AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT	1. CONTRACT ID CODE	PAGE OF PAGES 1 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0003	24 DEC 98		

6. ISSUED BY CODE N68462

PROCURING CONTRACTING OFFICE
NAVAL RESEARCH LABORATORY (NRL-SSC)
ATTN: CODE 3235.SE
STENNIS SPACE CENTER, MS 39529-5004

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, country, State and ZIP Code)*

TO ALL OFFERORS

CODE FACILITY CODE

(✓) X

9A. AMENDMENT OF SOLICITATION NO.
N00173-98-R-SE03

9B. DATED *(SEE ITEM 11)*
10 NOV 98

10A. MODIFICATION OF CONTRACT/ORDER NO.

10B. DATED *(SEE ITEM 13)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers [ ] is extended, [X] is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning 02 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer x submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(✓)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103 (b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

SEE CONTINUATION PAGE(S)

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY *(Signature of Contracting Officer)*	16C. DATE SIGNED

The purpose of this amendment is to clarify and correct errors to Amendment 0002 as follows:

A) The vessel rating for CLINS 000201, 000202 and CLIN 000204 on page 9 of Amendment 0002 should read 500 meters.

B) The Technical Performance Specification REVISION 12/9/98 attached to Amendment 0002 is hereby deleted in its entirety and replaced with 98se03swrev.htm available at http://heron.nrl.navy.mil/contract/home.htm.

REVISION 12/9/98

TECHNICAL PERFORMANCE SPECIFICATION

FOR

SEA-GOING ACOUSTIC MEASUREMENT SYSTEM

1.0 SCOPE

This specification establishes the requirements for a complete turn-key Sea-Going Acoustic Measurement System (SGAMS) to be deployed from UNOLS Class III, U.S. Navy or commercial oceanographic vessels as a fully autonomous acoustic data collection system with no sea surface expression. SGAMS shall be a modular system consisting of the following modules/hardware: Data Acquisition Unit (DAU), Data Storage Unit (DSU), Energy Unit (EU), Data Transfer Unit (DTU), acoustic hydrophone array(s), and the mechanical structure and ancillary equipment needed to make a deployable system. Each of the deployable modules (the DAU, DSU, and EU) shall be contained in individual pressure housings. The units shall be delivered so that the user can configure a system with various numbers of input channels, recording capacity, and deployment duration(increased energy capacity). The basic system shall provide for autonomous recording of 64 acoustic channels and 24 engineering sensor channels.

2.0 APPLICABLE DOCUMENTS AND GLOSSARY OF TERMS

2.1 Section 7.0 (Glossary of Terms)
Audio engineering Society AES17-1991

2.2 GLOSSARY OF TERMS:

mb	megabits (1mb = 1048576-bits)
MB	Megabytes (1MB = 1048576-bytes)
GB	Gigabytes (1GB = 1024 Megabytes)
mbs	megabits per second
MBS	Megabytes per second
rms	root mean square
Hz	hertz
kHz	kilohertz
DAU	Data Acquisition Unit
DSU	Data Storage Unit
DTU	Data Transfer Unit
EU	Energy Unit
SGAMS	Sea-Going Acoustic Measurement System
CMRR	Common Mode Rejection Ratio
GPS	Global Positioning System
A/D	Analog to Digital Converter
ADC	Analog to Digital Converter
dB	Decibels
I/O	Input/Output
COR	Contracting Officers Representative
RCM	remote control and monitoring
TTL	transition to transfer logic

3.0 REQUIREMENTS

3.1 System Definition. SGAMS deployed from oceanographic research vessels (UNOLS, U.S. Navy or commercial) shall serve as an acoustic data collection system for the recording of acoustic signals (phase and amplitude) which have propagated through the ocean. The base system shall include all components and equipment necessary to configure a baseline system which is safely transportable, deployable, and retrievable by end-users aboard an oceanographic vessel. The system shall include a shipboard DTU for data transfer from the DSU for archiving and evaluation and a serial communication port for an optional acoustic modem.

3.2 General Description. The components of the baseline SGAMS are a DAU module, DSU module, EU module, DTU module, and mechanical deployment hardware. The baseline DAU shall be designed to accept a minimum 64 channels of acoustic data and be upgradeable to 128 acoustic channels, in 32 channel increments. Inputs shall be provided for 4 engineering modules, each module containing up to **four** sensors for every 32 acoustic channels. The baseline DAU shall be designed to accept a minimum of eight (8) engineering modules. The DSU shall store all data collected on non-volatile media. The baseline DSU shall store a minimum 780 gigabytes of data. The EU shall provide all the energy required to operate the deployed system for a 7 day deployment. The EU shall be capable of being expanded to an energy capacity of at least one month (28 days). Deployment hardware shall consist of all mechanical components necessary for deployment of a baseline SGAMS. The DTU shall function as a system checkout/setup test instrument and shall enable at-sea transfer of DSU stored data without the requirement of opening the unit to archive collected data.

