Product Service

TEST REPORT
PPP 51096A:2023
TUV SUD Test Report for Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for Sodium ion cells and batteries, for use in industrial applications

Report No.:	64.280.24.60543.01
Date of issue:	2025-02-28
Project handler:	Alan Liang, Lena Li
Testing laboratory:	TÜV SÜD New Energy Testing (Guangdong) Co., Ltd.
Address:	North-1/F, 2/F & Unit 301-3/F, TÜV SÜD Testing Center, D1, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, China
Testing location:	as above
Client: Client number: Address: Contact person:	JIANGSU HIGHSTAR BATTERY MANUFACTURING CO., LTD 003600 No.306, Heping Road (S), 226200 Qidong City, Jiangsu, PEOPLE'S REPUBLIC OF CHINA Cai Hui
Standard:	This TUV SUD test report form is based on the following requirements: PPP 51096A:2023 Other information: Based on IEC 62619:2022 with modifications
TRF number and revision*:*	TRF PPP 51096A:2023 Rev. 0:2023
eDoc_ID:	-
TRF originated by:	TUV SUD Product Service, Mr. Ryan Jin
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Scheme:	☒ TUV Mark ☐ without certification ☐ other:
Non-standard test method: National deviations:	☒ No ☐ Yes, see details under *Summary of testing* N/A
Number of pages *(Report)*: Number of pages *(Attachments)*:	25 N/A

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Test sample: Type of test object: Trademark: Model and/ or type reference:	Rechargeable Sodium ion Cell Protype Sample HIGHSTAR NaCP71173208-160
Rating(s):	2.95Vd.c., 160Ah
Manufacturer: Manufacturer number: Address:	Same as the client Same as the client Same as the client
Name and address of factory(ies) JIANGSU HIGHSTAR BATTERY MANUFACTURING CO., LTD No.306, Heping Road (S), 226200 Qidong City, Jiangsu, PEOPLE'S REPUBLIC OF CHINA	
Sub-contractors / tests (clause): Name:	N/A N/A
Order description:	☒ Complete test according to TRF
	☐ Partial test according to manufacturer's specifications
	☐ Preliminary test
	☐ Spot check
	☐ Others:
Date of order: Date of receipt of test item: Date(s) of performance of test:	2024-11-12 2024-10-15 2024-11-15 to 2025-02-25
Test item particulars: PPP 51096A:2023 Other information: Based on IEC 62619:2022 with modifications	
Purpose of the product (description of intended use): The Rechargeable Sodium ion Cell, model no. NaCP71173208-160 is used in industrial application. It consists four cell cores with winding structure connected in parallel.	

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Characteristic data (not shown on the marking plate):

Table for parameters:	
Item	Specification
Product name	Rechargeable Sodium ion Cell
Type/model	NaCP71173208-160
Nominal voltage	2.95Vd.c.
Rated capacity	160Ah
Charging voltage declared by manufacturer	3.45V
Upper limit charging voltage	3.45V
Charging current declared by manufacturer	80A
Maximum continuous charging current	160A
Discharging current declared by manufacturer	80A
Maximum continuous discharging current	320A
Discharging cut off voltage	1.5V
Lower limit discharging voltage	1.5V
Standard temperature range for charging	0°C to 55°C
Standard temperature range for discharging	-40°C to 60°C
Standard charging method by manufacturer	Charge at constant current 80A until the voltage reaches 3.45V, then charge at 3.45V till charge current is 8A
Charging method for internal short-circuit test	Charge at constant current 160A until the voltage reaches 3.45V, then charge at 3.45V till charge current is 0.05I_tA (8A)
Dimension	T x W x H: (71.7±0.8)mm x (173.7±0.5)mm x (207.2±0.5)mm
Weight	(4.6±0.3)kg
Remark: 1.The Rechargeable Sodium ion Cell is used in industrial application.	

The final evaluation of the cell must be conducted in the end product for which the cell will be used.

Attachments:

1.Attachment 1: CDF (Critical components information): 8 pages;
2.Attachment 2: Photo documentation: 2 pages

