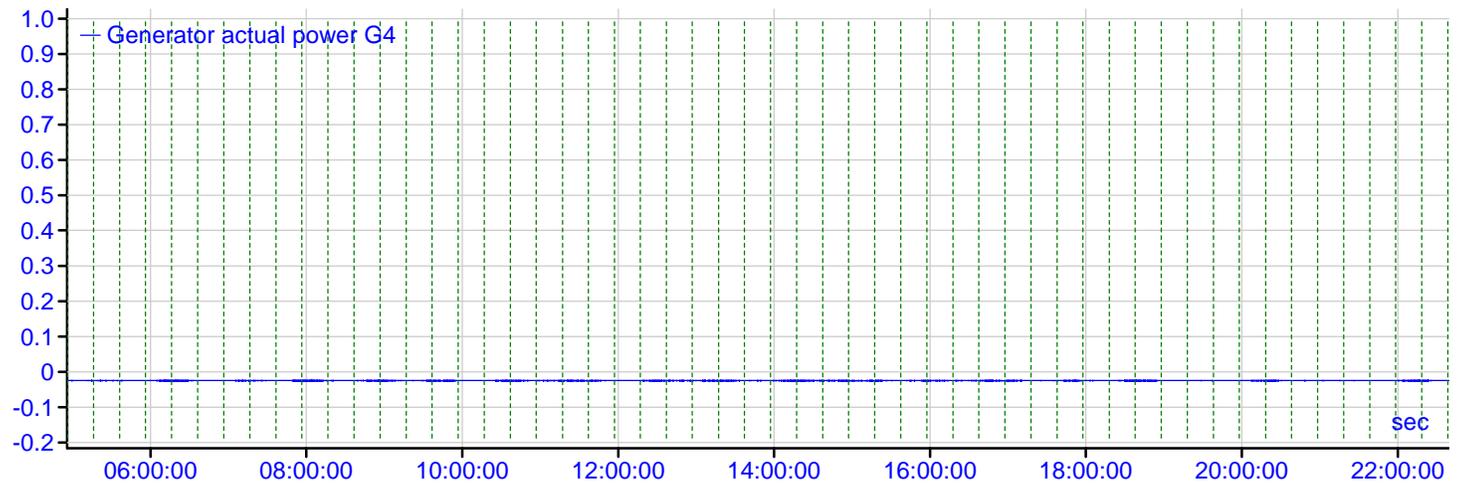
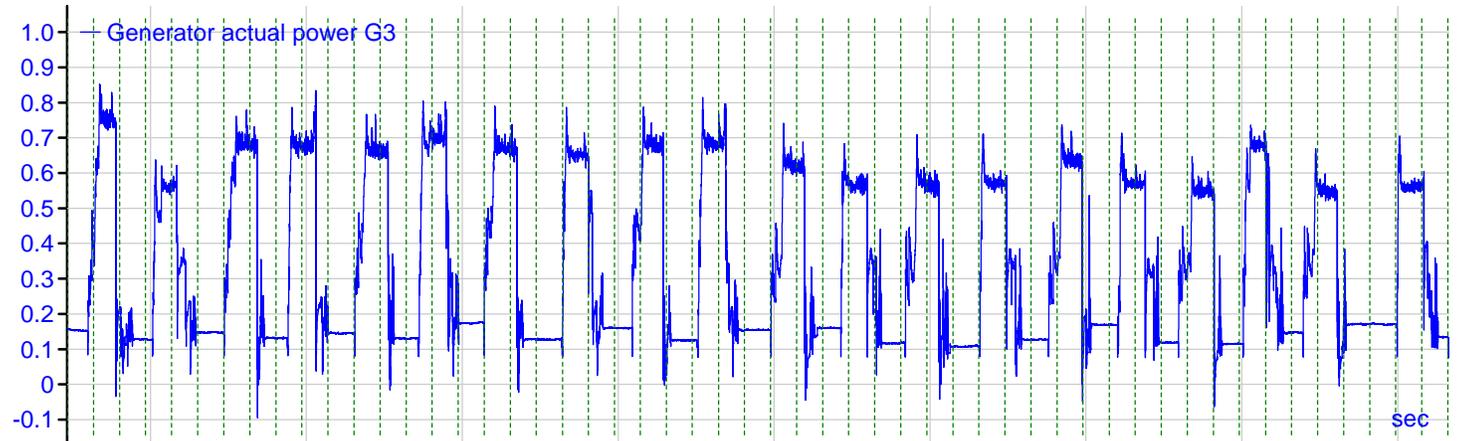
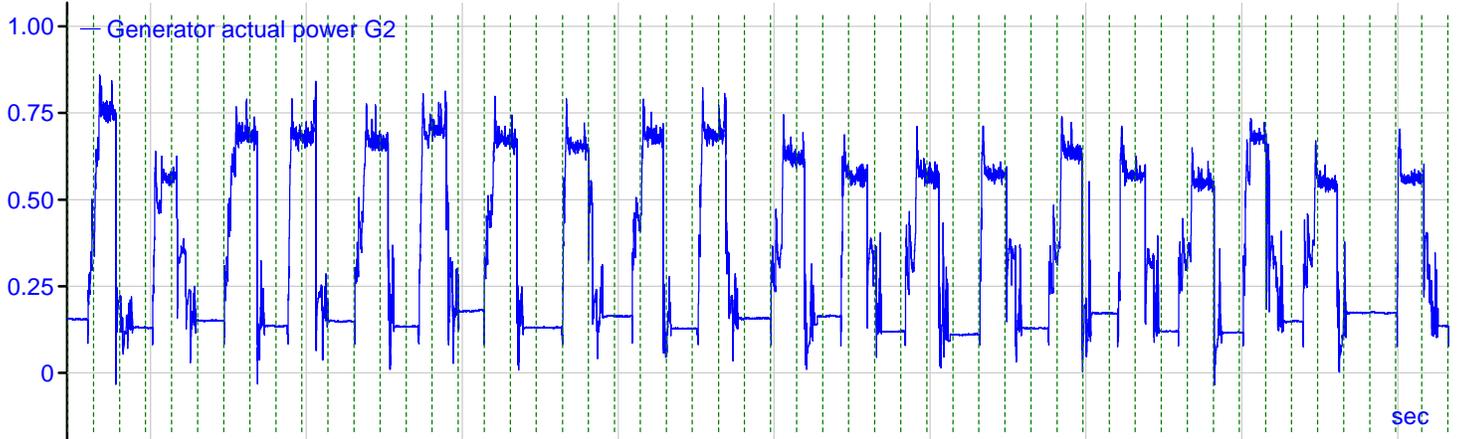
