Master Contract: *304401*
Report*: 80192231*
Project: *80192231*

November 29, 2024

Mr. Liu Yi,
Project Manager
Australia National Power Storage Holding Pty Ltd.
Chatswood West
Willoughby, New South Wales 2067
Australia
Subject: *Lithium-Ion Rechargeable Cell, model 3777AH (UL 9540A Test Report)*

Dear *Mr. Liu Yi*:

We are pleased to inform you that testing of your product per UL 9540A has been completed. Applicable test(s) was witnessed at facility ChuWeiNeng Testing Technology (Shanghai) Co.Ltd by CSA – Building 3, No.1065 Beihe Highway, Jiading District, Shanghai. Cell level of test(s) was conducted on the sample you provided and the results are enclosed in the test report.

> Note: This Test Report is not an Authorization to apply the CSA Mark to the product. The results contained in the report(s) provided are contingent upon the characteristics of the actual sample(s) used in the investigation. In the absence of a continuing inspection service, CSA provides no assurance, expressed or implied, that the contents of the report are applicable to reproductions of the sample(s). Use or reproduction of the CSA name, logo, or trademark is not permitted without the prior written consent of CSA. No references can be made to this report when using the results of this investigation for the purposes of advertising, promotion or litigation, without the prior written consent of CSA.

Please examine the enclosed documents and contact me if you have any questions or would like us to make any changes.

On behalf of CSA, I would like to thank you for your business and offer our services for your future needs.

Yours truly,

Marvin Peng
CSA –*CCIC-CSA International Certification Co., Ltd. Kunshan Branch*
2F-1, Building C12, No 555 Dujuan Road, Kunshan Economic & Technical Development Zone, Kunshan, Jiangsu, China 215331

Encl. [*UL 9540A Test Report*]
Att.1 - CSA Certificate of Cell_ 80192227
Att.2 - Cell charge/discharge conditioning graphs
Att.3 - Photos
Att.4 - Cell temperature/voltage graph during testing
Att.5 - Cell gas analysis report
Att.6 - Video (separated file)

CSA GROUP
Laboratory Test Data - UL 9540A Checklist and Test Result (Cell Level)
ORIGINAL TEST DATA

The results relate only to the items tested.
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Master Contract:	304401	Model:	3777AH	
Project / Network:	80192231	Description:	Lithium battery cell	

Standard(s): ANSI/CAN/UL 9540A:2019 Fourth Edition, Dated November 12, 2019 - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Testing Laboratory Name:	CCIC-CSA International Certification Co., Ltd. Kunshan Branch
Address:	2F-1, Building C12, No 555 Dujuan Road, Kunshan Economic & Technical Development Zone, Kunshan, Jiangsu, China 215331
Testing Program:	**Custom Test** : Cover Latter ☒, Testing Only ☐

If tests were performed at another facility, then described below:

Testing Laboratory Name:	ChuWeiNeng Testing Technology (Shanghai) Co.Ltd
Address:	Building 3, No.1065 Beihe Highway, Jiading District, Shanghai
Facility Qualification Number:	N/A

	As above / or describe otherwise
Customer:	Australia National Power Storage Holding Pty Ltd.
Address:	Chatswood West Willoughby, New South Wales 2067 Australia

Tested By:	Jiaming Huang	
	Name, Title	
	Jiaming Huang	2024-05-24 - 2024-08-07
	Signature	*Date (YYYY-MM-DD)*
☒ **Reviewed by:** ☒ **Witnessed by:**	Marvin Peng	
	Name, Title	
	Marvin Peng	2024-05-24 - 2024-08-07
	Signature	*Date (YYYY-MM-DD)*

Version6.1 : 2022-08-02

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Master Contract:	304401	Model:	3777AH	Page number 2 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Cell Level Test Summary	
Manufacturer:	Australia National Power Storage Holding Pty Ltd.
Brand name / Trademark:	N/A
Model number:	3777AH
Nominal cell voltage, (V)	3.2
Cell capacity, (Ah)	3777
Cell chemistry:	LFP
Physical format of cell:	Prismatic
Approximate dimension, (mm)	L*W*T: 1095×203×294
Mass, (kg)	110±0.5
Cell certification available?, (Yes/No)	Yes
Standard(s) used to certify product:	ANSI/CAN/UL1973:2022, 3rd Edition
Certification organization name and its certificate number:	CSA, Report number 80192227
Method used to initiate thermal runaway:	External Flexible heater
Average temperature at which cell first vented excluding gas collection sample, (°C)	145.5
Average temperature prior to thermal runaway excluding gas collection sample, (°C)	226.5
Location of maximum temperature:	Large surface of cell under the heater
Flammable gas generation, (Liter)	1576.8
Total gas generation, (Liter)	2380.0
Lower flammability limit (LFL) at ambient temperature (25 ± 5°C), (%)	8.1
Lower flammability limit (LFL) at average gas vent temperature, (%)	7.1
Burning velocity, (Cm/Sec)	0.335
Maximum pressure P_{max}, (psig)	104.8

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Gas composition:

Gas Component	Gas Type	Gas Volume in percentage (%)
CH_4	Methane	7.293
C_2H_6	Ethane	1.418
C_2H_4	Ethylene	5.019
C_3H_8	Propane	0.427
C_3H_6	Propylene	0.122
C_4H_{10}	Isobutane	0.862
C_4H_{10}	n-Butane	0.032
C_2H_2	Acelylene	0.186
C_4H_8	n-Butylene	0.279
C_4H_8	2-Methylpropene	0.103
C_5H_{12}	Isopentane	0.005
C_5H_{12}	Pentane	0.112
C_5H_{10}	n-Pentane	0.047
H_2	Hydrogen	39.374
CO	Carbon Monoxide	6.378
CO_2	Carbon Dioxide	38.343
Total	---	100

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Project / Network:	80192231	Description:	Lithium battery cell	

Performance - Cell Level Test		
Requirement	**Comments**	**Verdict**
Thermal runaway cannot be induced in the cell.	Thermal runaway induced on cell using film heater	F
Cell does not present a flammability hazard when mixed with any volume of air, as determined in accordance with ASTM E918 at both ambient and vent temperature.	Cell presented flammability hazard when tested in accordance with ASTME918, module and unit level test required	F
Summary of Result: Module level testing is required based on above performance condition indicated in Section 7.7 of UL 9540A 4th Edition.		

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)

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Master Contract:	304401	Model:	3777AH	Page number 5 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Clause	Requirement + Test	Result - Remark	Verdict
	Construction		
5	**General**	---	---
5.1	**Cell**	---	---
5.1.1	Cell chemistry:	Li-ion (LFP)	---
	Physical format of cell:	Prismatic	---
	Nominal voltage rating, (V)	3.2	---
	Nominal capacity rating, (Ah)	3777	---
	Approximate dimension, (mm)	L*W*T: 1095×203×294	---
	Mass, (kg)	110±0.5	---
5.1.2	Cell certification available?, (Yes/No)	Yes	---
	Standard(s) used to certify product:	ANSI/CAN/UL1973:2022,, 3rd Edition	---
5.1.3	Cell Level Test Report	CSA, Report number 80192227	---
	Performance		
7	**Cell Level**	---	---
7.1	**General**	---	---
7.1.1	Establish effective method by forcing a cell into a thermal runaway in a repeatable manner.	Test Method: Film heater	P
	Vent gas composition was gathered and analyzed.	See Table 4 for details	P
	Cell temperature was monitored to determine the temperature when cell vents.	See below See Table 3 for details	P
	Cell temperature was monitored to determine thermal runaway as defined in UL 9540A 4th Edition.	See below See Table 3 for details	P
7.2	**Sample**	---	---
7.2.1	Prior to testing, cell samples were conditioned for minimum 2 charge (100% SOC) - discharge (Specified end of discharge voltage) cycle as per manufacturer specified method.	See Attachment 2	P
	Cells were functional after minimum 2 charge discharge cycle.	Confirmed	P
	During conditioning a relationship between open circuit voltage and SOC was determined through measurement of voltage and SOC.	Confirmed, client declared charge/discharge procedure followed, see Attachment2	P
	Ambient temperature during cell conditioning.	Confirmed	P
7.2.2	The tested cells had 100% SOC at the start of the test. The samples were allowed to stabilize for a minimum of one	Confirmed	P

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Clause	Requirement + Test	Result - Remark	Verdict
	hour and a maximum of 8 h before the start of the test.		
7.2.3	Cells with flexible laminate casings were constrained during test in manner that simulate constraint in the BESS module to prevent excessive swelling during test.	Prismatic cell with jig to constrain cells when testing	P
7.3	**Determination of thermal runaway methodology**	**---**	**---**
7.3.1	General	See below	P
7.3.1.1	Ambient temperature during cell testing.	See Table 3	P
7.3.1.2	Propensity of cell to exhibit thermal runaway demonstrated by externally applied film heater.	Heater type: Film heater Heater dimension (mm): 190×160×0.36 Number of heaters used: 8 Heater: Size:190mm×160mm, Rated power: 220V,900W. Quantity: 8	P
	A surface heating rate of 4° C (7.2° F) to 7° C (12.6° F) per minute shall be applied to the cell.	☒ 4.5 ° C/min heating ramp was used for testing	P
	Maximum surface temperature endpoint criteria was determined based on cell design and cell chemistry.	Considered	P
	Thermal runaway method used, when external heating with flexible heater was not able to cause the cell to exhibit thermal runaway.	☐ Mechanical: ☐ Electrical Stress: ☐ Alternate heating sources: ☐ Other(explain):	N/A
7.3.1.3	Detail of thermal runaway test method when another method used as reference in 7.3.1.2.	Film heater was used for testing	N/A
7.3.1.4	Monobloc battery such as lead acid or nickel cadmium, was treated as individual cell for this testing.	Li-ion cell	N/A
7.3.1.5	Surface temperature at which internal short circuiting within the cell will occur that could lead to thermal runaway.	See below	N/A
	Surface temperature hold point. For lithium ion cell, hold point was between 5°C (9°F) and 15°C (27°F) greater than the melting temperature of the cell separator material as determined from differential scanning calorimetry	Cell was heated directly until thermal runaway initiated following UL 9540A Certification Requirement Decision	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	(DSC) data of the separator in accordance with UL 2591 (UL 746A).		
	If thermal runaway is not achieved at holding temperature after period of 4h, heating rate according to 7.3.1.3 was reestablished.	See above	N/A
7.3.1.6	If cell is susceptible to thermal runaway by external heating, cell was heated until thermal runaway has occurred.	Confirmed, film heater method used for testing	P
	If cell is not susceptible to thermal runaway by external heating, another method included in 7.3.1.2 was used.	See above	N/A
	If using another external heating method, temperature ramp and maximum surface temperature as outlined in 7.3.1.2 and 7.3.1.5 was used.	See above	N/A
7.3.1.7	Cell's exterior surface temperature was measured continuously, averaging over every 60 seconds	Confirmed	P
	The maximum of these averages was documented for each thermocouple location.	Confirmed	P
	Location of thermocouple during test.	☒ Below the heater film at center of cell surface: T2, T7-2, T9, T15, T20-2, T22 ☒ Near positive cell terminal: T27 ☒ Other(explain): Near vent: T28 Large surface not covered by heater: T4, T17 Ambient T31 Refer to Figure 6 for details	P
7.3.1.8	The temperature at which the cell case vents due to internal pressure rise.	Confirmed	P
	The thermocouple located below the heater film at the center of the cell surface is used for this measurement.	Confirmed	P
	If using the other cell abuse methods, the thermocouples would be located at the same locations on the cells as noted in 7.3.1.7.	See above	N/A
7.3.1.9	The temperature at the onset of thermal runaway was documented.	See Table 3 for details	P
	Onset of thermal runaway was determined by the point at which the rate of change of	Considered, see Table 3 for the onset temperature for thermal runaway.	P