If additional information is necessary, please provide

N/A

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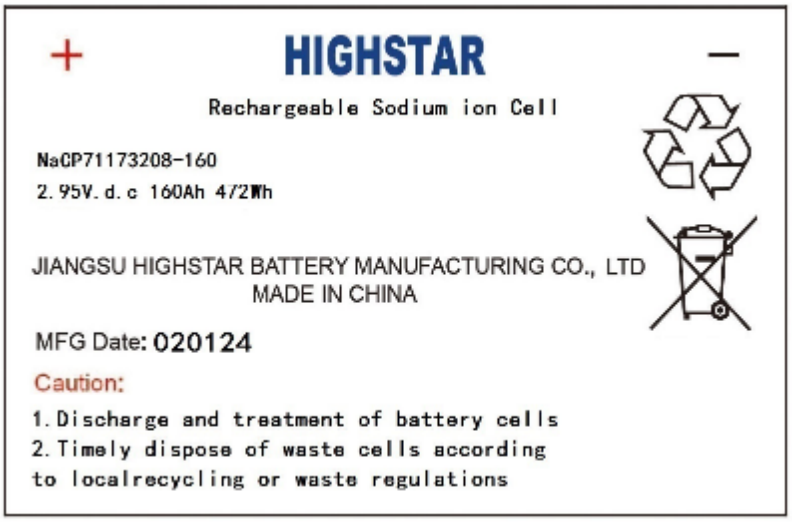
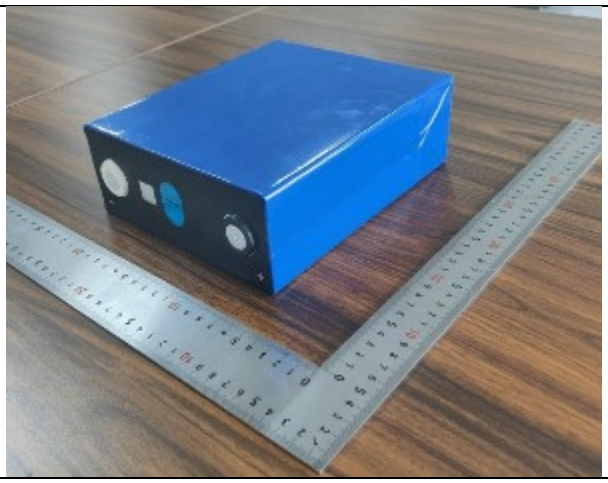
Copy of marking plate:





Remark:
1. The MFG Date “DDMMYY“on the label represents the manufacturing date of the product. For example, "020124" represents 2024-01-02.
2. The QR code can be used to trace the manufacture information of the cell.
3. It is just an example code and not for actual sample code.

Pictures of the product:



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Summary of testing:

In section 7, each test clause below is performed with three cells except for clause 7.2.1 and clause 7.2.2 with six cells, clause 7.3.2 with five cells, and clause 6.3 with 12 cells.

Name of test, test clause	Date of test performed
- Cl. 6.3 Capacity check(cell or cell block)	2024-11-21 to 2024-11-27
- Cl. 7.2.1 External short-circuit test (cell or cell block)	2024-11-27 to 2024-12-04
- Cl. 7.2.2 Impact test (cell or cell block)	2024-12-13 to 2024-12-14
- Cl. 7.2.3.2 Whole drop test (cell or cell block, and battery system)	2024-11-26 to 2024-11-27
- Cl. 7.2.4 Thermal abuse test (cell or cell block)	2024-11-28 to 2024-11-29
- Cl. 7.2.5 Overcharge test (cell or cell block)	2024-11-28 to 2024-11-29
- Cl. 7.2.6 Forced discharge test (cell or cell block)	2024-12-02 to 2024-12-09
- Cl. 7.3.2 Internal short-circuit test (cell)	2024-12-19 to 2024-12-20

☐ deviation(s) found

☒ no deviations found

Additional information on non-standard test method(s)

Sub clause: N/A

Page: N/A

Rational: N/A

Possible test case verdicts:

test case does not apply to the test object: N/A (not applicable / not included in the order)
test object does meet the requirement: P (Pass)
test object does not meet the requirement: F (Fail)

General remarks:

