

CHEMICAL POWER SOURCES TESTING LABORATORY

TEST REPORT

№ S 32/2022/1A

Test object/product: Lithium-Ion battery

	NAME/POSITION	SIGNATURE/STAMP
TEST RESULTS AUTHORIZED BY	Jędrzej Kałużny Technician Supervising Tests	Laboratorium Badań Chemicznych Źródeł Prądu TECHNIK NADZORUJĄCY BADANIA 
TEST REPORT VALIDATED BY	Kamil Frączek Laboratory Manager	KIEROWNIK Laboratorium Badań Chemicznych Źródeł Prądu  mgr Kamil Frączek
Date of test report: 26/05/2022		Distribution list: 1 copy for Client, 1 copy a/a

Statement:

- Information on the method used:
A/NA – accredited test / non-accredited test
A/NA (P) – accredited test / non-accredited test, performed by a subcontractor.
- Chemical Power Sources Testing Laboratory is accredited by Polish Centre for Accreditation testing laboratory, a signatory of EA MLA and ILAC MRA, confirming compliance with the requirements of PN-EN ISO / IEC 17025. Accreditation № AB 124.
- The test results refer only to the obtained / tested sample.
- This test report cannot be reproduced without Laboratory's written consent.
- Client is entitled to submit his claims up to 14 days after reception of this test report.
- The accreditation stamp is placed on the test report, if at least one test is accredited.
- Annex: Certificate (applies only to UN TEST tests).



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GENERAL INFORMATION	
CLIENT/MANUFACTURER	DOCUMENT
Name: MARINE TECH S.A. Address: Franciszka Żwirki i Stanisława Wigury 17, 38-400 Krosno Website: https://seacraft.eu/ Email: office@seacraft.eu Telephone: +48 693 800 849	Order / agreement №: 32/2022 date: 25/03/2022
TESTED OBJECT / PRODUCT	
Name:	LITHIUM-ION RECHARGEABLE BATTERY 9S1P Model: 70219031
Description / state:	Rated capacity: 3,0 Ah Rated voltage: 32,4 V Rated energy: 97,2 Wh
Sampling / sample delivery method:	Sample was delivered by the Client
Sample size:	8 pieces
Sample collection date: 26.04.2022	Sample production date: ----
Test initiation date: 28.04.2022	Test completion date: 26.05.2022
SCOPE AND METHODOLOGY	
Tests carried out according to: Recommendations on the Transport Of Dangerous Goods Manual of Tests and Criteria ST/SG/AC.10/11/Rev.7, Section 38.3 Lithium metal and lithium ion batteries (hereinafter referred to as UN TEST)	
SAMPLE IDENTIFICATION NUMBERS	
Laboratory identification numbers (sample ID): AZ 832 – (01÷08)	
(in the 1 cycle) AZ 832-(01÷08)	(after 25 cycles performed at the Client) AZ 832-(05÷08)

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TEST PROGRAMME

Test name	Methodology			Sample ID:
	Document number	Test point	A/NA	
T.1 Altitude simulation	UN 38.3, rev. 7	38.3.4.1	A	AZ 832-01+08
T.2 Thermal test	UN 38.3, rev. 7	38.3.4.2	A	AZ 832-01+08
T.3 Vibration	UN 38.3, rev. 7	38.3.4.3	NA	AZ 832-01+08
T.4 Shock	UN 38.3, rev. 7	38.3.4.4	NA	AZ 832-01+08
T.5 External short circuit	UN 38.3, rev. 7	38.3.4.5	A	AZ 832-01+08
T.7 Overcharge	UN 38.3, rev. 7	38.3.4.7	A	AZ 832-01+08

Before the test, the batteries AZ 832-(01+08) were fully charged

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T.1 ALTITUDE SIMULATION (A)

Test procedure (document): UN TEST point 38.3.4.1

Sample ID: AZ 832-(01÷08)

Test conditions: pressure in the chamber 11kPa/ time $t \geq 6h$ / ambient temperature $20 \pm 5^\circ C$

