AGENCIJA ZA VODNE PUTOVE
VUKOVAR, Parobrodarska 5
Tel: 032-450-613, fax: 032-450-653

TECHNICAL SPECIFICATION
MULTI-BEAM AND SINGLE-BEAM MEASURING SYSTEM

Annex V.

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FAIRway Danube

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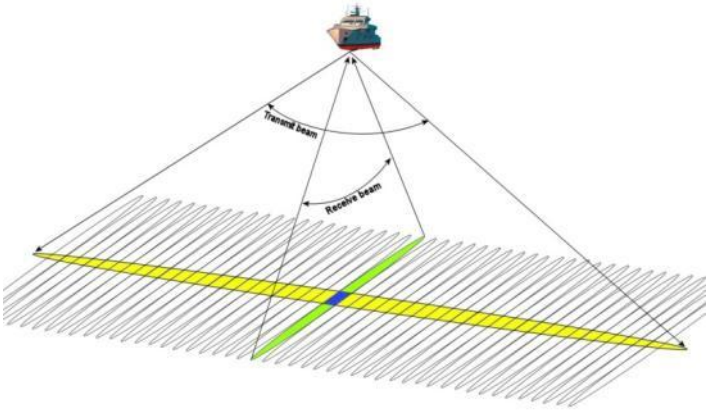
I. MULTI-BEAM ECHO-SOUNDER SURVEY SYSTEM - GENERAL

Differently from the usual depth sounders, the MBES system is able to scan the riverbed bottom in hundreds of lanes parallel to the movement with a single acoustic wave signal (ping). Due to this capability it has at least two main advantages:

- The resolution is far superior
- The wide acquisition cover significantly reduces the measuring time and costs

The multi-beam projector generates acoustic puls in a wide angle perpendicular to direction of travel and the receiver forms narrow beams in the direction of travel each steered at defined angle to cover the whole swath. This results in multiple bottom returns for each ping that form a detailed section of the bottom and multiple pings (up to 60/s) record a stripe of bottom along the survey line.

The direction of the emitted / projected beam is parallel with the movement of the unit (yellow in picture1), while the hydrophone receiver is perpendicular (green in picture 1). The cross-section of the projected beam area and the reflected echo areas provides the measured data (blue in picture 1). The real depth is the average of the scanned area. By this method a single ping results in hundreds of depth values.



Picture 1

The compliance of the echo sounders in shallow water (below 50 m) circumstances could be characterized by the following parameters:

- **swath coverage**, which is equivalent with the view angle; the higher the value is, the wider lane/zone could be scanned by the sensor – this could be considered as the most important factor in low water depth
- **frequency range**, that indicates the transmission-reflection rate; the higher the value is, the faster the measuring head able to emit and receive the signal, the denser is the scanning in the direction of movement – in low water depth the higher value is favourable
- **beam width**, the focus of emitted beam: the lower the value is, the smaller area is the basis of the calculation of the mean value to compute the depth, so the higher accuracy can be achieved – usually defined in degrees, the lower value is better

- **depth rating**, or measuring thresholds: the minimum and maximum water depth, where the sounder is applicable – in river acquisition the minimum value is important, lower is better

Parts of multi-beam survey system

1. Multi-beam (dual head) echo-sounder (MBES)
2. Integrated Navigation System (INS) withan RTK (Real Time Kinematic) GNSS position
3. Sound velocity sensor (SVS)
4. Sound velocity profiler (SVP)
5. GSM/GPRS Modem
6. Computer
7. Software (multi-beam and single-beam), set-up and education, guarantee
8. Console and mounting

1. Multi-beam (dual head) echo-sounder (MBES)

A main part of the survey system should be wideband beamforming dual head MBES, which should also be portable and compact.

Requirements:

Multi-beam echo-sounder (MBES)
Sonar frequency: selective 170- 450 kHz
Swath angle min - equidistant 140° - equiangular 160°
Swath coverage min up to 10 times water depth
Min. operating depth 0,5 meter
Beam Width min. 1° x 1° along and across at max frequency
Number of beams min. 10 – 256 or better
Snippets and side scan backscatter data
Splash proof processing deck unit
Sonar heads mounting frame
*Meets the requirements:*ResonSeaBat T20-P, T50-P, R2Sonic 2022 OR EQUIVALENT

2. Integrated Navigation System (INS) withan RTK (Real Time Kinematic) GNSS position

State of the art in precise, real time, dynamic positioning and orientation sensor. This should fully integrate Inertial measurement unit (IMU) and GNSS receivers to provide an accurate

georeferencing and motion compensation (Attitude, Heading, Heave, Position, Velocity and Time) of survey platform.