"(see remark #)" refers to a remark appended to the report.
"(see appended table)" refers to a table appended to the report.
*Throughout this report **a point** is used as the decimal separator.*
The test results presented in this report relate only to the object tested.
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Clause	Requirement + Test	Result – Remark	Verdict
1	**Scope**		P
(modified)	Secondary sodium ion cells and batteries used in industrial applications		P
4	**PARAMETER MEASUREMENT TOLERANCES**		P
	Parameter measurement tolerances		P
5	**GENERAL SAFETY CONSIDERATIONS**		P
5.1	**General**		P
	Cells and batteries are safe under conditions of both intended use and reasonably foreseeable misuse... :	Clause 6, Clause 7, 8.1, and 8.2. See also table 5.1 for Critical components information	P
	Reduce the risk of injuries from moving parts		N/A
5.2	**Insulation and wiring**		P
	Voltage, current, altitude, and humidity requirements		P
	Adequate clearances and creepage distances between connectors and live parts at different voltages or between live parts and non-current-carrying accessible parts		N/A
	Protect from hazardous live parts, including during installation		N/A
	The mechanical integrity of internal connections		P
5.3	**Venting**		P
	Pressure relief function		P
	Encapsulation used to support cells within an outer casing		N/A
5.4	**Temperature/voltage/current management**		N/A
	The design prevents abnormal temperature-rise		N/A
	Voltage, current, and temperature limits of the cells		N/A
	Specifications and charging instructions for equipment manufacturers		N/A
5.5	**Terminal contacts of the battery pack and/or battery system**		N/A
	Polarity marking(s)		N/A
	Polarity marking not provided for keyed external connector		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	Capability to carry the maximum anticipated current		N/A
	External terminal contact surfaces		N/A
	Terminal contacts are arranged to minimize the risk of short circuits		N/A
5.6	**Assembly of cells, modules, or battery packs into battery systems**		N/A
5.6.1	General		N/A
	Independent control and protection method(s)		N/A
	Recommendations of cell operating limits, mounting advice, storage conditions and other design recommendations by the cell manufacturer		N/A
	Batteries designed for the selective discharge of a portion of their series connected cells		N/A
	Protective circuit component(s) and consideration to the end-device application		N/A
5.6.2	Battery system design		N/A
	The voltage control function		N/A
	Maximum charging/discharging current of the cell are not exceeded		N/A
5.7 (modified)	**Operating region of sodium ion cells and battery systems for safe use**		P
	The cell operating region..... :	See page 3	P
	Designation of battery system to comply with the cell operating region		N/A
5.8	**System lock (or system lock function)**		N/A
	Non-resettable function to stop battery operation		N/A
	Manual with procedure for resetting of battery operation		N/A
	Emergency battery final discharge		N/A
5.9	**Quality plan**		P
	Manufacturing quality plan (for example: ISO9001, etc.) prepared and implemented..... :	ISO9001 certificate was provided	P
	The process capabilities and the process controls		P

6	**TYPE TEST CONDITIONS**	P
6.1	**General**	P

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Clause	Requirement + Test	Result – Remark	Verdict
6.2	**Test items**		P
	Cells or batteries that are not more than six months old (See Table 1 of IEC 62619)		P
	Capacity confirmation of the cells or batteries		P
(modified)	Default ambient temperature of test, 25 °C ± 2 °C for test of clause 7.2.1 External short-circuit test, 7.2.4 Thermal abuse test, 7.2.5 Overcharge test		P
(modified)	Default ambient temperature of test, 25 °C ± 5 °C for test of clauses except for clause 7.2.1, 7.2.4, 7.2.5		P
6.3 (Added)	**Capacity check**		P
(Added)	Prior to conducting abuse testing of clause 7.2.1, 7.2.4, 7.2.5, the capacity of the sodium ion cells shall be tested in accordance with the following steps:		P
(Added)	a) The cell shall be discharged at an ambient temperature of 25 °C ±2 °C at a constant current of 0.2ItA down to a specified final voltage.		P
(Added)	b) The cell shall then be charged in at an ambient temperature of 25 °C ±2°C at charging parameters specified by the manufacturer until fully charged.		P
(Added)	c) The cell shall be stored in an ambient temperature of 25 °C ± 2 °C, for not less than 1 h and not more than 4 h.		P
(Added)	d) The cell shall be discharged at a constant current discharge in accordance with the cell manufacturer's specifications down to a specified final voltage.		P
(Added)	The duration of the discharge shall be monitored, and the measured capacity of the cell shall be calculated.		P
(Added)	e) Steps (a) to (d) shall be repeated for 3 cycles.		P
(Added)	f) The test is completed when		P
(Added)	i. The capacity after last three cycles equals or exceeds the rated specifications		P
(Added)	ii. The capacity after last three cycles has < 3% deviation.		P
(Added)	g) If (f) cannot be fulfilled, two more cycles shall be added to the related cell:		—

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Clause	Requirement + Test	Result – Remark	Verdict
(Added)	i. If (f) can be fulfilled, the test is completed.		—
(Added)	ii. If (f) cannot be fulfilled, the cell is not suitable for further testing and repeatable test results. Capacity test shall be repeated with a new cell.		—