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Clause	Requirement + Test	Result - Remark	Verdict
	the surface temperature of the cell exceeds that of the externally applied heat input if utilizing the external heater method.		
	In cases where cell venting may occur first, cell was heated continuously until thermal runaway occurs.	Confirmed	P
	With other stress methods, it was necessary to continue applying the stress such as mechanical or electrical stress until onset of thermal runaway occurs.	External heating method used	P
	Separator information was available or at the manufacturer's discretion, the thermal ramp was conducted continuously without a hold point until thermal runaway.	Thermal ramp was conducted continuously without holding point considered	P
7.3.1.10	When using methods other than the heater method, the stresses (i.e. electrical or mechanical) were applied to the cell until thermal runaway occurs.	Film heater method used	N/A
7.3.1.11	If the cell exhibits thermal runaway behavior (using any method), 3 additional samples were tested using the same method and exhibit thermal runaway to demonstrate repeatability.	See Table 3 for details	P
	The vent temperature and thermal runaway onset temperatures were averaged over the tested samples (Excluding the gas vent capture sample).	See Table 3 for details	P
7.3.2	Flow battery thermal runaway determination tests	Li-ion battery cell	N/A
7.4	**Cell vent gas composition test**	**---**	**---**
7.4.1	Cell vent gas was generated and captured by forcing a cell into thermal runaway with the methodology developed in 7.3, inside a pressure vessel, which is large enough to accommodate cells, but not so large as to influence measurement of the gas composition.	Confirmed: 400L pressure vessel used for testing.	P
	The test was initiated with an initial condition of atmospheric pressure and less than 1% oxygen by volume.	See Table 4 for details	P
	The initial atmospheric conditions prior to testing was noted.	See Table 4 for details	P

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Clause	Requirement + Test	Result - Remark	Verdict
7.4.2	Cell vent gas composition was determined using Gas Chromatography (GC)	See Table 4 for details	P
	Hydrogen gas was measured with a sensor capable of measuring in excess of 30% by volume.	See Table 4 for details	P
	The initial atmospheric conditions prior to testing was noted.	See Table 4 for details	P
7.4.3	The lower flammability limit of the cell vent gas was determined in accordance with ASTM E918, testing at both ambient and cell vent temperatures.	See Table 4 for details	P
7.4.4	The burning velocity of the cell vent gas was determined in accordance with Annex in ISO 817.	See Table 4 for details	P
7.4.5	The P_{max} of the cell vent gas was determined in accordance with EN 15967.	See Table 4 for details	P
7.5	**Off gas composition for flow battery systems.**	**---**	**---**
7.5.1	The off gas composition from the flow battery testing of 7.3.2 shall be determined by conducting the test method of 7.3.2.2: 1. In a closed container and capturing the off gasses generated, and 2. By collecting the off gasses generated at vent openings and vent ducts during the overcharge and short circuit testing of 7.3.2.4 and 7.3.2.6 as applicable to the flow battery technology	Li-ion battery cell	N/A
	Composition of these captured gases and their flammability limit shall be determined through the methods outlined in 7.4.2 and 7.4.3 at both ambient temperature and the maximum temperature measured.	Li-ion battery cell	N/A
7.5.2	The volume of flammable gases measured during the testing were scaled to the maximum energy reservoir for the intended flow battery system.	Li-ion battery cell	N/A
7.6	**Cell level test report**	**---**	**---**
7.6.1	Cell level report include information indicated in item a) through m)	Confirmed	P
7.6.2	Flow battery report include information indicated in item a) through k)	Li-ion battery cell	N/A

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Table 1 – Cell charge/discharge specification			
Charging method	CC-CV	Discharging method	CC
Charge current, (Adc)	1888.5	Discharge current, (Adc)	1888.5
Charge voltage, (Vdc)	3.65	---	---
Charge end current, (Adc)	180	Discharge end voltage, (Vdc)	2.5
Manufacturer recommended charge temperature, (°C)	0-60	Manufacturer recommended discharge temperature, (°C)	-30-60

Table 2 – Cell rest duration				
Sample Number	Final charge end time		Test start time	
	Date (YYYY-MM-DD)	Time (HH:MM AM/PM)	Date (YYYY-MM-DD)	Time (HH:MM AM/PM)
202305013-1	2024-05-24	09:13 AM	2024-05-24	12:01 AM
202305013-2	2024-05-27	10:09 PM	2024-05-27	17:43 PM
202305013-3	2024-05-28	15:51 PM	2024-05-28	19:04 PM
202305013-4	2024-05-31	09:17 AM	2024-05-31	13:58 AM
202305013-5	2024-06-24	14:03 PM	2024-06-24	19:15 PM
Ambient temperature during cell conditioning				
Ambient Lab Temperature, (°C)		Relative Humidity, (%RH)		
24.2 to 25.2		61 to 68		

Table 3 – Determination of thermal runaway methodology					
Sample Number	Note 1				Note 2
	202405013-1	202405013-2	202405013-3	202405013-4	202405013-5
Open circuit voltage before test, (Vdc)	3.500	3.535	3.575	3.460	3.526
Cell charge capacity after final charge cycle, (Ahr)	3741.36	3741.36	3752.66	3772.13	3620.16
External film heater ramp rate, (°C/min)	4.5	4.5	4.5	4.5	4.5
Temperature at which gases are first vented, (ºC)	140.1(T4)/ 148.1(T17)	147.7(T4)/ 140.0(T17)	143.8(T4)/ 135.3(T17)	156.9(T4)/ 152.3(T17)	164.5(T4)/ 174.8(T17)
Temperature prior to thermal runaway, (ºC)	147.5 (T4)/ 175.9(T17)	211.1(T4) / 243.2(T17)	281.1(T4)/ 255.8(T17)	240.9(T4) / 256.5(T17)	219.9(T4)/ 213.1(T17)
Location of maximum temperature prior to thermal runaway	Cell surface under heater	Cell surface under heater	Cell surface under heater	Cell surface under heater	Cell surface under heater
Average temperature at which gases are first vented, (ºC)	145.5				---
Average temperature prior to thermal runaway, (ºC)	248.1 (calculated by sample 202405013-2,3 and 4)				---
Other method used to initiate thermal runaway: N/A					

Table 3 – Determination of thermal runaway methodology	
Note: The capacity was over manufacturer's declaration which is 90% of the full capacity.	
Ambient temperature during cell testing	
Ambient Lab Temperature, (°C)	Relative Humidity, (%RH)
24.2 to 25.2	61 to 68
Note 1: Sample tested outside pressure vessel Note 2: Sample tested inside pressure vessel for cell vent gas composition test	

Table 4 – Cell vent gas composition test	
Sample Number:	202404020-5
Pressure vessel volume (liter):	400
An initial condition of atmospheric pressure (kPa):	101.3
An initial condition of oxygen by volume (%):	0.14
Flammable gas generation volume(Liter):	1576.8
Total gas generation volume (Liter):	2380.0
LFL limit at ambient temperature (%):	8.1
LFL limit at cell vent temperature (%):	7.1
Burning velocity (cm/sec):	0.335
Maximum pressure P_{max} (kPa):	722.9
Ambient temperature during cell testing	
Ambient Lab Temperature, (°C)	Relative Humidity, (%RH)
24.2 to 25.2	61 to 68
Gas composition	
Gas composition:	

Gas Component	Gas Type	Gas Volume in percentage (%)
CH_4	Methane	7.293
C_2H_6	Ethane	1.418
C_2H_4	Ethylene	5.019
C_3H_8	Propane	0.427
C_3H_6	Propylene	0.122
C_4H_{10}	Isobutane	0.862

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Table 4 – Cell vent gas composition test

C_4H_{10}	n-Butane	0.032
C_2H_2	Acelylene	0.186
C_4H_8	n-Butylene	0.279
C_4H_8	2-Methylpropene	0.103
C_5H_{12}	Isopentane	0.005
C_5H_{12}	Pentane	0.112
C_5H_{10}	n-Pentane	0.047
H_2	Hydrogen	39.374
CO	Carbon Monoxide	6.378
CO_2	Carbon Dioxide	38.343
Total	---	100

Attachments

Attachment 1 - Cell UL 1973 certification

Certificate of Compliance

Certificate: 80192227 **Master Contract:** 304401

Project: 80192227 **Date Issued:** 2024-11-07

Issued To: **Australia National Power Storage Holding Pty Ltd.**
Chatswood West
Willoughby, New South Wales, 2067
Australia

Attention: Zhou

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Issued by: **Iris Gao**
Iris Gao

C US

PRODUCTS

CLASS 3701-16 - Cell for use in Battery/Module for Stationary and LER Application
CLASS 3701-86 - Cell for use in Battery/Module for Stationary, LER and EV Application - Certified to US Standard

Rechargeable Lithium-ion Cell, model 3777AH, rated 3.2V, 3777Ah.

