3)	P
6.3	**Thermal test**		**P**
6.3.1	High temperature endurance		P

IEC 62660-3			
Clause	Requirement + Test	Result - Remark	Verdict
	Adjust the SOC of cells to 100 % for BEV application or 80 % for HEV application	BEV application	P
	The cell, stabilized at room temperature, placed on a gravity or circulation air convention oven. The oven temperature raised at 5 K/min to 130 ºC ± 2 K. The cell is remain at this temperature for 30 min. Then, after the heater is turned off, the cell observed for 1 h in the oven		P
	During the test, the cell is exhibit no evidence of fire or explosion	(See appended table 6.3.1)	P
6.3.2	Temperature cycling		P
	The test performed in accordance with 6.2.2.1.1 of IEC 62660-2:2010		P
	During the test, the cell is exhibit no evidence of leakage, venting, rupture, fire or explosion	(See appended table 6.3.2)	P
6.4	**Electrical tests**		**P**
6.4.1	External short circuit		P
	The test performed in accordance with 6.3.1.1 of IEC 62660-2:2010		P
	During the test, the cell is exhibit no evidence of fire or explosion	(See appended table 6.4.1)	P
6.4.2	Overcharge		P
	Adjust the SOC of the cell to 100 %		P
	Continue charging the cell beyond 100 % SOC with a charging current of 1 It(A) for BEV application or 5 It(A) for HEV application at room temperature using a power supply sufficient to provide the constant charging current. The overcharge test discontinued when the voltage of cell reaches 120 % of the maximum charging voltage specified by the manufacturer, or the quantity of electricity applied to the cell reaches the equivalent of 130 % SOC, whichever comes first	BEV application	P
	During the test, the cell is exhibit no evidence of fire or explosion	(See appended table 6.4.2)	P
6.4.3	Forced discharge		P
	Adjust the SOC of the cell to 0 %		P
	Continue discharge the cell beyond 0 % SOC at 1 It discharge current at room temperature. The forced discharge test discontinued when the absolute value of the voltage of the cell reaches 25 % or less of the normal voltage specified by the manufacturer, or the cell is discharged for 30 min, whichever is sooner		P
	During the test the cell is exhibit no evidence of leakage, venting, rupture, fire or explosion	(See appended table 6.4.3)	P

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Clause	Requirement + Test	Result - Remark	Verdict
6.4.4	Internal short circuit test		P
	The test performed on the cell in accordance with 7.3.2 b) of IEC 62619 with modification		P
	Alternative test may be selected if the criteria are satisfied and agreed between the customer and the supplier		P
	During the test, the cell is exhibit no evidence of fire or explosion	(See appended table 6.4.4)	P
ANNEX A	**OPERATING REGION OF CELLS FOR SAFE USE**		
A.1	General		P
A.2	Charging conditions for safe use		P
A.2.1	General		P
A.2.2	Consideration on charging voltage		P
A.2.3	Consideration on temperature		P
A.2.3.1	General		P
A.2.3.2	High temperature range		P
A.2.3.3	Low temperature range		P
A.3	Example of operating region		P
ANNEX B	**EXPLANATION FOR THE INTERNAL SHORT-CIRCUIT TEST**		
B.1	General concept		P
B.2	Internal short circuit caused by particle contamination		P

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Clause	Requirement + Test	Result - Remark	Verdict

	TABLE: Critical components information				P
Object/part no.	**Manufacturer/ trademark**	**Type/model**	**Technical data**	**Standard**	**Mark(s) of conformity[1]**
Cell	EVE Power Co., Ltd.	LF280K	3.2V, 280Ah	IEC 62660-3: 2016	Tested with appliance
-Positive electrode	EVE Power Co., Ltd.	LFP	$LiFePO_4$	--	--
-Negative electrode	EVE Power Co., Ltd.	C	Graphite	--	--
-Separator	EVE Power Co., Ltd.	PE	Polyethylene	--	--
-Electrolyte	EVE Power Co., Ltd.	--	$LiPF_6$ + carbonate solvent + additive	--	--

Supplementary information:

1) Provided evidence ensures the agreed level of compliance. See OD-CB2039

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Clause	Requirement + Test	Result - Remark	Verdict

5.2	TABLE: Capacity				P
Model/Sample	**End-of-discharge voltage (V)**	**Discharge current (A)**	**Fully charged voltage (V)**	**Capacity (Ah)**	**Results**
SLine-3-1	2.50	93.333	3.65	293.47	More than the capacity
SLine-3-2	2.50	93.333	3.65	290.09	More than the capacity
SLine-3-3	2.50	93.333	3.65	286.68	More than the capacity
Supplementary information: --					