7	**SPECIFIC REQUIREMENTS AND TESTS**		P
7.1	**Charging procedure for test purposes**		P
	The battery discharged to a specified final voltage prior to charging		P
	The cells or batteries charged using the method specified by the manufacturer..... :	See page 3	P
7.2	**Reasonably foreseeable misuse**		P
7.2.1	External short-circuit test (cell or cell block)		P
(modified)	a) The test shall be carried out in an ambient temperature of 25 °C ± 2 °C		P
(modified)	b) Each test cell shall be discharged at a constant current of 0,2 It A to a final voltage specified by the manufacturer.		P
(modified)	Then, the cell shall then be charged in at an ambient temperature of 25 °C ±2°C at charging parameters specified by the manufacturer until fully charged.		P
(modified)	c) The cell shall be stored at room temperature, and then be short-circuited by connecting the positive and negative terminals with an external resistance. Test shall be done for both conditions d)i and d)ii.		P
(modified)	d) The total external resistance shall be:		P
(modified)	i. equal to or less than 5 mΩ (3 samples) and		P
(modified)	ii. 80 mΩ ± 20 mΩ (3 samples)		P
(modified)	e) The cells are to remain on test for 6 h or until the case temperature declines by 80 % of the maximum temperature rise, whichever is the sooner.		P
	Results: no fire, no explosion	See Table 7.2.1.	P
7.2.2	Impact test (cell or cell block)		P
	Cylindrical cell, longitudinal axis impact		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	Prismatic cell, longitudinal axis and lateral axis impact		P
	Results: no fire, no explosion.		P
7.2.3	Drop test (cell or cell block, and battery system)		P
7.2.3.1	General		P
7.2.3.2	Whole drop test (cell or cell block, and battery system)		P
	Description of the Test Unit..... :	Rechargeable Sodium ion Cell: NaCP71173208-160	—
	Mass of the test unit (kg)..... :	Measured: Max. 4.777kg	—
	Height of drop (m)..... :	1.00m	—
	Results: no fire, no explosion		P
7.2.3.3	Edge and corner drop test (cell or cell block, and battery system)		N/A
	Description of the Test Unit..... :		—
	Mass of the test unit (kg)..... :		—
	Height of drop (m)..... :		—
	Results: no fire, no explosion		N/A
7.2.4	Thermal abuse test (cell or cell block)		P
(modified)	a) The test shall be carried out in an ambient temperature of 25 °C ± 2 °C.		P
(modified)	b) Each test cell shall be discharged at a constant current of 0,2 It A to a final voltage specified by the manufacturer.		P
(modified)	Then, the cell shall then be charged in at an ambient temperature of 25 °C ±2°C at charging parameters specified by the manufacturer until fully charged.		P
(modified)	c) The cell, stabilized at room temperature, shall be placed in a gravity or circulating air convection oven.		P
(modified)	The oven temperature shall be raised at a rate of 5 K/min to 130 °C ± 2 K.		P
(modified)	d) The cell shall remain at this temperature for 30 min.		P
(modified)	e) After the heater is turned off, the cell shall be observed for 1 h in the oven.		P

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Clause	Requirement + Test	Result – Remark	Verdict
	Results: no fire, no explosion		P
7.2.5	Overcharge test (cell or cell block)		P
	For those battery systems that are provided with only a single protection for the charging voltage control		—
(modified)	a) The test shall be carried out in an ambient temperature of 25 °C ± 2 °C.		P
(modified)	b) Each test cell shall be discharged at a constant current of 0,2 It A to a final voltage specified by the manufacturer.		P
(modified)	Sample cells shall then be charged with a constant current equal to the maximum specified charging current of the cell (but at least 1ItA) until the voltage of the cell reaches or exceeds 120 % of the maximum voltage specified by the cell manufacturer, or the quantity of electricity applied to the cell reaches or exceeds the equivalent of 130 % SOC, whichever comes first.	The cell reaches or exceeds 120 % of the maximum voltage specified by the cell manufacturer.	P
(modified)	Then, the charging is terminated.		P
(modified)	c) The voltage and temperature should be monitored during the test.		P
(modified)	d) The test shall be continued until the temperature of the cell surface reaches steady state conditions (less than 10 °C change in a 30-min period) or returns to ambient temperature.		P
	Results: no fire, no explosion ..... :	See Table 7.2.5.	P
7.2.6	Forced discharge test (cell or cell block)		P
	Cells connected in series in the battery system ..... :		N/A
	Redundant or single protection for discharge voltage control provided in battery system ..... :		N/A
	Target Voltage ..... :	-3.45V	P
	Maximum discharge current of the cell, Im..... :	160A	P
	Discharge current for forced discharge, 1.0 It ..... :	160A	P
	Discharging time, t = (1 It / Im) x 90 (min.) ..... :	90min	P
	Results: no fire, no explosion ..... :	See Table 7.2.6.	P
7.3	**Considerations for internal short-circuit – Design evaluation**		P
7.3.1	General		P
7.3.2	Internal short-circuit test (cell)		P