Cell Model	Chemistry	Format
3777AH	$LiFePO4 + 6C \rightarrow FePO4 + LixC6$	Prismatic

ELECTRICAL RATING:

See also Conditions of Acceptability for charge limit specifications.

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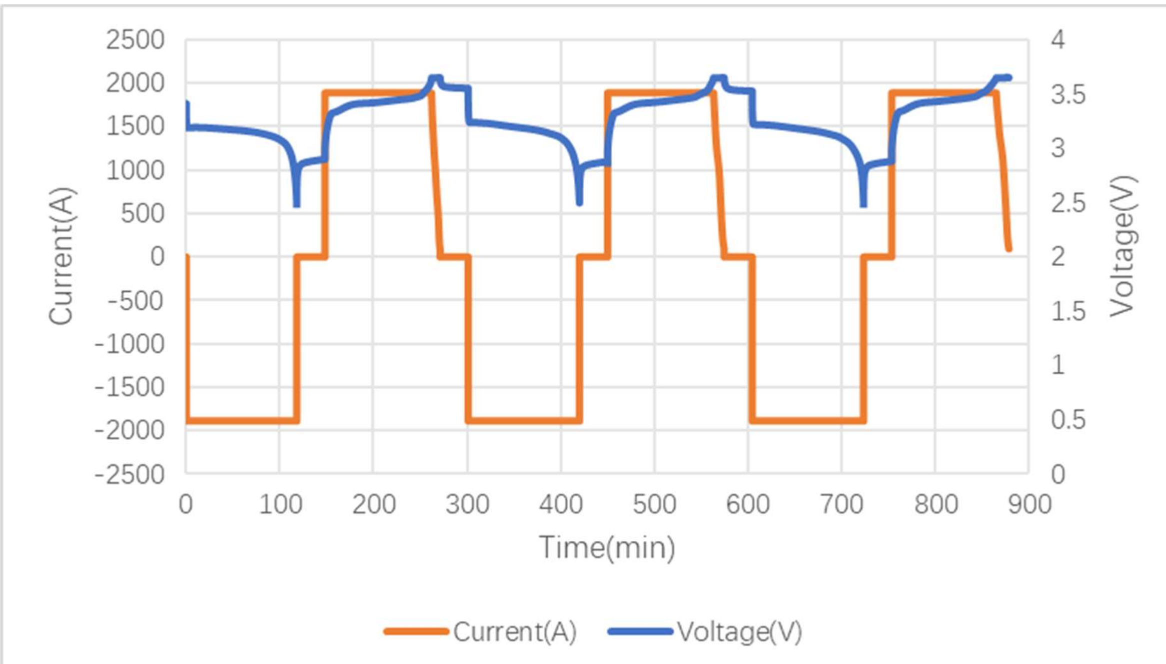
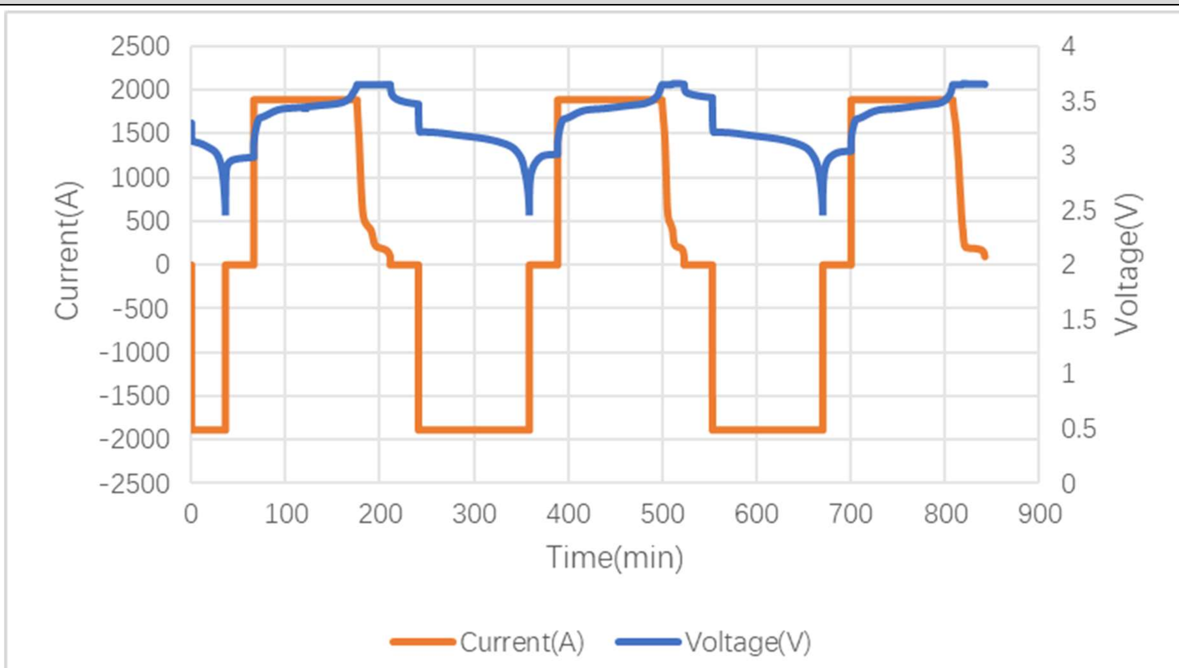
Attachment 2 - Cell charge/discharge conditioning graphs

Sample Number: 202405013-1



Sample Number: 202405013-2



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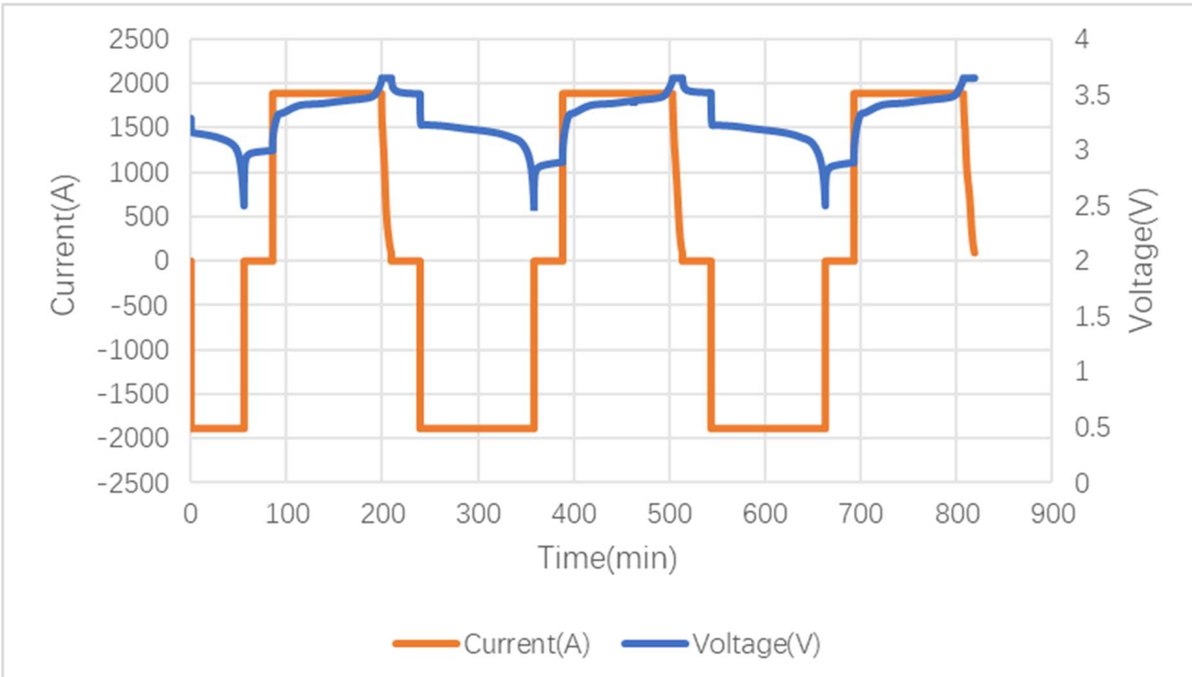
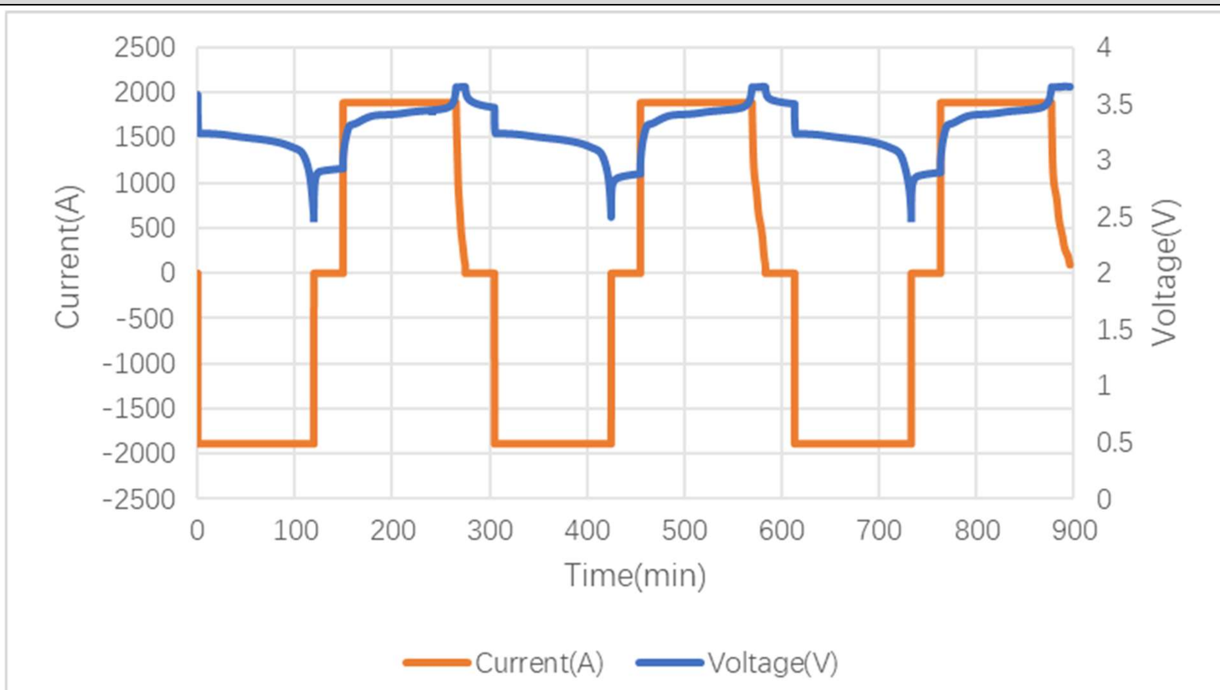
Attachment 2 - Cell charge/discharge conditioning graphs