TEST RESULTS								
Sample ID	Fully charged state	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV [%]	before testing	after testing	change mass [%]	
AZ 832-01	at 1 st cycle	37,53	37,53	100,00	535,55	535,55	0,00	O
AZ 832-02	at 1 st cycle	37,49	37,49	100,00	535,93	535,93	0,00	O
AZ 832-03	at 1 st cycle	37,54	37,54	100,00	534,57	534,57	0,00	O
AZ 832-04	at 1 st cycle	37,49	37,49	100,00	534,59	534,59	0,00	O
AZ 832-05	after 25 cycles	37,51	37,51	100,00	535,46	535,46	0,00	O
AZ 832-06	after 25 cycles	37,52	37,52	100,00	535,40	535,40	0,00	O
AZ 832-07	after 25 cycles	37,53	37,53	100,00	536,17	536,17	0,00	O
AZ 832-08	after 25 cycles	37,55	37,55	100,00	533,84	533,84	0,00	O
Measurement uncertainty:		± 0,01 V			± 0,02 g			
Result:		PASS						

Description phenomenon: **D** – disassembly; **F** – fire; **L** – leakage; **R** – rupture; **V** – venting; **SN** – the open circuit voltage after testing is less than 90% of its voltage immediately prior the test
Acceptance criteria: **O** – none of above phenomena were observed

Test equipment:	ATT TD150C vacuum chamber
	Digital thermometer
	METRAHIT X-TRA multimeter
	RADWAG WTC 2000 balance
	Electronic stopwatch
	Pressure gauge

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T.2 THERMAL TEST (A)

Test procedure (document): UN TEST point 38.3.4.2

Sample ID: AZ 832-(01÷08)

Test conditions: storage at a test temp. $72 \pm 2^\circ\text{C}$ for $t \geq 6\text{h}$ / storage at a test temp. $-40 \pm 2^\circ\text{C}$ for $t \geq 6\text{h}$ / x 10 cycles

TEST RESULTS								
Sample ID	Fully charged state	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV [%]	before testing	after testing	change mass [%]	
AZ 832-01	at 1 st cycle	37,53	37,07	98,77	535,55	535,66	0,02	O
AZ 832-02	at 1 st cycle	37,49	37,01	98,72	535,93	536,00	0,01	O
AZ 832-03	at 1 st cycle	37,54	37,02	98,61	534,57	534,67	0,02	O
AZ 832-04	at 1 st cycle	37,49	36,99	98,67	534,59	534,68	0,02	O
AZ 832-05	after 25 cycles	37,51	36,96	98,53	535,46	535,55	0,02	O
AZ 832-06	after 25 cycles	37,52	36,96	98,51	535,40	535,48	0,01	O
AZ 832-07	after 25 cycles	37,53	36,96	98,48	536,17	536,25	0,01	O
AZ 832-08	after 25 cycles	37,55	36,96	98,43	533,84	533,92	0,01	O
Measurement uncertainty:		± 0,01 V			± 0,02 g			
Result:		PASS						

Description phenomenon: **D** – disassembly; **F** – fire; **L** – leakage; **R** – rupture; **V** – venting; **SN** – the open circuit voltage after testing is less than 90% of its voltage immediately prior the test
Acceptance criteria: **O** – none of above phenomena were observed

Test equipment:	ATT TD150C climatic chamber
	METRAHIT X-TRA multimeter
	RADWAG WTC 2000 balance
	Digital thermometer
	Electronic stopwatch

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T.3 VIBRATION (NA)

Test procedure (document): UN TEST point 38.3.4.3

Sample ID: AZ 832-(01÷08)

Test conditions:

Frequency range [Hz]		Amplitudes	Duration of logarithmic sweep cycle (7 Hz – 200 Hz – 7Hz)	Axis	Number of cycles
from	to				
7	18	1 g _n	15 min	X	12
18	50	0,8 mm		Y	12
50	200	8 g _n		Z	12
And back to 7 Hz				Total	36

