



# REPORT

For

**Sterling PBES Energy Solutions Ltd.**

606-1200 W 73rd Ave.  
Vancouver, BC, V6P 6G5  
Canada

Date: May 26, 2021  
Report No.: 40.00.20479-1  
Revision No.: 0  
Project No.: 20479  
Equipment: Battery  
Model No.: BBU

**ONE STOP GLOBAL CERTIFICATION SOLUTIONS**

ISO 17025 ACCREDITED

ISO 17020 ACCREDITED

ISO 17065 ACCREDITED

205 - 8291 92<sup>nd</sup> Street, Delta, BC  
V4G 0A4, Canada  
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Prepared by: LabTest Certification Inc. Client: Sterling PBES Energy Solutions Ltd  
Date Issued: March 26, 2021 Report No.: 40.00.20479-1  
Project No: 20479 Revision No.: 0

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## TEST REPORT

### Fire Survivability Testing

**Report reference No.** .....: 40.00.20479-1

**Report Revision History:** Rev. 0

Tested, Report Compiled and Evaluated by  
(printed name and signature) .....: Ovidiu Harpa



Reviewed by  
(printed name and signature) .....: Dan Ichim



Date of issue .....: May 26, 2021

**Note:** By signing this report, both the Testing Technician and the Reviewer hereby declare to abide by the applicable LabTest policies:

- 1.) Statement of Independence # 3014 (LabTest Employees),
- 2.) Independence, Impartiality, and Integrity #1039, clause 11 (Engineering Service Subcontractors), or
- 3.) Independence, Impartiality, and Integrity #1019, clause 3.5 (Testing Subcontractors).

**Testing Laboratory Name** .....: LabTest Certification Inc.

Address .....: 205 – 8291 92nd Street, Delta, BC V4G 0A4, Canada

**Test Location Name** .....: N/A

Address .....: 2665 176 Street, Surrey, BC, V3S 9V4, Canada

**Applicant's Name** .....: Sterling PBES Energy Solutions Ltd.

Address .....: 606 - 1200 W 73<sup>rd</sup> Ave, Vancouver, BC, V6P 6G5, Canada

**Test specification**

Standards .....: ➤ N/A

Test procedure .....: ➤ Battery BBU Fire Survivability

Non-standard test method .....: SPBES procedure DOC-0306 Rev05

**Conclusion** The submitted test item noted below was found to be compliant with the tests noted in the "Summary of Tests" section below.

**Test item description** .....: Battery

Trademark .....: N/A

Manufacturer .....: Sterling PBES Energy Solutions Ltd.

Model and/or type reference .....: BBU

Serial number .....: N/A

Rating(s) .....: N/A

Sampling Plan Used.....: N/A

**Particulars: test item vs. test requirements**

Equipment mobility .....	Permanent connection
Operating condition .....	N/A
Mass of equipment (Kg) .....	90
Protection against ingress of water .....	N/A

**Test case verdicts**

Test case does not apply to the test object :	(N)/A
Test item does meet the requirement .....	(P)ass
Test item does not meet the requirement ..:	(F)ail

**Testing**

Date of receipt of test item .....	May 17, 2021
Date(s) of performance of test .....	May 18, 2021

**General remarks**

**"This report is not valid as a CB Test Report unless appended by an approved CB Testing Laboratory and appended to a CB Test Certificate."**

The test result presented in this report relate only to the object(s) tested.

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

"(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 comma is used as the decimal separator.
- Throughout this report a period is used as the decimal separator.

**Note:**

Representatives on site for test on 18th May 2021:

- Sergiy Pazukha - Senior Surveyor, North America West, Lloyd's Register Marine & Offshore
- Gilbert Braun - Senior Marine Inspector, Technical Services, Transport Canada

Representative on site for battery strip down on 19th May 2021:

- Sergiy Pazukha - Senior Surveyor, North America West, Lloyd's Register Marine & Offshore

**General product information:**

Model BBU - DC Ratings: 77-100V, Nominal 88.8V, Capacity 75 Ah, Energy 6.6kWh, RMS continuous current 225A, Max discharge current 450A, Max charge current 225A, Efficiency (1C)>98%, Self discharge per month <2%, Electrical isolation open circuit when not in operation, Weight 90kg, Dimensions L 580mm x H 380mm x W 320mm.