Sample Number: 202401022-3



Sample Number: 202405013-4



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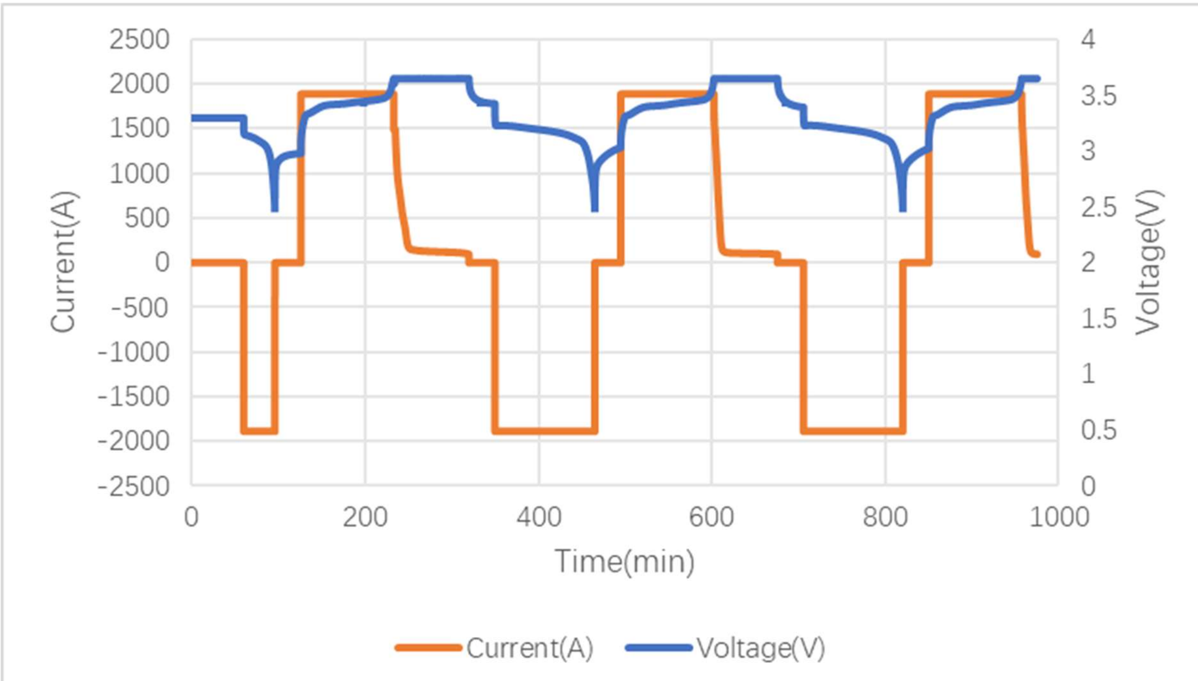
Attachment 2 - Cell charge/discharge conditioning graphs
Sample Number: 202405013-5



Attachment 3 – Photos	
General sample photos	

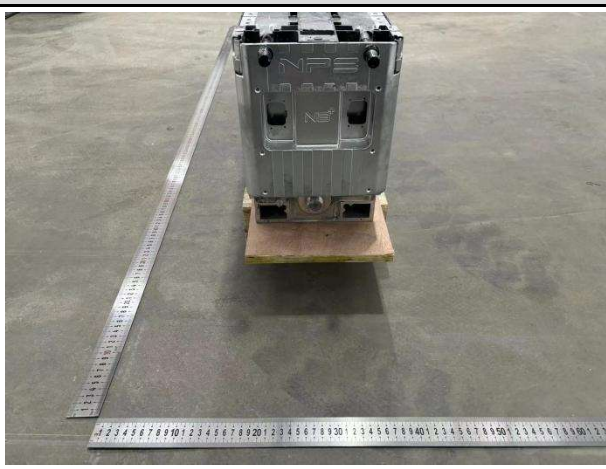



Figure 1: Front view of cell	Figure 2: Side view of cell

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Attachment 3 – Photos

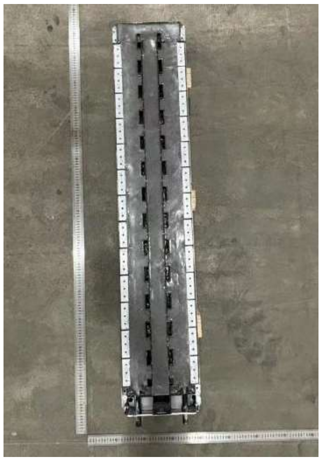

Figure 3: Top view of cell

The results relate only to the items tested.
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Photos with heater and thermocouple installation

Figure 4: Side view of cell before testing

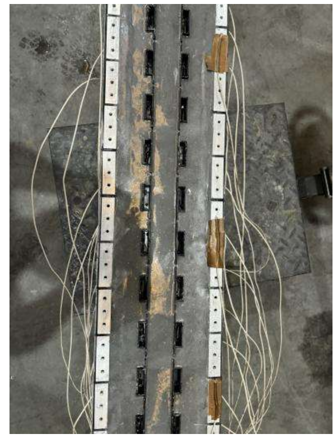

Figure 5: Top view of cell before testing

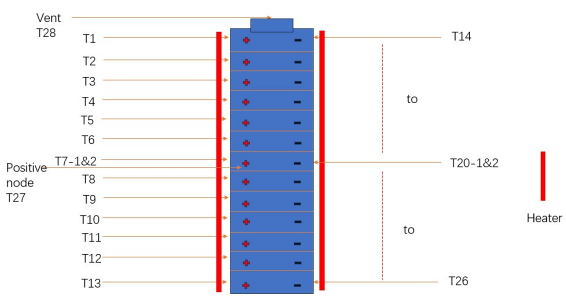

Figure 6: TC installation of cell

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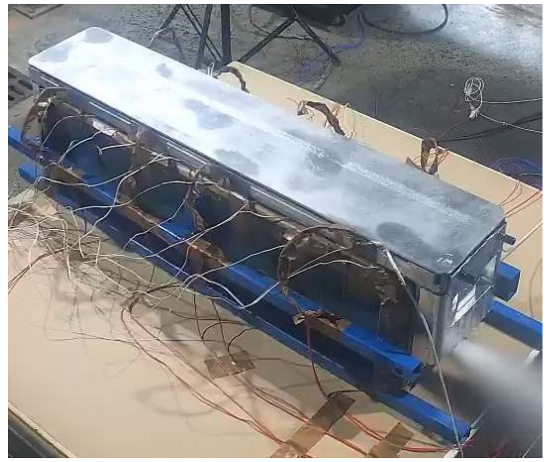
Sample Number: 202405013-1

	
Figure 7: At test start (Time in 12:01)	Figure 8: During cell venting (Time in 13:06)

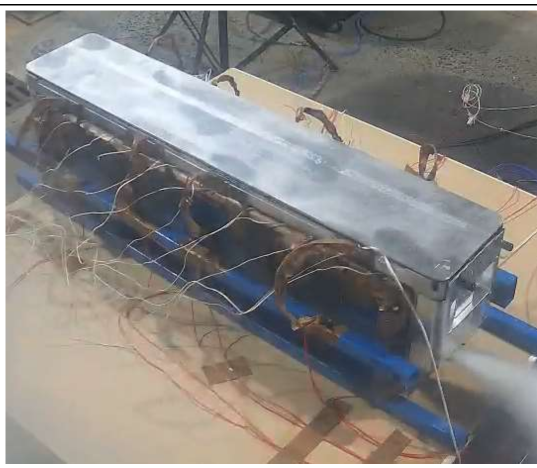
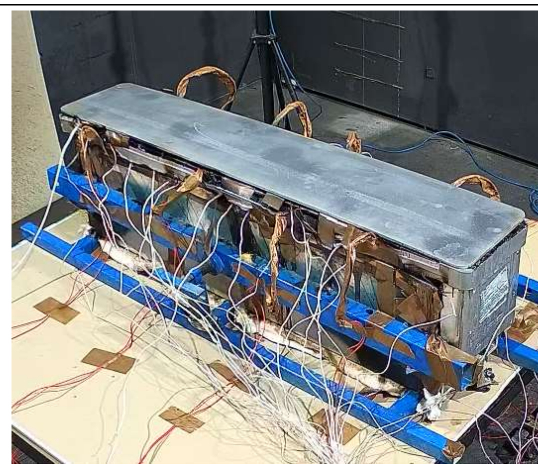

	

Figure 9: During thermal runaway (Time in 14:34)	Figure 10: After thermal runaway-1
	
Figure 11: After thermal runaway-2	Figure 12: After thermal runaway-3

Master Contract:	304401	Model:	3777AH	Page number 21 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202405013-2

Figure 13: At test start (Time in 17:43)

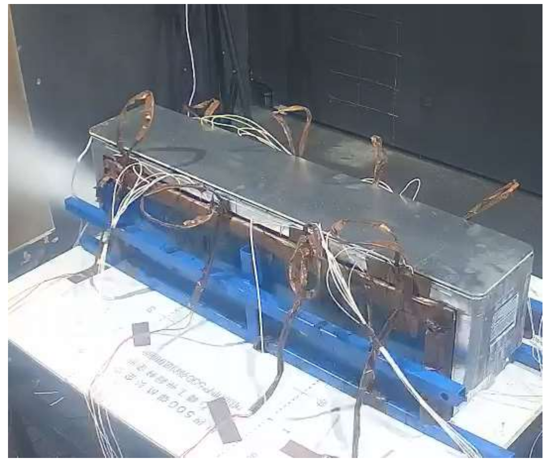


Figure 14: During cell venting (Time in 18:45)

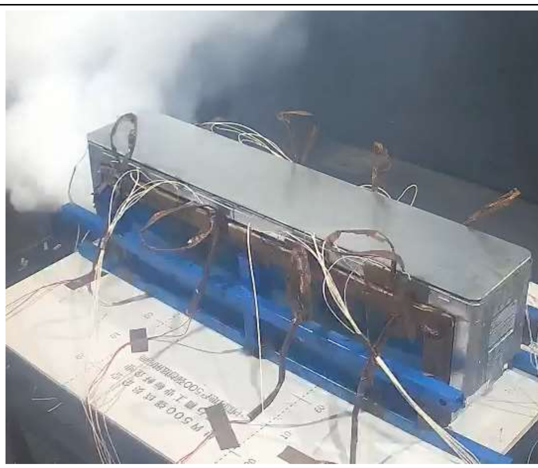


Figure 15: During thermal runaway (Time in 19:35)

