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Test Report

No. TRPVP10038/25E/001

**ANSI/CAN/UL 9540A:2025 - Standard for Test Method for Evaluating Thermal Runaway Fire
Propagation in Battery Energy Storage Systems**

Applicant: **Shanghai Shenyi Roche Energy Technology Co., Ltd.**
9F, Building 2, No. 369 Hexuan East Road, Jiading District, 201803
Shanghai, P.R. China

File No.: PVP06110/25E-001

Designed: by:

Reviewed: by:

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Test Report

File No.: PVP10038/25E-001

Test Report No.: TRPVP10038/25E/001

Applicant..... :	Shanghai Shenyi Roche Energy Technology Co., Ltd. 9F, Building 2, No. 369 Hexuan East Road, Jiading District, 201803, Shanghai, P.R. China
Manufacturer :	Roche Energy Technology (Lianyungang) Co., Ltd. No. 119, Lisha Road Ganyu High-tech Industrial Development Zone, Ganyu District, Lianyungang City 222199 Jiangsu P.R. China
Factory :	Roche Energy Technology (Lianyungang) Co., Ltd. No. 119, Lisha Road Ganyu High-tech Industrial Development Zone, Ganyu District, Lianyungang City 222199 Jiangsu P.R. China
Order No. :	QT-PVP05195/25E
Date of Application [YYYY-MM-DD] :	2025-10-15
Product :	Liquid-cooling Battery Pack
Model type(s)..... :	REMPL01660314C19AV02
Type of examination :	Commission testing only
Testing Period [YYYY-MM-DD] start/end..... :	2025-09-22 / 2025-09-25
Testing Location :	Chuweineng Testing Technology (Shanghai) Co. Ltd Building 3, No.1065 Beihe Road, Jiading District, Shanghai

Test results listed in this test report refer exclusively to the mentioned test sample.

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The submitted test samples as described in the reports hereunder are in compliance with the requirements, as of ANSI/CAN/UL 9540A:2025 Fifth Edition, Dated March 12, 2025 - Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.

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Summary of testing								
Tests performed (name of test and test clause): <table border="1"> <thead> <tr> <th>cl.</th> <th>Tests</th> <th>Reference Standard</th> </tr> </thead> <tbody> <tr> <td>8</td> <td>Module level</td> <td>ANSI/CAN/UL9540A:2025</td> </tr> </tbody> </table>		cl.	Tests	Reference Standard	8	Module level	ANSI/CAN/UL9540A:2025	Testing location: Chuweineng Testing Technology (Shanghai) Co. Ltd Building 3, No.1065 Beihe Road, Jiading District, Shanghai
cl.	Tests	Reference Standard						
8	Module level	ANSI/CAN/UL9540A:2025						
Number of samples required for testing: A 1P52S Li-ion battery Module.								
Module Level Test Summary								
Manufacturer:		Roche Energy Technology (Lianyungang) Co., Ltd.						
Model number:		REMP101660314C19AV02						
Nominal voltage rating, (V)		166.4						
Nominal capacity rating, (Ah)		314						
Approximate dimension, (mm)		/						
Electrical configuration of cell in module:		1P52S						
Method used to initiate thermal runaway:		Flexible thin film heaters						
Number of cells used for initiating thermal runaway:		1						
Number of cells exhibited thermal runaway within module:		4						
Cell to cell propagation condition:		Yes, cell to cell propagation occurred						
Peak chemical heat release rate, (kW)		12.93						
Peak smoke release rate, (m ² /s)		1.6815						
Total smoke release, (m ²)		213.39						
Flammable gas generation, (L)		513.6						
Total gas generation, (L)		621.8						
Weight loss, (%)		0.61%						
Gas composition:		CO(8.8%), CO ₂ (17.4%), THC(51.6%), H ₂ (22.2%)						
Cell Level Test Summary								
Unique identification of test report:		CN234568 001						
Standard and its edition used for testing:		UL 9540A: 2025(Fifth Edition)						
Manufacturer:		REPT BATTERO Energy Co., Ltd.						
Model number:		CB75						
Nominal cell voltage, (V)		3.2						
Cell capacity, (Ah)		314						
Cell chemistry: (e.g., NMC, LFP)		LFP						
Physical format of cell: (i.e., Prismatic, Cylindrical, Pouch)		Prismatic						
Approximate dimension, (mm)		/						
Mass, (kg)		5.78±0.3						

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Method used to initiate thermal runaway:	/
Average temperature at which cell first vented excluding gas collection sample, (°C)	127.9
Average temperature prior to thermal runaway excluding gas collection sample, (°C)	179.8
Flammable gas generation, (Liter)	/
Total gas generation, (Liter)	188 (STP)
Lower flammability limit (LFL) at ambient temperature (25 ± 5° C), (%)	7.7%
Lower flammability limit (LFL) at average gas vent temperature, (%)	7.1%
Burning velocity, (m/sec)	0.688
Maximum pressure Pmax, (psi)	0.798
Gas composition:	/

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General remarks

Possible test case verdicts:	
Test case does not apply to the test object.....:	Not Applicable (N/A)
Test object does meet the requirement.....:	Pass (P)
Test object does not meet the requirement.....:	Fail (F)
Other remarks:	
The test verdicts 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 issuing testing laboratory. “(see Annex #)” refers to additional information appended to the report. “(see Table #)” refers to a table appended to the report. Throughout this report, a point is used as the decimal separator.	