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## SUMMARY OF TESTS

	Test	Description of Test	Verdict
1	<b>Fire Resistance at 215°C Test</b>	<ul style="list-style-type: none"><li>This test is to verify that the BBU cooling system in a 215°C chamber can keep the cell temperature below 150°C for 60 minutes.</li></ul>	Pass
2	<b>Fire Resistance at 950°C Test</b>	<ul style="list-style-type: none"><li>This test is to determine how long the BBU cooling system in a 950°C chamber can keep the cell temperature below 150°C for 60 minutes.</li></ul>	Pass

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## TEST EQUIPMENT USED

Item	Type	Equipment No.	Calibration Due Date	Calibration Laboratory
1	Environmental Logger	695	June 18, 2021	Tektronix
2	Multiplexer Module	722	Calibrated with asset 725	—
3	Data Acquisition Unit	725	December 11, 2021	Wescan Calibration
4	Test Chamber	-	Used with asset 722 and 725	—
5	Stopwatch	1461	November 06, 2021	Wescan Calibration

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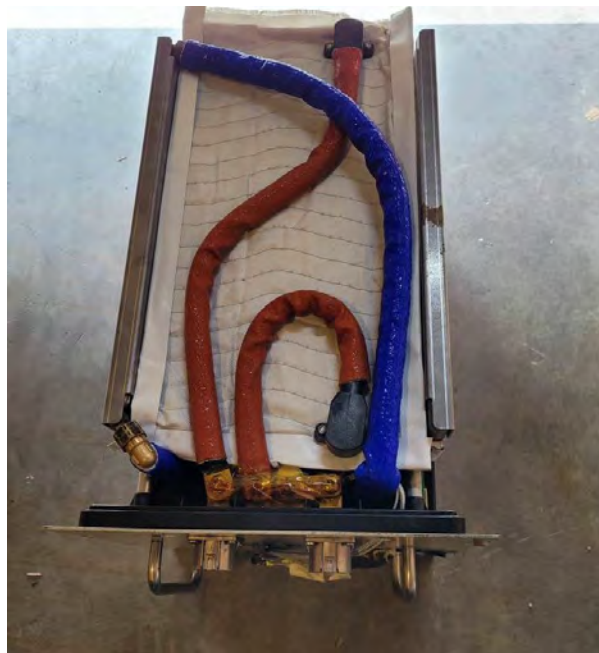
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## PICTURES



**Picture 1 – Unit BBU – Front View**



**Picture 2 – Units BBU – Top View**

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**Picture 3 – Unit BBU – Side View**



**Picture 4 – Unit BBU – Side View**

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**Picture 5 – Unit BBU – Rack Internal View**



**Picture 6 – Unit BBU – Unit Installed in the Test Chamber**

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**Picture 7 – Unit BBU – Unit After Exposure at 215°C**



**Picture 8 – Unit BBU – Unit After Exposure at 950°C**



**Picture 9 – Unit BBU – Unit After Exposure at 950°C – Rack Internal View**



**Picture 10 – Unit BBU – Unit After Exposure at 950°C – Battery Only – Top View**

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**Picture 11 – Unit BBU – Unit After Exposure at 950°C – Battery Only – Side View**



**Picture 12 – Unit BBU – Unit After Exposure at 950°C – Battery Only – Back View**



**Picture 13 – Unit BBU – Unit After Exposure at 950°C – Battery Only – Bottom View**



**Picture 14 – Unit BBU – Unit After Exposure at 950°C – Front Panel Removed**



**Picture 15 – Unit BBU – Unit After Exposure at 950°C – Water Coolant System Caps Removed – View of Gaskets**



**Picture 16 – Unit BBU – Unit After Exposure at 950°C – Top Protection Panel Removed – Exposed Battery Top Cells**

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**Picture 17 – Unit BBU – Unit After Exposure at 950°C – Back Protection Panel and Insulation Removed – Cell No.24 View**



