

Test Report issued under the responsibility of:



**BUREAU
VERITAS**

**TEST REPORT
UL 9540A
Test Method for Evaluating Thermal Runaway Fire
Propagation in Battery Energy Storage Systems**

Report Number: **CMCC-ESH-P25031171**

Date of issue.....: 2026-01-15

Total number of pages: 26 pages

**Name of Testing Laboratory
preparing the Report**.....: **BUREAU VERITAS LCIE CHINA COMPANY LIMITED**
Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-
Tech Park, Shanghai, P.R.China (201612)

Applicant's name: **Dunext Technology Suzhou Co., Ltd.**
Address: 1st & 2nd Floors, Factory Building 6, 58 Xingnan Road,
Wuzhong Economic and Technological Development Zone,
Suzhou,215100 Jiangsu P.R.China

Test specification:

Standard: ANSI/CAN/UL9540A:2025

Test Items: Module level

Non-standard test method: N/A

TRF template used: UL9540A:2025, Ed.1.5

Test Report Form No......: UL9540A

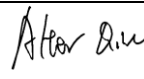

Test Report Form(s) Originator: UL Solutions (Demko)

Master TRF: Dated 2025-02-24

UL Standard for Safety for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, ANSI/CAN/UL 9540A

General disclaimer:

The test results presented in this report relate only to the object tested.
Specific test results are summarised in the main text of the test results.

Test item description :	Rechargeable Li-ion Battery Module	
Trademark(s) :	DUNEXT	
Manufacturer :	Dunext Technology Suzhou Co.,Ltd	
Model/Type reference :	1P52S/280Ah-0.5P	
Ratings :	166.4V, 280Ah, 46.5kWh	
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
<input checked="" type="checkbox"/>	Testing Laboratory:	BUREAU VERITAS LCIE CHINA COMPANY LIMITED
Testing location/ address:		Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Park, Shanghai, P.R.China (201612)
Tested by (name, function, signature):		Alter Qiu (Project Manager) 
Approved by (name, function, signature) ...:		Robin Wu (Reviewer) 
<input type="checkbox"/>	Testing procedure: CTF Stage 1:	
Testing location/ address:		
Tested by (name, function, signature):		
Approved by (name, function, signature) ...:		
<input type="checkbox"/>	Testing procedure: CTF Stage 2:	
Testing location/ address:		
Tested by (name + signature)		
Witnessed by (name, function, signature) ..:		
Approved by (name, function, signature) ...:		
<input type="checkbox"/>	Testing procedure: CTF Stage 3:	
<input type="checkbox"/>	Testing procedure: CTF Stage 4:	
Testing location/ address:		
Tested by (name, function, signature):		
Witnessed by (name, function, signature) ..:		
Approved by (name, function, signature) ...:		
Supervised by (name, function, signature) :		

<p>List of Attachments (including a total number of pages in each attachment):</p> <p>Attachment 1 (Pictures for product): Page 24 Attachment 2 (The location of triggered cell): Page 25 Attachment 3 (Test Equipment list): Page 26</p>	
<p>Summary of testing:</p>	
<p>Tests performed (name of test, test clause and date test performed):</p> <ul style="list-style-type: none"> -2.1 Thermal runaway test: <ul style="list-style-type: none"> -2.1.1 Sample Conditioning -2.1.2 Thermal runaway records -2.1.3 Temperature Measurement -2.1.4 Heat Release Measurements -2.1.5 Gas Composition Measurement -2.1.6 Flue gas measurement 	<p>Testing location: (CBTL, SPTL, CTF, Subcontractor)</p> <p>BUREAU VERITAS LCIE CHINA COMPANY LIMITED Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Park, Shanghai, P.R.China (201612)</p>
<p>Summary of compliance with National Differences (List of countries addressed):</p> <p><input checked="" type="checkbox"/> The product fulfils the requirements of <u>ANSI/CAN/UL9540A:2025.</u></p>	

Use of uncertainty of measurement for decisions on conformity (decision rule) :

No decision rule is specified by the UL standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty ("simple acceptance" decision rule, previously known as "accuracy method").

Other: ... (to be specified, for example when required by the standard or client, or if national accreditation requirements apply)

Information on uncertainty of measurement:

The uncertainties of measurement are calculated by the laboratory based on application of criteria given by OD-5014 for test equipment and application of test methods, decision sheets and operational procedures of IECEE.

IEC Guide 115 provides guidance on the application of measurement uncertainty principles and applying the decision rule when reporting test results within IECEE scheme, noting that the reporting of the measurement uncertainty for measurements is not necessary unless required by the test standard or customer.

Calculations leading to the reported values are on file with the NCB and testing laboratory that conducted the testing.

Copy of marking plate:**23. 2kW/46. 5kWh Energy Storage Battery Module**

Nominal voltage:166. 4Vd. c.

Rated capacity:280Ah

Rated energy:46. 5kWh

Rated current:140A

Designation:IFpP74/175/208/[1P52S]M/-20+55/85

Do not disassemble or modify;

Ne pas démonter ou modifier;

Do not dispose in fire;

Ne pas manipuler dans le feu;

Rechargeable Lithium-ion battery module

Dunext Technology Suzhou Co., Ltd.



Test item particulars	--
Classification of installation and use	To be defined in final product
Supply Connection	DC Connector
.....	:
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	: 2025-04-30
Date (s) of performance of tests	: 2025-05-19 to 2025-5-22
General remarks:	
"(See Enclosure #)" refers to additional information appended to the report.	
"(See appended table)" refers to a table appended to the report.	
Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.	
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies)	Dunext Technology Suzhou Co., Ltd. 1st & 2nd Floors, Factory Building 6, 58 Xingnan Road, Wuzhong Economic and Technological Development Zone, Suzhou,215100 Jiangsu P.R.China

General product information and other remarks:

The main features of the battery are shown as below:

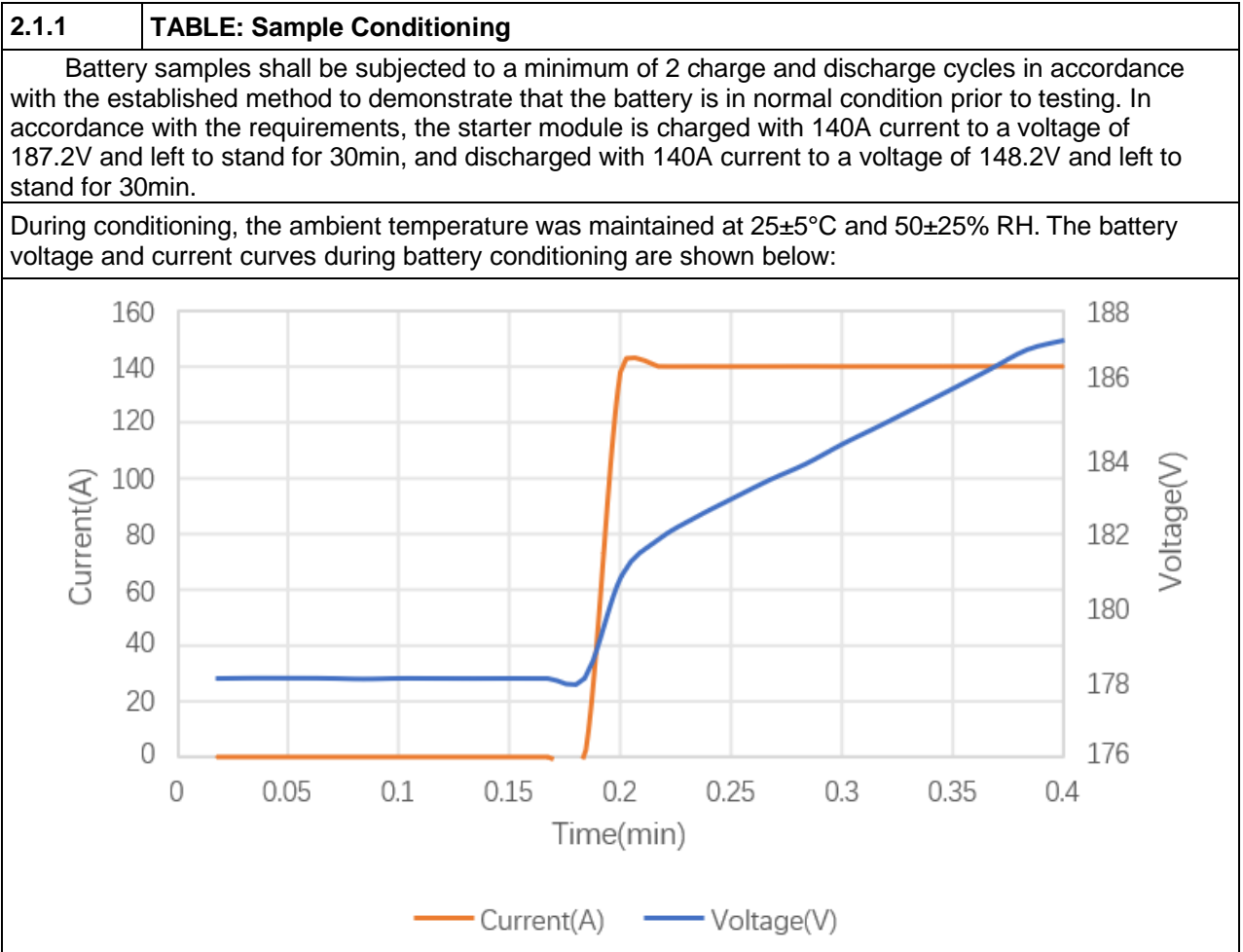
Sample name	Rechargeable Li-ion Battery Module	Model	1P52S/ 280Ah-0.5P
Appearance & Shape	Cuboid	Module cell configuration	1P52S
Nominal voltage (V)	166.4V	Mass (kg)	333±5kg
Nominal energy (kWh)	46.5 kWh	Rated capacity (Ah)	280Ah
Charging current (A)	140A	Discharge current (A)	140A
End of charge Voltage (V)	187.2V	End of discharge voltage (V)	148.2V
Overall size	(1160±3) mm× (810±2) mm× (245±2) mm		

2.1	BATTERY SYSTEM THERMAL RUNAWAY		P
	General requirements		P
2.1.1	Sample Conditioning		P
2.1.2	Thermal runaway records		P
2.1.3	Temperature Measurement		P
2.1.4	Heat Release Measurements		P
2.1.5	Gas Composition Measurement		P
2.1.6	Flue gas measurement		P







3	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.		P

ANNEX A	TEST CONCEPTS AND APPLICATION OF TEST RESULTS TO INSTALLATIONS		P
A1.1	This Annex is designed to help test sponsors, designers, owners, insurance companies and code authorities understand: a) The purpose of the tests included in this Standard; b) How the individual tests relate to each other; and c) How to interpret and apply the results to achieve a code compliant installation.		P
A1.2	Model fire codes and energy storage system standards require energy storage systems to comply with UL 9540, which in turn requires battery cells and modules to comply with UL 1973.		P
A1.3	To address these fire and explosion hazards associated with the installation of a BESS, the fire and other codes require energy storage systems to meet certain location, separation, fire suppression and other criteria.		P

2.1	TABLE: Thermal runaway test		
Test results			
Cell failure test method performed:	Heat, 5.5°C/min		
Number of initiating cells:	1		
Number of cells with thermal runaway in the module:	2		
Maximum Smoke Release Rate (m2/s)	0.3596		
Total Smoke Released: (m2)	10.28		
Peak Chemical Heat Release Rate: (kW)	16.91		
Loss of mass (kg)	0.7 (0.2%)		
<p>Performance Criteria in accordance with Clause 8.4 and Figure 1.1: The effects of thermal runaway was contained by the module design; <input type="checkbox"/> Cell vent gas (based upon the cell level test) was non-flammable ;</p>			
<p>Necessity of a unit level test:</p> <input type="checkbox"/> The performance criteria of the module level test as indicated in 8.4 and as shown in Figure 1.1 of UL 9540A 4th edition has not been met, therefore unit level testing in accordance with UL 9540A will need to be conducted on a complete unit employing this module. <input type="checkbox"/> The performance criteria of the module level test as indicated in 8.4 and as shown in Figure 1.1 of UL 9540A 4th edition has been met, therefore unit level testing in accordance with UL 9540A need not be conducted.			