Test Report

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General product information

Product Description:

The tested module is a Li-ion battery module. The module has a capacity of 314Ah and nominal voltage 166.4 Vdc.

The module is comprised of 52 lithium iron phosphate(LFP) battery cells connected in series, with each cell having a nominal voltage of 3.2V.

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Parameters:

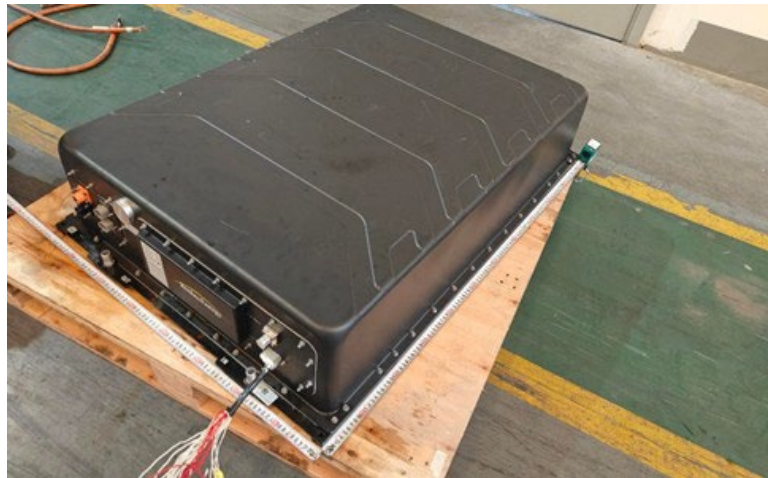
Module		
Rated capacity:	314Ah	
Nominal voltage:	166.4V	
Rated capacity:	314Ah	
Rated energy:	52250Wh	
Standard charge method:	Charge current	157A
	End of charge voltage	189.8V
	Cut off current	157A
Upper limit charging voltage:	/	
Charge temperature range:	/	
Standard discharge method:	Discharge current	157A
	End of discharge voltage	145.6V
Discharge temperature range:	/	
Nominal weight:	/	
Nominal dimension:	/	
Storage temperature range:	/	

Test results

ANNEX IV		
8	Module Level	-
8.1	Sample	-
8.1.1	Prior to testing, module sample was conditioned for minimum 2 charge (100%SOC) - discharge (Specified end of discharge voltage) cycle as per manufacturer specified method.	See Annex 2 for details
	Module was functional after minimum 2 charge discharge cycle.	See above
	Ambient temperature during module conditioning.	See Table 1 for details
8.1.2	The tested module had 100% SOC at the start of the test. The samples were allowed to rest for a minimum of 1 hour before the start of the test.	See Annex 2 for details
8.1.3	Prior to initiating the test, the module voltage shall be measured at the module terminals and Recorded.	See Table 1 for details
	If the module is not in a fully charged condition, the module shall be charged again as noted in 8.1.2 and this value shall be recorded.	See Annex 2 for details
8.1.4	Electronics and software controls such as BMS were not relied upon for this testing.	Confirmed
8.2	Test method	-
8.2.1	Ambient temperature during module testing.	See Table 1 for details
8.2.2	Test was conducted under smoke collection hood.	Yes
8.2.3	Weight of module was recorded before and after testing.	Confirmed, See Table 1 for details
8.2.4	Number of cells forced into thermal runaway inside module:	1 cell
	Number of cells forced into thermal runaway were able to create condition of cell-to-cell propagation	1 cell
	Location of cells forced into thermal runaway were selected to present greatest thermal exposure to adjacent cell.	Confirmed
	Factors consider when selecting location of cells inside module:	☒ Heat transfer was maximized to other cells. ☐ Cooling by ventilation was restricted or limited. ☐ Thermal sensors, detection and suppression discharge points were remote. ☐ Other(explain):

