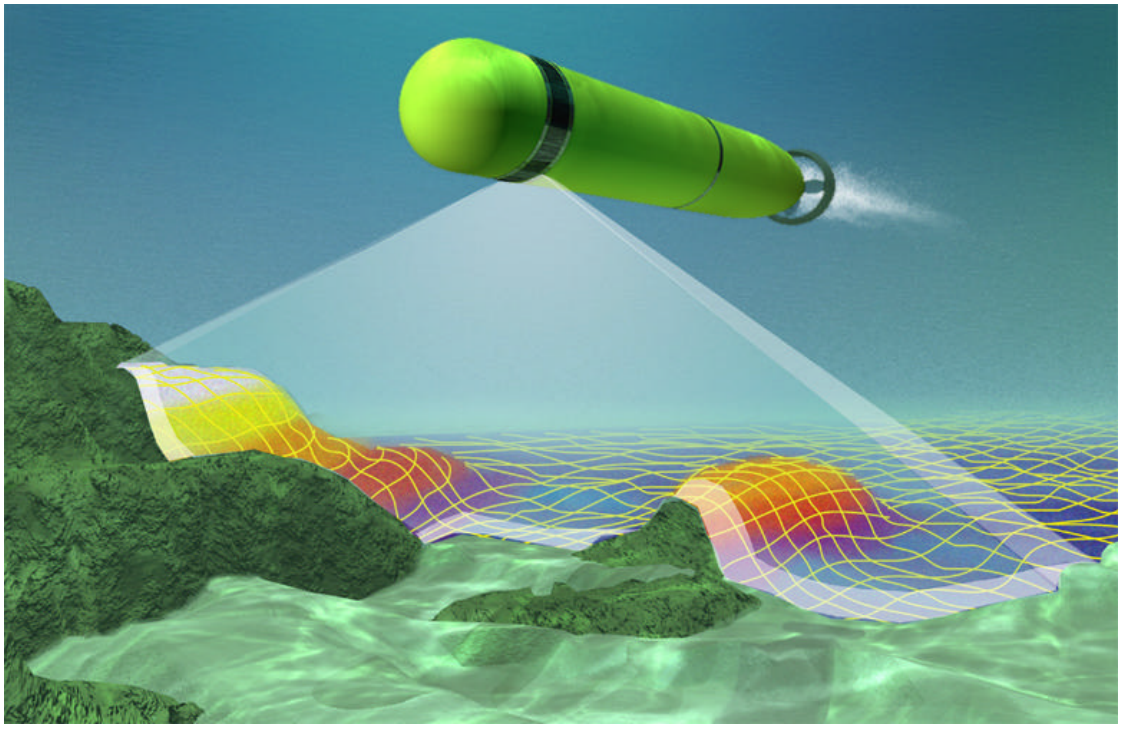
Multibeam Echosounder SeaBat 7100 for DORADO AUV

Revision 2.0



Proposal Prepared for

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MBARI

By
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REVISION HISTORY

Revision	Date	Prepared By	Checked By
1.0	10 SEP 2000	Thomas Meurling, Technical Manager	Jens R. Steenstrup President
2.0	1 OCT 2000	Thomas Meurling, Technical Manager	

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1. INTRODUCTION

RESON is a leading supplier of high-resolution, multibeam sonars for the international market. Our sonars are currently in use worldwide and have achieved a reputation for reliability and cost effectiveness. RESON is also an experienced system integrator and have delivered many integrated hydrographic sensor system.

This proposal consists of:

- A company profile of RESON, including a summary of RESON's experience
- An overview of the interim Integrated Hydrographic Sensor Suite
- An overview of the final Integrated Hydrographic Sensor Suite
- A technical description of RESON's new SeaBat 7100 Multibeam Echosounder in dual head configuration
- A description of the common Data Acquisition System
- Mechanical integration of sensors on the Dorado AUV
- List of proposed deliverables from MBARI
- Pricing

1.1. Proposed Equipment

The proposed equipment consists of a integrated hydrographic sensor system based around the new SeaBat 7100 multibeam echosounder and 6046 Data Acquisition System.

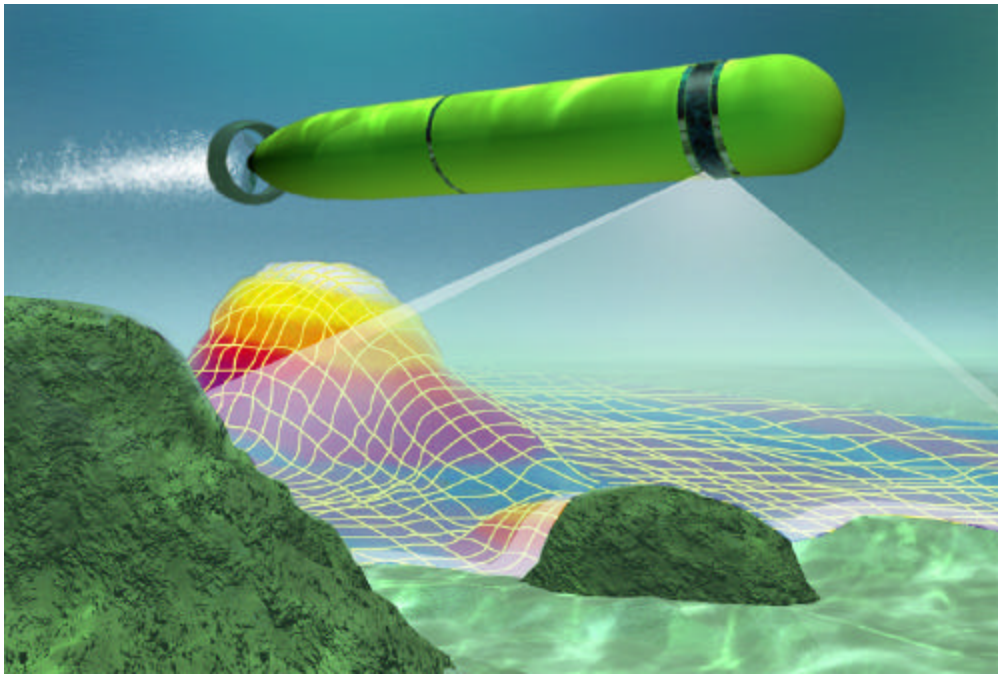

Figure 1 – Proposed Equipment

This is a new development especially designed for AUV applications but all of the system's software and hardware is based on products in current use with many survey operators worldwide.