Figure 16: After thermal runaway-1

Figure 17: After thermal runaway-2

Figure 18: After thermal runaway-3

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Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202405013-3

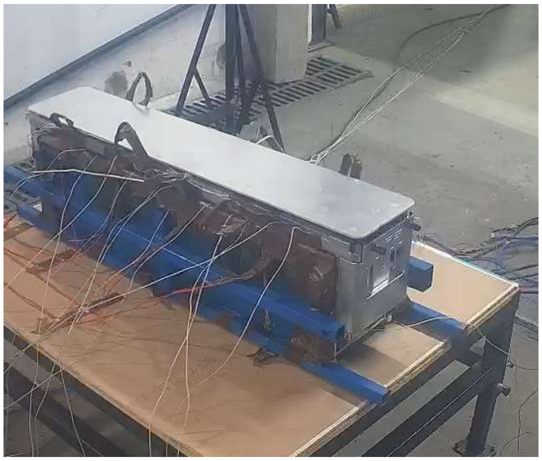	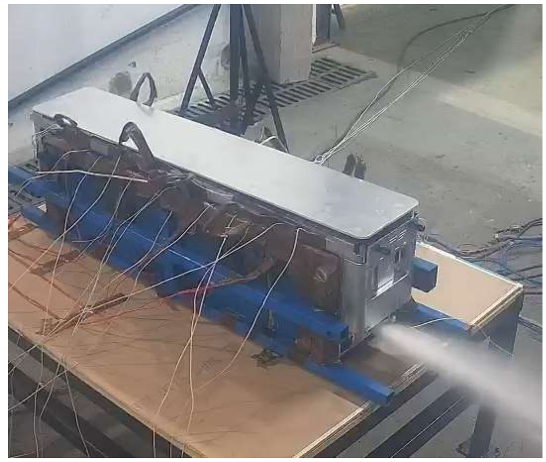
Figure 19: At test start (Time in 19:04)	Figure 20: During cell venting (Time in 20:13)
	
Figure 21: During thermal runaway (Time in 21:47)	Figure 22: After thermal runaway-1

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Figure 23: After thermal runaway-2


Figure 24: After thermal runaway-3

Master Contract:	304401	Model:	3777AH	
Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202405013-4

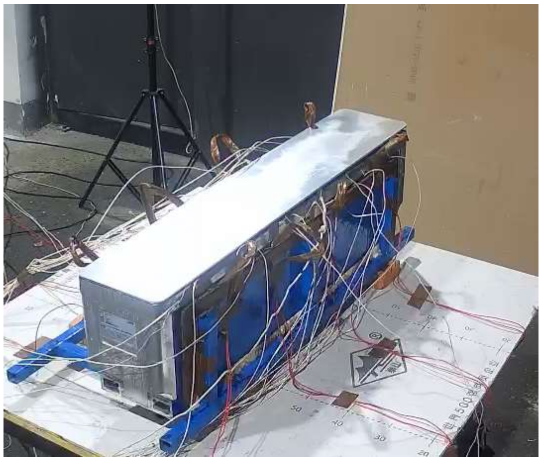

Figure 25: At test start (Time in 13:58)

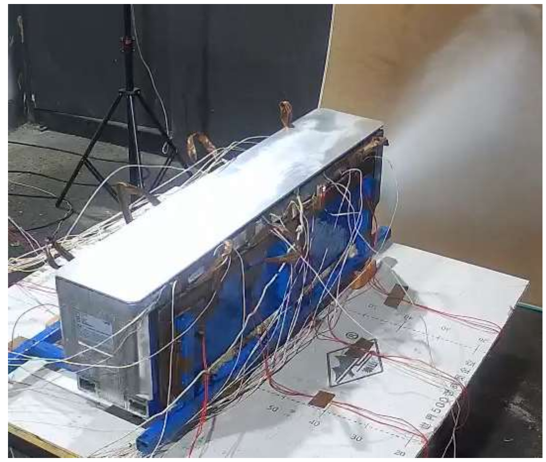

Figure 26: During cell venting (Time in 15:07)

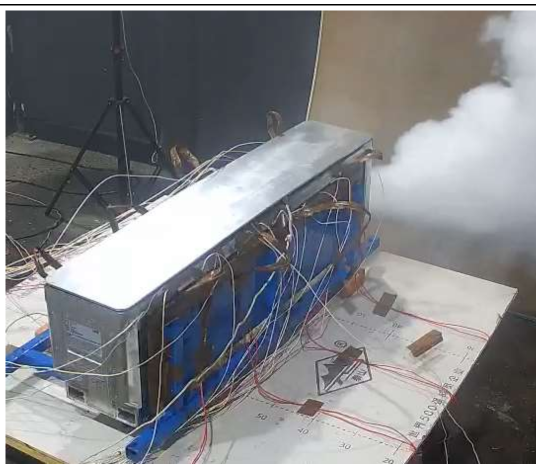

Figure 27: During thermal runaway (Time in 15:43)

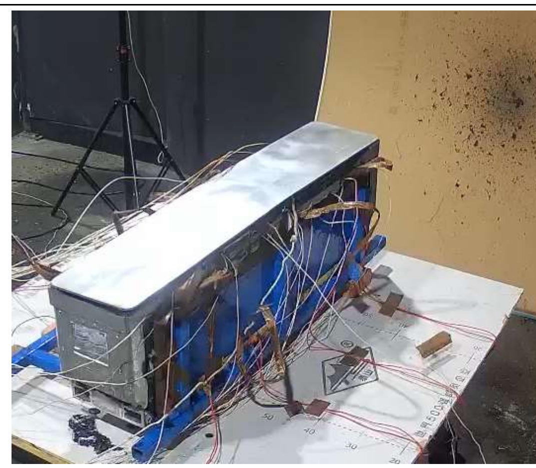

Figure 28: After thermal runaway-1

Figure 29: After thermal runaway-2

Figure 30: After thermal runaway-3

Master Contract:	304401	Model:	3777AH	Page number 25 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202405013-5