8.2.5	Cell to cell thermal runaway propagation occurs when at least one additional non-initiating cell goes into thermal runaway during the test.	See Annex 3 for details	P
	Temperatures shall be measured on the initiating cells and nearby non-initiating cells to determine cell to cell thermal runaway propagation.	See Annex 4 for details	P
8.2.6	Temperatures shall be measured on the initiating cells, nearby non-initiating cells and exterior surface of the module enclosure in the area closest to the initiating cell location(s). to determine thermal runaway propagation.	See Annex 4 for details	P
8.2.7	Method used to initiate thermal runaway during cell level was used at the module level of testing	Film heater	P
8.2.8	Occurrence of thermal runaway was verified by sustained temperature above the cell surface temperature at the onset of thermal runaway	Confirmed	P
8.2.9	Module was placed on top of a noncombustible horizontal surface	Confirmed	P
	Module orientation was representative of its intended final installation	Confirmed	P
8.2.10	Chemical heat release rate of the module in thermal runaway was measured with oxygen consumption calorimetry	Oxygen consumption calorimetry was used.	P
8.2.11	Chemical heat release rate was measured for the duration of the test	Confirmed	P
8.2.12	Equipment used for chemical heat release rate measurement:	☒ Heat Release Rate Analyzer ☒ Type K thermocouple ☐ Other(explain): ---	P
	The instrumentation was located in the exhaust duct.	Confirmed	P
8.2.13	Heat release rate was calculated as per following formula. $HRR_1 = \left[E \times \phi - (E_{co} - E) \times \frac{1 - \phi}{2} \times \frac{X_{co}}{X_{O_2}} \right] \times \frac{m_e}{1 + \phi \times (a - 1)} \times \frac{M_{O_2}}{M_a} \times (1 - X_{H_2O}^a) \times X_{O_2}^a$	Confirmed	P
8.2.14	The hydrocarbon content of the vent gas was measured using flame ionization detection.	Palladium-nickel sensor was used for gas components measurement as reference	P
	Hydrogen gas shall be measured with an appropriate sensor	Total Carbon and Hydrogen Analyzer was used for gas components measurement as reference	P
8.2.15	The hydrocarbon components of the vent gas composition may additionally be measured using a Fourier-Transform Infrared Spectrometer with a minimum resolution of 1 cm- 1 and a pathlength of at least 2 m (6. 6 feet), or an equivalent gas analyzer.	FTIR was used for gas components measurement as reference	P

	Velocity and temperature measurements respectively shall be obtained in the exhaust duct of the heat release rate calorimeter using equipment specified in 8.2.12.	Confirmed	P
8.2.16	Light transmission in the exhaust duct was measured for the duration of the test.	Confirmed	P
8.2.17	Smoke release rate was calculated as per following formula. $SRR = 2.303 \left(\frac{V}{D} \right) \log_{10} \left(\frac{I_o}{I} \right)$	See Table 3	P
8.3	Module test method for high temperature batteries		N/A
8.3.1	During the test, the module shall be placed on top of a noncombustible horizontal surface with the module orientation representative of its intended final installation.	No high temperature batteries	N/A
8.3.2	The module shall be fully charged prior to testing and heated to the manufacturer's specified operating temperatures. The module shall be provided with electrical connections to the cell(s) to be failed in order to overcharge the cell(s).	No high temperature batteries	N/A
8.3.3	The cell failure test method as outlined in 7.3.4 shall be conducted on at least one cell within the module. During the test, the voltage of the cell(s) being failed as well as temperatures on the failed cell(s) and surrounding cells shall be monitored and documented. The voltage of the module shall be monitored during the test.	No high temperature batteries	N/A
8.3.4	Thermocouples shall be placed on the external casing of the module to monitor any breakdown of thermal insulation in the module case. The chemical heat release rate, smoke release rate and gas measurements are not conducted.	No high temperature batteries	N/A
8.3.5	The results of the cell(s) failure shall be observed and documented.	No high temperature batteries	N/A
8.4	Module level test report		-
8.4.1	Module level report include information indicated in item a) through p)	Confirmed	P
8.4.2	High temperature battery module level report include information indicated in item a) through i)	No high temperature batteries	N/A