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Clause	Requirement + Test	Result – Remark	Verdict
	Samples preparation procedure: In accordance with Clause A.5 and A.6 of IEC 62133-2:2017		P
	Tested per 7.3.2 b) in an ambient temperature of 25 °C ± 5 °C.		P
	The appearance of the short-circuit location recorded by photograph or other means .....:	By photograph	—
	The pressing was stopped - When a voltage drop of 50 mV was detected; or		N/A
	- The pressing force of 800 N (cylindrical cells) or 400 N (prismatic cells) was reached	400N	P
	Results: no fire ..... :	See Table 7.3.2.	P
7.3.3	Propagation test (battery system)		N/A
	Method to create a thermal runaway in one cell ... :	See Annex B and C	N/A
	Results: No external fire from the battery system, no battery case rupture..... :	See results in Table 7.3.3	N/A

8	**BATTERY SYSTEM SAFETY (CONSIDERING FUNCTIONAL SAFETY)**		N/A
8.1	**General requirements**		N/A
	Functional safety analysis for critical controls		N/A
	Conduct of a process hazard analysis for both the cell manufacturing process and the battery system manufacturing process		N/A
	Conduct of risk assessment and mitigation of the battery system		N/A
8.2	**Battery management system (or battery management unit)**		N/A
8.2.1	Requirements for the BMS		N/A
	The safety integrity level (SIL) target of the BMS		N/A
	The charge control evaluated by tests in clauses 8.2.2 to 8.2.4		N/A
8.2.2	Overcharge control of voltage (battery system)		N/A
	The exceeded charging voltage applied to the whole battery system		N/A
	The exceeded charging voltage applied to only a part of the battery system, such as the cell(s)..... :		N/A
	Results: no fire, no explosion ..... :	See Table 8.2.2.	N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	The BMS terminated the charging before exceeding the upper limit charging voltage		N/A
8.2.3	Overcharge control of current (battery system)		N/A
	Results: no fire, no explosion ..... :	See Table 8.2.3	N/A
	The BMS detected the overcharging current and controlled the charging to a level below the maximum charging current		N/A
8.2.4	Overheating control (battery system)		N/A
	The cooling system, if provided, was disconnected		N/A
	Elevated temperature for charging, 5 °C above maximum operating temperature ..... :		N/A
	Results: no fire, no explosion ..... :	See Table 9.2.5	N/A
	The BMS detected the overheat temperature and terminated charging		N/A
	The battery system operated as designed during test		N/A

9	**EMC**		N/A
	Battery system fulfil EMC requirements of the end-device application ..... :	See Table 9 [ ] See attachment # __ for detail EMC report [ ] Intended for to be tested in the end use application [*include specific application*]	N/A

10	**INFORMATION FOR SAFETY**		P
	The cell manufacturer provides information about current, voltage and temperature limits of their products		P
	The battery system manufacturer provides information regarding how to mitigate hazards to equipment manufacturers or end-users.		N/A

11	**MARKING AND DESIGNATION**	P

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Clause	Requirement + Test	Result – Remark	Verdict
(modified)	The marking items listed below are indicated on the cell, battery system.		P
(modified)	Secondary (rechargeable) Sodium ion cell or battery or battery system		P
(modified)	Polarity		P
(modified)	Date of manufacture (which may be in code)		P
(modified)	Name or identification of manufacturer or supplier		P
(modified)	Rated capacity		P
(modified)	Nominal voltage		P
(modified)	Appropriate caution statement		P
(modified)	Cell designation		N/A
(modified)	Battery designation		N/A
(modified)	The following information shall be marked on or supplied with the cell or the battery:		P
(modified)	disposal instructions;		P
(modified)	recommended charge instructions.		P
(modified)	Cell or battery system has clear and durable markings		P

12	**PACKAGING AND TRANSPORT**		P
	Refer to Annex D		P

ANNEX A	**OPERATING REGION OF CELLS FOR SAFE USE**		P
A.1	General		P
A.2	Charging conditions for safe use		P
A.3	Consideration on charging voltage		P
A.4	Consideration on temperature		P
A.5	High temperature range		N/A
A.6	Low temperature range		N/A
A.7	Discharging conditions for safe use		P
A.8	Example of operating region		P

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Clause	Requirement + Test	Result – Remark	Verdict

ANNEX B	**PROCEDURE OF 7.3.3 PROPAGATION TEST BY LASER IRRADIATION**		N/A
B.1	**General**		N/A
B.2	**Test conditions**		N/A
B.2.1	Cell test (preliminary test)		N/A
	The cell fully charged according to the manufacturer recommended conditions ..... :		—
	Laser irradiation point on the cell ..... :		—
	Output power of laser irradiation..... :		—
	Tested in an ambient temperature of 25 °C ± 5 °C		N/A
	Repeat of cell test for 3 times		N/A
B.2.2	Battery system test (main test)		N/A
	The battery system fully charged according to the manufacturer recommended conditions ..... :		—
	Target cell to be laser irradiated ..... :		—
	The irradiation point on the target cell same or similar as that on the cell test		
	Output power of laser irradiation..... :		—
	Tested in an ambient temperature of 25 °C ± 5 °C		N/A