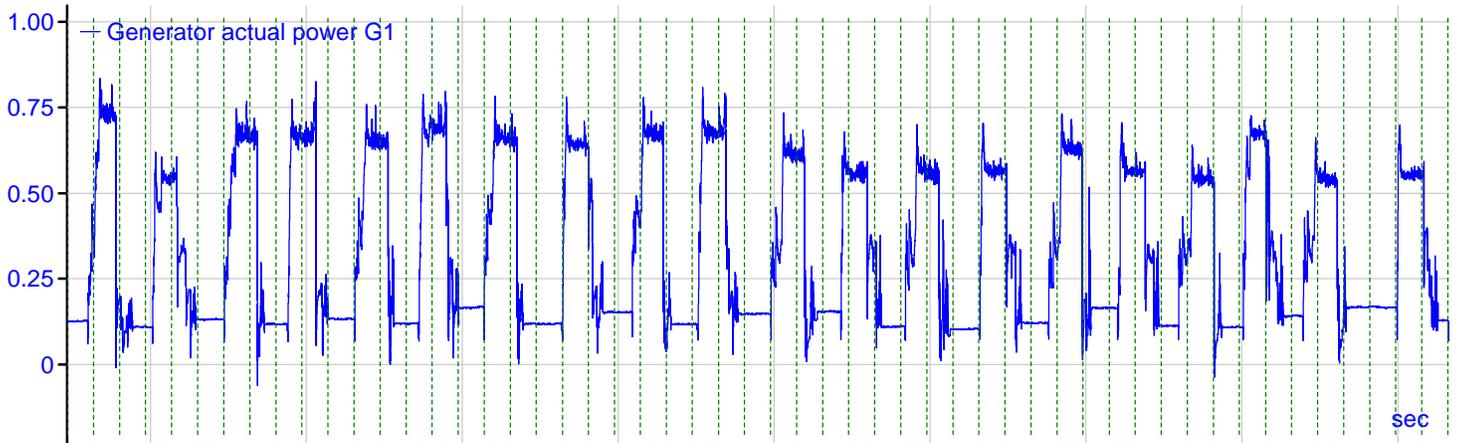
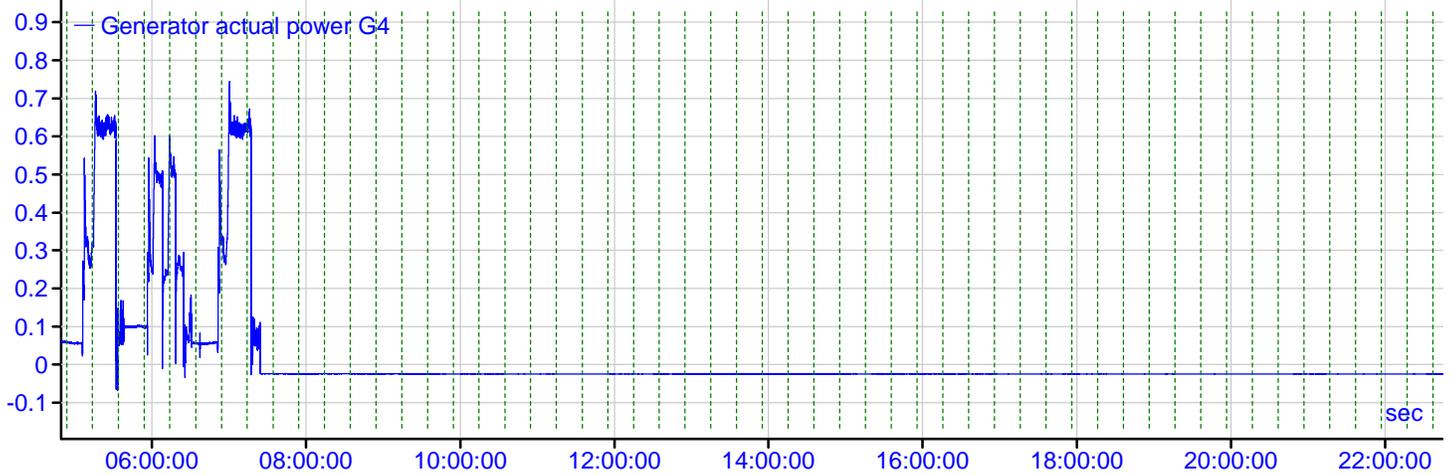