Annex 1: Sample Pictures

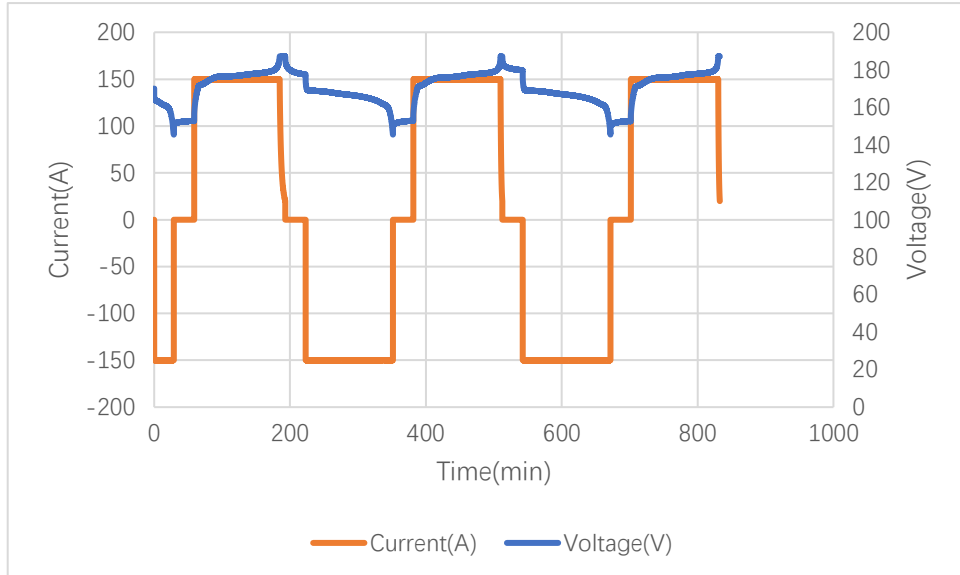
Overall photo before module testing



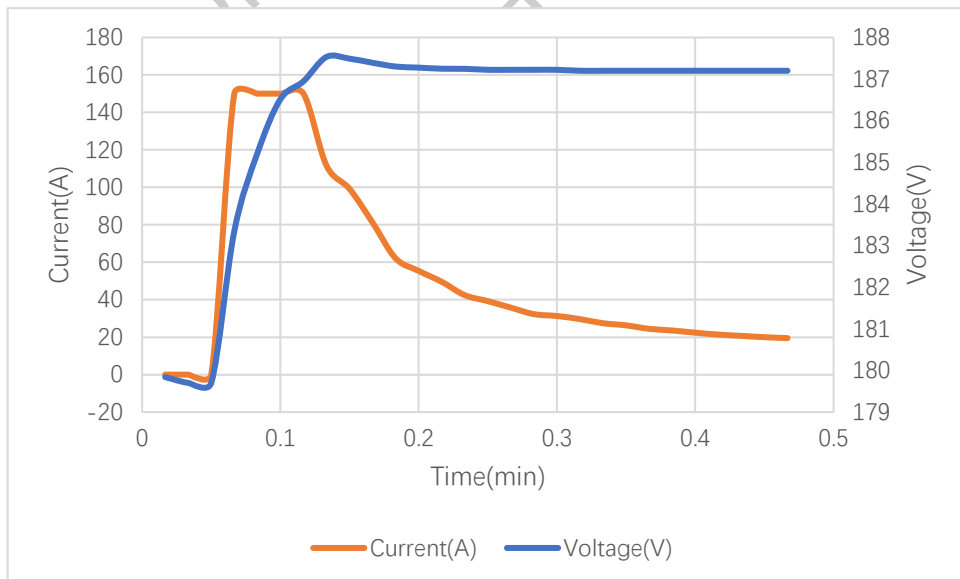
Photo of the module with the cover open before testing

Annex 2: Sample Conditioning

The battery voltage and current curves during battery conditioning are shown below:



Sample charge and discharge curve



Sample recharge curve

Annex 3: Thermal runaway records

Table 1 Recording of the results of the thermal runaway method				
Sample Number	01#			
Ambient temperature during cell conditioning	28.1℃ ,65%RH			
Open circuit voltage before test (V)	182.3			
Pre-test mass (kg)	343.5			
Cell failure test method performed:	Heater, 5.5℃/min			
Test start time	2025-9-23 13:28:50			
Valve opening/thermal runaway records during testing	Cell vented	Vent time	Thermal runaway	Thermal runaway time
	1 st	14:06:04	1 st	14:17
	2 nd	14:16:50	2 nd	14:22
	3 rd	14:18:00	3 rd	14:22
	4 th	14:24:00	4 th	14:28
	5 th	14:30:27	5 th	/
	6 th	15:03:31	6 th	/
Test Process Test Phenomenon Record	No fire or abnormal phenomenon			
Test end time	2025-9-24 08:30:00			
voltage at the end of the test (V)	159.5			
Sample status after testing	4 cells thermal runaway			
Post-test mass (kg)	341.4			
Loss of Mass (%)	2.1kg (0.61%)			
Thermal runaway test picture				
Sample Number: 01#				



Test start (13:28:50)

1st Cell venting (14:06:04)1st thermal runaway (14:17)2nd thermal runaway (14:22)

3rd thermal runaway (14:22)4th thermal runaway (14:28)Test end (08:30@2nd day)