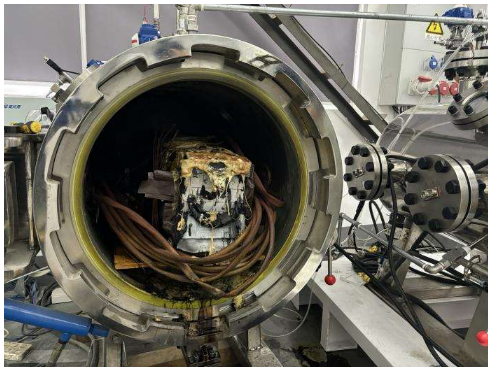

Figure 31: At test start

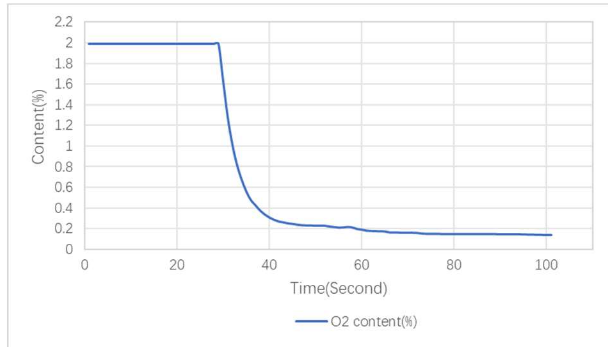

Figure 32: oxygen concentration

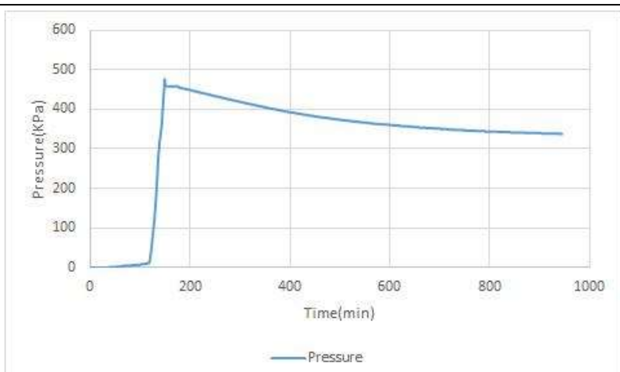

Figure 33: Gas pressure diagram

Figure 34: After thermal runaway-1

Figure 35: After thermal runaway-2

Figure 36: After thermal runaway-3

The results relate only to the items tested.
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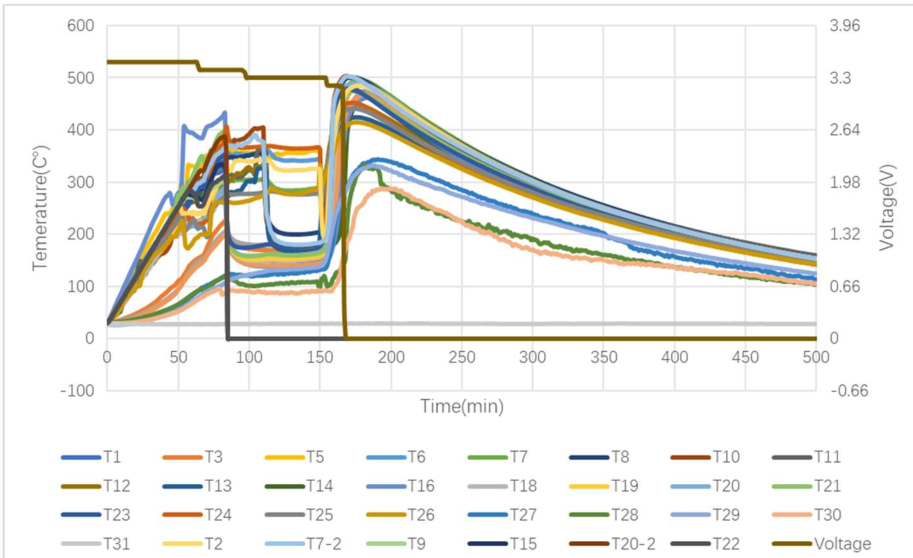
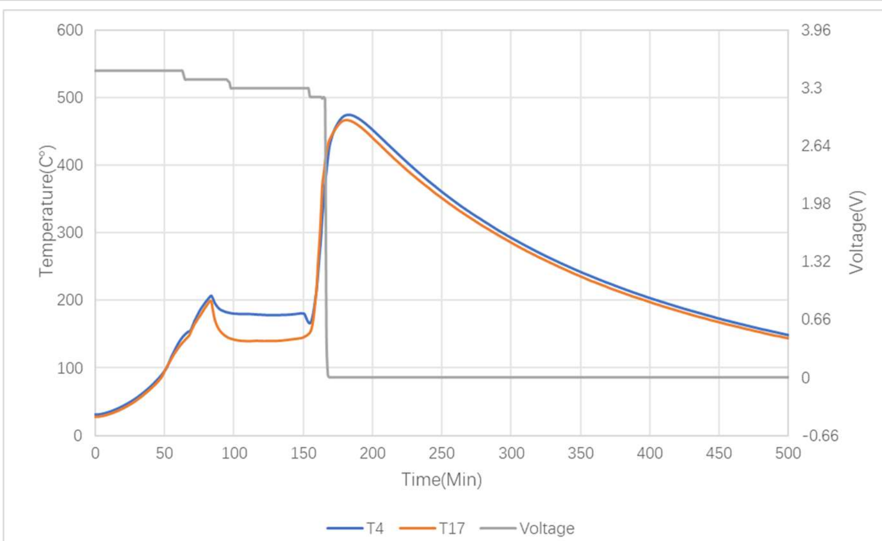
Project / Network:	80192231	Description:	Lithium battery cell	

Attachment 4 - Cell temperature/voltage graph during testing

Sample Number: 202405013-1





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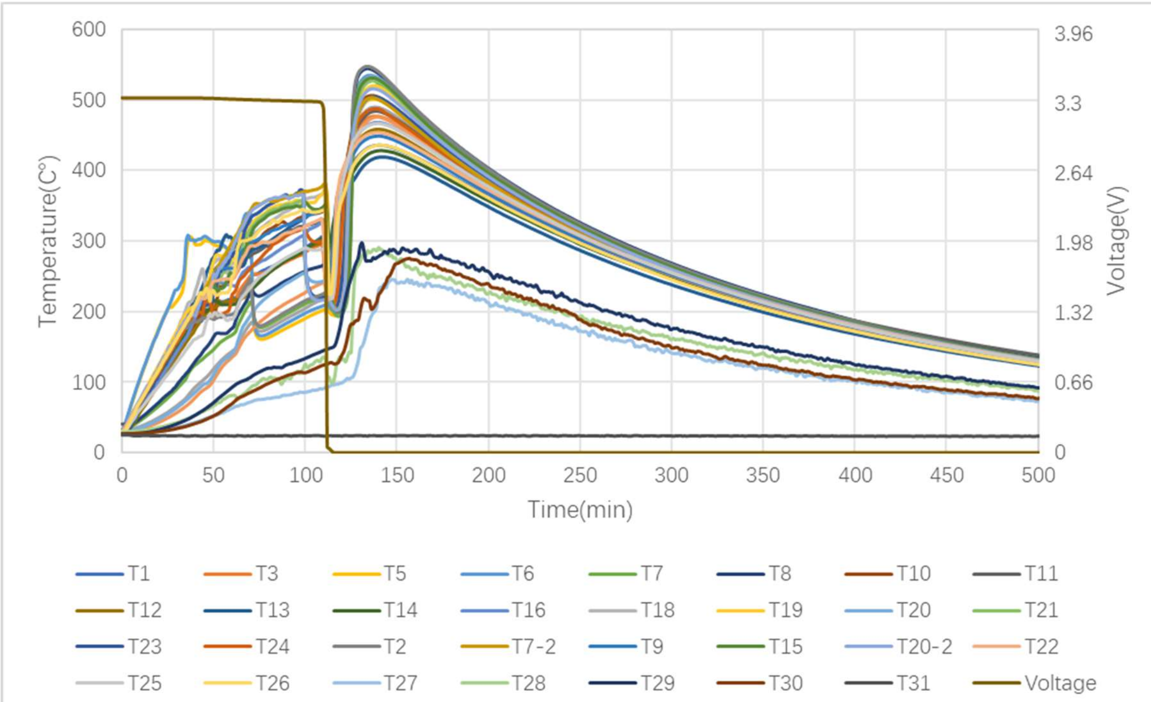
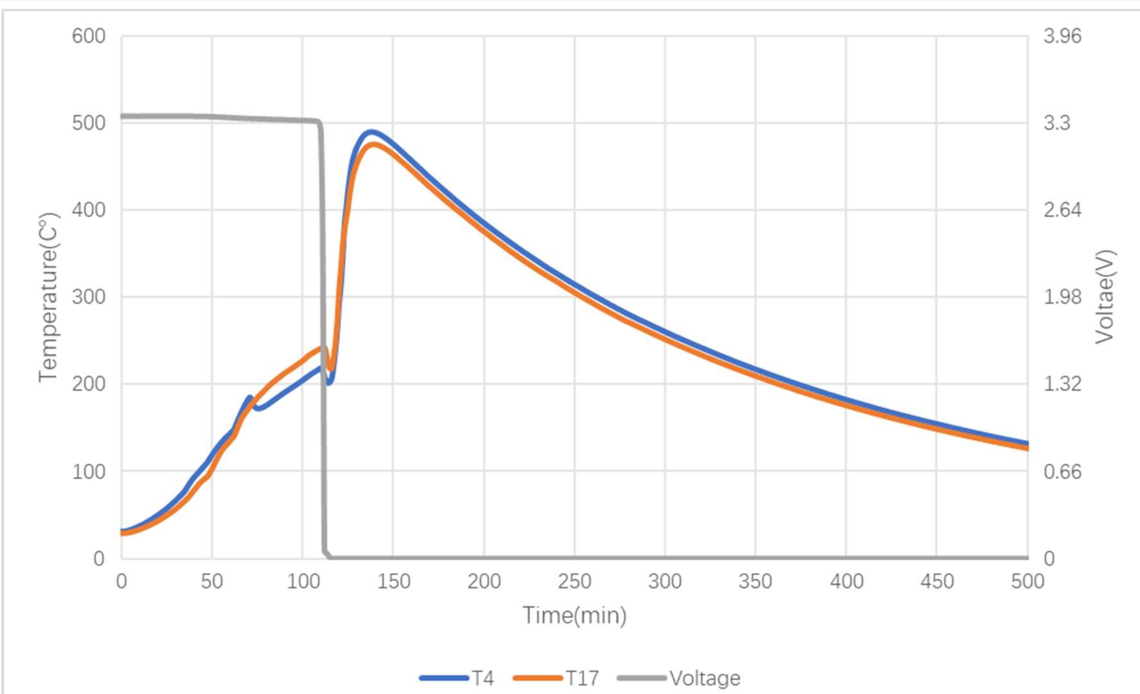
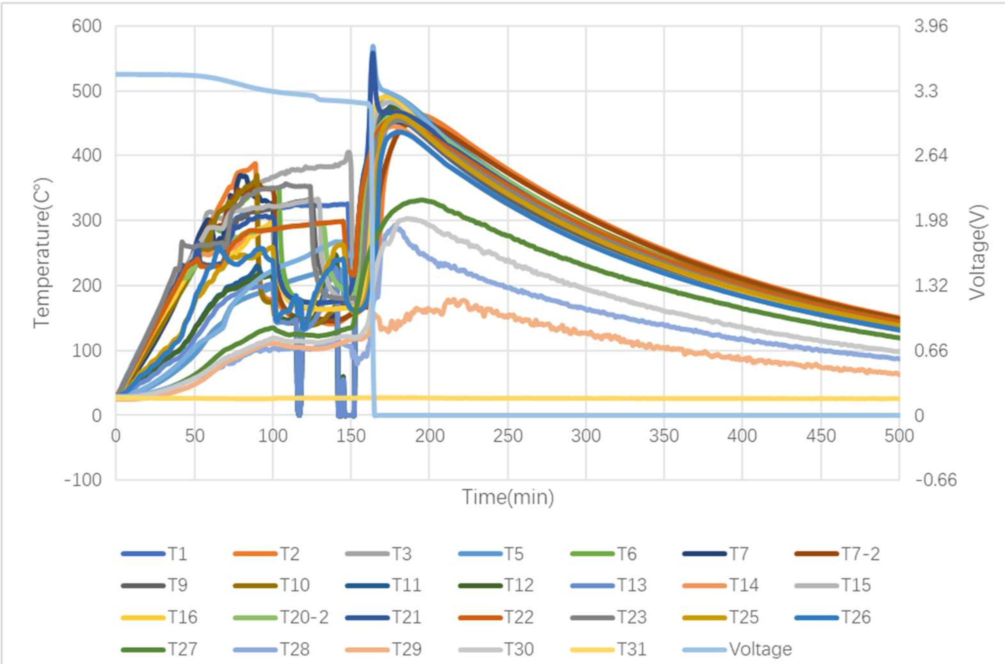
Sample Number: 202405013-2

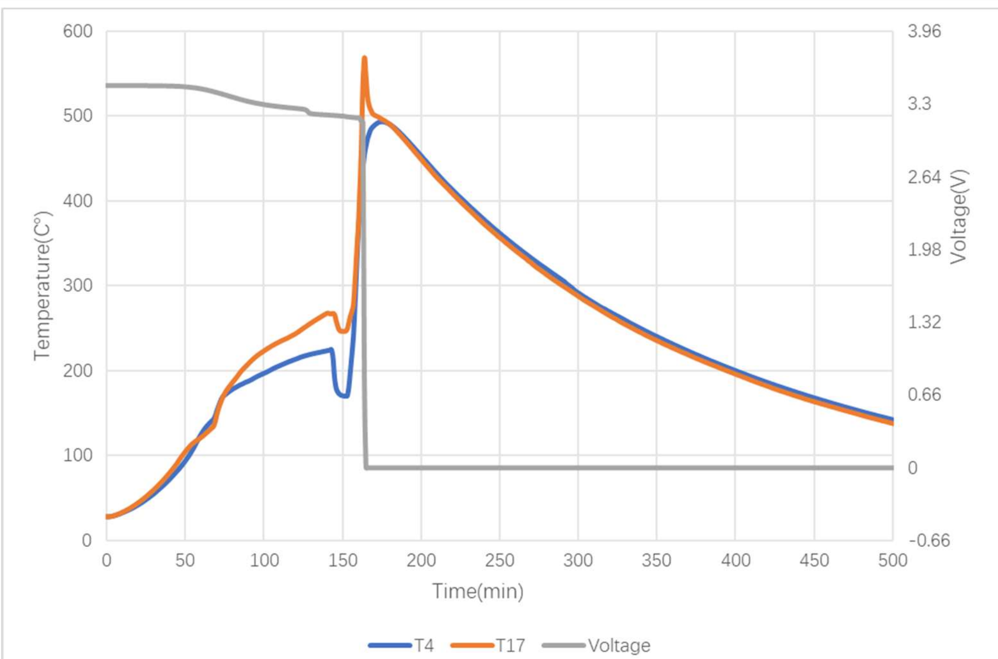




Master Contract:	304401	Model:	3777AH	Page number 28 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