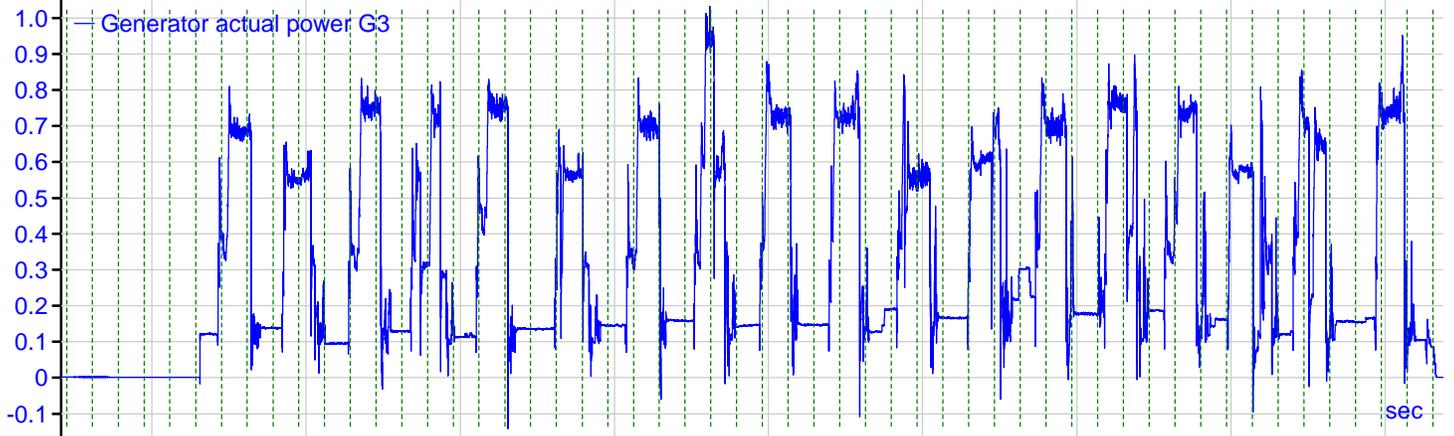
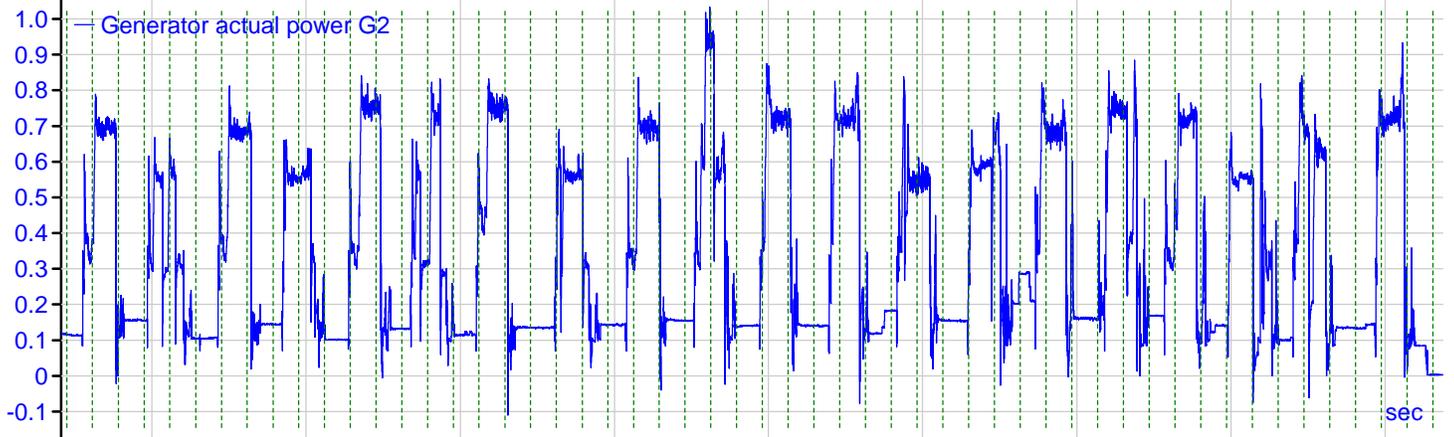
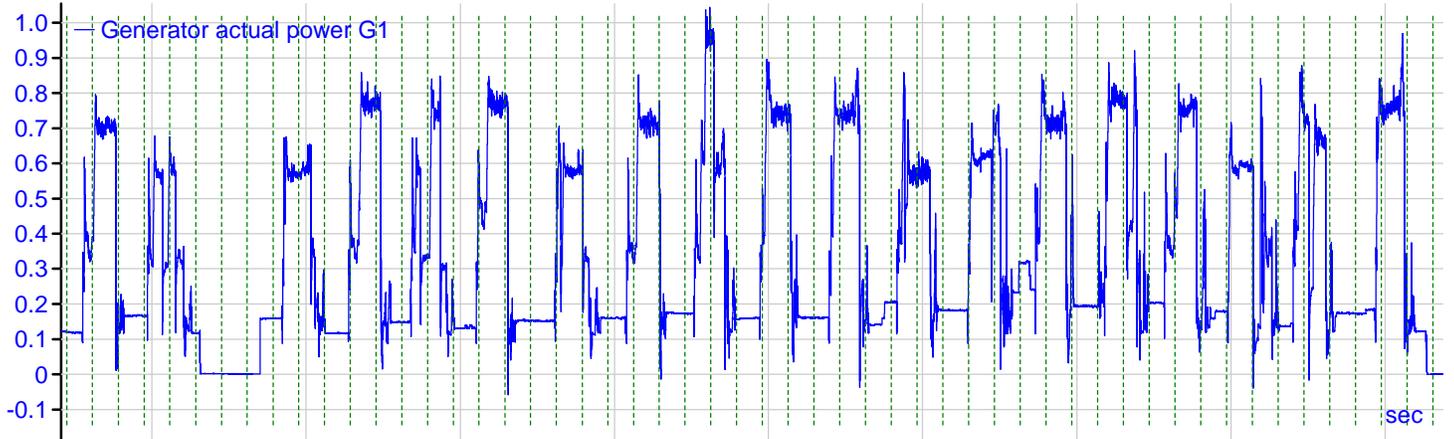