The complete system will be available in November 2001.

2. RESON COMPANY PROFILE

Established in 1976, RESON has grown steadily and is now one of the world's leading companies in the field of underwater acoustics and high-power ultrasonics. In addition, RESON is the leading company in the design, manufacture, delivery, and support of integrated multibeam echosounder systems. More than 300 RESON sonars are currently in use worldwide.

RESON also designs and manufactures specialty Transducers, Hydrophones, and complete Sonar Systems. RESON was forced by necessity to develop its own automated precision calibration system. The system was developed to meet the varied requirements of both development and production testing.

RESON is an international corporation with offices in Denmark, Scotland, Germany, and the United States. Regional offices are maintained in Ventura and San Jose, California; Vancouver, Canada; Salt Lake City, Utah; and St. Petersburg, Florida.

We have assembled a team of highly skilled engineers committed to advanced engineering and to the design of sonar and acoustic systems. In addition, RESON employs a team of more than hundred professionals dedicated to such disciplines as Program Management, Quality Assurance, Manufacturing, Software Development, Security, and Administration. The resulting corporation, RESON, is renowned for providing innovative solutions to complex underwater surveying and military problems.

RESON has a team of engineers dedicated to the development of advanced processing algorithms for signal processing, bottom detect, and image processing. RESON also employs a core R&D group drawn from Bruel & Kjaer engineers.

RESON operates under the auspices of the AQAP-120 quality system held by the Denmark facility.

Figure 2 — RESON Inc., USA

Figure 3 — RESON A/S, Denmark

An Engineering Laboratory, comprising 2,700 square feet, includes Spectrum/Network Analysis, Electronics, Mechanical, Prototyping and Fabrication, and Computer Aided Drafting Systems.

Our manufacturing facilities include an environmental chamber and a secured acoustic calibration tank. The acoustic calibration test tank is utilized for final acceptance testing of our transducers, hydrophones, and sonar systems as well as for demonstrating proof-of-concept in new designs and prototypes. The size of the tank allows testing in close range field measurement conditions.

RESON has a fully equipped Machine Shop capable of both prototype and large-scale manufacturing. We have the expertise required for machining stainless steel, titanium, and aluminum, and for the specialized machining of potted materials.

RESON also has the equipment and expertise to perform various injection molding processes on a wide series of hydrophones and transducer assemblies. These special processes are conducted in accordance with RESON-documented process instructions. RESON has the necessary electronic equipment to perform each step — from receiving inspection, to in-process inspection, to final inspection and testing.

RESON is proud of its large number of repeat customers. We believe that the key to maintaining customer loyalty is providing reliable and dependable equipment backed up by thorough and competent service. The fact that RESON has successfully supplied equipment and support to customers such as the Royal Swedish Navy, the Royal Danish Navy, the Royal Australian Navy, as well as to demanding commercial and National Agency customers bears testament to this philosophy.

In summary, RESON is involved in the following application areas:

- Seafloor Mapping and Inspection
- Offshore and Construction
- Acoustic Calibration
- Acoustic Test Range
- Surveillance and Security
- Mine Counter Measures, MCM
- Anti-Submarine Warfare, ASW
- Systems Performance Modeling
- High-Speed Telemetry
- High-Speed Signal Processing Hardware and Software
- Image Processing

The experience and qualifications that RESON brings to this contract are as follows:

- RESON is the leading designer and manufacturer of multibeam sonar systems.
- RESON has a strong record in the design, manufacturing and system integration of high-performance multibeam sonars for commercial and military applications.
- The proposed design is the first sensor system developed for AUV application.
- The multibeam sonar system proposed herein is the next generation of the internationally accepted SeaBat series of high-precision multibeam echosounding and imagery systems.

2.1. Past Performance Summary

RESON has commissioned and supports more than 300 SeaBat multibeam systems worldwide. A partial list of users of SeaBat multibeam systems follows:

Commercial

- Akita Fishery Research Station, Japan
- Ashtead Technology Ltd., UK
- Danish Coastal Authority, Denmark
- Finnish Hydrographic Office, Finland
- Fugro Survey, Australia
- Fugro West Inc., USA
- HAM Dredging, The Netherlands
- Harwich Harbour Authority, UK
- Hong Kong Marine Department, PRC
- Institute of Ocean Sciences, Qingdao, PRC
- John E. Chance and Associates Inc., USA
- Maritime Safety Administration – Guangzhou, PRC
- Maritime Safety Administration – Tianjin, PRC
- Minnesota University, USA
- National Institute of Ocean Technology, India
- National Oceanographic and Atmospheric Administration (NOAA), USA
- NeSA BV, The Netherlands
- RACAL NCS International Inc., USA
- RACAL Pelagos Inc., USA
- RACAL Survey Inc., USA
- Rijkwaterstaat, The Netherlands
- South China Sea Institute of Ocean Sciences, Guangzhou, PRC
- State Oceanic Administration – Hangzhou, PRC
- Terra Surveys Inc., USA
- Tottori Fishery Research Station, Japan

Military / Defense

- Brazilian Navy
- Finnish Navy
- French Navy
- German Navy
- Japanese Navy
- Royal Danish Navy
- Royal Navy, United Kingdom
- Royal Netherlands Navy
- Royal Swedish Navy
- Saudi Royal Guard
- Science Applications International Corporation (SAIC), USA
- U.S. Army Corps of Engineers – Buffalo, USA
- U.S. Army Corps of Engineers – Galveston, USA
- U.S. Army Corps of Engineers – New York, USA
- U.S. Army Corps of Engineers – Norfolk, USA
- U.S. Navy

Recently, SeaBat systems were determined to be the system of choice in support of NOAA Hydrographic Survey Operations. NOAA subsequently ordered, and RESON delivered, three systems for installation aboard the survey vessel *Rainier*.

2.2. Commitment to Quality and Service

The continued endeavor by RESON development staff to improve the quality and performance of the SeaBat range of sonars has assured RESON's market lead and the continued acceptance of the SeaBat as an industry standard in the execution of seafloor imaging and precise bathymetry.

RESON operates a full technical service for the inspection, adjustment, and repair of all our products. Additionally, we provide on-site trouble shooting, installation, and training.

3. INTEGRATED HYDROGRAPHIC SENSOR SYSTEM

3.1. Structure

The integrated system consists of two separate parts, the AUV system and the onshore system. The proposed baseline system consists of SeaBat 7100 multibeam echsounder, data acquisition and QC control. All other parts marked with dotted lines are optional.

