Certificate no.:
TAE00004VT

TYPE APPROVAL CERTIFICATE

This is to certify:

that the Li-Ion Battery System

with type designation(s)
Battery System HB-M-LFP

issued to
Haf Power Solutions AS
Trondheim, **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 following DNV Rules of July 2023.

Issued at **Høvik** on **2024-10-22**
This Certificate is valid until **2029-10-21**.
DNV local unit: **East & South Norway CMC**

for **DNV**

Approval Engineer: **Georgy Abramenko**

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.

Name and place of manufacture

Haf Power Solutions AS, Trondheim, Norway
ECO Power, Nanjing, China

Product description

Air cooled lithium-ion modular battery based electrical energy storage system (EES) for use in battery-powered or hybrid vessels and offshore units.
The system consists of one or more pack units connected in series to one PDU (power distribution unit) switchbox. Packs of A, B, C types may be configured differently to achieve the system voltage of 1000V.

Each battery pack contains LiFePo4-cell modules (4 to 6 pcs), MMU slave (module management unit), MSD fuse (maintenance service disconnect), HV, LV interfaces and independent temperature protection.

The integrated battery management system (BMS) monitors all the cells and battery pack voltages and the temperatures which can be transmitted to the system control unit via CANBUS.
BMS is designed with master-slave principle. Master (BMS) is provided in PDU and interfacing to slave MMU's arranged in each battery pack, collecting the relevant data from sensors in modules, cells. Master unit calculates all relevant parameters like SOC, SOH and communicates with vessel power management system.

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

Battery system parameters

Type: HB-M-LFP-x-x

System capacity	280 Ah
System voltage range	76.8 – 768 V
System energy	21.504 – 215.04 kWh
Temperature range	-25... 55 °C
Ingress protection	IP67

Type	HB-M-LFP-280		
Pack size	A	B	C
Capacity	280 Ah		
Voltage	76.8 V	153.6 V	172.8 V
Cells configuration	24	48	54
Modules configuration	3x (1p8s)	6x (1p8s)	6x (1p9s)
Energy	21.05 kWh	43.01 kWh	48.38 kWh
Cooling	Natural cooling		

Modules			
Type of cells	Prismatic		
Chemistry	Lithium ion LiFePO4		
Cells manufacturer	Wuhu ETC Battery Limited		
Number and configuration of cells in module	1p8s	1p16s	1p18s
Max voltage	29.2 V	58.4 V	65.7 V
Min voltage	20 V	40 V	45 V
Energy	7.09 kWh	14.43 kWh	16.12 kWh
Cooling	Natural cooling		

Power distribution unit (PDU)

Type:

No. of controllable packs	10
Enclosure	IP67

Battery Management system (BMS)

Functionality of BMS is distributed between the battery modules BMS (MMU), and master BMS unit.

MMU type: JKY30310-M36
MMU firmware: 50.0.233.1.x
Master BMS type: JKY00352
Master BMS firmware: 50.0.231.205

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 listed under Place of Manufacture.
4. Independent overcharge protection is provided with Fireline temperature sensing strap in the packs, which needs to be controlled by external independent safety device/ PLC, handling the disconnection of the battery system when Fireline is melted.

Type Approval documentation

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;
- (I200) Documentation for product certification of independent safety device/ PLC handling the disconnection of system upon melting of Fireline. System to be designed according to DNV Pt.6 Ch.2 Sec.1 4.10.3 Independent Overcharge Protection.

Location classes (DNV-CG-0339)
Temperature Class C
Humidity Class B
Vibration Class A
EMC Class A
Enclosure class IP67

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, Rules for Ships Pt.6 Ch.2 Sec.1 (ed. July 2023), 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.

END OF CERTIFICATE