Components:

- Inertial measurement unit - IMU
- processor unit with dual GNSS receiver capable of producing an RTK solution
- two GPS antennas
- configuration software

Requirements:

Integrated Navigation System (INS) withan RTK (Real Time Kinematic) GNSS position
Roll, Pitchaccuracy:
Min 0.03° RTKoperations
Min 0.05° during GNSSoutages
HeadingAccuracy:
Min 0.06° with 4 m antennabaseline
Min 0.08° with 2 m antennabaseline
HeaveAccuracy:
Real Time: Min 5 cm or 5%
TrueHeaveTM: Min 2 cm or 2%
RTK PositionAccuracy:
Horizontal: Min ±(8 mm + 1 ppm x baselinelength)
Vertical: Min ±(15 mm + 1 ppm x baselinelength)
Meets the requirements: IMU APPLANIX POS MV 120 OR EQUIVALENT

3. Sound Velocity Sensor (SVS)

Multi-beam echo-sounder (MBES)needs a precise sound velocity in real time at a sonar heads to produce an accurate beamforming. For this a small sound velocity sensor (SVS) is installed close to the sonar head which should have the following specifications:

Sound Velocity Sensor (SVS)
Range: 1375 - 1900m/s
Resolution: 0.001m/s
Accuracy: ±0.020m/s
*Meets the requirements:*Valeport_miniSVSOR EQUIVALENT

4. Sound Velocity Profiler (SVP)

For the proper operation of the MBES a sound velocity in the water column is a must. For this an SVP sensor is needed.

Requirements:

Sound Velocity Profiler (SVP)
Sound Velocity
Range: 1375 - 1900m/s
Resolution: 0.001m/s
Accuracy: ±0.020m/s
Temperature
Range: -5°C - 35°C
Resolution: 0.001°C
Accuracy: ±0.01°C
Pressure
Range: 5, 10, 30, 50, 100, 300 or 600 Bar
Resolution: 0.001% of the range
Accuracy: 0.05% of the range
*Meets the requirements:*ValeportminiSVPOR EQUIVALENT

5. GSM/GPRS Modem

Data modem is needed to provide GPS correction (CROPOS) to the INS processing unit (GNSS receiver). The modem must support frequencies used by telecom operators in the Croatian territory.

6. Computer

Computer is a part of the system and it should be suitable to run the measuring system calibration program, the survey program during the measurement, deal with the large amounts of data, and ensure the post-processing of the measured data.

Requirements:

Computer
Op system: Windows Professional 64 bit (7, 8.1 or 10) or equivalent

Processor: 4. gen. Intel Core i7 or equivalent
Memory: Min 8GB
Screen: 14.0" FHD
Hard drive: Min 256GB SSD + 1 TB external drive
Dedicated video card with dual external display support
Communication links: LAN, Wifi, Bluetooth, Serial, USB 2.0 and 3.0, HDMI, card reader
Carrying case
Wireless mouse
Extra Battery
Docking station that is compatible with your computer
12V charger
Drop and shock resistant design (semi-rugged, MIL-STD-810G and IP51 certified standard)
Two LCD monitors (24" and 15") for operator and for skipper
Meets the requirements: Panasonic TOUGHBOOK 54, Dell Latitude 14 RuggedOR EQUIVALENT

7. Software (multi-beam and single-beam), set-up and education, guarantee

The measuring system has to be delivered with pre-installed all-in-one software package that are able to accomplish calibration, measurement, post-processing, data modelling, volume calculations and chart production. The supplier has to provide the set-up of the system and the necessary education for proper use.

Requirements:

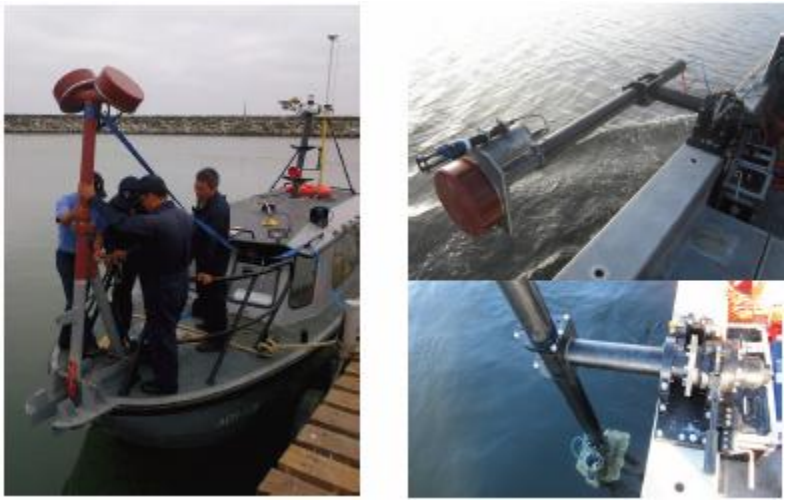
Software (multi-beam and single-beam), set-up and education, guarantee
The associated software package has to be capable for field measurements, data storage, manipulation of depth sounder output and the complementary data, process-tracking and 3D visualization.
If the software package has a yearly subscription, the supplier covers the related fees for 3 years.
The supplier or its subcontractor has to ensure the in situ set-up of the system and the calibration field measurements.
The supplier has to provide 5 day (min 8h/d) course for the future operators of the multi-beam system, including all parts of the equipment and the software. The expected number of participants is 3 persons. The aim of the education is to be able to accomplish a full measurement cycle individually.
Specified location of the lectures: Vukovar, Danube river.