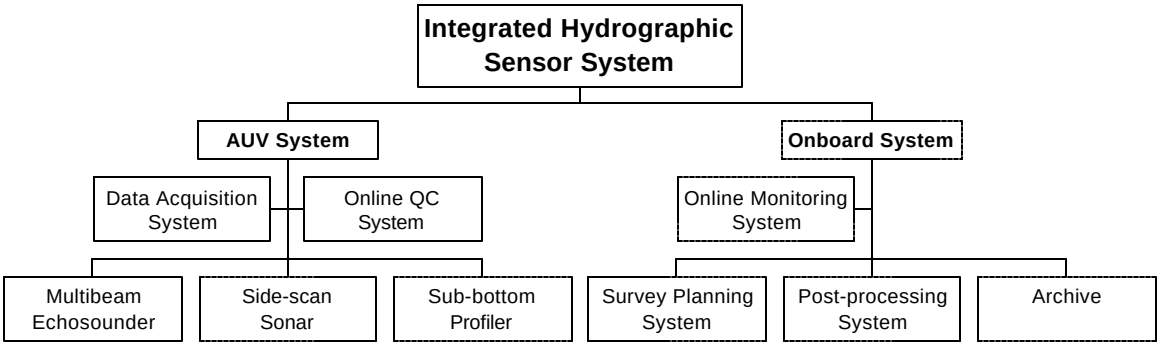

Figure 3 – Integrated Hydrographic Sensor System

3.2. Survey mission

The survey mission starts with planning the survey by utilizing the Survey Planning System. RESON 6042/6041 line generator will calculate the different survey lines based on constraints of the mission profile. Navigation data is automatically generated and downloaded to the AUV navigation computer.

All hydrographic sensors and data acquisition systems are tested using a maintenance console. Any problems are detected by the Built-In-Test system and logged by the maintenance console. The final part of the system check will be self-calibration of the MBES, which can be performed after deployment of the AUV.

The next phase is transit of the AUV to the selected survey area. When the vehicle is in the starting position, the navigation computer will initiate the survey by starting up the selected sensors and the data acquisition system with the pre-programmed parameters.

The system will begin to log bathymetric data, sidescan data, and sub-bottom profiler data, depending on the set-up for the survey. One of the most important functions of the system is the on-line quality control (QC) functions, which calculate swath coverage, standard deviation, and other QC functions for hydrographic survey. The status data and summary of QC is transferred back to the mother ship via the underwater communications link.

When the AUV reaches the end of the survey, all hydrographic sensors shut down and the vehicle transits back to the mother ship. The AUV is recovered and the logged data is transferred from the data acquisition system to the post processing system via files.

The post-processing system processes all data and creates an integrated data set that includes 3D digital terrain modeling with draped sidescan data. All data is also formatted for easy transfer and storage into a Geographical Information System (GIS) such as ArchView.

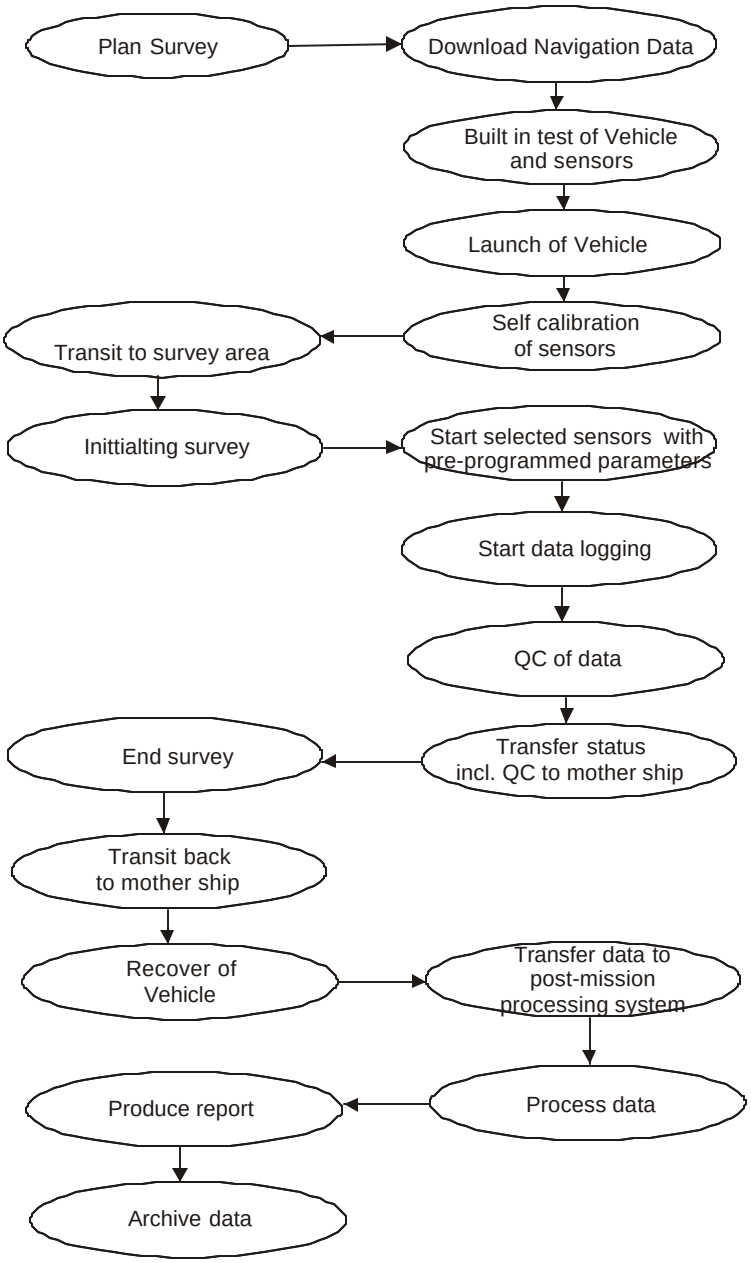

Figure 4 – Flow diagram of survey

3.3. Block diagram

The block diagram of the proposed hydrographic AUV system shows the different parts and the relationship with the other sensors onboard the AUV.