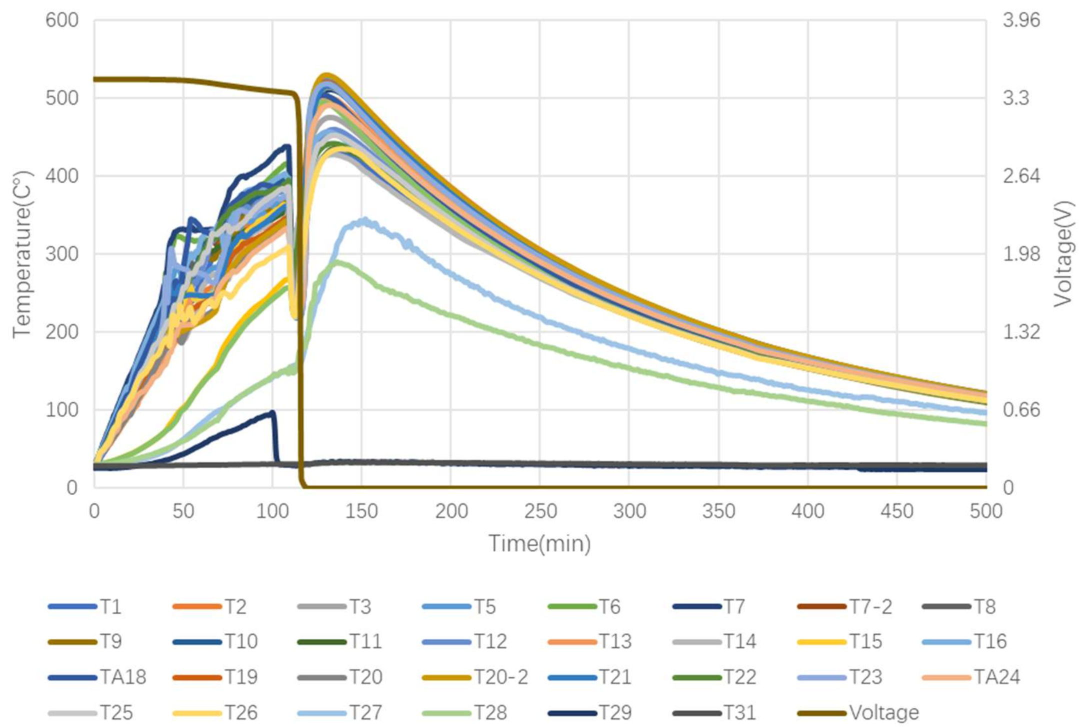
Sample Number: 202404020-3

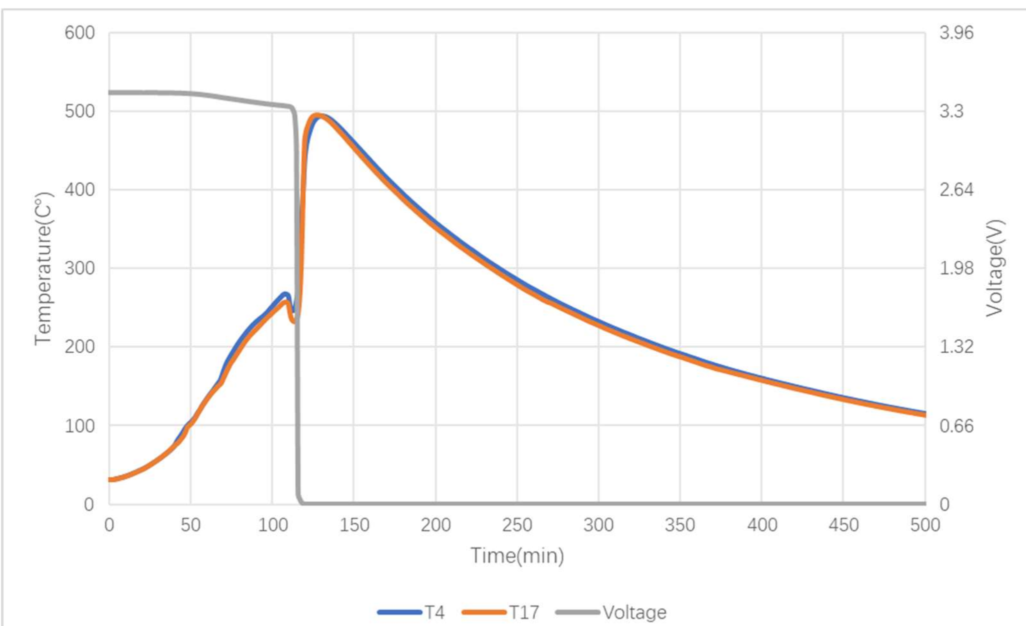




Master Contract:	304401	Model:	3777AH	Page number 29 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202404020-4





The results relate only to the items tested.
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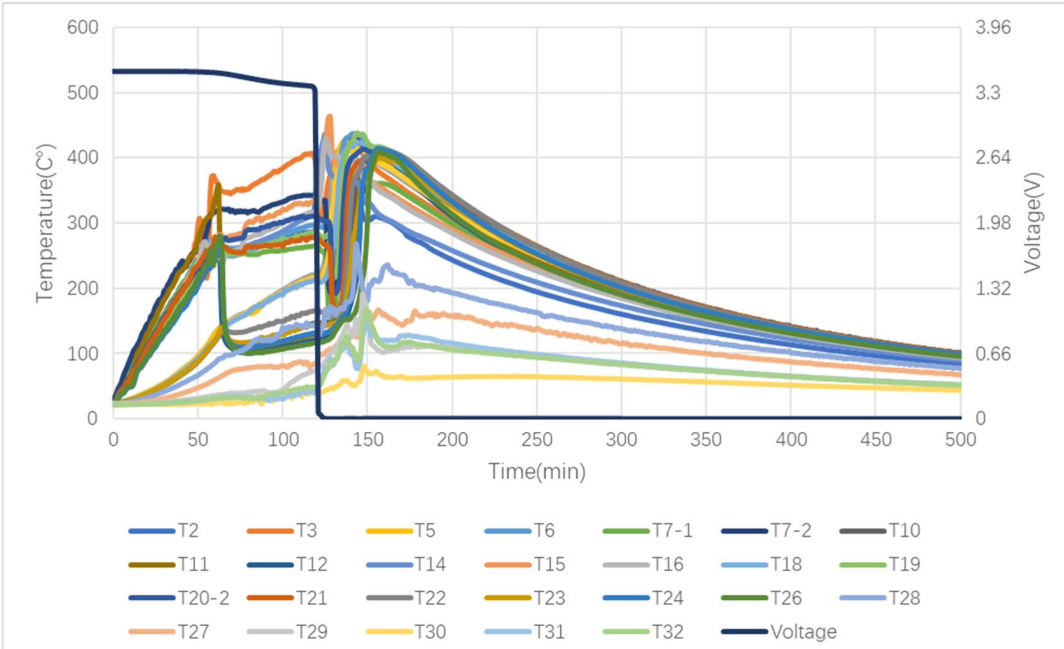
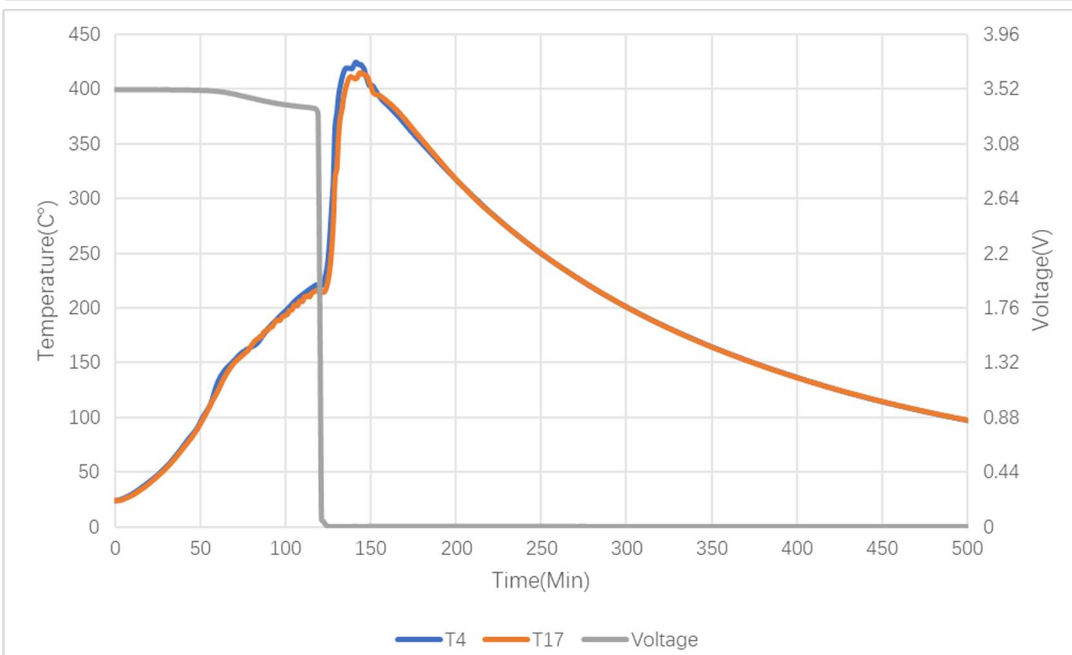
Master Contract:	304401	Model:	3777AH	Page number 30 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Sample Number: 202404020-5