**Picture 18 – Unit BBU – Unit After Exposure at 950°C – Back Protection Panel and Insulation Removed – Cell No.24 Back View**

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Picture 19 – Unit BBU – Unit After Exposure at 950°C – Cell No.12 View



Picture 20 – Unit BBU – Unit After Exposure at 950°C – Cell No.1 View



**Picture 21 – Unit BBU – Unit After Exposure at 950°C – Cell No.1 Exposed Side View**




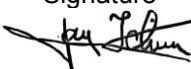
**Picture 22 – Unit BBU – Unit After Exposure at 950°C – Front Panel Isolation Block Condition and Close-up of Gas Gasket**

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## APPENDIX A – TEST DATA SECTION

<b>Project No.:</b>	<u>20479</u>	<b>Date:</b>	<u>May 18, 2021</u>
<b>Equipment ID#:</b>	<u>695; 722; 725; 1461; Test Chamber</u>	<b>Room Temp/Humidity:</b>	<u>18.1 °C / 37.3 %RH</u>
<b>Model No(s):</b>	<u>BBU</u>	<b>Barometric Pressure:</b>	<u>101.1 kPa</u>
<b>Sample No(s):</b>	<u>6213</u>	<b>Serial No(s):</b>	<u>N/A</u>
<b>USE A SEPARATE DATA SHEET FOR EACH MODEL. ALL TEST RESULTS MUST BE TRACEABLE TO THE SN# OF THE TESTED UNIT</b>			
<b>Note: By signing the below, both the Issuer and the Reviewer hereby declare to abide by the applicable LabTest policies:</b> 1.) Statement of Independence # 3014 (LabTest Employees), or 2.) Independence, Impartiality, and Integrity #1019, clause 3.5 (Testing Subcontractors).			
<b>Tested By:</b>	<u>Ovidiu Harpa</u> Print	 Signature	
<b>Reviewed by:</b>	<u>Dan Ichim</u> Print	 Signature	

### Test Data:

#### **Test No.1**

The Testing chamber was heated up just over 215°C and maintained for 1 hour to verify that the BBU cooling system can keep the cell temperature below 150°C for 60 minutes.

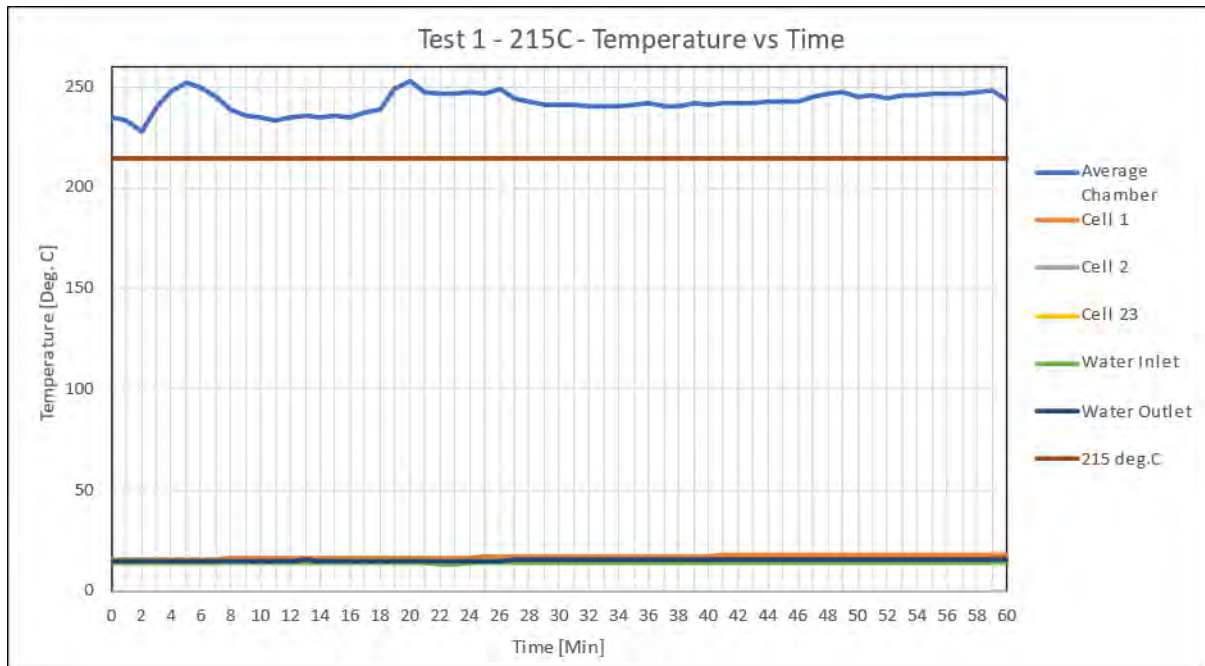
The average test chamber temperature during the 60 minute period was 242.58°C