ANNEX C	**PROCEDURE OF 7.3.3 PROPAGATION TEST BY METHODS OTHER THAN LASER**		N/A
C.1	General		N/A
C.2	Test conditions:		N/A
	– The battery fully charged according to the manufacturer recommended conditions ..... :		—
	– Target cell forced into thermal runaway ..... :		—
	– A specially prepared sample (e.g. a heater or a hole for nail penetration provided) used for ease of testing..... :		—

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Clause	Requirement + Test	Result – Remark	Verdict
C.3	Method used for initiating the thermal runaway. 1) Heater (Heater, Burner, Laser, Inductive heating 2) Overcharge 3) Nail penetration of the cell 4) Combination of above methods 5) Other methods..... :		—

ANNEX D	**PACKAGING AND TRANSPORT**		P
	The materials and pack design chosen in a way as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of environmental contaminants		P
	Regulations concerning international transport of secondary lithium batteries		P

Supplementary tests (optional) (Added)			
S1 (Added)	**Nail penetration test (cell)**		N/A
(Added)	Prior to conducting nail penetration test, the capacity of the sodium ion cells shall be tested in accordance with the method described in clause 6.3.		N/A
(Added)	Then the sodium ion cells shall be tested in accordance with the clause 4.3.3 Penetration Test of SAE J2464:2021		N/A
(Added)	Results: no fire, no explosion.		N/A
S2 (Added)	**Cell thermal runaway test (Cell level test based on UL 9540A:2019, the Fourth Edition)**		N/A
S2.1 (Added)	Prior to conducting cell level thermal runaway test, the capacity of the sodium ion cells shall be tested in accordance with the method described in clause 6.3.		N/A
(Added)	Then the sodium ion cells shall be tested in accordance with the following steps:		N/A
(Added)	a) Two charge and discharge cycles specified by the manufacturer at 25 ±5°C.		N/A
(Added)	b) Charge cell to 100% SOC, start test between 1 – 8h after cycling is completed		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
Supplementary tests (optional) (Added)			
(Added)	c) Cell surface is to be covered with film heater:		N/A
(Added)	i. Heating area round cell: whole cylindric area (±5%)		N/A
(Added)	ii. Heating area prismatic and pouch cell: whole area of two larger surfaces (±5%)		N/A
(Added)	d) Constrain pouch cells and prismatic cells with steel plates (thickness: ≥10 mm) in the manner that simulates the constraint in the battery module/pack to prevent excessive swelling during the test.		N/A
(Added)	e) Laboratory environmental conditions at test start: 25 ±5°C and 50 ±25% RH.		N/A
(Added)	f) The cell's exterior surface temperature shall be measured continuously through the test with thermocouples (Type-K, 24-gauge or smaller). The location of the thermocouple junctions shall be at the center of the larger cell surface and one near the positive cell terminal.		N/A
(Added)	g) Cell is to be heated with externally applied film heater with a heating rate of 5°C/min until thermal runaway has occurred When thermal runaway is observed, stop heating.		N/A
(Added)	h) If external heating with film heater does not cause the cell to exhibit thermal runaway, one of the following methods shall be employed to cause thermal runaway:		N/A
(Added)	i. Mechanical (e.g. nail penetration);		N/A
(Added)	ii. Electrical stresses in the form of overcharging, over discharging or external short- circuiting; or		N/A
(Added)	iii. Use of alternate heating sources (e.g. oven).		N/A
(Added)	i) The temperature at which the cell case vents due to internal pressure rise shall be documented.		N/A
(Added)	j) The temperature at the onset of thermal runaway shall be documented		N/A
(Added)	k) If the cell exhibits thermal runaway behavior (using any method), 3 additional samples shall be tested using the same method and exhibit thermal runaway to demonstrate repeatability.		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
Supplementary tests (optional) (Added)			
(Added)	l) The vent temperature and thermal runaway onset temperatures shall be averaged over the tested samples.		N/A
S2.2 (Added)	The report on cell level testing shall include the following:		N/A
(Added)	a) Cell manufacturer name and cell model number;		N/A
(Added)	b) Whether UL 1973 compliant;		N/A
(Added)	c) Energy storage technology		N/A
(Added)	d) The rated energy storage capacity of the cell (e.g. Ampere-hours);		N/A
(Added)	e) Voltage and current obtained during conditioning of the cell;		N/A
(Added)	f) Open-circuit voltage of the cell at initiation of test;		N/A
(Added)	g) Methods attempted and used to initiate thermal runaway;		N/A
(Added)	h) Surface temperature at which gases are first vented and the average temperature of the samples tested excluding the gas collection sample;	See Table S2	N/A
(Added)	i) Surface temperature (and location of maximum temperature) prior to thermal runaway and average temperature of the samples tested excluding the gas collection sample;	See Table S2	N/A