6.2.1	TABLE: Vibration		P
Model/Sample	**Voltage before test (V)**	**Voltage after Test (V)**	**Results**
SLine-3-4	3.410	3.402	No leakage, No venting, No rupture, No fire, No explosion
SLine-3-5	3.407	3.401	No leakage, No venting, No rupture, No fire, No explosion
SLine-3-6	3.410	3.404	No leakage, No venting, No rupture, No fire, No explosion
Supplementary information: --			

6.2.2	TABLE: Mechanical shock		P
Model/Sample	**Voltage before test (V)**	**Voltage after test (V)**	**Results**
SLine-3-7	3.401	3.401	No leakage, No Venting, No rupture, No fire, No explosion
SLine-3-8	3.403	3.402	No leakage, No Venting, No rupture, No fire, No explosion
SLine-3-9	3.399	3.398	No leakage, No Venting, No rupture, No fire, No explosion
Supplementary information: --			

6.2.3	TABLE: Crush	P
Model/Sample	**Voltage before test (V)**	**Results**
SLine-3-10	3.414	No fire, No explosion
SLine-3-11	3.407	No fire, No explosion

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Clause	Requirement + Test	Result - Remark	Verdict

SLine-3-12	3.392	No fire, No explosion
Supplementary information: --		

6.3.1	TABLE: High temperature endurance			P
Model/Sample	**Voltage before test (V)**	**Maximum temperature (ºC)**	**Results**	
SLine-3-13	3.409	131.0	No fire, No explosion	
SLine-3-14	3.415	131.2	No fire, No explosion	
SLine-3-15	3.420	131.3	No fire, No explosion	
Supplementary information: --				

6.3.2	TABLE: Temperature cycling		P
Model/Sample	**Voltage before test (V)**	**Results**	
SLine-3-16	3.333	No leakage, No Venting, No rupture, No fire, No explosion	
SLine-3-17	3.331	No leakage, No Venting, No rupture, No fire, No explosion	
SLine-3-18	3.330	No leakage, No Venting, No rupture, No fire, No explosion	
Supplementary information: --			

6.4.1	TABLE: External short circuit				P
Model/Sample	**Voltage before test (V)**	**External resistance (mΩ)**	**Maximum temperature (ºC)**	**Results**	
SLine-3-19	3.415	4.8	45.3	No fire, No explosion	
SLine-3-20	3.402	4.8	44.2	No fire, No explosion	
SLine-3-21	3.411	4.8	55.5	No fire, No explosion	
Supplementary information: --					

6.4.2	TABLE: Overcharge					P
Model/Sample	**Voltage before test (V)**	**Charge Current (A)**	**Test voltage (V)**	**Test time (min)**	**Results**	
SLine-3-22	3.384	280	4.38	0.342min	No fire, No explosion	
SLine-3-23	3.347	280	4.38	0.433min	No fire, No explosion	
SLine-3-24	3.364	280	4.38	0.383min	No fire, No explosion	
Supplementary information: --						

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Clause	Requirement + Test	Result - Remark	Verdict

6.4.3	TABLE: Forced discharge			P
Model/Sample	**Voltage before test (V)**	**Terminal voltage (V)**	**Results**	
SLine-3-25	2.942	0.798	No leakage, No venting, No rupture, No fire, No explosion	
SLine-3-26	2.983	0.798	No leakage, No venting, No rupture, No fire, No explosion	
SLine-3-27	2.962	0.798	No leakage, No venting, No rupture, No fire, No explosion	
Supplementary information: --				

6.4.4	TABLE: Internal short circuit test		P
Model/Sample	**Voltage before test (V)**	**Results**	
SLine-3-28	3.411	No fire, No explosion	
SLine-3-29	3.407	No fire, No explosion	
SLine-3-30	3.405	No fire, No explosion	
Supplementary information: --			