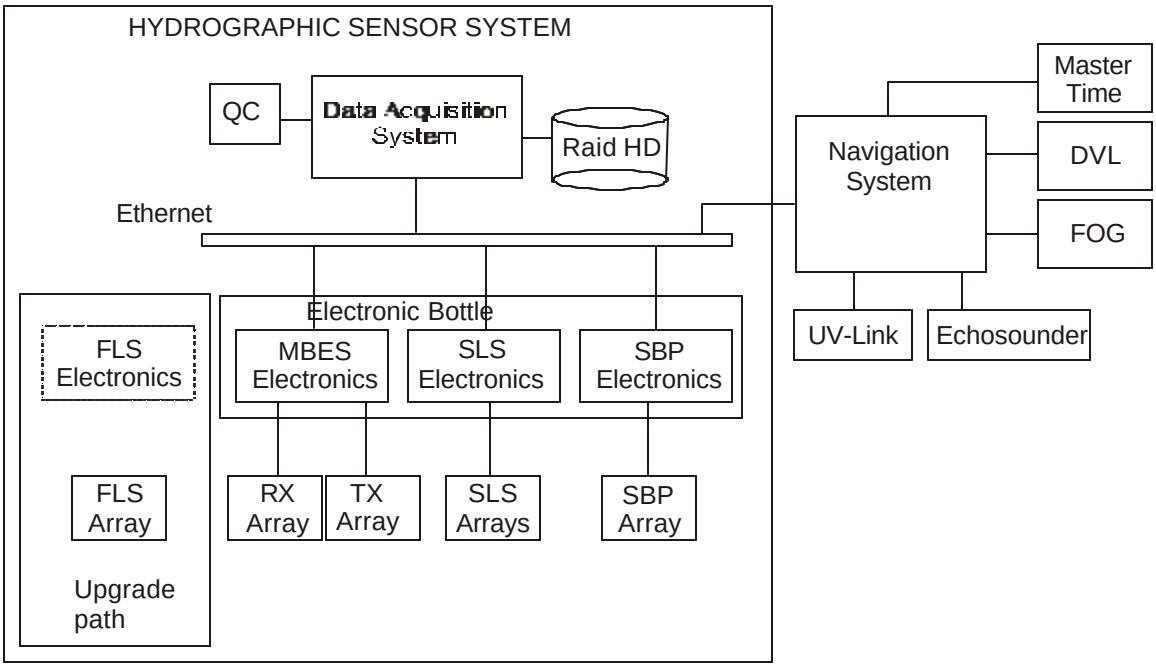

Figure 5 – Block diagram of final AUV system

The block diagram also shows one proposed upgrade path, implementation of a real forward-looking sonar into the AUV. The system architecture will be designed for easy upgrades and modifications.

All communications between the different sub-systems will be performed via Ethernet.

The interface between the hydrographic system and the navigation system will also be Ethernet.

4. MBES SUB-SYSTEM

4.1. Introduction

In the past, RESON has established a wide range of sonar systems utilizing a common architecture, both in hardware/firmware and interfaces.

This commonality provides several advantages in that it:

- Allows short-term development of new sonar systems and functions
- Reduces operator familiarization and training requirements
- Allows logistic flexibility and transfer of equipment between host platforms

The new SeaBat 7101 integrated system proposed makes full use of Commercial-off-the-Shelf (COTS) hardware and software to increase cost-effectiveness while maintaining full functionality and providing a well-defined path for future upgrades and expansion.

The system incorporates all experience from the well-known SeaBat 8100 series of multibeam echosounders. (SeaBat 8101 and 8125)

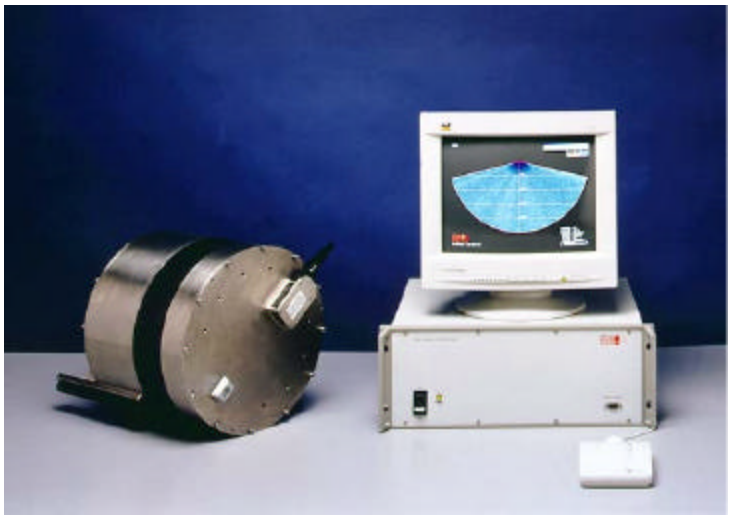

Figure 6 – SeaBat 8101

The Multibeam Echosounder is designed to work together with Side Looking Sonar, Sub Bottom Profiler and even Forward Looking Sonar.

4.2. SeaBat 7125

The SeaBat 7100 is a multibeam sonar system, operating in a dual-frequency band of 200 kHz and 400 kHz. The system allows collection of seamless high-resolution bathymetry data in water depths of between 10 and 500 meters.