TEST RESULTS								
Sample ID	Fully charged state	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV [%]	before testing	after testing	change mass [%]	
AZ 832-01	at 1 st cycle	37,07	37,01	99,84	535,66	535,66	0,00	O
AZ 832-02	at 1 st cycle	37,01	37,01	100,00	536,00	536,00	0,00	O
AZ 832-03	at 1 st cycle	37,02	37,00	99,95	534,67	534,67	0,00	O
AZ 832-04	at 1 st cycle	36,99	36,99	100,00	534,68	534,68	0,00	O
AZ 832-05	after 25 cycles	36,96	36,96	100,00	535,55	535,55	0,00	O
AZ 832-06	after 25 cycles	36,96	36,96	100,00	535,48	535,48	0,00	O
AZ 832-07	after 25 cycles	36,96	36,95	99,97	536,25	536,25	0,00	O
AZ 832-08	after 25 cycles	36,96	36,96	100,00	533,92	533,92	0,00	O
Measurement uncertainty:		± 0,01 V			± 0,02 g			
Result:		PASS						

Description phenomenon: **D** – disassembly; **F** – fire; **L** – leakage; **R** – rupture; **V** – venting; **SN** – the open circuit voltage after testing is less than 90% of its voltage immediately prior the test
Acceptance criteria: **O** – none of above phenomena were observed

Test equipment:	TIRA vibration test system
	SVAN 956 vibration meter
	METRAHIT X-TRA multimeter
	RADWAG WTC 2000 balance
	Electronic stopwatch

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T.4 SHOCK (NA)

Test procedure (document): UN TEST point 38.3.4.4

Sample ID: AZ 832-(01÷08)

Test conditions: peak acceleration 150g / pulse duration 6 ms / 3 shocks for each axis and each direction/ total 18 shocks

TEST RESULTS								
Sample ID	Fully charged state	VOLTAGE [V]			MASS [g]			Sample observation
		before testing	after testing	change OCV [%]	before testing	after testing	change mass [%]	
AZ 832-01	at 1 st cycle	37,01	37,01	100,00	535,66	535,66	0,00	O
AZ 832-02	at 1 st cycle	37,01	37,01	100,00	536,00	536,00	0,00	O
AZ 832-03	at 1 st cycle	37,00	37,00	100,00	534,67	534,67	0,00	O
AZ 832-04	at 1 st cycle	36,99	36,99	100,00	534,68	534,68	0,00	O
AZ 832-05	after 25 cycles	36,96	36,96	100,00	535,55	535,55	0,00	O
AZ 832-06	after 25 cycles	36,96	36,96	100,00	535,48	535,48	0,00	O
AZ 832-07	after 25 cycles	36,95	36,95	100,00	536,25	536,25	0,00	O
AZ 832-08	after 25 cycles	36,96	36,96	100,00	533,92	533,92	0,00	O
Measurement uncertainty:		± 0,01 V			± 0,02 g			
Result:		PASS						

Description phenomenon: **D** – disassembly; **F** – fire; **L** – leakage; **R** – rupture; **V** – venting; **SN** – the open circuit voltage after testing is less than 90% of its voltage immediately prior the test

Acceptance criteria: **O** – none of above phenomena were observed

Test equipment:	TIRA vibration test system
	SVAN 956 vibration meter
	METRAHIT X-TRA multimeter
	RADWAG WTC 2000 balance
	Electronic stopwatch

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T.5 EXTERNAL SHORT CIRCUIT (A)

Test procedure (document): UN TEST point 38.3.4.5 **Sample ID:** AZ 832-(01÷08)

Test conditions: heating time $t \geq 6h$ / temperature $57 \pm 4^\circ\text{C}$ / external resistance $< 0,1\Omega$ / short circuit duration $t_z \geq 1h$