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5.1	TABLE: Critical components information				
Object/part No.	**Manufacturer/ trademark**	**Type/Model**	**Technical Data**	**Standard**	**Marks of Conformity**
1.Cell	JIANGSU HIGHSTAR BATTERY MANUFACTURING CO., LTD	NaCP71173208-160	2.95Vd.c., 160Ah	-	-
-Electrolyte	Zhuhai Smoothway Electronic Materials Co.,Ltd	SWHSD-NAF06	$NaPF_6$, DMC, EMC, EC, VC, PC	-	-
-Separator	Shanghai Energy New Materials Technology Co., Ltd	9+3+1	PE, (9+3+1)μm*197mm*10716mm*2pcs / for one core, total four cores	-	-
-Positive electrode	JIANGSU HIGHSTAR BATTERY MANUFACTURING CO., LTD	YN-NFPP-2	$Na_x(PO)_4P_2O_7$, Conductive Additive PVDF, Aluminium Foil (9601*191)mm, Thickness: 0.144mm / for one core, total four cores	-	-
-Negative electrode	JIANGSU HIGHSTAR BATTERY MANUFACTURING CO., LTD	YHC-2	Hard Carbon, Conductive Additive, Aluminium Foil (9968*192)mm, Thickness: 0.120mm / for one core, total four cores	-	-
-Positive electrode tab	HANGZHOU FIVE STAR ALUMINIUM CO., LTD	71173-160Ah	Positive Electrode: Width+Hight+ Thickness(30+40+0.0120)mm*29, aluminium	-	-
-Negative electrode tab	HANGZHOU FIVE STAR ALUMINIUM CO., LTD	71173-160Ah	Negative electrode: Width+Hight+ Thickness(30+40+0.0120)mm*30, aluminium	-	-
-Insulation tap	Qidong Jinhong Packaging Materials Co., Ltd.	71173-160Ah	Materials: PET, Width and thickness: 16mm*0.045mm	-	-
-Can	Changshu Gaojia Energy Technology Co.,Ltd	(173.6±0.15)mm*(71.5±0.1)mm*(203.7±0.1)mm	Thickness: (0.6±0.1)mm, Materials: Aluminium	-	-
- Top Case / Venting	Changshu Gaojia Energy Technology Co.,Ltd	71173	Thicknes: (2±0.05)mm, Materials: Aluminium, PP, PET, Popping pressure: (0.8±0.2) MPa	-	-
Supplementary information: N/A					

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7.2.1	TABLE: External short-circuit test (cell or cell block)				P
Sample No.	**Ambient (at 25°C ± 2°C)**	**OCV at start of test (V dc)**	**Resistance of Circuit (mΩ)**	**Maximum Case Temperature Rise ΔT (K)**	**Results**
Cell 1	21.5	3.225	4.123	33.5	A, E
Cell 2	25.0	3.216	4.076	21.2	A, E
Cell 3	21.3	3.198	4.092	33.2	A, E
Cell 4	23.4	3.202	78.804	5.0	A, E
Cell 5	22.2	3.225	78.749	6.5	A, E
Cell 6	22.6	3.217	78.752	5.9	A, E

Supplementary information:

A – No fire or Explosion
B – Fire
C – Explosion
D – The test was completed after 6 h
E – The test was completed after the cell casing cooled to 20% of the maximum temperature rise
F – Other (Please explain):___

7.2.5	TABLE: Overcharge test (cell or cell block)					P
Sample No.	**OCV at start of test (V dc)**	**OCV at end of test (V dc)**	**Measured Maximum Charging Current (A)**	**Measured Maximum Charging Voltage (V dc)**	**Max. Cell Case Temperature, (°C)**	**Results**
Cell 16	1.837	3.259	160	4.140	37.9	A, E
Cell 17	1.865	3.261	160	4.140	35.4	A, E
Cell 18	1.811	3.273	160	4.140	36.1	A, E

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Test concluded when temperature reached a steady state condition
E – Test concluded when temperature returned to ambient
F – Other (Please explain): _____

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7.2.6	TABLE: Forced discharge test (cell or cell block)				P
Sample No.	**OCV before applying reverse charge, (V dc)**	**Target Voltage (V dc)**	**Measured Reverse Charge Current It, (A)**	**Total Time for Reversed Charge Application (min)**	**Results**
Cell 19	2.006	-3.45	160	90	A, D
Cell 20	1.981	-3.45	160	90	A, D
Cell 21	1.970	-3.45	160	90	A, D

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Other (Please explain): Venting, Cell pressure relief.