The cooling system was supplied water at ambient temperature at a minimum of 8 litres/min.

No safety issues or damage to the cooling system was observed at conclusion of test.

<b>215°C Temperature Test</b>						
	<b>Cell 1</b>	<b>Cell 2</b>	<b>Cell 23</b>	<b>Cell 24</b>	<b>Water in</b>	<b>Water out</b>
<b>Maximum temperature measured (°C)</b>	17.99°C	15.77°C	15.64°C	N/A	13.97°C	15.55°C
<b>Safety Issues (fire, smoke)</b>	No					
<b>Damage to cooling system (leakage)</b>	No					

**Note:** Cell 24 temperature could not be recorded due to a fault in the thermocouple.



**215°C Test Temperature Graph**

**Test No.2**

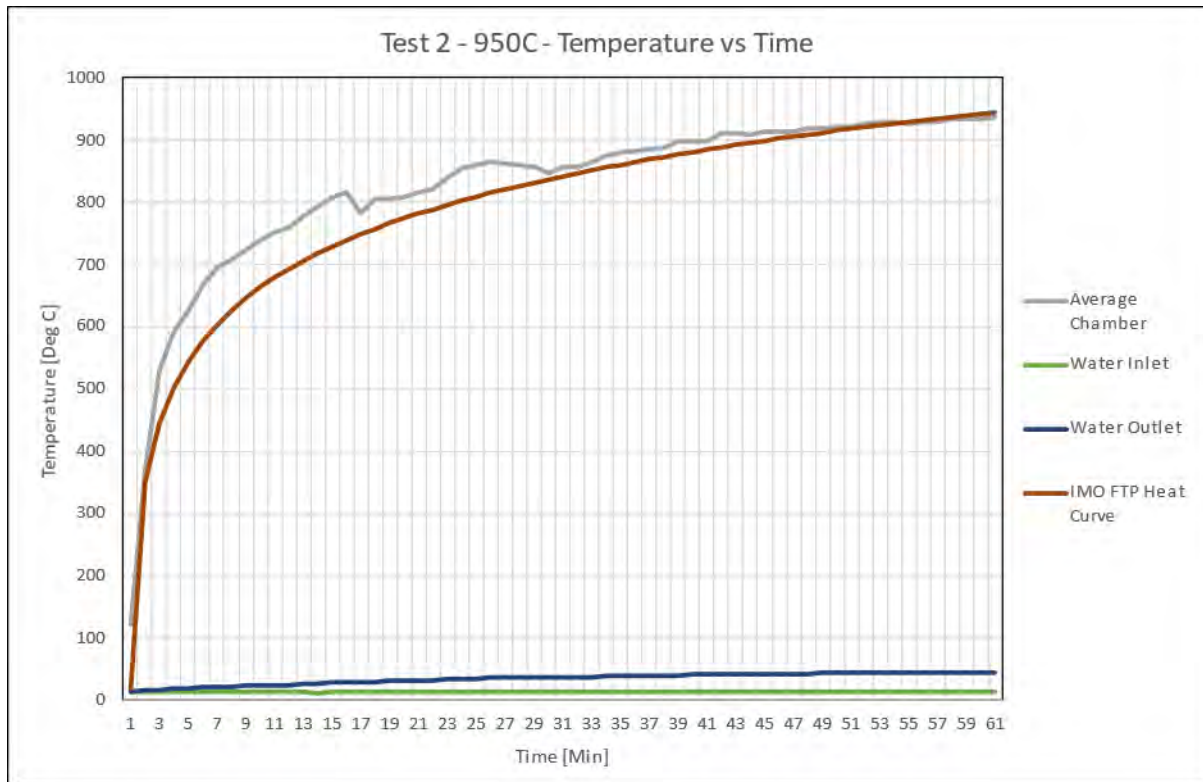
The Testing Chamber was set to heat up to 950°C and intended to be maintained for 1 hour to verify that the BBU cooling system can keep the cell temperature below 150°C for 60 minutes and the cooling systems is not damaged.