Appendix A

TACOMA Datalog





Appendix B

Spear Power Systems Brochure (SMAR-11N and SMAR-3T)

PBES Power 65 Brochure

PBES DNV Type Approval Certificate

Corvus Orca Energy Brochure

Corvus DNV Type Approval Certificate

Leclanché TiRack Brochure (partial)

EP Systems EPiC-t32 Brochure



Trident[®] Solutions

OPTIMIZE YOUR APPLICATION WITH THE MOST VERSATILE SERIES OF MARINE ENERGY STORAGE

Spear Power Systems' Trident[®] family of marine battery solutions offer end users the ability to integrate the optimal lithium-ion chemistry for their application while leveraging the same BMS control interface. Trident[®] energy storage systems lead the charge in performance, safety, reliability, flexibility, and value.

With over a decade of experience developing next generation lithium-ion battery solutions, including the first large format lithium-ion cell used in commercial marine propulsion applications, Spear Power Systems delivers unmatched value to ship builders, owners, operators, and designers. Spear's solutions are based on knowledge from designing and manufacturing lithium-ion packs for markets that demand quality and performance.

As a chemistry and cell agnostic integrator, Spear selects the most appropriate cell for a given application, balancing performance, cost, and quality.

TRIDENT[®] ADVANTAGES

- + **Exceptional Value** – cost competitive
- + **Industry-Leading Energy Density** – 20% system-level energy-density improvement compared to competition
- + **Industry-Leading Power Density** – reduce weight with high power cells capable of 30C pulse discharge rates
- + **Safety Oriented** – thermal propagation prevention without the need for active liquid cooling, multi-level BMS protection, high voltage / current / temperature resolution, redundant safety features
- + **Sophisticated Thermal Management** – keeps cells cool and extends battery life, all systems support forced air or liquid cooling
- + **Best-In-Class Cell Technologies** – safety and performance starts with a high-quality cell, flexible BMS configuration allows the customer to pick the optimal lithium-ion chemistry for their application
- + **Scalable Architecture** – technology supports voltages up to 1250 VDC and installations beyond 10 MWh
- + **Longer Life** – variety of solutions that support 5,000 to over 20,000 cycles at high depths of discharge





Trident[®] Solutions

ROBUST, RELIABLE SOLUTIONS FOR EVERY APPLICATION

Trident[®] modules integrate Spear's proven SMOD technology and is designed with a rugged marine-grade enclosure to protect it from the harsh environment. All Trident[®] systems are feature propagation prevention and are monitored with Spear's internally developed battery management system (BMS), ensuring a high degree of safety and accuracy.

Technical Specifications

Trident [®] System	SMAR-11N	SMAR-3T	SMAR-2P	SMAR-6A	SMAR-2F
Defining Features	Industry-Leading Energy Density	Fast Charge / Industry-Leading Cycle Life	High Power Density	High Power / Fast Charge / Long Cycle Life	High Power
Cell Chemistry	NMC	LTO	NMC	NANO	LFP
Embedded Energy	11.3 kWh	3.4 kWh	2.7 kWh	6.2 kWh	2.4 kWh
Nominal Capacity	128 Ah	65 Ah	30 Ah	70 Ah	39 Ah
Maximum Continuous Discharge Rate	2.0 C	5.0 C	20.0 C	8.0 C	6.0 C
Pulse Discharge Rate	4.0 C	8.0 C	30.0 C	15.0 C	20.0 C
Maximum Continuous Charge Rate	2.0 C	5.0 C	3.0 C	4.0 C	3.0 C
Energy Density <i>(system-level)</i>	91 Wh/L	34 Wh/L	38 Wh/L	61 Wh/L	34 Wh/L
Specific Energy <i>(system-level)</i>	108 Wh/kg	49 Wh/kg	60 Wh/kg	88 Wh/kg	52 Wh/kg
Specific Power <i>(system-level)</i>	215 W/kg	247 W/kg	1196 W/kg	703 W/kg	309 W/kg
System Scalability	2.0 kWh — 10 MWh+				
System Voltage Range	48 VDC — 1250 VDC				
Battery Management System	Spear Scalable Battery Management System (SBMS)				
Cooling Method	Forced Air / Liquid Cooling				



PBES Specification Sheet

System Specifications for the PBES Power & Energy Systems

PBES Power and Energy Industrial Lithium Batteries:

Power 65 (P65) is designed for high discharge power applications requiring high C-rates and faster cycling, the system provides 15,000 charge/discharge cycles at 80% DoD.

ROI focussed Energy 100 (E100) has been designed for applications requiring lower discharge rates and greater energy density. A 35% decrease in cost and weight provides the end user with a faster path to ROI and decreased footprint and weight.

Both systems use the same PBES form factor and are backed by industry leading safety, performance, and recycling systems. CellCool™, ThermalStop™ and CellSwap™ provide ideal operating conditions, thermal runaway prevention and best industry value.

PBES batteries are manufactured in Norway and exceed NMA flag approval and DNV Type Approval criteria (DNV Type Approval pending).

PBES proudly uses the highest quality lithium-ion NMC cells from XALT Energy in USA.