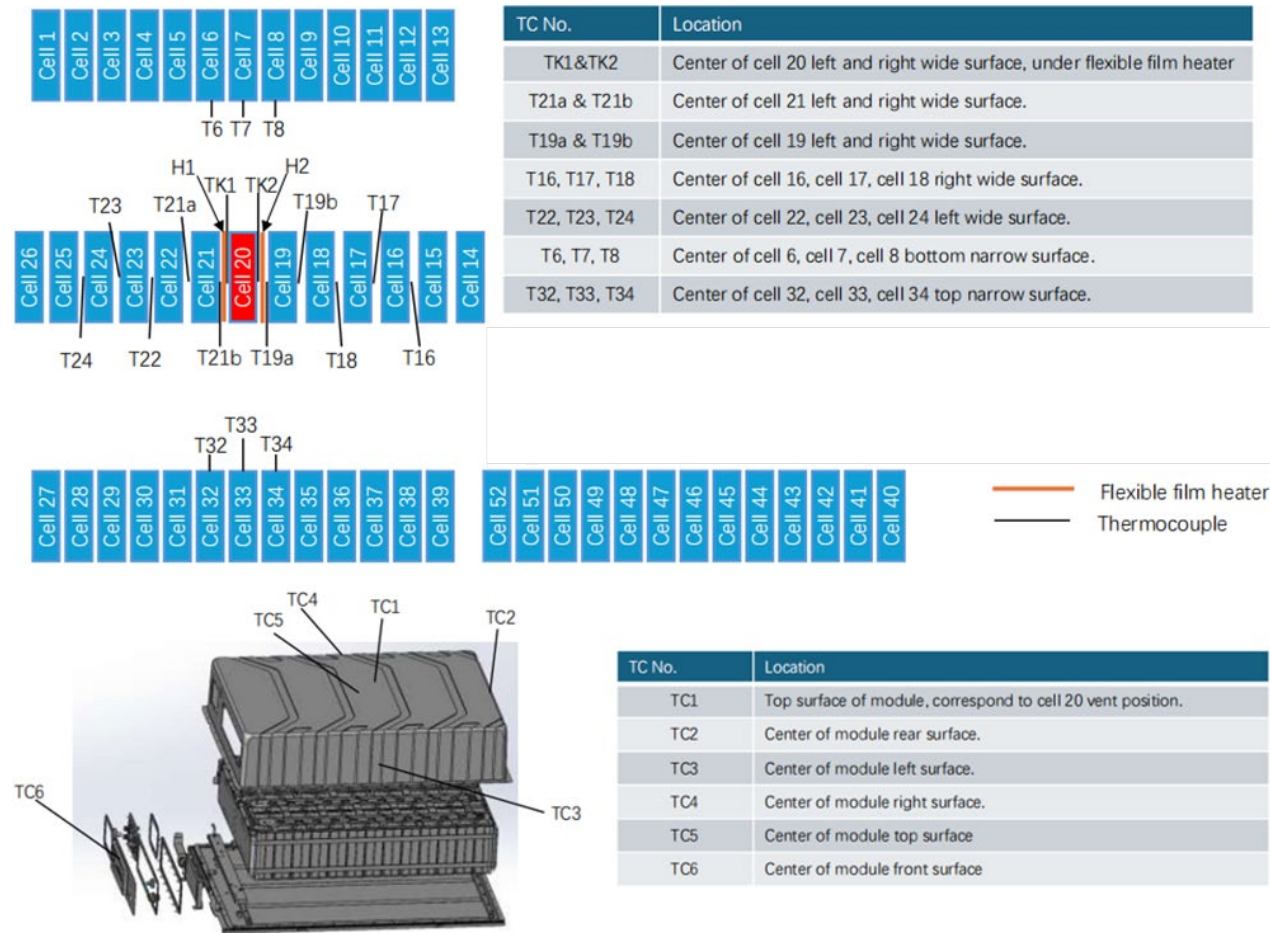


After thermal runaway

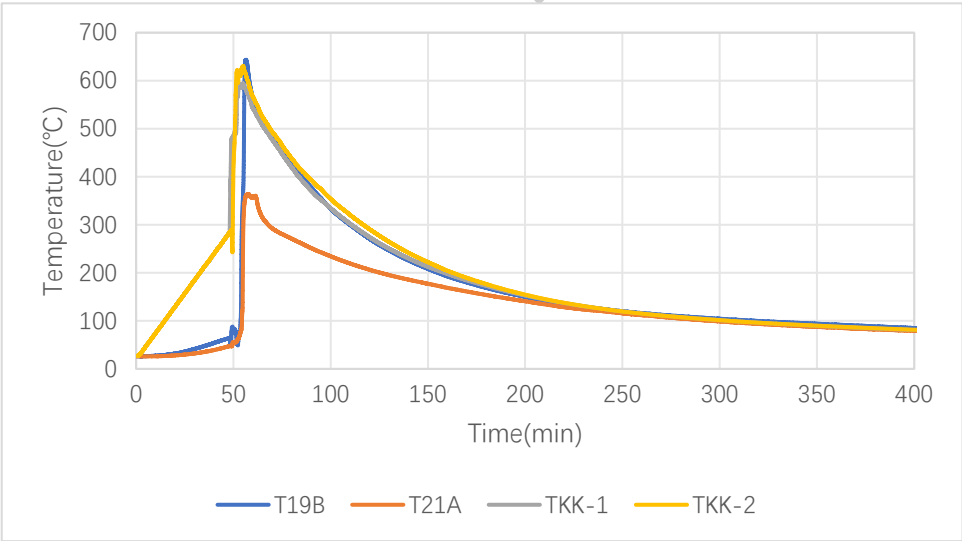
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Annex 4: Temperature and voltage profiles at each monitoring point of the samples during the test period

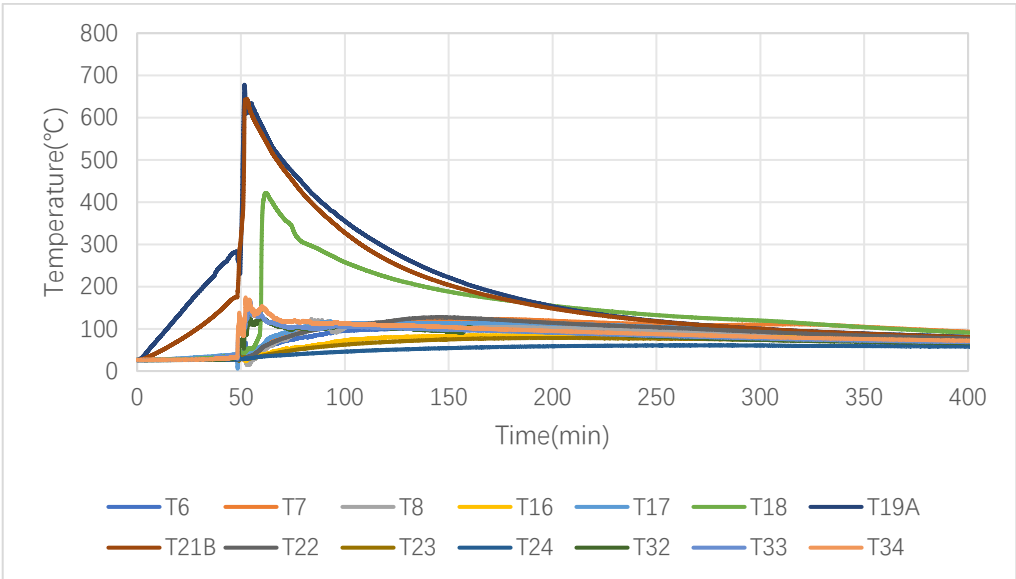
Thermocouple layout scheme and schematic diagram