Master Contract:	304401	Model:	3777AH	Page number 31 of 35
Project / Network:	80192231	Description:	Lithium battery cell	

Attachment 5- Cell gas analysis report

检测项目 **Test Items**	气体/蒸气燃烧（爆炸）极限-下限 Flammable (explosion) limits of gas and vapours - LFL					
检测方法 **Test Method**	ASTM E918-19 Standard Practice for Determining Limits of Flammability of Chemicals at Elevated Temperature and Pressure					
备注 **Remarks**	c_s=样品的浓度/ Concentration of sample T_i=每次试验中的初始温度/ Initial temperature in each trial; p_i=每次试验中的初始压力/ Initial pressure in each trial; p_{ex}=每次试验中的超压/ Overpressure in each trial； L_1=使火焰传播的最小样品浓度/ The minimum sample concentration that gives flame propagation； L_2=不产生火焰传播的最大样品浓度/ The maximum sample concentration that does not give flame propagation; LFL=可燃性下限/ Lower flammable limit； LFL =$(L_1 + L_2)/2$ 如果$p_{ex}/p\,i \geq 1.07$，则认为爆炸发生。 It is considered explosion occurred, if $p_{ex}/p\,i \geqslant$ 1.07. 本试验中定义的浓度是指体积百分比。 Concentration defined in this report means volume percentage.					
检测条件 **Test Conditions**	初始温度：(24±2)°C； 初始压力：(101±3) kPa Initial Temperature: (24±2)°C; Initial Pressure: (101±3) kPa					
环境条件 **Environmental Conditions**	温度：(20~24)°C；相对湿度：(32~65)% Ambient Temperature: (20~24)°C; Relative Humidity: (32~65)%					
部分测试数据/ Part of Test Data						
No.	c_s [%]	T_i [°C]	p_i [kPa]	p_{ex} [kPa]	$p_{ex}/p\,i$	Ignition?
1	8.0	25	100.00	105.83	1.06	N
2	8.0	25	100.46	106.35	1.06	N
3	8.2	25	100.31	109.31	1.09	Y
4	8.2	25	100.33	108.25	1.08	Y
结果 Result	L1=8.2%, L2=8.0%, LFL=8.1% at (24±2)°C and (101±3) kPa.					

Attachment 5- Cell gas analysis report

检测项目 Test Items	气体/蒸气燃烧（爆炸）极限-下限 Flammable (explosion) limits of gas and vapours - LFL
检测方法 Test Method	ASTM E918-19 Standard Practice for Determining Limits of Flammability of Chemicals at Elevated Temperature and Pressure
备注 Remarks	c_s=样品的浓度/ Concentration of sample T_i=每次试验中的初始温度/ Initial temperature in each trial; p_i=每次试验中的初始压力/ Initial pressure in each trial; p_{ex}=每次试验中的超压/ Overpressure in each trial; L_1=使火焰传播的最小样品浓度/ The minimum sample concentration that gives flame propagation; L_2=不产生火焰传播的最大样品浓度/ The maximum sample concentration that does not give flame propagation; LFL=可燃性下限/ Lower flammable limit; LFL $=(L_1+L_2)/2$ 如果$p_{ex}/p_i \geq 1.07$，则认为爆炸发生。 It is considered explosion occurred, if $p_{ex}/p_i \geq 1.07$. 本试验中定义的浓度是指体积百分比。 Concentration defined in this report means volume percentage.
检测条件 Test Conditions	初始温度：(145.5±2)°C； 初始压力：(101±3) kPa Initial Temperature: (145.5±2)°C; Initial Pressure: (101±3) kPa
环境条件 Environmental Conditions	温度：(20~24)°C；相对湿度：(32~65)% Ambient Temperature: (20~24)°C; Relative Humidity: (32~65)%

部分测试数据/ Part of Test Data

No.	c_s [%]	T_i [°C]	p_i [kPa]	p_{ex} [kPa]	p_{ex}/p_i	Ignition?
1	7.0	145	100.42	106.08	1.06	N
2	7.0	145	100.60	106.63	1.06	N
3	7.2	145	100.46	107.98	1.07	Y
4	7.2	145	100.40	107.75	1.07	Y
结果 Result	L1=7.2%, L2=7.0%, LFL=7.1% at (145.5±2)°C and (101±3) kPa.					

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Project / Network:	80192231	Description:	Lithium battery cell	

Attachment 5- Cell gas analysis report

检测项目 **Test Items**	气体/蒸气的最大爆炸压力 Maximum explosion pressure of gases and vapours
检测方法 **Test Method**	EN 15967:2022 Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours
检测设备 **Test Apparatus**	8L 封闭球体，感应火花 Test Vessel: 8L closed sphere; Ignition System: Spark
试验混合物的制备 **Preparation of test mixtures**	分压法 Partial pressure method used inside the vessel
检测条件 **Test Conditions**	初始温度：(22±2)℃；初始压力：(101±3) kPa Initial Temperature: (22±2)℃; Initial Pressure: (101±3) kPa
环境条件 **Environmental Conditions**	温度：(20~24)℃；相对湿度：(32~65)% Ambient Temperature: (20~24)℃; Relative Humidity: (32~65)%
备注 **Remarks**	c_s=样品的浓度/ Concentration of sample; p_{max}=最大爆炸压力/ Maximum explosion pressure; $p_{ex,n}$=在一定浓度下第 n 次点火试验中的爆炸超压/p_{ex} in different trials at a certain concentration; $p_{ex,max}$=某一浓度下 n 次点火试验中爆炸超压的最大值/The maximum value of all the $p_{ex,n}$ at a certain concentration, p_{mean}=某一浓度下爆炸超压的平均值/The average value of all the $p_{ex,n}$ at a certain concentration; p_{lowest}= 5（或 3）次点火试验中最低的爆炸超压/Lowest explosion pressure in 5 (resp. 3) tests; p_{highe} = 5（或 3）次点火试验中最高的爆炸超压/Highest explosion pressure in 5 (resp. 3) tests. p_{max}是$p_{ex,max}$的最大值/p_{max} is expressed as the maximum value of $p_{ex,max}$ 本试验中定义的浓度是指体积百分比。 Concentration defined in this report means volume percentage.
部分测试数据/ Part of Test Data	

Attachment 5- Cell gas analysis report

No.	c_s [%]	$p_{ex,1}$ [bar]	$p_{ex,2}$ [bar]	$p_{ex,3}$ [bar]	$p_{ex,4}$ [bar]	$p_{ex,5}$ [bar]	p_{mean} [bar]
1	18.0	6.634	6.641	6.552	/	/	6.609
2	20.0	6.978	6.864	6.892	/	/	6.911
3	21.0	7.037	7.127	7.017	/	/	7.060
4	21.6	7.025	6.916	7.059	/	/	7.000
5	21.8	7.219	7.131	7.205	/	/	7.185
6	22.0	7.173	7.229	7.14	/	/	7.181
7	22.2	7.129	7.160	7.049	/	/	7.113
8	22.4	7.094	7.002	7.044	/	/	7.047
9	22.6	7.093	6.979	7.092	/	/	7.055
10	23.0	7.108	6.968	7.023	/	/	7.033
11	24.0	7.031	6.966	7.068	/	/	7.022
12	26.0	6.962	6.891	6.997	/	/	6.950

爆炸压力的测定/ Determination of the explosion pressure

No.	c_s [%]	p_{lowest} [bar]	$p_{highest}$ [bar]	p_{mean} [bar]	$p_{ex,max}$ [bar]
1	18.0	6.552	6.641	6.609	6.641
2	20.0	6.864	6.978	6.911	6.978
3	21.0	7.017	7.127	7.060	7.127
4	21.6	6.916	7.059	7.000	7.059
5	21.8	7.131	7.219	7.185	7.219
6	22.0	7.14	7.229	7.181	7.229
7	22.2	7.049	7.16	7.113	7.16
8	22.4	7.002	7.094	7.047	7.094
9	22.6	6.979	7.093	7.055	7.093
10	23.0	6.968	7.108	7.033	7.108
11	24.0	6.966	7.068	7.022	7.068
12	26.0	6.891	6.997	6.950	6.997

最大爆炸压力的确定/Determination of the maximum explosion pressure

可燃物质含量/Content of flammable substance	22.0%
最小易燃物质含量增量/Smallest flammable substance content increment	0.2%
最大爆炸压力/Maximum explosion pressure	7.229bar

结果/Result	初始温度 22(±2)°C，初始压力 101(±3)kPa 条件下，p_{max}=7.229bar。 p_{max}=7.229bar at 22(±2)°C and 101(±3)kPa.

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Project / Network:	80192231	Description:	Lithium battery cell	

Attachment 5- Cell gas analysis report

检测项目 Test Items	可燃气体燃烧速度 Burning velocity of flammable gases
检测方法 Test Method	ISO 817:2014 Refrigerants—Designation and safety classification
检测条件 Test Conditions	初始温度：(22±2)°C；初始压力：(101±3) kPa Initial Temperature: (22±2)°C; Initial Pressure: (101±3) kPa
环境条件 Environmental onditions	温度：(20~24)°C；相对湿度：(32~65)% Ambient Temperature: (20~24)°C; Relative Humidity: (40~65)%
备注 Remarks	c_s=样品的浓度/ Concentration of sample; S_s=火焰传播速度 /Flame propagation speed; a_f= 火焰底部横截面积/Cross-sectional area of flame bottom; A_f= 火焰表面积//Flame surface area; S_u=燃烧速度/ Burning velocity. $S_u = S_S \times \frac{a_f}{A_f}$ 本试验中定义的浓度是指体积百分比。 Concentration defined in this report means volume percentage.

部分测试数据/ Part of Test Data

No.	c_s [%]	S_s [m/s]	a_f/A_f /	S_u [m/s]
1	18.0	0.706	0.3212	0.227
2	20.0	0.790	0.3256	0.257
3	21.0	0.886	0.3323	0.294
4	21.8	0.982	0.3264	0.321
5	22.0	0.932	0.3412	0.318
6	22.2	0.996	0.3362	0.335
7	22.4	0.886	0.3123	0.277
8	22.6	0.799	0.3238	0.259
9	23.0	0.876	0.3246	0.284
10	24.0	0.886	0.3142	0.278
11	26.0	0.742	0.3021	0.224
结果 Result	S_u=0.335m/s 在室温和大气压条件下。			

End of Report….