3.3 Data Acquisition Unit: The DAU module shall function as the collection point of all acoustic and engineering data to be collected. It shall interface to acoustic arrays, engineering sensors, receive its power from the EU, convert analog acoustic data to a digital form at an accurately controlled sample rate, and shall output a formatted data stream to the DSU. The DAU shall be programmable through a hardwired interface before deployment and shall be remotely programmable through an acoustic telemetry system after deployment.

3.3.1 Mechanical Requirements:

a. Pressure housing: The DAU electronics shall be housed in a container with an operating depth in seawater of at least 1000 meters.

b. Connectors: All connectors shall have a minimum operating depth in seawater greater than 1000 meters. Each connector shall be provided with a protective metal end cap rated to the pressure rating of the connector. All connectors shall have either a protective shield or be located such that they are protected from accidental damage during unit movement and deployment of the DAU. At each connector a method of strain relief shall be provided which minimizes the stress in the cable conductors and the connector. Each connector shall have a locking mechanism to prevent accidental disconnect.
c. Seals: All pressure vessel joints shall have dual o-ring seals.
d. Finish: All exposed surfaces of the DAU shall be designed to minimize deterioration of the structure by exposure to the ocean environment. As a minimum it shall have two coats of primer and be painted with an epoxy based paint.
e. Attachment/lift points: The DAU or any framework it is mounted in shall be provided with a minimum of three mechanical attachment points for shipboard tie-down/storage and deployment/lifting. Lift points shall have an operating strength of at least 40,000 newtons.
f. Purge Port: The pressure vessel shall have a purge system which allows the vessel to be filled with dry nitrogen. The system shall allow the nitrogen to displace the atmosphere in the pressure vessel.
g. Corrosion Protection: The pressure vessel and any framework used to support it or attach it to other units shall use passive cathodic protection against corrosion. The protection method shall have minimum useful rated usage of one year.

3.3.2 General Requirements:

a. Power: Because SGAMS primary mode of operation shall be battery powered the DAU shall be designed for minimum power usage. Power shall be provided from the EU Module when deployed, and from the DTU power supply for shipboard/laboratory checkout.
b. Input Channels: The basic DAU shall accept 64 acoustic channels, 8 engineering modules (each engineering module can consist of up to six sensors).

c. Acoustic Channel Calibration: The DAU shall have the capability to supply a sine-wave calibration signal simultaneously to the front end of each DAU channel. This signal shall be applied at the input of the DAU’s first amplifier stage. The DAU shall supply a minimum of eight discrete frequencies, spread linearly in octave increments over a 10 Hz to 20 kHz band, signal amplitude shall apply the maximum input level at the maximum gain setting to the A/D input for the channel. The variation in amplitude shall be less than 0.1 dB. The signal shall be applied simultaneously to all channels. A similar signal shall be available from the DTU for use as a system calibration. The DTU signal shall be applied directly the array hydrophone.

d. Array Connections Acoustic Channels: DAU acoustic channel connections shall be in 32 channel groups. The connection shall support the array specifications provided under section 4.10. Each acoustic channel connector shall be wired identically to facilitate trouble shooting.
e. Array Test Leader: The offerer shall provide an unterminated test leader for all array input (acoustic and engineering) connectors. Each test leader shall consist of a connector which mates to the appropriate connector interface on the DAU housing and a minimum of 1.0 meter of unterminated wire. Each wire shall be labeled.
f. Array Engineering Channels: For every 32 acoustic channels there shall be a minimum of 4 engineering modules, each with a capacity to support at least six sensors. Each engineering group of 4 modules shall have its own connector. Each engineering channel connector shall be wired identically to facilitate trouble shooting. The power for the engineering modules shall also be supplied through this connector.
g. System Temperature Specifications: The system shall meet the following temperature requirements:

Operating:	5°C to 50°C
Storage:	-30°C to 70°C

3.3.3 DAU System Requirements:

3.3.3.1 Remote Control and Monitoring Ports: The DAU shall have two serial ports to provide remote control and monitoring communications between the DAU and shipboard based DTU. Two serial ports are required to provide on-deck communications when an acoustic modem is connected.