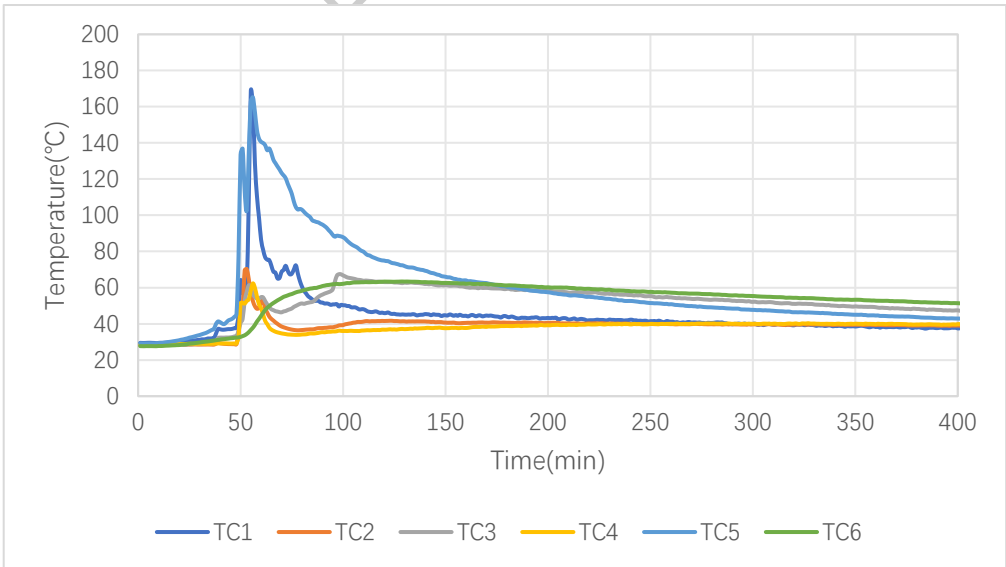
Temperature and voltage curves



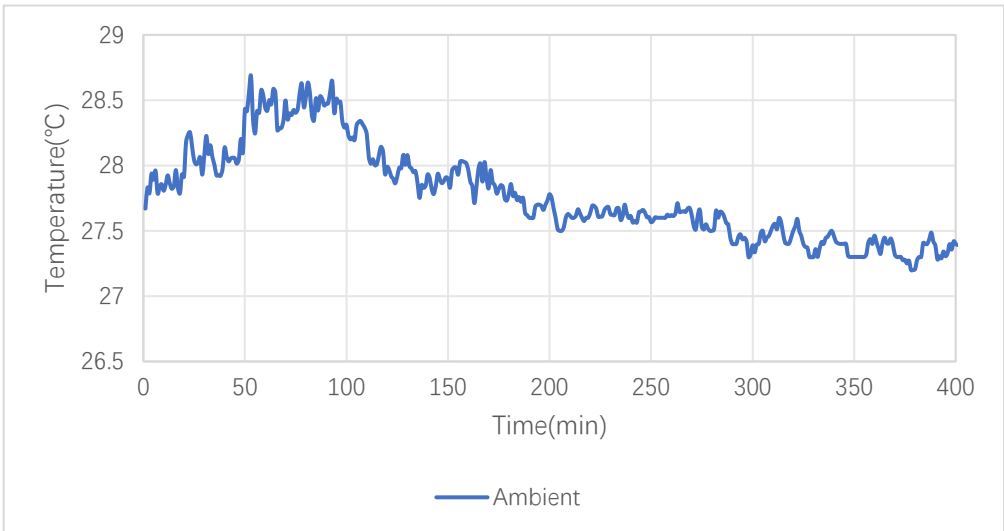
Initiating cell temperature



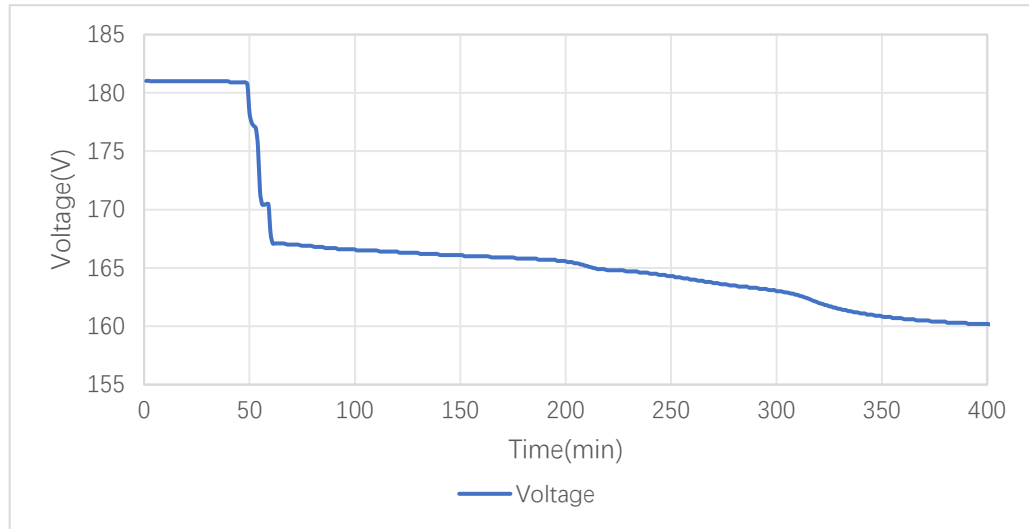
Temperature of other cells



Module enclosure temperature



Ambient temperature