The supplier finances the travel, accommodation and catering costs of its own staff or expert for the education.
The language should be Croatian, but English is also acceptable.
The minimum guarantee for the full system with all parts is 2 years.
*Meets the requirements:*PDS 2000 Multibeam/singlebeam softwareOR EQUIVALENT

8. Console and mounting

For the proper and safe attachment, transport and the submerge or lift-out process of the measuring dual heads and the sensors, the supplier have to deliver a required mounts (bracket, bumpers and other).

Picture 2



Picture 3

Mounting system for multi-beam (Console) must be produced by the manufacturer of the vessel with the technical assistance and guidance of the supplier of multi-beam equipment.

Requirements:

Console and mounting
Console should accommodate sonar heads mounting bracket, IMU and SVS at the wet end and optionally two GNSS antennas spaced at min. 2 m at the top end.
The console of the measuring heads has to be placed on the bow or on the starboard side of the boat (example: Picture 1).
The material of the console and the mounting - including screws and other parts – have to be stainless and acid-proof steel or aluminium.
The console have to be suitable to submerge and lift-out of the measuring unit. In the elevated position the measuring head must not reach the water (it should be no obstacle during high-speed cruise).
The console has to be robust and massive enough to stabilize the measuring unit in the time of the acquisition. The water pressure and waving must not cause deformation or self-vibration.
On the top of the pole the positioning system have to be placed (GNSS receiver). If it is not possible to place a GNSS receiver on the top of the pole different arrangement is acceptable.

II. SINGLE-BEAM ECHO SOUNDER SURVEY SYSTEM

Parts of single-beam survey system:
1. Single-beam echo-sounder
2. RTK receiver

1. Single-beam echo-sounder

Single-beam echo-sounder will be fixed installed in the hull of the vessel. Preparation for the installation of equipment must be done by the manufacturer of the vessel with the technical assistance and guidance of the supplier of single-beam equipment.

Requirements:

Single-beam echo-sounder
Single frequencyecho sounder Min. Range: 0.3 -100m (210kHz) Accuracy: ±0.01m or ±0.02% Resolution: Min. 0.01m (210kHz)
The integrated GPS receiver accuracy of ± 2m SBAS correction RTK data input
Communication portRS232fordata acquisition: TidegaugeorRTKheavesensor@60Hz, SVSsensorIMU, remoteeventmarker, outputdata
Power –internalrechargeable battery –external power12-24 VDC
Transducer 210 kHz, max. 9° beam width
Software
*Meets the requirements:*ValeportmidassurveyorOR EQUIVALENT

2. RTK receiver

Requirements:

RTK receiver
Min 220 channels

GNSSSIGNALS: - GPS L1 C/A, L2C, L5 - GLONASS L1 C/A, L1P, L2 C/A, L2P. L3 - SBAS - GALILEO - BEIDOU
POSITIONING ACCURACY: – Static horizontal 2.5mm + 1ppm , vertical 5mm+1ppm – RTK horizontal 8mm+1ppm, vertical 15mm+1ppm
INTERFACE: Bluetooth, WiFi, output data RTCM 3.0; 3.1; 3.2; ASCII NMEA-0183, WebUIforwirelesssoftware update, downloadingdata, controlreceiver, connectwith the tablet, smartphone, laptop, WindowsOS, iOS, Android
GSM modem: – GPRS/EDGE – WCDMA/HSDPA
IMU – Gyro: -correcting measurements with inclined pole (measuring diagonal) to 30 ° -digital compass -inclinometer -digital level
PROTECTION: - IP67 immersion in water to 1m depth - operating temperature -30 ° C to + 65 ° C
POWER: -internalremovablebattery with charge indicator -external power9-22VDC -resistance tofall from2mheightonto a concrete floor
ACCESSORIES: -2xbattery -chargerforboth batteriessimultaneously -documentation -protective hermetically sealed case -GSMantenna -Telescopiccarbonpole -Consoleto calibratethe IMUsystem -cableto connect externalsensorsandPC
CONTROLLER: –Operating SystemWindows –Processormin. 800MHz –Internal memorymin. 4GB –slotforMicroSDup tomin. 32GB –2batteries –chargerforboth batteries –Operating Temperature-20°C to+60°C

–display-touch screenmin. 3.7' –IP65minresistance, resistance tofall from1.5 monto a concrete floor –Numeric Keypad –GSM, Bluetooth, Wi-Fi –USB, RS232 –RTCM2.1, 2.3, NMEA – Camera –GPSreceivermin. 50channels, 1Hz, SBASaccuracy1-3m –RTKfield softwareforland surveying
*Meets the requirements:*STONEX S10NOR EQUIVALENT