2.1.2		TABLE: Thermal runaway records			
Environmental conditions at the start of the test	27.2°C 64%RH				
Module open circuit voltage before test (V)	179.2				
Module weight before test (kg)	332.8				
Trigger thermal runaway method	Heat,5.5°C/min				
Test start time	2025.05.20 16:00:00				
Open valve/thermal runaway recording during testing	Number of valve openings	Valve opening time	Number of thermal runaway	Thermal runaway time	
	1st	16:37:35	1st	16:49	
	2nd	17:09:38	2nd	17:10	
	3rd	17:11:36	3rd	/	
Test Process Test Phenomenon Record	Nothing but smoke				
Test end time	2025.05.21 08:30:00				
Module voltage at the end of the test (V)	171.2				
Sample status after testing	Thermal runaway 2 cells				
Module weight after test (kg)	332.1				
Loss of module mass before and after testing (kg)	0.7 (0.2%)				

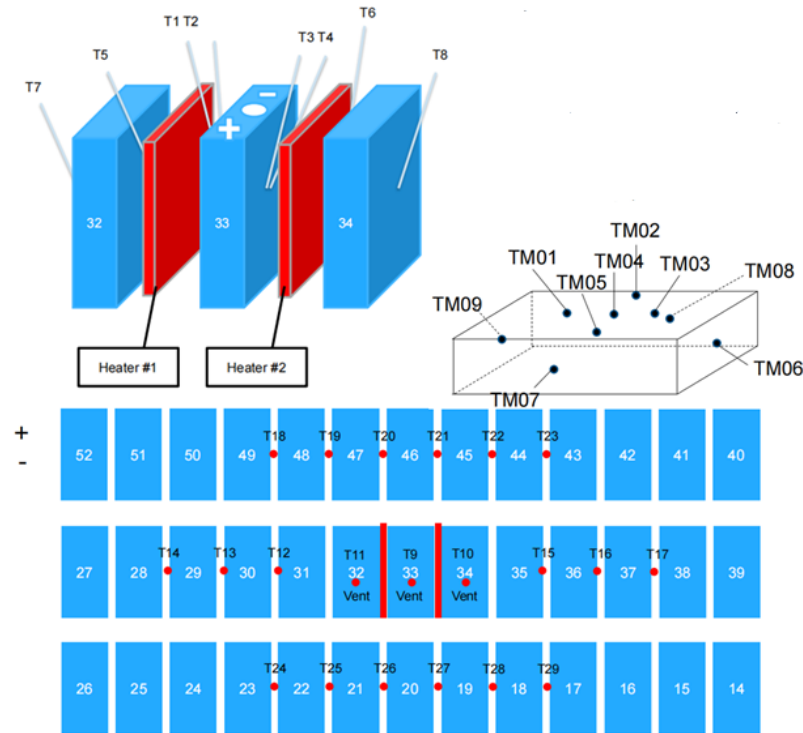
Test Photos	
	
Test start 16:00:00	Open valve 16:37:35
	
Thermal runaway 16:49	Thermal runaway 17:10
	
Test ends at 8:30	Sample overall after testing



Sample uncapping after testing

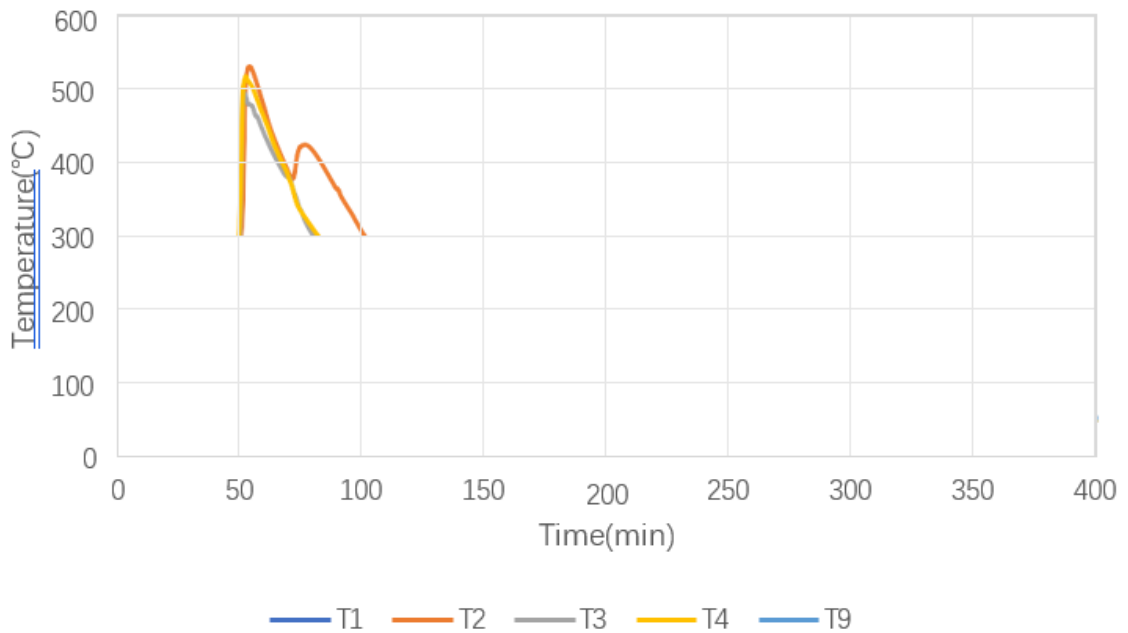
2.1.3 TABLE: Temperature Measurement

Thermocouple arrangement scheme and schematic

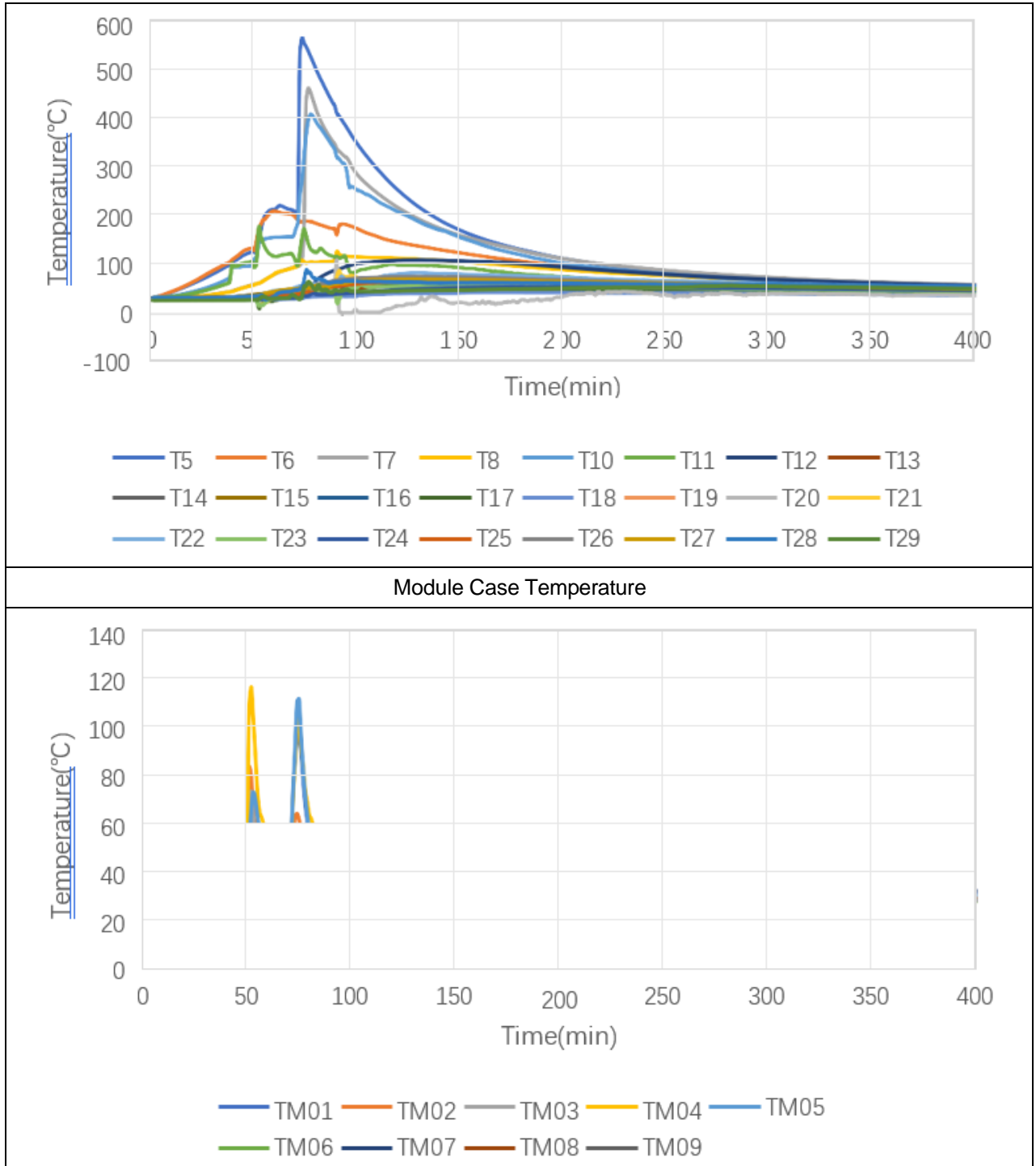


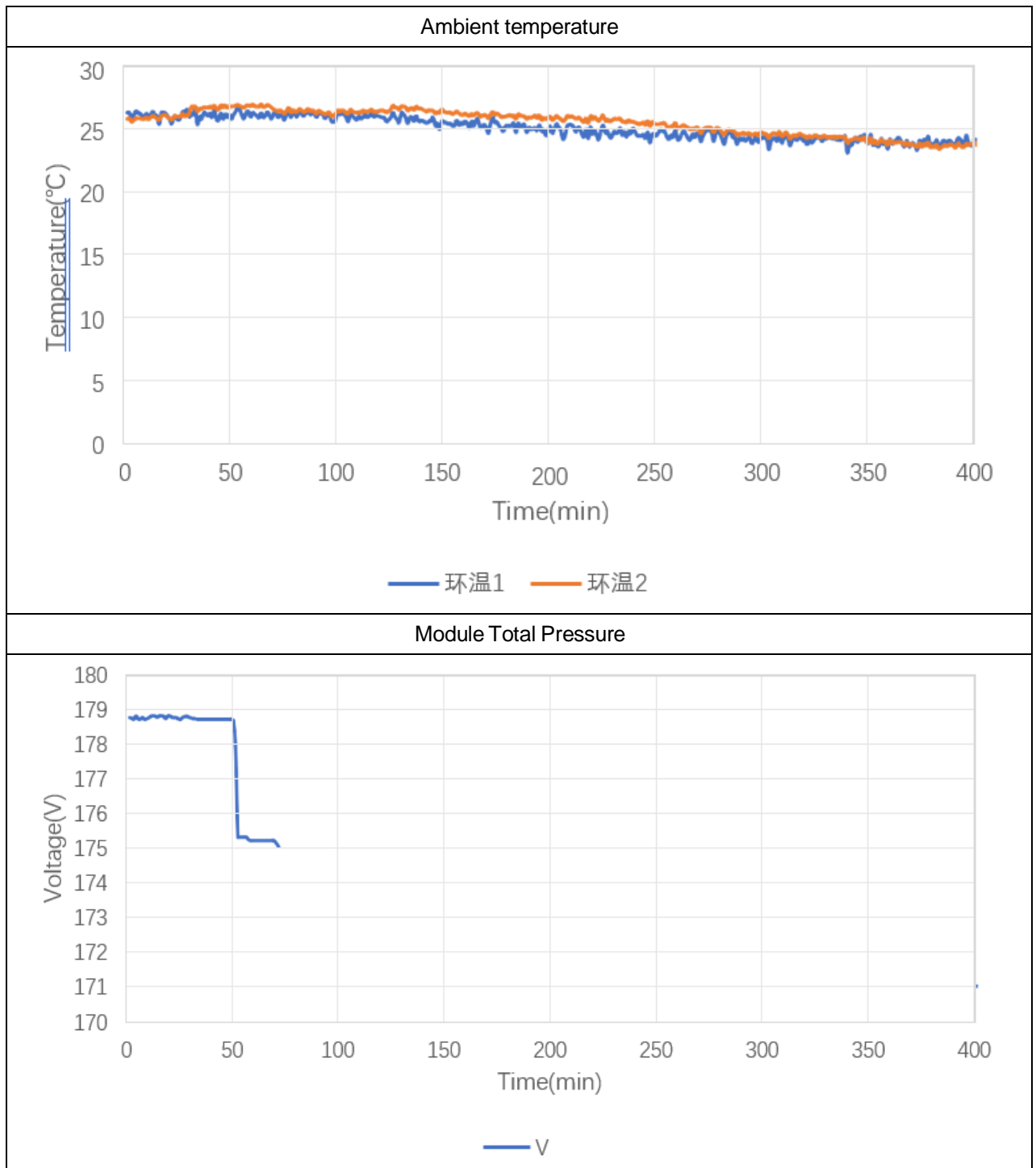
The temperature profile is shown in the graph below:

Module Trigger Cell Temperature



Temperature of other cells inside the module

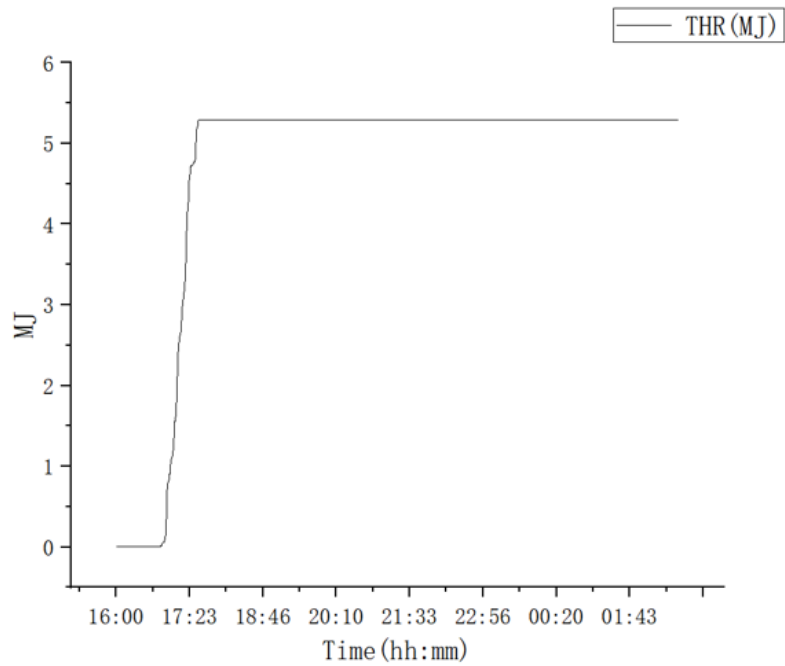
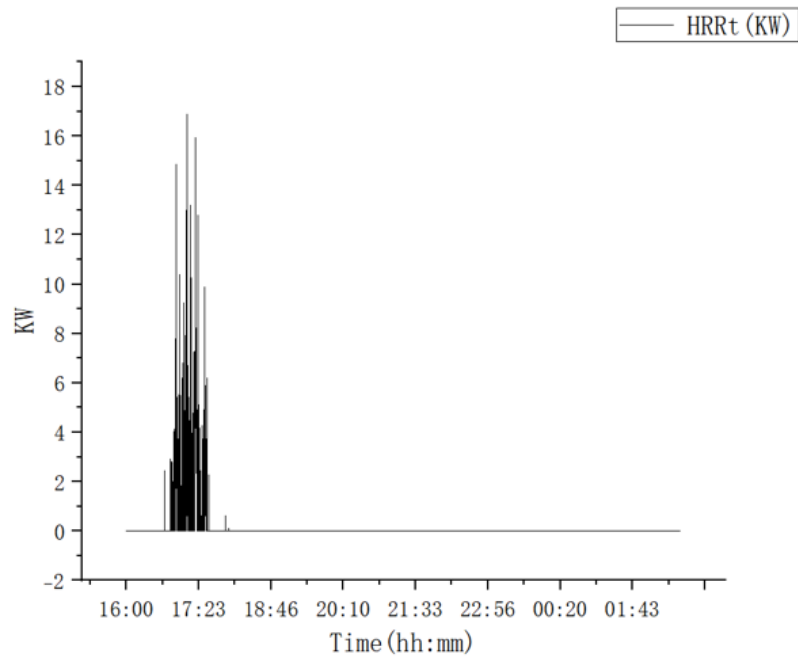




The maximum temperature at each point is shown in the table below					
Temp. No.	Maximum temperature (°C)	Temp. No.	Maximum temperature (°C)	Temp. No.	Maximum temperature (°C)
T1	112.9	T15	70.4	T29	63.9
T2	531.6	T16	61.9	TM01	98.9
T3	496.3	T17	74.4	TM02	83.9
T4	518.2	T18	41.9	TM03	73.8
T5	565.8	T19	67.2	TM04	117.4
T6	208.9	T20	108.7	TM05	112.4
T7	461.9	T21	86	TM06	29.6
T8	126.8	T22	82.4	TM07	41.9
T9	235.1	T23	58.7	TM08	37.6
T10	407.2	T24	53.2	TM09	46.3
T11	176.2	T25	67.1	Ambient 1	26.9
T12	108.6	T26	74.5	Ambient 2	27
T13	66.5	T27	69	/	/
T14	51.5	T28	86.8	/	/