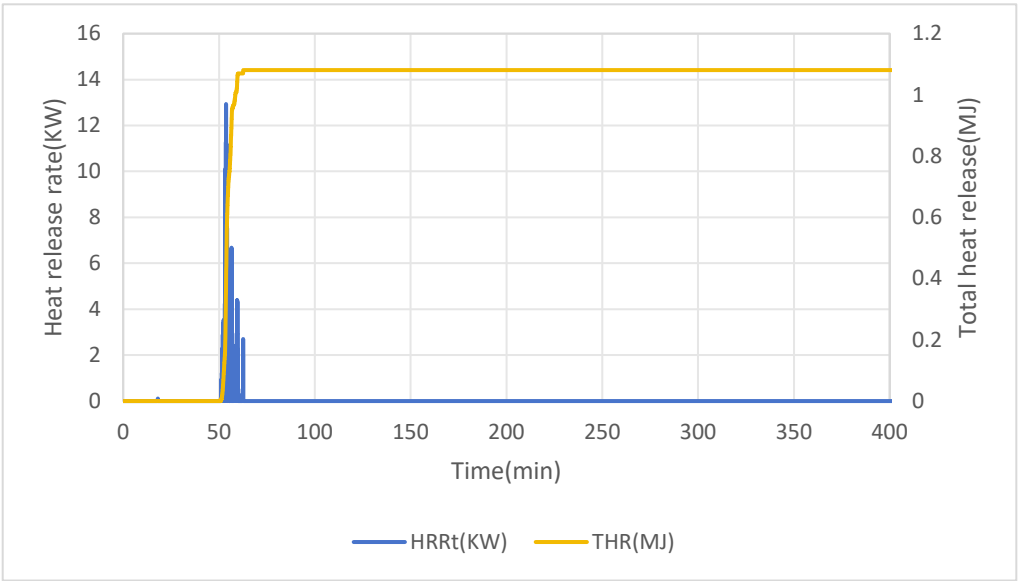
Module voltage

The maximum temperature at each point is shown in the table below

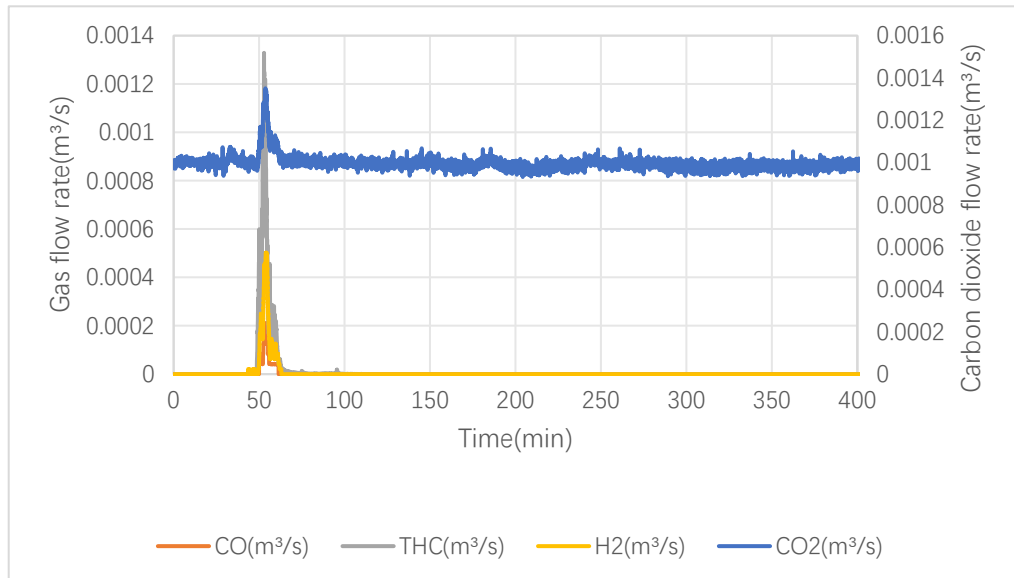
The surface temperature of the cell is measured continuously, while other temperatures are averaged every 60 seconds.