General PBES Features	PBES System Specifications
BMS (Battery Management System)	MegaWatt ++
IMS (Information Management System)	API Interface
Engineered Design Life	5/10 year
CellCool™ Liquid Cooling	Yes - Patent Pending
Cell Partner	XALT Energy (USA)
TCP Ultra Fast Internal Comms	Yes
Thermal-Stop™ Thermal Runaway Protection	Yes - Patent Pending
E-Vent™ Safety Venting System	Yes - Patent Pending
Operating Temperature (active heating/cooling)	15°C to 30°C
Series Configurable	Yes
OnPoint™ Remote Active Monitoring	Yes
OnPoint™ Remote Active Programming	Yes
Parallel Configurable (capacity scalable)	Unlimited

*Specifications subject to change



Plan B Energy Storage

Locations: Vancouver • Trondheim • Barcelona • Copenhagen
www.pbes.com • info@pbes.com



PBES Specification Sheet

System Specifications for the PBES Power & Energy Systems

Single Module (BBU)	Power 65	Energy 100
C Rate RMS (Continuous)	3C	1.4C
Cycle Life @ 80% DoD	15000 cycles	TBF
Cell Chemistry	NMC	NMC
Dimensions	L 580mm, H 380mm, W 320mm	L 580mm, H 380mm, W 320mm
Weight	90kg	90kg
Energy	6.5kWh	10kWh
Capacity	75Ah	112Ah
Voltage Range	77-100VDC	77-100VDC
Nominal Voltage	88.8VDC	88.8VDC
RMS Continuous Current	225A	160A
Max Discharge Current	450A	336A
Max Charge Current	225A	112A
Connectors	IP67	IP67
Terminal Isolation at Module	Contactors	Contactors
Thermal-Stop™ Thermal Runaway Protection	Yes	Yes
Self Discharge Rate/month	<2%	<2%
Internal resistance	17mΩ	20mΩ
Efficiency (at 1C)	>98%	>97%
Electrical Isolation	Open circuit when not in operation	Open circuit when not in operation
Communication interface	UDP	UDP

Series String (1000V)	Power 65	Energy 100
Dimensions (including racking, venting and lifting apparatus)	W 896mm, H 2550mm, D 632mm	W 896mm, H 2550mm, D 632mm
Weight 10BBUs +1 MBU	950 kg	950 kg
Energy	65kWh	100kWh
Capacity	75Ah	112Ah
Voltage Range	770-1000VDC	770-1000VDC
Nominal Voltage	888VDC	888VDC
RMS Continuous Current	225A	160A
Max Discharge Current	450A	336A
Max Charge Current	225A	112A
Internal Resistance	180mΩ	200mΩ
Electrical Isolation at DC Bus	Breaker	Breaker
Integrated Racking System	Included	Included
Communication to Higher Level System	Modbus/TCP	Modbus/TCP

*Specifications subject to change



Plan B Energy Storage

Locations: Vancouver • Trondheim • Barcelona • Copenhagen
www.pb.es.com • info@pb.es.com

TYPE APPROVAL CERTIFICATE

This is to certify:**That the Battery (Accumulator)**

with type designation(s)

Basic Battery Unit (BBU), Main Battery Unit (MBU), Parallel Battery Unit (PBU)

Issued to

PBES Ltd.**Vancouver BC, Canada**

is found to comply with

DNV GL 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 **Høvik** on **2017-10-12**This Certificate is valid until **2022-10-11**.DNV GL local station: **Trondheim**for **DNV GL**Approval Engineer: **Sverre Eriksen**

.....

Andreas Kristoffersen
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.



Product description

Liquid cooled lithium-ion battery based energy storage system (EES) for use in battery-powered or hybrid vessels and off-shore units.

The system consists of basic battery units (BBU) connected in series to form a string and achieve the needed system voltage. The string is controlled by a main battery unit (MBU) that includes a breaker. The strings can be installed in parallel in order to provide the required energy capacity. The parallel strings are controlled by a separate controller, Parallel Battery Unit (PBU).

The liquid cooled [CellCool™] BBU is designed with thermal runaway protection [Thermal-Stop™] and the battery units BBU and MBU are housed within a dedicated racking system with an integrated off-gas exhaust duct [E-Vent™].

Battery Module Unit

Type: BBU
Cell Type: XALT 75 HP
Chemistry: Lithium ion NMC
Number of cells: 24
Cell configuration: 1p24s
Max Voltage: 100.8 V
Min Voltage: 76.8 V
Capacity: 75 Ah
Energy: 6,5 kWh
Cooling: Liquid

Main Battery Unit

Type: MBU

Parallel Battery Unit

Type: PBU

String

Max Number of modules: 10
Max Voltage: 1008 V
Max Energy: 65 kWh

Battery Management system

Functionality of BMS is distributed between BBU and MBU.

The software is identified by the following versions:

BBU sw: 0.1.x.x

MBU sw: 0.1.x.x

Application/Limitation

The type approval covers hardware and software listed under Product description.

Software versions

Software versions are declared in PBES document TN-0018. BMS software version is a common identifier for software in BBU, MBU and PBU. Identifiers in the software version denoted as "x" may vary and are covered by the type approval.

Modifications to software resulting in a new version (identified by the 2nd number in the version string) shall be informed to DNV GL by forwarding updated software version documentation and updated version of TN-0018. Such modifications may require witnessing of type testing and will require that the certificate is renewed to identify the new software version.

Ventilation fans

The capacity and speed of the ventilation fans for the integrated exhaust duct are to be submitted for each product certification individually.