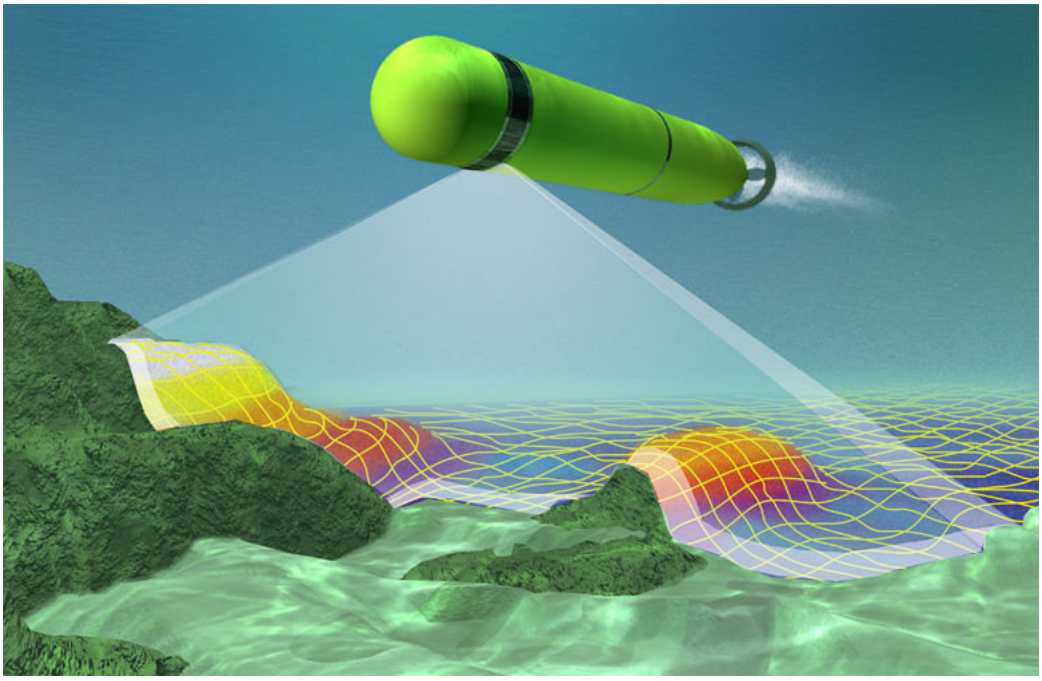

Figure 7 – SeaBat 7100

The SeaBat 7100 is designed for installation on an AUV. The special design provides the user great flexibility and allows system configuration to optimize for specific missions or tasks. The new 71-P sonar processor may be controlled from an external device such as the AUV mission control computer via Ethernet.

A special smart power management system optimizes power consumption by using different swath coverage and powering down part of the system between transmissions.

The system forms up to 200 receiver beams to cover a total angular swath of up to 150 degrees. Dynamically focused beamforming will be used for shallow water operation to improve the performance of the system.

The special bottom detection algorithm uses a combination of amplitude and phase information in order to detect the bottom in each individual beam with the highest possible accuracy.

Detailed requirement and architecture for the MBES sub-system will be specified as a part of the proposed Product Definition Phase (PDP).

4.3. System Components

The SeaBat 7100 consists of the following components:

- Cylindrical receiver array
- Linear projector arrays (100 kHz and/or 200 kHz)
- 71-P Sonar Processing Unit

4.3.1. Receiver Array

The SeaBat 7100 is based on a linear transmit array and a cylindrical receiver array, arranged in a Mill's Cross configuration.

The cylindrical receiver array is mounted in a ring. The outer dimension of the receiver array is 21 inches, to conform to the hull of the AUV.

Figure 8 – SeaBat 7100 Receiver array

NOTE: The final design of the receiver array will depend on the results of the PDP and the mechanical interface that is agreed upon between MBARI and RESON

The receiver array contains 272 individual elements with an across-track beam width of 2 degrees for 100 kHz and 1 degree for 200 kHz.

4.3.2. Transmitter arrays

The SeaBat 7100 baseline system uses conventional cylindrical transmitter arrays. The two transmit arrays produce a wide transmit fan beam, >150 degrees, in both 100 kHz and 200 kHz.

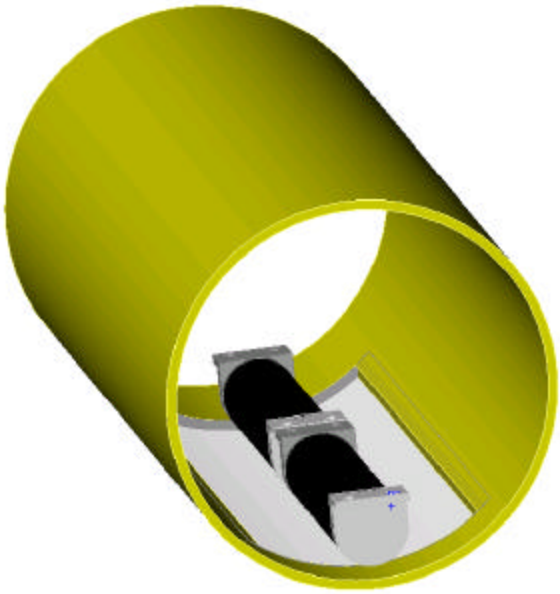

Figure 9 – SeaBat 7100 projector configuration with two separate linear projectors for 100 kHz and 200 kHz mounted under the AUV

Transmit along-track beamwidth is approximately 2 degrees for 100 kHz and approximately 1 degree for 200 kHz.

The transmission is either on 100 kHz or 200 kHz (not simultaneously).

The SeaBat 7100 does not need to be equipped with both projectors to be functional; the second projector can be added as an upgrade at a later time.

4.3.3. MBES Processing Unit

The processing unit performs initial signal processing, beamforming, and bottom detection processing before exporting time-tagged bathymetric and imagery data to the 6046 data acquisition system over a network link.

The 71-P Sonar Processor Unit is remotely controlled from the AUV mission control computer.

The processor firmware is downloaded through a communications port, and is distributed to the Flash memory throughout the system, which facilities upgrades.

The purpose of the 71-P Sonar Processing Unit is to:

- Receive digitized sonar data from the transceiver
- Receive operational settings from the AUV mission control computer
- Conduct beamforming
- Output bathymetric and imagery data
- Control data output to the 6046 data acquisition system
- Perform Built-in-Test routines and alert the AUV mission control computer to any abnormal conditions

4.4. SeaBat 7100 Acoustical Data

Characteristic	Parameter	Remark
Acoustic Center Frequency	100 kHz and 200 kHz, nominal frequencies	
Altitude Range	5 m to 500 m NOTE: Dynamic beamforming for 200 kHz will start at 5 meter range)	1,000 meters is estimated max. slant range
Swath Width	150 deg 120 deg	
Number of Beams	200 beams across swath	
Transmit & Receive Beam	1 deg x 1 deg for 200 kHz 2 deg x 2 deg for 100 kHz	
Range Resolution	2.5 cm	
Bottom Detection Range Resolution, BDRR	< 7 mm	
Motion Correction	N/A	
Calibration Mode	Automatic & manual calibration	Automatically at start-up and manually by AUV mission controller
Data Input	Navigation data and time	
Data Output	Bathymetric and imagery over Ethernet	

4.5. SeaBat 7100 Performance

The SeaBat 7100 acoustical performance modeling uses the directivity functions based on real transducer measurements. Modeling was performed at frequencies of 100 and 200 kHz with altitudes up to 900 meters.

The medium was characterized as having a temperature of 6°C (at a depth of 200 meters), salinity of 35 ppt, a pH of 8.0, and sea state 3. Absorption coefficients were computed using the Francois-Garrison equation.