TEST REPORT

Photos

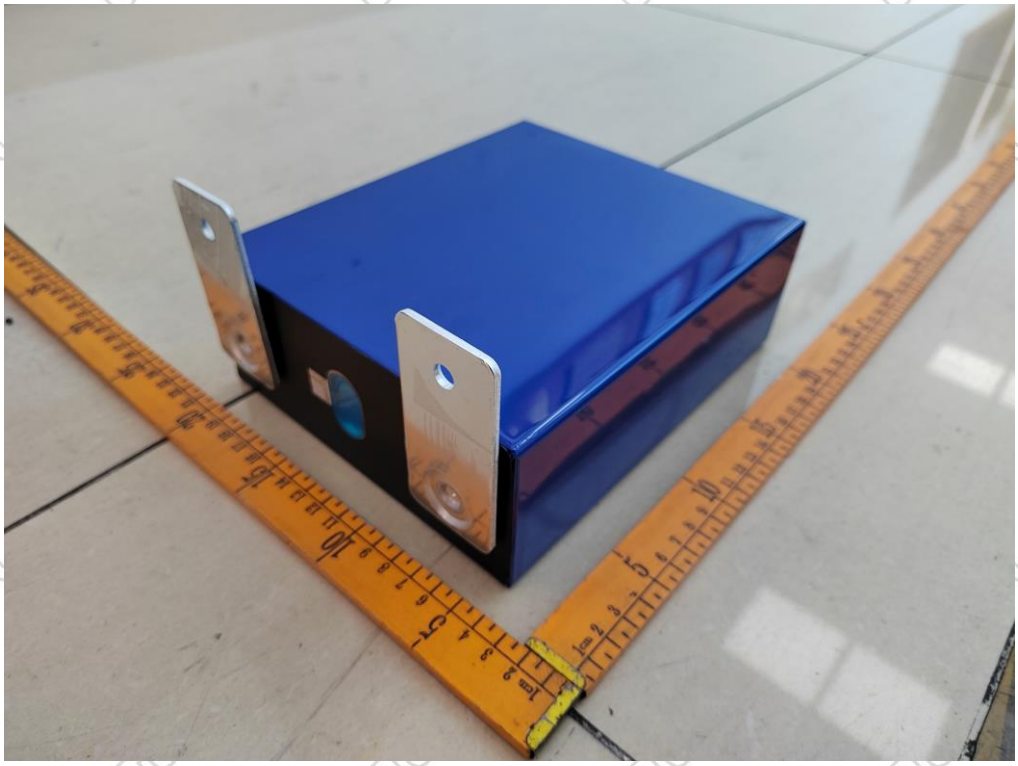

Fig.1 General view I of cell

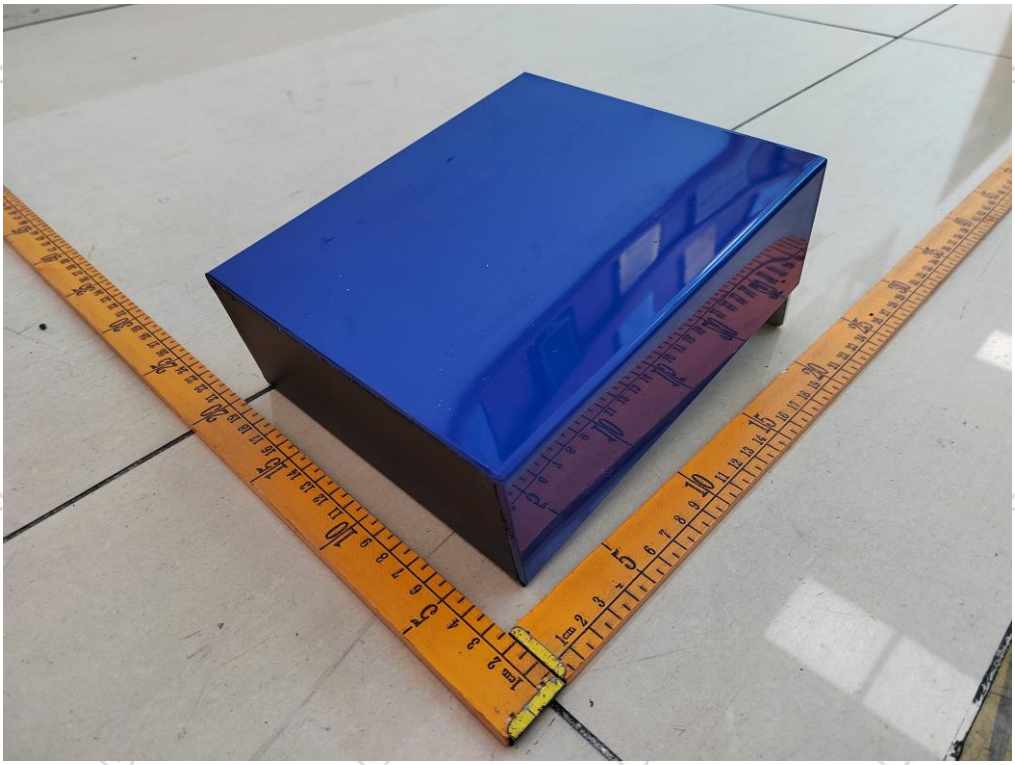

Fig.2 General view II of cell

-- END --