7.3.2	TABLE: Internal short-circuit test (cell)			P
Sample No.	**OCV at start of test, (V dc)**	**Particle location [1)]**	**Maximum applied pressure, (N)**	**Results**
Cell 22	3.438	1	402	A, E
Cell 23	3.211	1	402	A, E
Cell 24	3.214	1	402	A, E
Cell 25	3.217	1	402	A, E
Cell 26	3.196	1	402	A, E

Supplementary information:

[1)] Identify one of the following:
1: Nickel particle inserted between positive and negative (active material) coated area.

Results:

A – No fire or explosion
B – Fire
C – Explosion
D – Test concluded when 50 mV voltage drop occurred prior to reaching force limit
E – Test concluded when 800/400 N pressure was reached and 50 mV voltage drop was not achieved
F – Test was concluded when fire or explosion occurred
G – Other (Please explain): __

Remark: There is no particle location 2 in this cell.

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7.3.3	TABLE: Propagation test (battery system)				-
Sample No.	**OCV of Battery System Before Test, (V dc)**	**OCV of Target Cell Before Test, (V dc)**	**Maximum Cell Case Temperature, (°C)**	**Maximum DUT Enclosure Temperature, (°C)**	**Results**
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Method of cell failure [1)]	**Location of target cell**	**Area for fire protection (m^2)**
-	-	-
-	-	-
-	-	-

Supplementary information:

1) Cell can be failed through laser exposure, applied heat, overcharge, nail penetration or combinations of these failures or other acceptable methods. See supporting documentation for details on cell failure method

2) If the battery system has no outer covering, the manufacturer is required to specify the area for fire protection.

Results:
A – No fire external to DUT enclosure or area for fire protection or no battery case rupture
B – Fire external to DUT enclosure or area for fire protection
C – Explosion
D – Battery case rupture
E – Other (Please explain): __

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8.2.2	TABLE: Overcharge control of voltage (battery system)				-
Sample No.	**OCV at start of test for Cell/Cell Blocks, (V dc)**	**Maximum Charging Current, (A)**	**Max. Charging Voltage, (V dc)**	**Max. Voltage of Cell/Cell Blocks, (V dc)**	**Results**
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

	Charge Voltage Applied Battery System: 1)	
	Whole	**Part**
	-	-

Supplementary information:

1) The exceeded voltage can be applied to only a part of the system such as the cell(s) in the battery system per Figure 6 of IEC 62619, if it is difficult to do it in using the whole battery system.

Results:
A – No Fire or Explosion
B – Fire
C – Explosion
D – The voltage of the measured cells or cell blocks did not exceed the upper limit charging voltage
E – The voltage of the measured cells or cell blocks did exceed the upper limit charging voltage
F – All function of battery system did operate as intended during the test.
G – All function of battery system did not operate as intended during the test.
H – Other (Please explain): ___

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8.2.3	TABLE: Overcharge control of current (battery system)			-
Sample No.	**OCV at start of test, (V dc)**	**Max. Charging Current, (A)**	**Max. Charging Voltage, (V dc)**	**Results**
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Overcurrent sensing function of BMU did operate and then charging stopped
E – Overcurrent sensing function of BMU did not operate and then charging stopped
F – All function of battery system did operate as intended during the test.
G – All function of battery system did not operate as intended during the test.
H – Other (Please explain): ____

8.2.4	TABLE: Overheating control (battery system)		-
Model No.	**OCV at start(SOC 50%) of test, V dc**	**Maximum Charging Current, A**	Measured **Maximum Charging Voltage, V dc**
-	-	-	-
-	-	-	-
-	-	-	-
Maximum Specified Temperature of Battery System, °C		**Maximum Measured Cell Case Temperature, °C**	**Results**
-		-	-
-		-	-
-		-	-

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Supplementary information:

Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Temperature sensing function of BMU did operate and then charging stopped
E – Temperature sensing function of BMU did not operate and then charging stopped
F – All function of battery system did operate as intended during the test.
G – All function of battery system did not operate as intended during the test.
H – Other (Please explain): ____

9	TABLE: EMC	-

Standard used for EMC test:

Sample No.	EMC Test Item	Battery Condition	EMC Test Level/ Parameters	Compliance Criteria	Results
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Supplementary information:

Battery Condition During EMC test

1 – In Operation Mode, [ ] Supplied at ____, [ ] Load at____

2 – In non-operation Mode, Battery state of charge (SOC) before test at around____

Compliance Criteria and Test Results:
A – No fire or Explosion
B – Fire
C – Explosion
D – Battery system did operate as intended during the test.
E - All function of battery system did operate as intended after the test.
F - All function of battery system did not operate as intended during the test, (Please explain): ____
G - Other (Please explain): ____

--- End of test report ---

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