Cable protection

The power cables between the battery modules must be overload protected by the charger. Documentation of the chargers cable protection functionality are to be submitted for each product certification individually.

Environmental temperature control

To avoid condensation inside the liquid cooled battery modules the modules must be located in an environmental controlled room where the temperature and /or humidity of the room is controlled so that the room temperature is at all time above the dewpoint temperature of the cooling water.

Alarms

All alarms required by the rules shall be "latching" (i.e. use of non-latching warnings/alarms shall be limited to abnormal conditions which are not safety-related and which are not required alarmed).

Network storm on external network

External network storm testing shall be done onboard after the MBUs/PBUs are commissioned and connected to the external system.

Documentation for product certification

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

- Reference to this type approval certificate
- Copy of the approved 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 and emergency stop
- Z060 Functional description, including
 - o Project-specific overall description of the battery management system
 - o Software and hardware versions of BBU, MBU and PBU
 - o capacity calculations for the gas extract ventilation fan
 - o description of the cable protection (overload) functionality of the charger
 - o other relevant information not covered by the safety description.
- Z252 Test program for product certification, including routine tests specified in applicable rules

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, all changes in software/configuration 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.

Type Approval documentation

Tests carried out

Tests according to DNVGL-CP-0418, DNVGL-CG-0339

Marking of product

PBES-BBU
PBES-MBU
PBES-PBU

Periodical assessment



Job Id: **262.1-023774-1**
Certificate No: **TAE0000271**

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



The Scandlines M/V Berlin – the latest addition to the world's largest fleet of hybrid ferries and the 6th Scandlines ferry powered by a Corvus ESS

Orca ESS Solutions

THE WORLD'S MOST ADVANCED MARITIME ESS (ENERGY STORAGE SYSTEMS). Designed and built specifically for the maritime industry, the Orca ESS product line from Corvus Energy represents the future of maritime ESS solutions. Corvus combined its industry leading research & development capabilities and knowledge gained from having the largest global installed base of ESS solutions, to build the industry's safest, most reliable, highest-performing and most cost-effective maritime ESS product line, which includes: **Orca Energy** and Orca Power.

Orca Energy

Orca Energy is ideal for applications that are primarily energy capacity driven, moving large amounts of energy at an inexpensive lifetime cost per kWh. Specifically designed to meet the operational requirements of:

HYBRID FERRIES	CRUISE SHIPS
ALL-ELECTRIC FERRIES	SUPER YACHTS
TUG BOATS	CARGO VESSELS



Air Cooled Module



Air Cooled Pack



Liquid Cooled Pack

THE ORCA ENERGY DIFFERENCE

- Price per kWh reduced by 50%
- Highest C-Rates in the industry - up to a 6C peak C-rate
- Increased cycle life - lowering total system cost and extending ESS Lifespan
- Unparalleled energy density - 50% volume & 35% weight reductions
- Connection & commissioning time reduced by 80%
- Enhanced EMI immunity design for maritime environments
- Economical upfront & through-life costs = lower total cost of ownership
- Power connections contained within rack - no manual connections, enhanced reliability, increased safety
- Designed for pack voltages up to 1200VDC
- Scalable beyond 10MWh
- Industry-proven 4th generation BMS
- Easily monitored through the Watchman™ ESS Advisory Portal

ORCA SAFETY INNOVATIONS

Cell-level Thermal Runaway (TR) Isolation

- True cell-level thermal runaway isolation - TR does not propagate to neighbouring cells
- Isolation NOT dependant on active cooling
- Exceeds Class and Flag standards

TR Gas venting

- Integrated thermal runaway gas exhaust system
- Easily vented to external atmosphere rather than the battery room
- Additional fire suppression system not required



Quality
ISO 9001
SAI GLOBAL



The Norled Ampere – powered by a Corvus ESS; the world's first all-electric car and passenger ferry.

Technical Specifications*

PERFORMANCE SPECIFICATIONS	
C-Rate – Peak	6C
OPERATIONAL SPECIFICATIONS	
Pack Sizing	50-1200V 5.7-137kWh
1100V STANDARD BATTERY PACK EXAMPLE ¹	
Energy	125 kWh
Voltage	Maximum: 1100 VDC Nominal: 980 VDC Minimum: 870 VDC
Cooling	Forced Air / Liquid Cooling
Dimensions (vertical arrangement)	Height: 2200 mm Width: 870 mm Depth: 710 mm
Dimensions (horizontal arrangement)	Height: 1220 mm Width: 1740 mm Depth: 710 mm
Weight	1550 kg (3420 lb)
GENERAL SPECIFICATIONS	
EMC	IEC 61000-4, CISPR16-1, 2, IEC60945-9
Ingress Protection	System: IP44 Module: IP56 (IP67 optional)
Vibration & Shock	UNT 38.3, DNV 2.4, IEC 60068-2-6
Class compliance	DNV-GL, Lloyds Register, Bureau Veritas, ABS
SAFETY SPECIFICATIONS	
Voltage Isolation	7.2 kV (IEC 60947-2)
Thermal runaway anti-propagation	Cell-level; DNV-GL Pt.6 Ch.2, NMA 2016 circular
Fire suppression recommended	Per SOLAS (machinery space)
Disconnect circuit	Hardware-based fail-safe for over-temperature, over-voltage
Maximum current parameter	Updated 2x per second
Faults communicated	Over-voltage, under-voltage, over-temperature
Short circuit protection	Fuses included
Disconnect switchgear rating	Full load
Emergency stop circuit	Hard-wired
Ground fault detection	Integrated

* Subject to change without notice ¹ Values shown are for reference only and should not be used for system design. Please contact Corvus Energy for complete system design solutions.

