Certificate No:
TAE00004TA

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Li-Ion Battery System

with type designation(s)
AKASYSTEM 9 AKM 150 CYC

Issued to
BorgWarner Akasol GmbH
Darmstadt, Hessen, Germany

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 **2023-10-25**
This Certificate is valid until **2028-10-24**.
DNV local unit: **Augsburg**

Approval Engineer: **Andreas Andrecht**

for **DNV**

Oddvar Deinboll
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

The AKASYSTEM 9 AKM 150 CYC battery contain lithium-ion cells, made typically of lithium-ion nickel-manganese-cobalt oxide cell chemistry (Li-Ion NMC). The cell temperatures and voltages are measured by a monitoring unit, called cell supervising circuit (CSC). The 9 AKM 150 CYC battery pack is a serial connection of nine modules. All modules are located inside the battery tray, as well as the removable contactor box containing electrical components such as controller, contactors, sensors and fuse. The tray has an inlet and an outlet connector for coolant fluid. The whole pack has one HV and one LV connector and is operated by a controlling device, called BMU.

AKASYSTEM 9 AKM 150 CYC Mechanical Data	
Coolant	Liquid
Liquid coolant pressure (max.)	1.1 bar
Typical coolant pressure drop (Water/glycol = 50/50)	230 mbar @600l/h, nom. 25 °C
Operating cell temperature range	-20° to 55 °C
Recommended operating cell temperature range	22°C to 28 °C
Protection class	IP67, IP6K9K
Weight (incl. RCB and brackets)	~ 598 kg
Outer dimensions (L x W x H in mm) incl. mounting brackets	1,890 x 726 x 310

AKASYSTEM 9 AKM 150 CYC Specifications		**Value**	**Unit**
Number of serial modules per tray		9	[-]
Number of serial cells per module		20	[-]
Number of parallel cells per module		30	[-]
Nominal Voltage		665	V
Max. Voltage		759,6	V
Min. Voltage		468	V
Nominal Capacity		148	Ah
Peak Discharge Current (10s)		150	A
Peak Charge Current (10s)		150	A
Energy		98	kWh
Operating temperature range	Min.	-20	°C
	Max.	55	°C

Specifications of Cell (Li-Ion NMC)		**Value**	**Unit**
Nominal Voltage		3,69	V
Max. Voltage		4,2	V
Min. Voltage		2,5	V
Rated Energy @ 0,2 C		18,2	Ah
Operating Temperature	Min.	-20	°C
	Max.	55	°C

The battery cell has a built-in feature (CID) that will, in case of overcurrent, overcharge or when the temperature exceeds the safety limits, electrically disconnect the cell. This provides a second shut down path independent from the electronic control system.

Type designation

AKASYSTEM 9 AKM 150 CYC
Part Number P102040200010

Software version

S XX XX 05.XX.XXX 27-00162

Location Classes

Temperature Class	A
Humidity Class	B
Vibration Class	A
EMC Class	A
Enclosure Class	IP67

Application/Limitation

Water Ingress Detection
The water ingress detection system must be present and installed for the product certification at manufactures workshop. System design declared within document 3030316TEN0028 V1.0 dated 2023-10-11. If no product certification is required, the water ingress detection system has to be installed before commissioning. The certificate holder is responsible for the correct installation and function of the water ingress detection system.

Battery room ventilation
The battery room ventilation shall comply with the requirements as given for design option 1 without integrated ventilation duct.

Additional Fuse
The minus pole must be protected externally against short-circuits by fuse type EVPack MEV100A150-4Y or fuse with equivalent characteristic described in 3030316TEN0003 Overload and Short circuit Protection Concept. Junction box mandatory for DNV installations cable length < 3m.

Multi String Pack Controller
Multipack controller not covered by this type approval certificate. DNV Type approved hardware must be used.

Automatic reconnection
The automatic reconnection of the battery system performed by the failure reset has to be inhibited by system integrator and tested on system level.

Approval conditions

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

Battery system
- Reference to this type approval certificate
- Copy of the safety description
- I130 Project-specific Battery System Block 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 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 program for product certification, including routine tests specified in applicable rules

The Type Approval covers hardware and software listed under product description.

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.

Product certificate
When installed on a DNV classed ship or offshore unit 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. The independent overcharge protection is CID based on cell level and is not required to be tested during product certification. For non DNV classed installations the product certification will be not mandatory.

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 for the battery system according to applicable DNV rules and standards as listed below have been carried out. DNV-RU-SHIP Pt.6 Ch.2 Sec.1 (Edition 2022-07), DNV-RU-SHIP Pt.4 Ch.8, DNV-RU-SHIP Pt.4 Ch.9, DNV-CG-0339 (Edition: 2019-12), DNV-CP-0418 (Edition: 2020-07).

The Propagation test has been passed in accordance to DNV-RU-SHIP Pt.6 Ch.2 Sec.1 design option 1 no propagation between cells.

Marking of product

The products to be marked with:

- manufacturer name
- model name
- serial number
- power supply ratings

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