



TYPE APPROVAL CERTIFICATE

Certificate No:
TAE00001WZ
Revision No:
4

This is to certify:

That the Li-Ion Battery System

with type designation(s)
G/NMC Lithium Ion Battery

Issued to

Leclanché S.A.
Yverdon-les-Bains, VD, Switzerland

is found to comply with

DNV rules for classification – Ships, offshore units, and high speed and light craft

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.

Issued at **Hamburg** on **2022-01-24**

for **DNV**

This Certificate is valid until **2022-05-11**.

DNV local station: **Augsburg**

Approval Engineer: **Andreas Andrecht**

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Arne Schaarmann
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid. The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.



Product description

Lithium-ion battery system for use in battery powered vessels and hybrid applications. The system consists of battery modules (up to 32 G/NMC cells per module) with included battery monitoring unit (BMU), battery control unit (BCU) for modules connected in series as string and a switch unit for each string.

Cell

Cell type: 946A01
LecCell G/NMC 43Ah/160Wh
Lithium Nickel Manganese Cobalt oxide (NMC) – graphite
Nominal Capacity: 43Ah (C/5 discharge rate)
Nominal Voltage: 3,65V
Weight: ~1000g

Cell type: LC-51LE 48Ah
LecCell G/NMC 48Ah/178Wh
Lithium Nickel Manganese Cobalt oxide (NMC) – graphite
Nominal Capacity: 48Ah (C/8 discharge rate)
Nominal Voltage: 3,7V
Weight: ~1120g

Cell type: GL55 55Ah / 936A03
LecCell G/NMC 55Ah/200Wh
Lithium Nickel Manganese Cobalt oxide (NMC) – graphite
Nominal Capacity: 55Ah (C/10 discharge rate)
Nominal Voltage: 3,7V
Weight: ~1140g

Cell type: GL60 60Ah / 936A04
LecCell G/NMC 60Ah/220Wh
Lithium Nickel Manganese Cobalt oxide (NMC) – graphite
Nominal Capacity: 60Ah (C/10 discharge rate)
Nominal Voltage: 3,7V
Weight: ~1120g
Expected lifetime > 4500 cycles (at 1C charge/discharge full DoD and RT)

Cell type: GL65 65Ah / 936A06
LecCell G/NMC 65Ah/245Wh
Lithium Nickel Manganese Cobalt oxide (NMC) – graphite
Nominal Capacity: 65Ah (C/10 discharge rate)
Nominal Voltage: 3,72V
Weight: ~1120g
Expected lifetime up to 4000 cycles. Dependent on specific charge conditions

Volume: 475ml
Housing: Foil packing
Expected calendar life 10 years (at RT)

Module

Type: M2Marine Battery Module technology
Module includes embedded BMU which monitors up to 24 individual cell voltages and up to 4 cell group temperatures and the passive cell balancing. Each module is equipped with an independent heat detection line (Excessive Temperature Detection) which disconnect the main switch and activates the fire suppression. Every module is inserted in IP 65 box with water cooling element, exhaust channel and for water mist and foam based fire suppression systems designed.

Battery Management system BMS G2 1.0.X

Software: BMU: ver. 1.8.x
BCU: ver. 1.1.x
Hardware: BMU 24 channels version: rev C12 (embedded in the module)
BMU 12 channels version: rev C13 (embedded in the module)
BCU: rev C10

The BCU monitored cell parameters and ensures the safe operating range. BCU controls the charging, discharging, cell balancing etc. with the maximum number of 60 modules connected in series as string.

Excessive Temperature Detection

Consists of heat sensing cable FyreLine (fixed temperature 68°C) and WAGO PLC.

Cable Type: Thermocable 68°C (Eurofyre Limited, Fyreline, FLD68)

PLC Type: Wago controller 750-8101 (DNV-GL certificate#: TAA00000Y7)

Fire Suppression System Activation

The activation of the external fire suppression system is based on the excessive temperature detection line on the battery modules and the smoke detection at the extremity of the duct channel.

Battery module configurations:

Module Article No.	Cell type	Config.	Cell s	Nominal			Discharge		Charge
				Capacity	Energy	Voltage	Continuous	Pulse	Continuou s
M2.GNMC(43)16s2p 034000819	43Ah	16s2p	32	86Ah	5,1kWh	58,40V	258A	453A	86A
M2.GNMC(43)8s4p 034000808	43Ah	8s4p	32	172Ah	5,1kWh	29,20V	516A	905A	172A
M2.GNMC(43)4s8p 034000796	43Ah	4s8p	32	344Ah	5,1kWh	14,60V	1032A	1811A	344A
M2.GNMC(43)6s5p 034000802	43Ah	6s5p	30	215Ah	4,8kWh	21,90V	645A	1132A	215A
M2.GMNC(48)4s8p 034001000	48Ah	4s8p	32	384Ah	5,7kWh	14,8V	680A	1920A	384A
M2.GMNC(55)16s2p 034001011	55Ah	16s2p	32	110Ah	6,4kWh	59,2V	330A	550A	110A
M2.GNMC(55)8s4p 034001012	55Ah	8s4p	32	220Ah	6,4kWh	29,6V	660A	1100A	220A
M2.GMNC(55)4s8p 034001002	55Ah	4s8p	32	440Ah	6,4kWh	14,8V	680A	2200A	440A
M2.GMNC(55)6s5p 034001025	55Ah	6s5p	30	275Ah	6,4kWh	22,2V	680A	1375A	275A
M2.GMNC(60)4s8p 034001054	60Ah	4s8p	32	480Ah	7,0kWh	14,8V	680A	1200A	480A
M2.GMNC(60)8s4p 034001039	60Ah	8s4p	32	240Ah	7,0kWh	29,6V	660A	1200A	240A
M2.GMNC(60)16s2p 034001055	60Ah	16s2p	32	120Ah	7,0kWh	59,2V	360A	600A	120A
M2.GMNC(65)4s8p 034000974	65Ah	4s8p	32	520Ah	7,7kWh	14,9V	680A	680A	480A
M2.GNMC(65)8s4p 034000975	65Ah	8s4p	32	260Ah	7,7kWh	29,8V	660A	680A	260A
M2.GMNC(65)16s2p 034000976	65Ah	16s2p	32	130Ah	7,7kWh	59,5V	360A	390A	130A

Location classes

Temperature	Class A
Humidity	Class A
Vibration	Class A
EMC	Class A
Enclosure	IP6x

Application/Limitation

Ventilation Fans

The capacity and speed of the smoke extraction and ventilation fans for the integrated exhaust duct as mentioned within the safety description are to be submitted for each product certification individually.

Switch Unit

The switch unit with fuses and contactors is excluded from this type approval, individual approval and acceptance test should be carried out as part of the product certification.

Smoke detector

Smoke detector must be installed in the venting duct as described in the safety description.

Fire Suppression System

The battery system shall only be operated with a fire suppression system, either a HI-Fog water mist system or a foam based system. The installation and arrangement shall be performed in accordance with the setup during the propagation tests. The activation of the external fire suppression system is based on the excessive temperature detection line on the battery modules and the smoke detection at the extremity of the duct channel. Failures of the system are to be alerted at the machinery alarm system. Individual approval and acceptance test should be carried out as part of the product certification.

Cooling liquid leakage

Cooling liquid leakage hazards are to be considered individually for each installation.

Approval conditions

For each delivery to DNV GL class the following documentation of the battery system is to be submitted for approval:

Switch unit:

- E120 Electrical datasheet
- E140 Assembly schedules and technical data
- E170 Electrical schematic diagram
- E180 Layout of electrical assembly

Battery system:

- Reference to this type approval certificate
- Copy of the approved Safety description
- I130 Project-specific Battery System Block Diagram
- I150 Battery System Circuit diagram
- E120 Technical specification of the battery system that is subject for product certification
- E170 Electric schematic diagram of the battery system showing internal arrangement of battery modules, battery strings, switch unit, emergency stop and independent safety system
- Z060 Functional description, including
 - o Project-specific overall description of the battery management system
 - o Software and hardware versions of BCU and BMU
 - o interface between the BCU and switching unit
 - o capacity calculations for the gas extract ventilation fan
 - o other relevant information not covered by the safety description.
- Z252 Test program for product certification, including routine tests specified in applicable rules

The Type Approval covers hardware and software listed under Product description. Hard and software versions are declared within the BMS G2 release note (BMSG2 - RN 25042017.docx).

When the type approved software is revised (affecting all future deliveries) DNV GL is to be informed by forwarding updated software version documentation and updated BMS G2 release note. If the changes are judged to affect functionality for which rule requirements apply a new functional type test may be required and the certificate may have to be renewed to identify the new software version.

Product certificate

Each delivery of the application system is to be certified according to Pt.6, Ch.2, Sec. 1. The certification test is to be performed at the manufacturer of the application system before the system is shipped to the yard. After certification, the clause for application software control will be put into force.

Application software control

All changes in software are to be recorded as long as the system is in use on board. Documentation of major changes is to be forwarded to DNV GL for evaluation and approval before implemented on board.

Tests carried out

Type tests according to applicable DNV GL rules and standards as listed below have been carried out. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1, DNVGL-RU-SHIP Pt.4 Ch.8, DNVGL-RU-SHIP Pt.4 Ch.9, DNVGL-CG-0339, DNVGL-CP-0418

Propagation testing acc. DNVGL-RU-SHIP Pt.6 Ch.2 Sec.1 [4.2.2] edition July 2021 (with design option 2: No propagation between modules)

Periodical assessment

The scope of the periodical assessment is to verify that the conditions stipulated for the Type approval are complied with and that no alterations are made to the product design or choice of materials.

The main elements of the assessment are:

- Inspection on factory samples, selected at random from the production line (where practicable)
- Results from Routine Tests (RT) checked (if not available tests according to RT to be carried out)
- Review of type approval documentation
- Review of possible change in design, materials and performance
- Ensuring traceability between manufacturer's product type marking and Type Approval Certificate.

Periodical assessment is to be performed after 2 years and after 3.5 years. A renewal assessment will be performed at renewal of the certificate.

END OF CERTIFICATE