TEST RESULTS				
Sample ID	Fully charged state	Temp. of external case after heating [°C]	Max. temp. of external case during test [°C]	Observation of the sample after 6h
AZ 832-01	at 1 st cycle	56,1	56,2	O
AZ 832-02	at 1 st cycle	55,8	55,8	O
AZ 832-03	at 1 st cycle	55,3	55,4	O
AZ 832-04	at 1 st cycle	55,1	55,3	O
AZ 832-05	after 25 cycles	55,2	55,3	O
AZ 832-06	after 25 cycles	54,8	54,9	O
AZ 832-07	after 25 cycles	55,2	55,3	O
AZ 832-08	after 25 cycles	54,7	55,1	O
Measurement uncertainty:		$\pm 0,1^\circ\text{C}$		
Result:		PASS		

Description phenomenon: D – disassembly; R – rupture; F – fire; T - temperature $>170^\circ\text{C}$

Acceptance criteria: O – none of above phenomena were observed during the test and within 6 h after the test

Test equipment:	MSK-TE901-UL device to short-circuit tests
	Temperature chamber
	Hioki resistance tester
	Digital thermometer
	Electronic stopwatch

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T.7 OVERCHARGE (A)

Test procedure (document): UN TEST point 38.3.4.7 **Sample ID:** AZ 832-(01÷08)

Test conditions: test duration 24h/ ambient temperature $20 \pm 5^\circ\text{C}$ / if charge voltage $> 18\text{V}$, min. test voltage is $1,2 \times \text{max. charge voltage}$ / charge current = $2 \times \text{max. charge current}$ recommended by the manufacturer

TEST RESULTS			
Charge current $I_c \leq 6,6 \text{ A}$			Voltage $U_{\text{const}} = 45,36 \text{ V}$
Sample ID	Fully charged state	Sample observation	
AZ 832-01	at 1 st cycle	O	
AZ 832-02	at 1 st cycle	O	
AZ 832-03	at 1 st cycle	O	
AZ 832-04	at 1 st cycle	O	
AZ 832-05	after 25 cycles	O	
AZ 832-06	after 25 cycles	O	
AZ 832-07	after 25 cycles	O	
AZ 832-08	after 25 cycles	O	
Result:		PASS	

Description phenomenon: D – disassembly; F – fire

Acceptance criteria: O – none of above phenomena were observed during the test and within 7 days after the test

Test equipment:	DIGATRON tester
	Digital thermometer
	Electronic stopwatch

END OF TEST REPORT

TEST SUMMARY

Product: LITHIUM-ION RECHARGEABLE BATTERY		
Model №: 70219031		
Product description: 9S1P		
Mass: 536,25 g	Nominal energy: 97,2 Wh	
Manufacturer: (name, address)	MARINE TECH S.A. Franciszka Żwirki i Stanisława Wigury 17, 38-400 Krosno	
Website: https://seacraft.eu/		
Email: office@seacraft.eu	Telephone: +48 693 800 849	
Based on the following test results:		
UN TEST POINT	TEST NAME	¹⁾ RESULT/CONFIRMATION OF CONFORMITY
38.3.4.1	T.1 Altitude simulation	passed
38.3.4.2	T.2 Thermal test	passed
38.3.4.3	T.3 Vibration	passed
38.3.4.4	T.4 Shock	passed
38.3.4.5	T.5 External short circuit	passed
38.3.4.6	T.6a Impact	not applicable
38.3.4.6	T.6b Crush	not applicable
38.3.4.7	T.7 Overcharge	passed
38.3.4.8	T.8 Forced discharge	not applicable
¹⁾ according to Test Report № S 32/2022/1A result: passed/failed/not applicable (not required or not included in the order). This Test Summary is an integral part of the Test Report, which contains detailed test results.		
<u>it is confirmed</u> that the product met requirements of: Recommendations on the Transport Of Dangerous Goods Manual of Tests and Criteria ST/SG/AC.10/11/Rev.7:2019, Lithium metal and lithium ion batteries (Section 38.3) /except paragraph 38.3.4.6, 38.3.4.8		

Poznań, 26.05.2022

Technician supervising test

Jędrzej Kałużny
Jędrzej Kałużny



Head of Laboratory

Kamil Frączek
Kamil Frączek, M.A.