CONTACT Toll Free: +1 (888) 390-7239 | sales@corvusenergy.com || www.corvusenergy.com

HEAD OFFICE #220-13155 Delf Place, Richmond, BC V6V 2A2, Canada || NORWAY Nagelgården 6, 5004 Bergen | +47 918 25 618 | sales@corvusenergy.com

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Battery (Accumulator)

with type designation(s)
ORCA Energy

Issued to

Corvus Energy Inc.
Richmond BC, Canada

is found to comply with
DNV GL 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 **Høvik** on **2017-08-14**

This Certificate is valid until **2022-08-13**.

DNV GL local station: **Vancouver**

for **DNV GL**

Approval Engineer: **Marta Alonso Pontes**

.....
Andreas Kristoffersen
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.



Name and place of manufacture

Corvus Energy
Richmond BC
Canada

Product description

Air cooled lithium-ion battery based energy storage system (EES) for use in battery-powered or hybrid vessels and off-shore units.

The system consists of battery modules connected in series to form a pack and achieve the required system voltage. Packs are installed in parallel in order to provide the required energy capacity. Each battery module contains a module control board (MCB) which monitors and communicates voltage, temperature and diagnostic information to the pack controller. The pack controller consists of pack disconnection module (PDM) and master control module (MCM). PDM is the electrical interface between the load and the battery pack. The MCM communicates with the pack modules, other packs, and external systems.

The battery modules, PDM, MCM and all other pack components are housed within a dedicated racking systems which provides: all module and pack electrical interconnection, pack communication, module cooling, and an integrated thermal runaway exhaust duct.

Module including cells and MCB

Type: ME1(G)-(VVV)V-AR*
Chemistry: Lithium ion NMC
Number of cells: 24
Cell configuration: 2P12S
Max Voltage: 50 V
Min Voltage: 36 V
Capacity: 128 Ah
Energy: 5,7 kWh
Cooling: Forced air

MCM

Type: MCM10(G)-(EE)*

PDM

Type: PDM100-(AAA)A-(PS)-(F)-(RR)R-(BS)*

Pack

Type: E(NN)(VVV)(C)-AR-(EE)-(PS)-ST-(Core)*
Max No. of modules: 24
Max Voltage: 1200V
Max Energy: 137 kWh

* The values in parenthesis may vary from one configuration to another. Refer to CORVUS document "Configurations for DNVGL TAC Rev2" dated 18 July 2017 for possible configurations.

Battery Management system

Functionality of BMS is distributed between MCB, MCM and PDM. Independent overtemperature protection according to DNV GL Pt.6 Ch.2 Sec.1 [4.1.5.2] is arranged as hardwired signal tripping high voltage interlock loop (HVIL).

The software is identified by the following versions:

Modules

SW: v1.3.2 Build# 359

MCM

SW: v.1.3.18 Build # 449

PDM

SW: v1.3.9 Build#338

Application/Limitation

1. When installed on a ship or offshore unit, the DNV GL class rules for battery installation must be followed (DNV GL 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 GL rules Pt.6 Ch.2 Sec.1 shall be fulfilled.
3. Communication interface between battery arrays / banks is not covered by this Type Approval and if installed it shall be approved and tested on case by case basis
4. The Type Approval covers hardware and software listed under Product description
5. The Type Approval is valid for systems made by production facilities listed under Place of Manufacture

Product certification:

A DNV GL product certificate according to DNV GL Pt.6 Ch.2 Sec.1 Table 2 is required for each delivery. The following documents shall 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
- (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

Location classes (DNVGL-CG-0339)

Temperature	Class A
Humidity	Class B
Vibration	Class A
EMC	Class A
Enclosure	IP44

Software update notification

When the type approved software is revised (affecting all future deliveries) DNV GL 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 DNVGL-CP-0418, DNVGL-CG-0339 and pack level safety function tests, DOC#: 1009814 rev.C

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



Job Id: **262.1-023629-1**
Certificate No: **TAE000026N**

- 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

Lithium-titanate – technology of a new standard

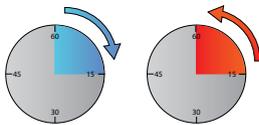
Benefit from unprecedented cell qualities

The heart of any storage device is the cell. Its quality determines the performance of the entire storage system. Cells provided with a lithium-titanate anode are vastly superior to conventional lithium-ions with regard to capacity, service life and load cycles.



15,000 full cycles

With 15,000 charging and discharging cycles the lithium-titanate cell LecCell is particularly suitable for long-term investment and low-maintenance storage systems. The costs for maintenance and exchange are minimal and shorten the return on investment period.



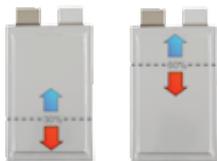
Permanent charging/discharging rate of up to 4C

The quality of the cell permits a stable current of 4C. Thus a cell is charged or discharged within 15 min.



100% DoD (= Depth of Discharge)

The possible Depth of Discharge of LecCell of 100% considerably increases the efficiency of the storage system. The depth of discharge persists over the 15,000 charge/discharge life of the cells.



Stable operating range on any SOC level

The service life of the cell is not influenced by the operation of the cell in a specific SOC (= State Of Charge) range. Whether primarily in a range of 30% SOC or 60% SOC: The service life is entirely independent of the SOC.



Water-based cell manufacturing

As the only manufacturer worldwide Leclanché avoids using ecologically damaging solvents in electrode manufacturing and using water based method. This method is environmentally friendly and prolongs the service life of the cell.