Temp. No.	Maximum temperature (°C)	Temp. No.	Maximum temperature (°C)	Temp. No.	Maximum temperature (°C)
T6	100	T21B	644	TC1	168.6
T7	123.5	T22	127.2	TC2	70.3
T8	123.2	T23	78.3	TC3	67.4
T16	84.9	T24	60.9	TC4	62.3
T17	117.3	T32	134.5	TC5	165.3
T18	421.7	T33	165.6	TC6	63.4
T19A	677.9	T34	174.4	Ambient	28.7
T19B	643.6	TKK-1	597	/	/
T21A	364.2	TKK-2	630.5	/	/

Annex 5: Heat Release

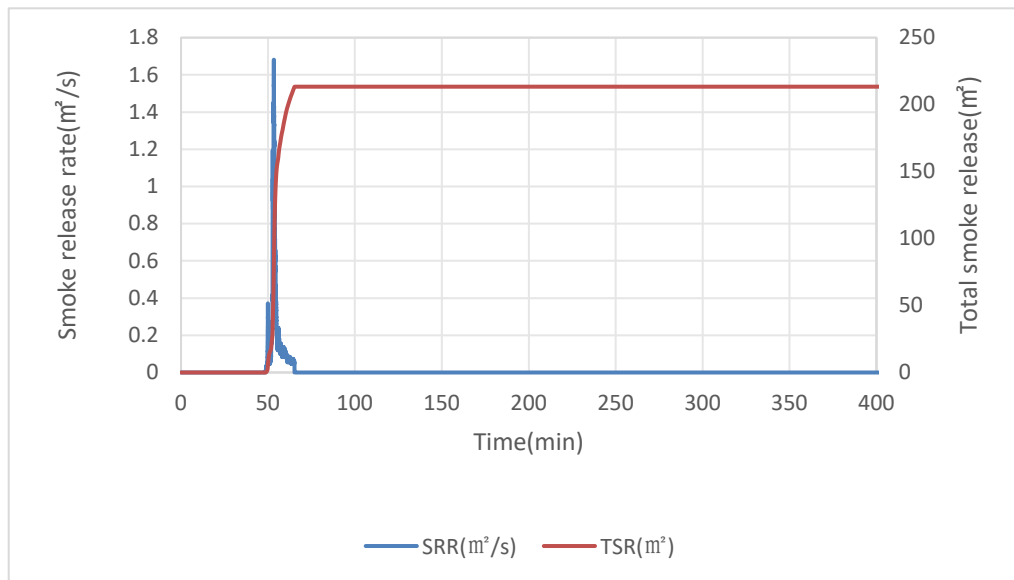


Heat release rate graph

Annex 6: Gas generation

Gas generation rate graph

Table 2 Gas composition			
Gas Components		Total volume of gas (L)	
		☒ Before the cell valve opens ☐ Before catching fire	☒ Throughout the entire experiment ☐ After catching fire
Carbon Monoxide(NDIR)	CO	0	55.0
Carbon Dioxide(NDIR)	CO ₂	0	108.3
Hydrogen(Palladium nickel thin film solid state sensor)	H ₂	0	137.7
Total Hydrocarbons (equivalent to CH ₄ , measured by FID)	THC	0	320.9
Flammable gas generation (L)	/	0	513.6
Total gas production (L)	/	0	621.8
Gas composition	CO(8.8%), CO ₂ (17.4%), THC(51.6%), H ₂ (22.2%)		

Annex 7: Smoke release

Smoke release rate graph

Table 3 Module level test	
Peak chemical heat release rate, (kW)	12.93
Peak smoke release rate, (m^2/s)	1.6815
Total smoke release, (m^2)	213.39

Annex 8: Main Instrumentation

No.	Equipment name	Equipment model	Calibration certificate	Calibration validity	Remark
1	Multimeter	ZTW890DS PRO	DW044-250130633	2026-08-08	/
2	Electronic scale	XK3150 (W) (0~800kg)	YSZ-20250630-3503	2026-06-29	/
3	Battery testing cabinet	RCDS-500V 300AV2CH-300KW	J202506132739D-0012	2026-07-08	/
4	Temperature and voltage acquisition device	ICDAM C-4117/Autonics MT4W-DV-48/DELTA DTM/ICDAM C-4118/DELTA DT320VA-0200	J202507106537F-0003	2026-08-25	/
5	Heat Release Rate Analyzer	O2:OXYMAT 61 CO/CO2:ULTRAMAT 23	J202411272818A-0001 J202411272818A-0003	2025-11-18	/
6	Total Carbon and Hydrogen Analyzer	AO2040	J202411272818A-0002	2025-11-18	/
7	Palladium-nickel sensor	710B	J202506132739A-0005	2026-06-29	/
8	Fourier Transform Infrared Online Analyzer	MG6000	/	/	/

----- End of test report -----