



Certificate no.:
TAE00004Y0

TYPE APPROVAL CERTIFICATE

This is to certify:

that the Li-Ion Battery System

with type designation(s)
ZEN Battery

issued to

Zen AS
Oslo, Norway

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.

Issued at **Høvik** on **2024-09-17**

This Certificate is valid until **2029-09-16**.

for **DNV**

DNV local unit: **East & South Norway CMC**

Approval Engineer: **Uwe Supke**

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.



Form code: TA 251

Revision: 2023-09

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Page 1 of 4

Product description

The liquid cooled ZEN battery is designed to be modular and can be scaled up to 985VDC. The smallest entity of the battery is the battery module. Battery modules shall include 15 cell blocks arranged in series, where each cell block includes two prismatic cells in parallel. Battery modules are casted into a flame-retardant resin acting as a watertight enclosure. Battery modules are waterproof and they are constructed for water immersion. This means that the battery room may be flooded without causing harm to the battery modules.

Battery modules can be connected in series with up to 18 modules to form a string. The voltage of the string depends on the number of modules connected in series. Strings are connected to a power cabinet connecting the battery string with the power receiver (vessel).

The power cabinet includes a service switch, fuses and contactors downstream of the battery string that ensures short circuit and overcurrent protection. Contactors are opened and/or closed by a string BMS, or opened by hardwire from manual emergency stop button or the overcharge protection module (OPM).

The power cabinet includes a String BMS and a Pack BMS for control and monitoring of battery modules within a battery string. The string BMS will perform the standard BMS functions like cell monitoring, SOC and balancing, while the Pack BMS monitors the auxiliaries, and is the interface to the Vessels PMS/IAS through a bus communication. Pack BMS is connected to an HMI for manual control and monitoring of the battery pack.

LFP Prismatic cell	Cell Type A
Rated capacity	271 Ah
Discharge Energy	972 Wh
Limited Charge Voltage	3.65 V
Discharge Cut-off Voltage	2.5 V
Nominal Voltage	3.2 V
Nominal Charge/Discharge Current	81.3 A

Module	Cell Type A
Module has a 2P15S configuration	29.2 kWh (0.3C)
Discharge Energy	54.75 V
Limited Charge Voltage	37.5 V
Discharge Cut-off Voltage	48 V
Nominal Voltage	170 A (0.3C)
Nominal Charge/Discharge Current	

String	Cell Type A
18 Module in series	525 kWh (0.25C)
Discharge Energy	985 V
Limited Charge Voltage	675 V
Discharge Cut-off Voltage	864 V
Nominal Voltage	170 A (0.3C)
Nominal Charge/Discharge Current	

Identification Battery Module

50039-330-147140-XE - Module assembly - LFP 2P15S 0.3C Rev 2

Identification Power Cabinet

50039-330-149550-XE - Power cabinet assembly Rev 2
String BMS Software V3.5.x
Pack BMS Hardware PFC200
Pack BMS Software V1.0.x

Location Classes

Temperature	Class B
Humidity	Class B
Vibration	Class A
EMC	Class A
Enclosure class	Module: IP 68, power cabinet: IP 55

Software update notification

When the type approved software is revised (affecting all future deliveries), DNV is to be informed by forwarding updated software version documentation. 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.

Application/Limitation

1. When installed on a DNV classed ship or offshore unit, the valid DNV class rules for the battery installation must be followed (DNV Pt.6 Ch.2 Sec.1).
2. The piping system, venting the exhaust gases from the rack to open air/safe location, shall be verified onboard in each case. Requirements in DNV Rules Pt.6 Ch.2 Sec.1 shall be fulfilled.
3. The Type Approval covers hardware and software listed under product description.
4. Total flooding fire extinguishing system shall be provided according to DNV Rules for Ships Pt.6 Ch.2 Sec.1.
5. Ambient temperature in battery system space should be maintained in the range 0...+25°C for conformance to continuous load performance.

Product certification:

Each delivery of the application system to be certified according to DNV Pt.6 Ch.2 Sec.1. This includes factory acceptance test to be performed at the manufacturer before the system is delivered to the yard.

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

- Reference to this type approval certificate
- Copy of the Safety description
- (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
- (I030) Project-specific Battery System Block Diagram
- (I020) Project-specific functional description
- (Z060) Functional description, including a project-specific overall description of the battery management system
 - software and hardware versions of components
 - capacity calculations for the gas extract ventilation fan
 - other relevant information not covered by the safety description
- (Z252) Test procedure at manufacturer
- (Z265) Calculation report, documentation of the SOC and SOH calculation

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 are to be forwarded to DNV for evaluation and approval before implemented on board.

Type Approval documentation

Tests carried out

Type tests according to applicable DNV rules and standards as listed below have been carried out.
DNV-CP-0418, DNV RU SHIP Pt.6 Ch.2 Sec.1 (2023-07) and DNV-CG-0339, IEC 62619 and IEC 62620
Propagation test has been passed according to DNV-RU-SHIP Pt. 6 Ch. 2 Sec 1 [4.2.2.1] (2023-07) for cell type A, (design option 1: No propagation between cells with modules equipped with external water from a dedicated cooling system activated by a gas detector).

Marking of product

Manufacturer name, battery system type designation with serial number.

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