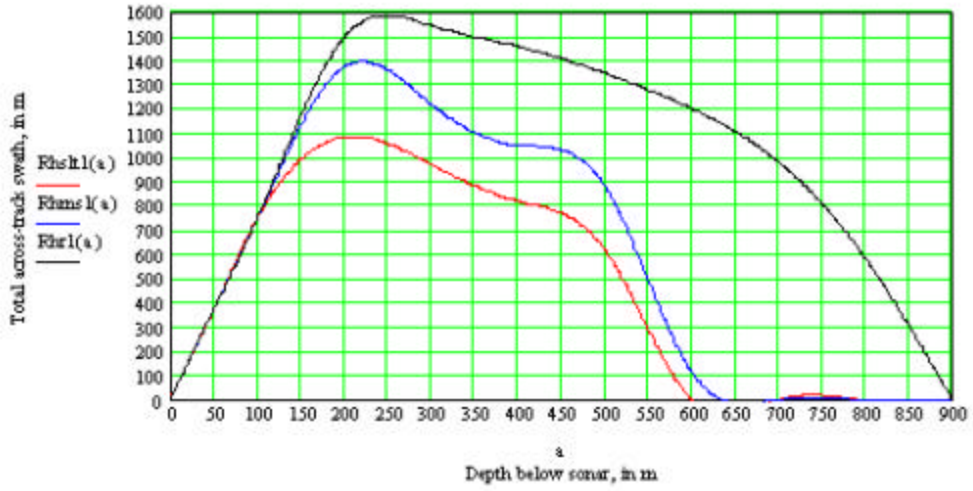

Figure 10 – Total swath coverage for 100 kHz in meters versus altitude of the AUV. The curves from top to bottom are for rock, medium sand, and silt.

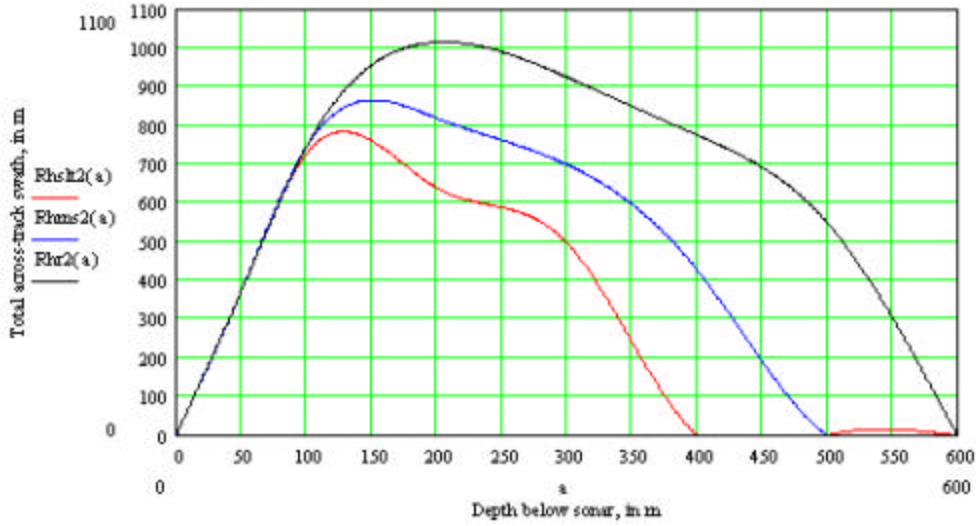

Figure 11 – Total swath coverage for 200 kHz in meters versus altitude of the AUV. The curves from top to bottom are for rock, medium sand, and silt.

5. SLS SUB-SYSTEM

Optional system. Proposed system is EdgeTech SLS. Information provided on request.

6. SBP SUB-SYSTEM

Optional system. Proposed system is EdgeTech SBP. Information provided on request.

7. FLS SUB-SYSTEM

Optional system. Information provided on request. Proposed system is RESON SeaBat 7012 system.

8. DATA ACQUISITION SUB-SYSTEM

The new common data acquisition system is a PC-based system especially designed for AUV applications with low power consumption and robust behavior as its major objectives.

The software allows real-time control and monitoring of data collection and absolute/relative positions of selected survey objects. In addition, it provides a central interface for all system sensors and peripheral devices. 6046 collects bathymetric, imagery, and navigation data.

The proposed version of the data acquisition system collect data from the MBES. It can be easily upgraded to also include SLS, SBP and FLS in the future.

The system uses the Windows 2000 operating system, and the data collection is implemented as a background service within the operating system to minimize overhead and latency.

RAID concept is considered as a means to achieve better reliability for the data storage system.

The system also allows for easy export of stored data via network to the post-mission analysis/processing system.

Detailed requirement and architecture for the Data Acquisition system will be specified as a part of the Product Definition Phase (PDP).

9. INSTALLATION

9.1. General

This installation only covers SeaBat 7100 and Data Acquisition system. Any optional systems must be handled separately.

9.2. Transducer Installation

The recommended installation of the cylindrical SeaBat 7101 receiver unit is between the front section and the center section.

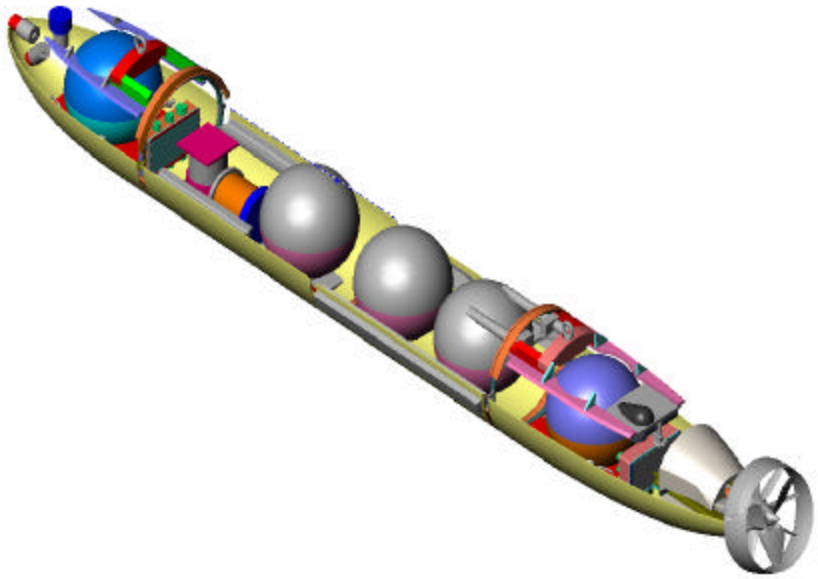

Figure 12 – Isometric view of AUV

9.3. Electronic Installation

The electronic bottle will be based on existing design, and the most promising candidate is a 445 mm aluminum sphere, rated for 3,000 meters. This sphere has a buoyancy of +18 kg (according to specifications).