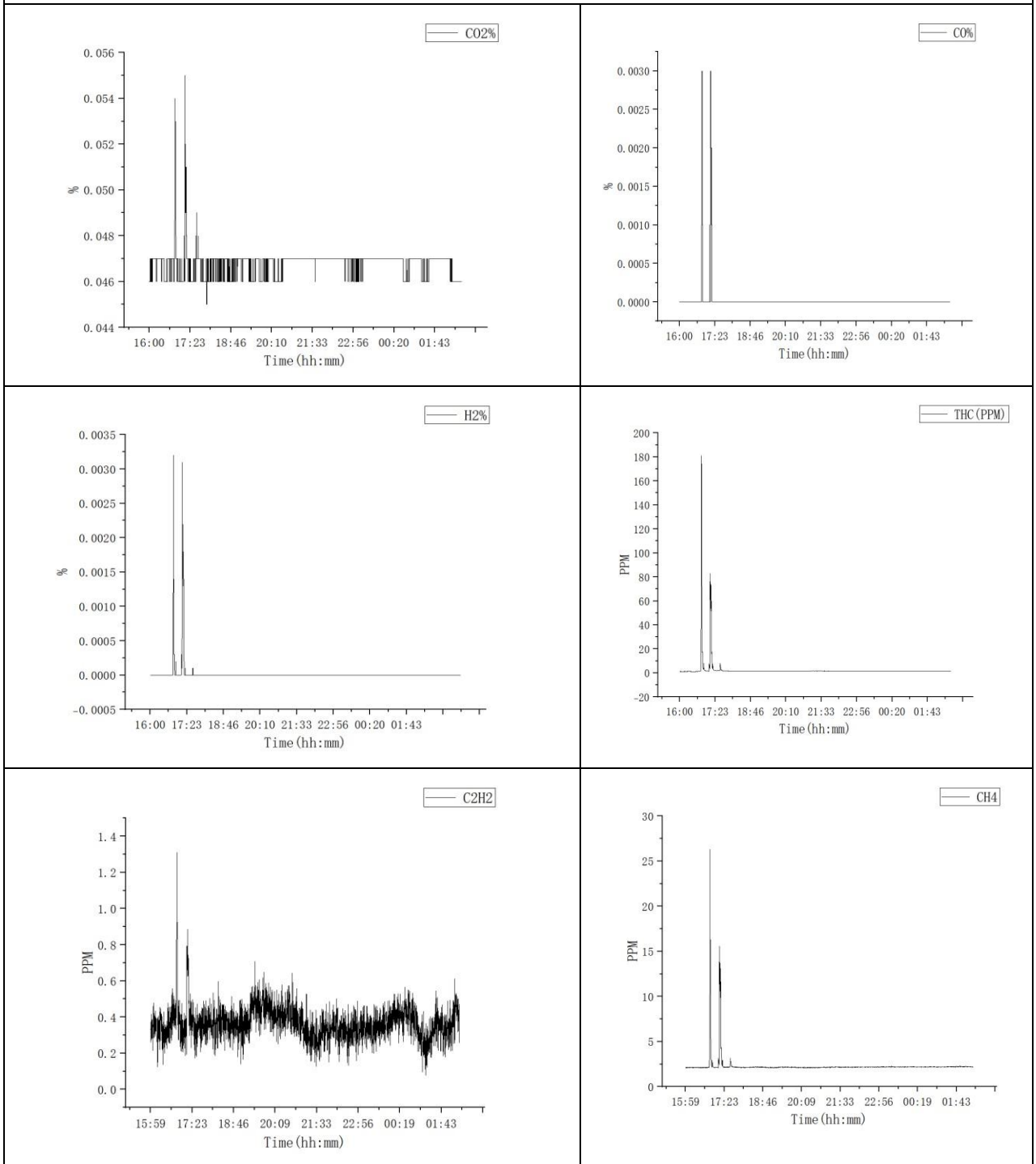
2.1.4 **TABLE: Heat Release Measurements**

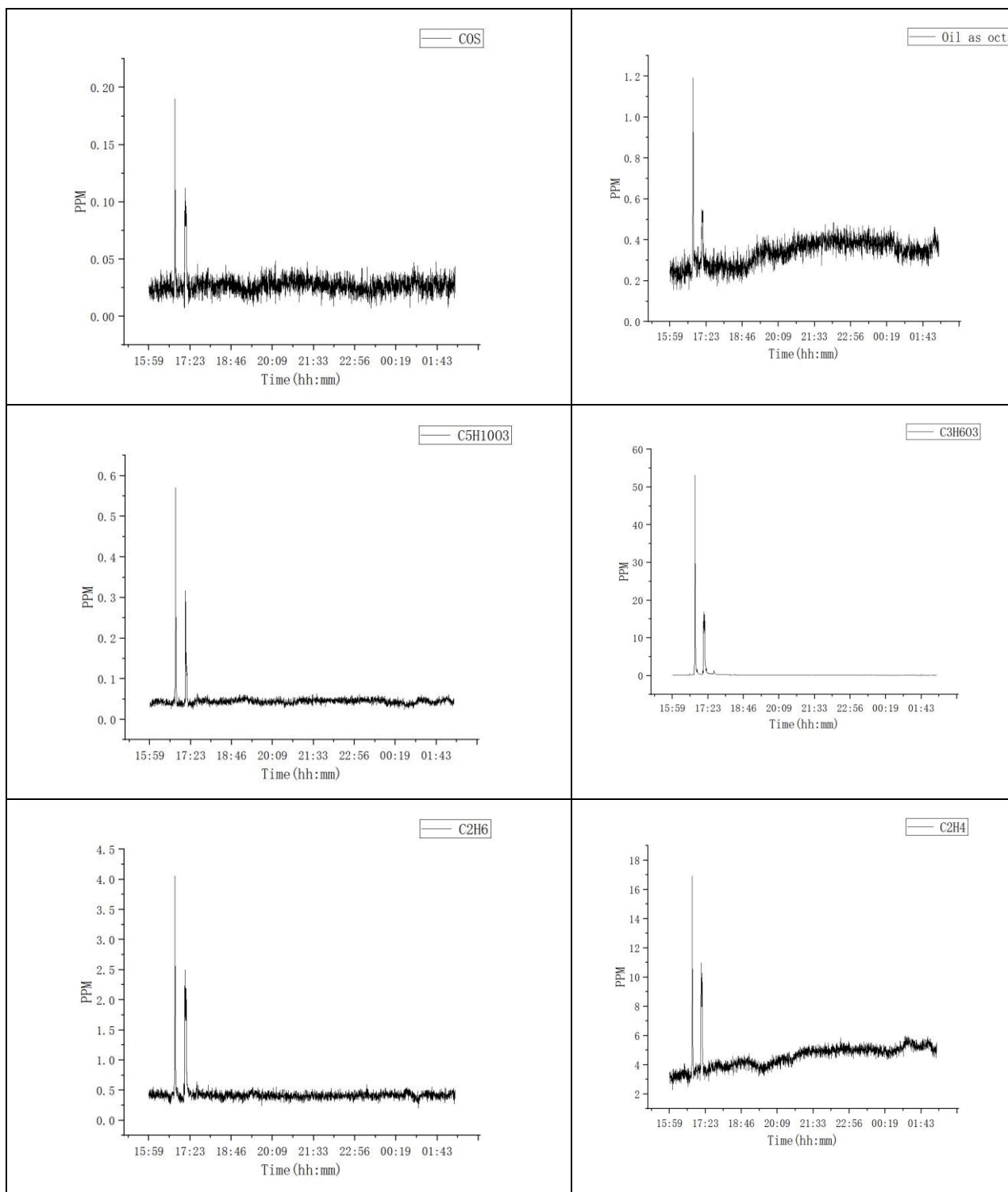
The chemical heat release rate curve is shown below

