



TECHNICAL SPECIFICATION ON SYSTEM FOR THE PRODUCTION AND STORAGE OF ELECTRICAL ENERGY ON PROTOTYPE

Attachment I

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1 SOURCE OF ELECTRICITY

Energy grid of the vessel is powered from 4 sources of electricity:

- Power-train battery set for the portside propulsion system – 48 Vdc
- Power-train battery set for the starboard propulsion system – 48 Vdc
- Small consumers battery set – 24 Vdc
- Bow thruster battery set – 24 Vdc

Nominal voltage of power-train battery sets is 48 Vdc, which secures direct powering of the operating motors. They are charged through the charger connected to the power grid and through the on board solar plant charger. Small consumers and bow thruster battery sets are powered from power-train sets through converter 48/24 Vdc.

Power-train battery sets are interconnected with balancing DC/DC converter.

1.1 SHIP'S SOLAR PLANT

Ship's solar plant is located on the roof of the ship and it consists of the solar modules with total power of 7,4 kW minimum.

Technical specification of each module are:

- Minimum peak power of 300 W
- Minimum rated voltage of 35 V
- Temperature range -20°C to +60°C
- Impact resistant
- Salt mist corrosion certificate
- Power cord 1 m minimum
- MC4 type connectors
- Minimum efficiency of 90% after 10 years
- Panel weight up to 23 kg
- Panel dimensions
 - o Height 1960 mm
 - o Width 990 mm
 - o Thickness 40 mm
 - o Tolerance ± 2 mm

Scope of delivery 24 panels

1.2 SHIP'S BATTERIES

LiFePO4 batteries are arranged into following sets:

- | | |
|---|------------------------|
| - Power-train battery set for the portside propulsion system | 48 V/33 kWh (minimal) |
| - Power-train battery set for the starboard propulsion system | 48 V/33 kWh (minimal) |
| - Small consumers battery set | 24 V/2,5 kWh (minimal) |
| - Bow thruster battery set | 24 V/2,5 kWh (minimal) |

Power-train battery sets are located in the battery compartment, one per hull. Small consumers and bow thruster battery sets are located in portside hull.

Drive battery sets work independently, but each one of them has option to power both engines in case of malfunction of other set.

Each battery set will be approved by the Register of Shipping, and have to be designed in accordance with required rules.

Each battery set have BMS (battery management system), CAN open data for monitoring purpose of each battery, and monitoring system with integrated alarm system (GPS module, display):

- Voltage
- Current
- Temperature
- Capacity
- Alarm status

Battery system must include all the components and fittings for intermediate connection between charger on the one end, and consumers (converters) on the other end.

Battery provider has Type Approval issued by the one of the Registers of Shipping recognized by the Croatian Registry of Shipping

Battery provider issue 3 years warranty for the equipment. Battery provider declare battery life in accordance with the operational indicators as defined:

- C1 discharging
- C1 charging
- DOD 80% maximum
- Operational 365 days per year

Declared battery life must be minimum 5 years

Delivery by the above specified amounts

1.3 BATTERY CHARGERS

Battery charging is defined with two source of charging energy, and set of converters:

1. Solar plant chargers
2. Power grid chargers
3. Converters for the consumers and batteries

1.3.1 Solar plant chargers

Solar plant is charging battery sets with minimum of two chargers and it's a primary source of energy for battery charging.

The battery chargers from the solar power plant must have the following characteristics:

- Minimum input power 3600 W / 36 V
- Rated charge current 85 A
- Connection of 12 solar modules per charger minimum
- Without mechanical cooling
- Efficiency at full load 95% or more
- Charge control option: turn on/off and voltage regulation
- Terminal type AWG2
- Weight up to 5 kg
- Dimensions less than 160x160x370 mm
- Standards: EN/IEC 62109-1; EN 61000-6-1; EN 61000-6-3
- Accepted by the CRS

Nominated charger is Victron SmartSolar MPPT 150/75 or equivalent

Scope of delivery is two chargers

1.3.2 Power grid chargers

From the power grid batteries are charged with two chargers with automated control of charging current and battery overheating sensor which turn off charger and protect battery.

Power grid chargers are defined with following characteristics:

- Input voltage 230 V
- Input voltage range 190 V to 260 V

- Frequency range 45 Hz to 65 Hz
- Power factor 1
- Charging voltage 57 V
- Battery capacity 480 Ah
- Operating temperature range -40°C to +50°C
- Short circuit protection, battery reverse polarity protection, high battery voltage protection, high temperature protection
- Weight up to 10 kg
- Dimensions less than 270x270x370 mm
- Standards: EN 60335-1; EN 60335-2-29; EN 55014-1; EN 61000-3-2; EN 55014-2; EN 61000-3-3

Nominated charger is Victron Skylla TG 48/50 or equivalent

1.3.3 Converters for the consumers and batteries

Each battery set has appropriate voltage converters:

- 48/24 Vdc, 2 piece
- 24/12 Vdc, 2 pieces
- Galvanic protection
- Power rating 360 W
- Fast assisted cooling
- Weight up to 1,5 kg
- Dimensions less than 100x150x200 mm
- Standards: EN 60950; EN 61000-6-3; EN 55014-1; EN 61000-6-2; EN 61000-6-1; EN 55014-2; ECE R10-4

Nominated converters are Victron Victron Orion xx/yy or equivalent

1.3.4 Scope of delivery

- | | |
|---|----------|
| 1. Solar plant chargers | 2 pieces |
| 2. Power grid chargers | 2 pieces |
| 3. Converters for the consumers and batteries | |
| o Converter 48/24 V | 2 pieces |
| o Converter 24/12 V | 2 pieces |