This type of sphere could also be delivered with a cylindrical center section to simplify the implementation of the electronics (see Figure 13).

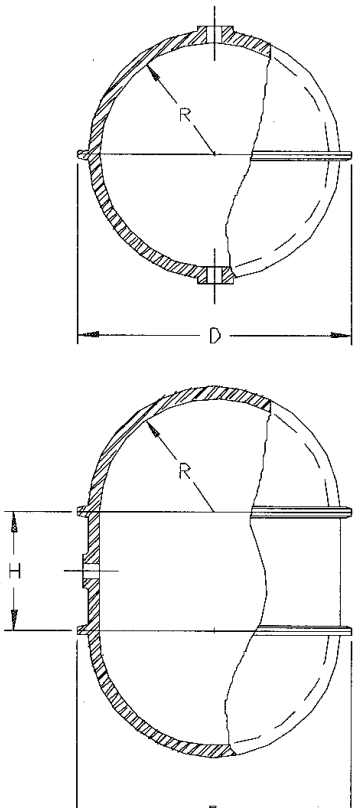

Figure 13 – Examples of spheres

The electronic installation will use either a sphere or a sphere with a cylindrical center section. This must be studied in detail before any decisions can be made.

The data for the sphere is shown in the table.

Material	Al, B95	
Pressure rating	3000 m	Same as for RACAL
OD	445 mm	
ID	415 mm	
Cylindrical center section	200 mm (max)	If used
Weight of sphere	28 kg	+18 kg buoyancy
Weight of sphere + cylinder	61 kg	+31 kg buoyancy

10. ONBOARD SYSTEM

The onboard system consists of the following units:

- Survey planning
- Online monitoring
- Import of survey data from AUV system
- Post-mission processing
- Import/export functionality against third-party systems, such as WinFrog and CARIS
- Report generation
- Transfer of data for storage to a Geographical Information System (GIS)

Detailed requirement and architecture for an optional onboard system will be presented at PDR.

10.1. Survey planning

The survey planning tool is used for planning and optimizing the survey for an AUV with the integrated hydrographic system. The tool optimizes the survey based on the characteristics of the sensor and the AUV.

RESON propose the use of 6042 Navigation and Presentation system for this application. Some minor modifications are maybe necessary but most of the tools are already in place. This software package is already in use for the Maridan AUV and the NUWC STDV/Manta AUV.

10.2. Online monitoring

This module takes the data from the UW-link and presents the status of the survey in real-time. Update rate and data content will depend on the UW-link data rate.

The Survey Planning is used as a reference and any deviations are shown in real-time.

The software architecture will also allow for update over the Internet, indicating the online status of the AUV survey back in the office.

RESON propose the use of 6042 Navigation and Presentation system for this application. This will require some minor modifications, but mainly adapting the 6042 for the bandwidth/data rate that is available for the underwater link.

10.3. Import of survey data

Automatic import/export of MBES, SLS, SBP, and AUV data to the post-processing system using the maintenance console. This is a part of RESON's 6042 software.

10.4. Post-mission processing

The proposed post-mission processing system is based on RESON's 6041 software. This software includes the following functionalities:

- Automatic despiking of data sets
- Automatic object and feature detection
- Automatic object/feature extraction
- Mosaicing
- DTM
- Draping of SLS on DTM

Some of these functions are currently under development, but will be available for this program.

10.5. Import/export of data

Allows data to be imported and exported to various specified third-party systems.

The import/export function is part of RESON 6042. Export to different data formats such as XTF, CARIS and also ESRI/ArchView will be available.

10.6. Report Generation

This module allows the user to print reports about the survey, e.g., list of automatic detected objects, feature extractions, and number of removed spikes in a specific data set, etc.

This is an existing function for 6041 software package.

10.7. Transfer of data to GIS

RESON believes that all future hydrographic data will be stored in Geographical Information Systems (GIS). The onboard system will therefore allow easy interface against GIS systems such as ArchView/ArchInfo.

11. SCOPE OF WORK

11.1. Project Structure

RESON will supply the MBES and the data acquisition system. RESON will also be responsible for system test and integration of the system, with exception of the mechanical integration into the vehicle.

11.2. Phases and Milestones

The proposed phases and milestones for this project is shown in Fig.14.