The cooling system was supplied water at ambient temperature at a minimum of 8 litres/min.

The 950C test furnace heating followed the IMO FTP Code temperature curve,  $T=345\log_{10}(8t+1)+20$ , as seen in the figure below, to a maximum of 945°C at 60 minutes test duration. The actual maximum heat chamber temperature reached during the test was 937°C.

950°C Temperature Test						
	Cell 1	Cell 2	Cell 23	Cell 24	Water in	Water out
Maximum temperature measured (°C)	N/A	N/A	N/A	N/A	14.08°C	47.78°C
Safety Issues (fire, smoke)	No					
Damage to cooling system (leakage)	No					

**Note:** Cell temperatures could not be recorded due to faults with the thermocouples.



**950°C Test Temperature Graph**

**Observation:**

Notes from A60 test battery strip down, 19th May 2021:

Strip down steps;

- Battery removed from heat chamber
- Battery module removed from rack
- Two internal cooling hoses disconnected from cell carriers
- Face plate removed – pulled off of the cell stack as the upper isolation blocks had melted and lower blocks were partially attached
- Water drained from cell stack – stack was rested on its front to allow the water to escape
- Two cooling cap brackets removed
- All cooling caps removed
- Top plate removed
- Compression bars removed
- Stand up all cell tabs
- End plate removed
- Cell carriers removed one at a time, with cell voltages recorded and cell condition noted

Battery largely intact although almost all plastics melted and consumed, as expected. Insulation sheets applied to top and ends also intact but damaged at edges due to melting of the sealing tape used. None of the insulation had burned. The two cooling cap brackets came off easily with no evidence of heat warping. Cooling caps themselves and the seals beneath were all in excellent condition. The compression bars were in very good condition, as were the plastic isolation bars – only the end bars (#1 and #25) has heat damage on their respective external sides. There was only minor heat damage observed on cells #1 and #24 without affecting their integrity or voltage – all other 22 cells were in almost pristine condition. All cells still had a serviceable voltage, just below the charged voltage when the battery was constructed for testing, allowing for about 5 days relaxation.

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24 hours after completion of test each cell voltage was measured.

Cell No.	Voltage Measured (Volts)
1	4.066
2	4.056
3	4.080
4	4.060
5	4.055
6	4.080
7	4.060
8	4.085
9	4.058
10	4.075
11	4.106
12	4.055
13	4.076
14	4.053
15	4.071
16	4.063
17	4.060
18	4.075
19	4.073
20	4.060
21	4.080
22	4.066
23	4.066
24	4.080

**Final Result:** Pass – Test 1  
Pass – Test 2

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## APPENDIX B – ISO 17025:2005 ACCREDITATION CERTIFICATE

For complete scope of certification <https://www.iasonline.org/wp-content/uploads/2017/05/TL-367-cert-New-1.pdf>

END OF REPORT