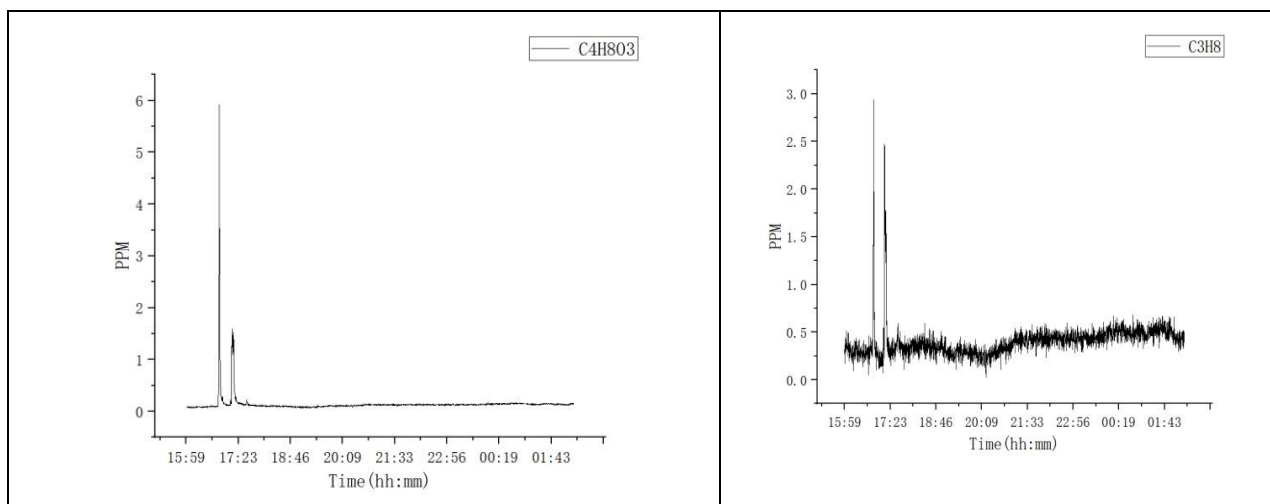


2.1.5 **TABLE: Gas Composition Measurement**

The exhaust composition graph is shown below:







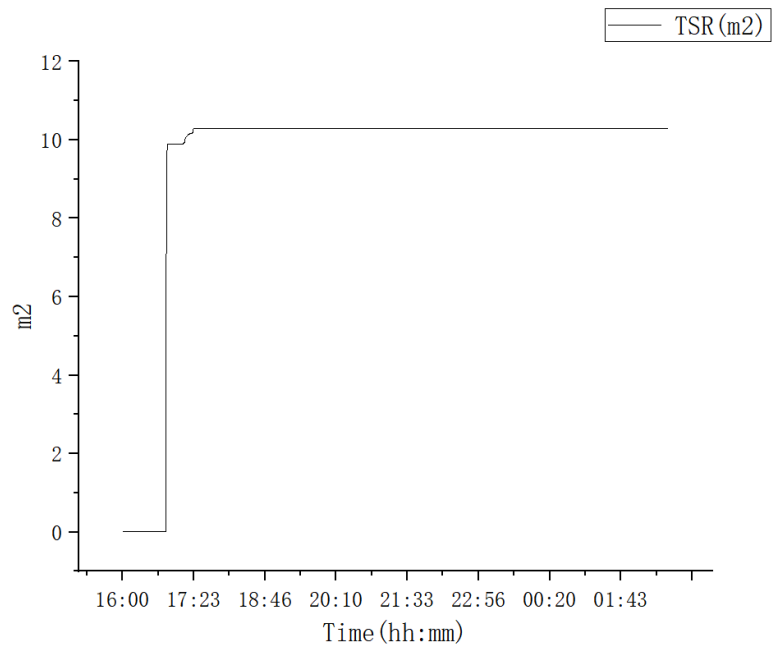
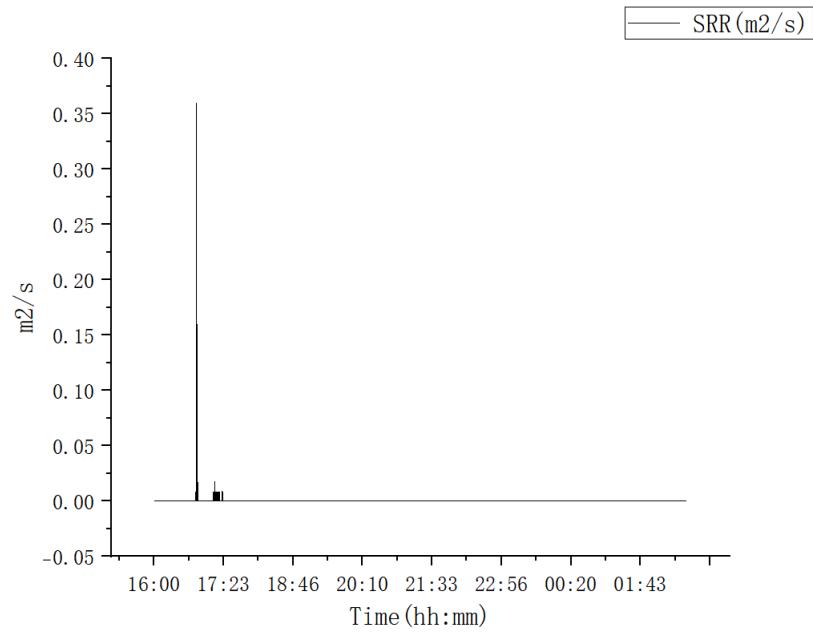
The exhaust composition and volume are as follows