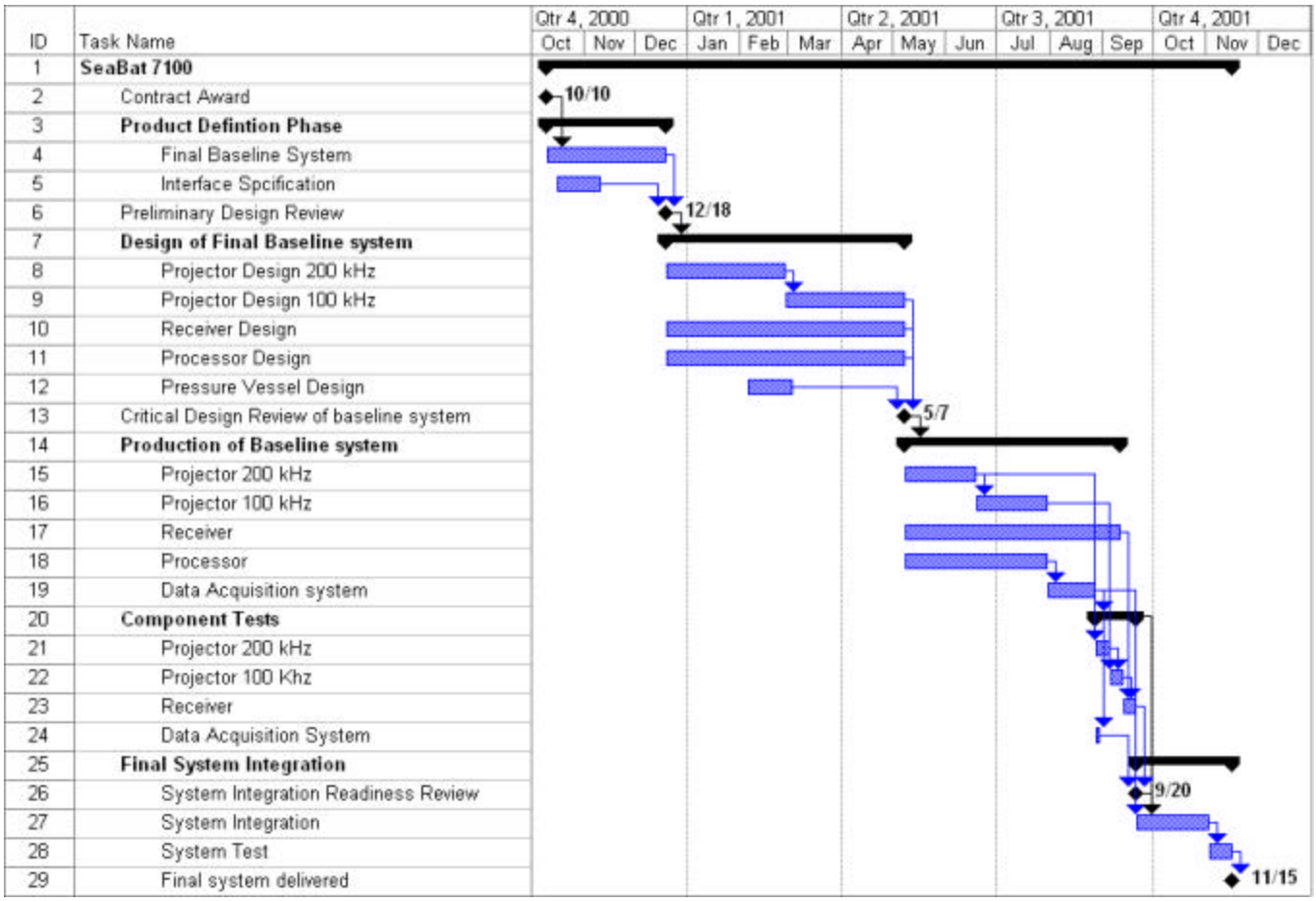

Figure 14 – Project Time plan

- Contract Award is estimated to be October 10, 2000. (as a reference for the time plan. Any delays after October 10 will probably delay the whole project with the same time as the delay.)
- PDP starts after contract award and involves the investigation of the system integration of the SeaBat 7100 into the Dorado AUV. This includes

interface specifications and mechanical interface. The PDP ends with a Preliminary Design Review (PDR).

- The PDR is estimated to December 18, 2000. At the PDR will the different solutions will be presented together with the detailed specification of the final system.
- The detailed design work starts for the different components in the system. This design phase ends with a Critical Design Review (CDR).
- The CDR is planned for May 7, 2000. This involves a presentation of the detailed design including results from prototype tests. Draft test procedures will also be available.
- Final development and production of the SeaBat 7100 will begin.
- The component testing of each individual sub-system will start as soon as each sub-system is available. Part of components test will be performed in Denmark (RESON Denmark)
- The final system integration and testing starts with a formal review to make sure that everything is ready for system tests. This is planned for September 20, 2001.
- The final system will be completed and delivered from RESON, November 15, 2001.

11.3. Meetings and Reviews

The progress of the project will be reported in Progress Meetings (PM) every third month, unless there is a formal review (PDR, CDR) , which will replace the PM.

A kick-off meeting and two PM are planned. There will also be technical meetings regarding electrical, signal, and mechanical interfaces.

A special interface group that deals with the electrical and signal interfaces will be created with participants from RESON and MBARI.

Included are the following interface meetings:

- Kick-off meeting at RESON
- One PM meeting at MBARI
- One PM Meeting at RESON
- One PDR
- One CDR
- System Integration Readiness Review at RESON

The important reviews are the Preliminary Design Review and the Critical Design Review. The Readiness Review (RR) for the system integration will not be treated as a formal review.

11.4. Acceptance Tests

As the contractor, RESON will perform Factory Acceptance Test for the complete system. The final Sea Acceptance Test will be performed by MBARI and monitored by RESON.

The FAT for the final baseline system will consist of simulator tests and tank tests of each sub-system and the integrated system.

11.5. Deliverables from MBARI

The table below shows the deliverables that RESON will expect RACAL to provide.

No.	Item	Remark
1	Design drawing for mounting all acoustical sensors	Needs to be discussed between RESON and MBARI
2	Detailed information about DVL, echosounder, and UV-link	Needs to be discussed between RESON and MBARI
3	Design drawing for mounting acoustical windows	Needs to be discussed between RESON and MBARI
4	Interface specification between AUV mission controller and 71-P/6046	Needs to be discussed between RESON and MBARI
5	Electrical power specification	Needs to be discussed between RESON and MBARI
6	Drawings of AUV	Needs to be discussed between RESON and MBARI
7	Mounting brackets for sensors	Needs to be discussed between RESON and MBARI
8	Acoustical window	Needs to be discussed between RESON and MBARI
9	Mounting brackets for acoustical window	Needs to be discussed between RESON and MBARI
10	Mounting brackets for electronic bottle	Needs to be discussed between RESON and MBARI

12. PRICING

In response to MBARI request for proposal, RESON Inc. respectfully submits its commercial proposal and suggested inputs for the proposed contract.

The short time frame and the uncertainties regarding the mechanical and electrical integration of the multibeam sonar on the AUV necessitates that RESON propose a fixed price baseline system for the sonar itself plus a day rate cost for technical support and integration work. We believe that the proposed sonar can be packaged into a section that is neutrally buoyant, but we lack the vehicle design capabilities to understand the scope of such a design, and we also lack a proper understanding of battery packaging and the signal interfaces intended to be used with the vehicle.

The baseline system is proposed as the most cost-efficient solution, allowing MBARI to optimize the integration of the 7100 on the Dorado AUV.

No.	Item	Units	Price	Remark
1	Product Definition Phase	1	TBD	See option B
2	SeaBat 7100	1	$350,000.00	Final System with 200 kHz projector only including pressure vessel as described in section 9.3
3	Data Acquisition System (6046)	1	$30,000.00	SW and HW
4	System Integration – Final system	-	TBD	See option B

12.1. SeaBat 7100 Options

RESON have identified the following options to the Baseline System.

No.	Item	Units	Price	Remark
A	100 kHz option, includes projector, electronics and firmware	1	$65,000	
B	Technical support for integration of the baseline sonar system regarding: - Mechanical integration - Electrical integration - Interface with mission control computer	Day rate	$1000/day and Engineer	Any travels must be reimbursed with cost + 10%
C	6042 SW	1	TBD	Depends on final requirements
D	6041 SW	1	TBD	Depends on final requirements