Certificate no.:
**TAE0000575**

# TYPE APPROVAL CERTIFICATE

## This is to certify:

**that the Li-Ion Battery System**

with type designation(s)
**Volvo Cube 1 / ESSLR600V138Ah-A**

issued to
**ZEM AS**
**Høvik**, **Norway**

is found to comply with
**DNV rules for classification – Ships, offshore units, and high speed and light craft**

## Application:

**Product approved by this certificate is accepted for installation on all vessels classed by DNV.**

Issued at **Høvik** on **2026-04-09**
This Certificate is valid until **2031-04-08**.
DNV local unit: **East & South Norway CMC**

for **DNV**

Approval Engineer: **Per Henning Hammerstad Møllevold**

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 USD 300 000.

## Product description

The rechargeable Li-Ion battery pack is an integrated system primarily designed for use in dedicated Volvo trucks. The pack contains cell modules, battery management system, voltage, current, temperature measurement, contactors, and CAN network interfaces.

The battery pack is based on 21x700 mm cylindrical lithium-ion cells (INR21700-53G: 3.63 V, 5.3 Ah, 19.239 Wh), with NCA cathode and graphite anode. The battery pack consists of 4680 cells in a 180s26p configuration.

The battery pack consists of six modules within one common housing plus a service box on top. The lower three modules include 832 Li-Ion cells each in 2 times 16s26p configuration. The top three modules include 728 Li-Ion cells each in 2 times 14s26p configuration.

- The Service Box includes Battery System Monitor (BSM), Battery Disconnect Module electronics (BDUe), pre-charge circuitry, fuse and the +/- contactors.
- The BDUe is a measurement device for current and voltage on the power path.
- The BSM is the main Electronic Control Unit (ECU) which supervises and controls the battery pack and communicates with the vehicle/vessel over CAN.
- The Battery Stack is composed of 6 modules incorporating cells and Battery Module Monitor (BMM). BMM is a device which measures temperatures and voltages of cells and runs the balancing operation.

The battery system meets the DNV Pt.6 Ch.2 Sec.1 Non-Propagation Design Option #1, no cell-to-cell propagation.

The table below lists the main specifications of the battery pack:

| **Overview** | **ESSLR600V138Ah-A** |
|---|---|
| Configuration | 180s26P CYC |
| Cell | Samsung SDI INR 21700 – 53G |
| Size | l=792 mm, w=686 mm, h=657 mm |
| Weight | 532 +/- 2.5kg |
| Usable SoC range | 5 – 98 % |
| Nominal capacity | 137.8 Ah |
| Nominal voltage | 653.4 V |
| Voltage range | 500 – 750 V |
| Nominal energy | 90 kWh |
| Discharge current (continuously) | 138 A |
| Charge current (continuously) | 96 A |
| Gravimetric energy density | 169 Wh/kg |
| Cooling system | Water/glycol |
| Flow rate | 10 L/min |

**Battery Management system (BMS)**

The Cube 1 type approval is based on BMU SW Version: C5.0.3
Minor updates will increment the 2nd and 3rd digits marked with “x”: C5.x.x
Major updates will increment the 1st digit, e.g. to: C6.x.x

## Application/Limitation

1. When installed on a ship or offshore unit, the DNV class rules for battery installation must be followed (DNV Pt.6 Ch.2 Sec.1).
2. The Type Approval covers hardware and software listed under Product description.
3. The Type Approval is valid for systems made by production facilities stated under Manufactured by.
4. The BMS’s calculated SOC indicated on the HMI has an accuracy of +/-5%.
5. Liquid cooling failure needs to be tested with the header tank sensor after being installed. A HAT test procedure will be required to be submitted for approval as part of the product certification.

**Product certification:**

Battery systems rated equal or larger than 50kWh shall have a product certificate according to DNV Pt.6 Ch.2 Sec.1 Table 4 for each delivery to DNV classed vessels.
For product certification, at least the following documents should be submitted for approval:
- Reference to this type approval certificate;
- Copy of the approved safety description;
- (E120) Technical specification of the battery system that is subject for product certification;
- (E170) Electrical schematic diagram showing the battery packs, strings, modules with switchgears and control gears, dimensions of bus bars as relevant;
- (I030) Project-specific battery system block diagram;
- (I020) Project-specific functional description;

- Information on software versions applicable for the particular delivery;
- (Z252) Test procedure at manufacturer;
- (Z253) Test procedures for quay and sea trial (Liquid cooling failure test procedure).

**Location classes (DNV-CG-0339)**

| | |
|---|---|
| Temperature class | B |
| Humidity class | B |
| Vibration class | A |
| EMC class | A |
| Enclosure | IP67; IPx9K |

**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.

## Type Approval documentation

## Tests carried out
Tests according to DNV-CP-0418, DNV Rules for Ships Pt.6 Ch.2 Sec.1 (ed. July 2025), DNV-CG-0339

## Marking of product
Manufacturer name, and battery system type designation

## 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.

## Manufactured by:
**Volvo Powertrain AB**, Volvovägen 5, 541 34 Skövde, Sweden.