Gas type	Gas components		Total volume of gas (L)	
			Before cell opening <input type="checkbox"/> Before the fire	Throughout the test period After the fire
Hydrocarbon species	Methane	CH ₄	0	13.2
	Acetylene	C ₂ H ₂	0	0.6
	Ethylene	C ₂ H ₄	0	8.5
	Ethane	C ₂ H ₆	0	2.1
	Propylene	C ₃ H ₆	0	/
	Propane	C ₃ H ₈	0	1.9
Hydrogen halide species	Hydrogen Cyanide	HCN	0	/
	Hydrogen Chloride	HCL	0	/
	Hydrogen Fluoride	HF	0	/
	Hydrogen bromide	HBr	0	/
Nitrogen containing species	Nitrogen Monoxide	NO	0	/
	Nitrogen Dioxide	NO ₂	0	/
	Nitrous Oxide	N ₂ O	0	/
Others	Carbon Monox(NDIR)	CO	0	21.9
	Carbon Dioxide(NDIR)	CO ₂	0	48.1
	Hydrogen(Palladium nickel thin film solid state sensor)	H ₂	0	19.8
	Carbonyl Sulfide	COS	0	0.07
	Oil as octane	/	0	0.5
	Diethyl carbonate	C ₅ H ₁₀ O ₃	0	0.16

	Dimethyl carbonate	C ₃ H ₆ O ₃	0	26.2
	Ethylene oxide	C ₂ H ₄ O	0	/
	Ethylmethyl carbonate	C ₄ H ₈ O ₃	0	2.7
	Formaldehyde	CH ₂ O	0	/
	Methanol	CH ₄ O	0	/
	Ammonia	NH ₃	0	/
Total Hydrocarbons (equivalent to CH ₄ , measured by FID)			0	101.9

2.1.6 | **TABLE:Flue gas measurement**

Smoke release rates and total smoke production are shown below

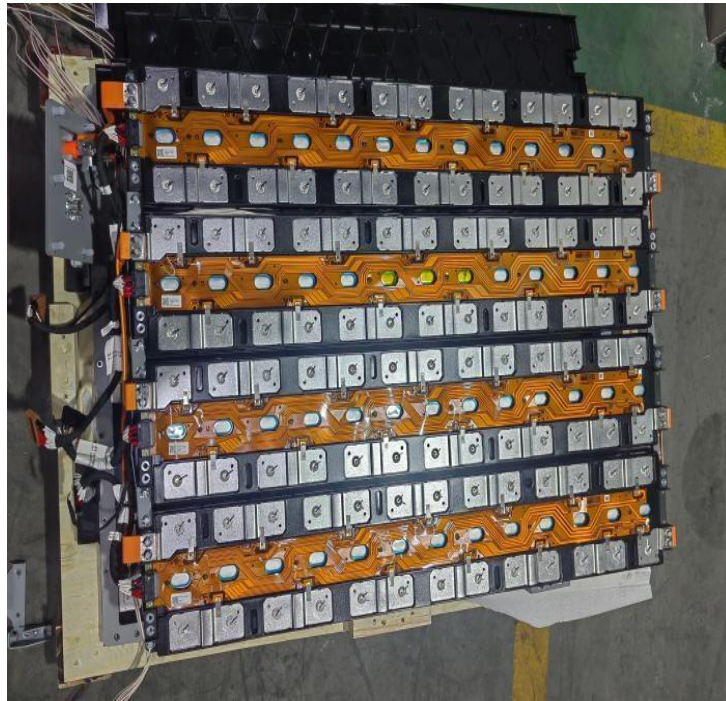


Attachment 1(Pictures for product)

Picture for product Battery module 1P52S/280Ah-0.5P



Attachment 2 (The location of triggered cell)



Attachment 3 (Test Equipment list)

No.	Equipment	Internal No,	Type	Manufacturer	Last Calibration	Due Date
1	Oscilloscope	A4089036SH	DL850	YOKOGAWA	7/May/25	6/May/26
2	Voltage probe	A4089059SH	DP6150A	CYBERTEK	5/Jun/25	4/Jun/26
3	Current probe	A4089061SH	CPL8100A	CYBERTEK	5/Jun/25	4/Jun/26
4	Bidirectional AC power source	A7040135SH	AGS-40-7006	ACTION	5/Jun/25	4/Jun/26
5	Bidirectional DC power source	A7040136SH	ABS-E40-2006	ACTION	5/Jun/25	4/Jun/26
6	Power Analyzer	A1240097SH	WT3000	YOKOGAWA	7/May/25	6/May/26
7	Temperature Test System	G2000402SH	PETWS-ZH01	WUXI PINTUO	5/Jun/25	4/Jun/26
8	Refrigerant gas leak detector	B3120003SH	RD99	RS	10/Jun/25	9/Jun/26
9	Thermal shock chamber	D1080042SH	AZT52000U-2T	ZUNDAR	7/May/25	6/May/26
10	electrical balance	B3041009SH	60Kg	KERN	15/May/25	14/May/26
11	Combustible gas concentration tester	B3240019SH	PGM-1600	SearchRAE	3/Mar/25	2/Mar/26
12	Temperature & humidity meter	B4200078SH	314	center	10/Jun/25	9/Jun/26