- Wide temperature range for operating the cell
- CE and UN 38.8 tested by TÜV Rheinland
- Individual ID for each cell for tracking the manufacturing process
- Continued internal and external tests

Innovative Technology – quantifiable added value in the field

Profit from our sound partnership with ads-tec

The heart of any storage device is the cell. Its quality determines the performance of the entire storage system. Cells provided with a lithium-titanate anode are vastly superior to conventional lithium-ions with regard to capacity, service life and load cycles.

➤ Flexibility

Leclanché energy storage systems are individually designed, developed and produced according to the customers' requirements. Depending on the specific demand and application alternative cell technologies are used. The integration of the storage system into existing systems is possible without problems owing to the use of prevailing industry

➤ 100 % depth of development – the expertise in detail

- Development of everything from electronics, mechanics and software to complete systems takes place in-house
- Years of research and development work lead to special results in important points such as cell bonding and cooling
- Multi-stage and redundant monitoring equipment ensures safe shutdown and monitored operation on module and system level

➤ Final assembly, logistics and service Under one roof

- Based on highly integrated, IT-driven processes, material flow, final assembly, tests and services take place in a modern and optimised infrastructure
- Key process steps of module assembly take place on automation lines developed by ads-tec for this purposed
- Final assembly and testing are monitored and documented with the aid of » in-line « measurement methods and processes



- Flexible and demand-based warranty for up to 10 years
- 19" industry standard mounting
- International certifications
- In-house laboratory and testing facilities
- Free from maintenance
- Quality "Made in Germany"

Example of product: TiRack 63

Unbeatable facts of technology

Security	Embedded String-Controller External / internal interfaces Protokoll ads-tec	Integrated Ethernet / CAN Master or slave
String configuration	String format Number of battery modules connected in series Number of string controllers per triple rack Number of string controllers per double rack Number of string shutoff modules »bipolar«	19" triple rack 15 1 - 1
Connection values	Battery voltage »empty« Battery voltage »full«	510V DC 810V DC
Currents	Operating current (up to 2C charging / 2C discharging) Maximum string current	180A 300A
Battery system	Cell chemistry Cell capacity Nominal system capacity Specified cycles 1C/1C @23°C at 100% DOD Expected calendar lifespan	Lithium-titanate 30Ah 63kWh 15.000 20 years
Environmental conditions	Temperature range (long life < 2C) Protection class Humidity	10 to 30 °C IP20 < 90%, non-condensing
Guarantee	Limitation period for claims due to defects	24 months
Function and durability	In combination with a Big-LinX service contract	Up to 10 years
Standards	EMV: EN 61000-6-2:2006; EN 61000-6-3:2007 + A1:2011; EN 61000-6-4:2007 + A1:2011; EN 55024:2010; EN 55022:2010; EN 61000-4-2:2009; EN 61000-4-3:2006 + A1:2008 + A2:2010; EN 61000-4-4:2004 + A1:2010; EN 61000-4-5:2006; EN 61000-4-6:2009; EN 61000-4-11:2004; EN 55016-2-1:2009 + A1:2011; EN 55016-2-3:2010 + A1:2010 <hr/> Safety (functional and electrical): EN 61010-1:2010; EN 50272-2:2001 <hr/> Transport: UN38.3 Transport directive for lithium batteries <hr/> Isolation and fire protection: DIN EN 60664-1, VDE 0110-1, DIN VDE 0298-4, VDE 0471 DIN EN 60695-11-10 und -20	

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EPiC t32 Liquid Cooled Lithium Titanate Battery



Features

- Integrated liquid cooling system
- Scalable in series and parallel
- Lightweight (75 Wh/kg)
- Compact (79 Wh/l)
- High power (1,000W/l)
- 15,000+ Cycles (100% DOD)
- Isolated CANbus interface
- Isolated discrete control and sense I/O

Specifications

Electrical

Voltage @ Charge:	31 - 32 V
Nominal Discharge Voltage:	27.6 V
Voltage @ Discharge Termination:	24 V
Nominal Capacity (C/2):	23 Ah
Standard Discharge:	23 A (C)
Max Cont. Charge:	184 A (8C)
Max Cont. Discharge:	184 A (8C)
Peak Discharge:	460 A (20C, <10s)

Mechanical

Dimensions:	13.5"L x 6.0"W x 6.0"H
Mass:	8.5 Kg / 18.7 lbs
Cooling:	50/50 glycol mix, ~1 gpm

Temperature

Discharge:	-30°C to +70°C
Charge:	0°C to +60°C
Storage:	-20°C to +35°C

Interfaces

Module:	Isolated Serial x1
Controller COM:	Isolate CANbus x2
Controller Discrete Out:	Isolated <60V, x4
Controller Discrete In:	Isolated <60V, x4

Life Data

Cycle Life:	15,000 cycles > 80% BoL 100% DOD
Shelf-Life	60 months



EPiC t32

27.5 V @ 23 Ah (633Wh)

EPS introduces the *t32* advanced lithium-ion battery offering very high power, long life rechargeable energy in an extremely lightweight compact package. The chemistry uses high power lithium titanate (LTO) chemistry, capable of very high symmetrical discharge and charge rates, very high cycle life and very long calendar life. A proprietary cooling system allows the *t32* to operate at very high discharge and charge rates continuously without impacting the cycle life of the cells.

The design also allows the *t32* to be assembled into parallel and series strings up to 1kV to construct larger battery systems. The *t32*'s integrated battery management system (BMS) communicates to a central controller that manages the complete system, balances the lithium cells, controls charge and discharge operations, measures current, and provided state-of-charge information over the integrated CANbus interface.

Contact EPS to discuss incorporation of this advanced technology into your application.