a. Electrical Protocols: One serial port shall satisfy RS-232 protocols. The second serial port shall satisfy RS-422 protocols.
b. Baud Rate: Both serial ports shall support a minimum communication speed of 115 kilobaud. Both serial ports shall automatically adjust their baud rate to the device connected to the serial port (i.e., autobaud functionality).
c. Connectors: Each serial port shall have a separate connector which is accessible without opening the DAU pressure vessel. Each connector shall be pressure rated to an operational water depth of at least 1000 meters. Each connector shall have a locking mechanism to prevent accidental disconnect. Each connector shall be provided with a protective metal end-cap which is pressure rated to the rating of the connector.

3.3.3.2 User Programmable Parameters: The following DAU parameters shall be user configurable by the DTU via the RCM link.

a. System Power On/Off: DAU, DSU, and array system power requirements shall be reduced to a minimum system maintenance level on command by the user via the DTU (when data acquisition is not desired) to conserve EU lifetime. System configuration parameters shall not be lost in this power down state. Full system power levels shall be restored at user command.
b. System Reboot: Any computer control in the DAU or DSU shall be user rebootable to the default state via the DTU.
c. Number of Acoustic Channels: The number of acoustic channels to be acquired and recorded shall be user selectable via the DTU. Active channels shall begin with channel 1 and continue for the number of channels selected. For example, in a 64 channel system, channels 1-16 or channels 1-48 could be active at user discretion.
d. Acoustic Channel Gain: The gain of each acoustic channel shall be user selectable via the DTU.
e. Hydrophone Sensitivity: The hydrophone sensitivity for each acoustic channel shall be user selectable via the DTU.
f. Acoustic Channel Pre-Emphasis In/Out: Application of the pre-emphasis filter to each channel shall be user selectable via the DTU.
g. Acoustic Channel Bandwidth and Center Frequency: If the Basebanding option is exercised (Section 4.9), then the bandwidth and center frequency for all acoustic channels shall be user selectable via the DTU.
h. Time/Date: The time and date shall be user settable via the DTU.
i. Sample Rate: The user shall be able to select the acoustic channel sample rate for the system, within the parameters specified in Section 3.3.6.

3.3.3.3 System Acquisition Schedule: The SGAMS system shall be capable of acquiring data on a user defined schedule to conserve power and recording capacities. This schedule shall be provided by the DTU. The schedule shall be defined by an absolute start time (e.g. JD 256, 1999, 13 hours, 27 minutes, 10.0000000 seconds), a power on (acquisition) duration (e.g. 7200 seconds), and a power off duration. Maximum power on/off duration shall be a minimum of 65,000 seconds. This schedule shall repeat until modified or turned off by user command via the DTU. The power off condition is defined in the previous section.

3.3.3.4 System Status Monitoring: DAU and DSU system status shall be monitored and displayed by the DTU. System status shall be refreshed whenever a change of state occurs and on user command. The following system status information shall be provided to the DTU.

a. Acoustic Channel Levels: The power level for each acoustic channel shall be provided to the DTU for display. These acoustic levels are necessary for setting system gains and identifying dead channels. Power levels for all active acoustic channels shall be provided. Power levels shall be integrated over the user selected acoustic channel bandwidth.
b. User Selectable Parameters: The state or value of all user selectable parameters shall be provided to the DTU for display.
c. EU Power Level: The EU voltage level or estimated remaining battery life shall be provided to the DTU for display.
d. DSU Recording Counter: The total amount of data recorded on the DSU or percentage of total recording capacity used to date shall be provided to the DTU for display.
e. Leak Detectors: Sensors to detect water leaks in all pressure vessels shall be provided. Status of these leak detectors shall be provided to the DTU for display.
f. System Diagnostics: The SGAM system shall perform system diagnostics on user command via the DTU. Results of diagnostic tests shall be provided to the DTU for display. Specific tests are at the discretion of the offerer, but should provided enough information to confirm proper SGAM system operation.

3.3.4 DAU System Timing Functions:

a. Master System Clock: All DAU system timing and Time/Date functions shall be derived from the Master System Clock. The master system clock shall be accurate to better than **4 parts** in 10^{11} over a 1 day period.
b. User Access to Master System Clock: Easy access to the DAU master system clock shall be provided to the user for synchronization of various measurement devices and to measure clock drift. This access point shall be buffered to prevent modification of clock operation by the user device.
c. Time/Date: The DAU shall provide a Time/Date clock for system scheduling and for insertion into every data header. The Time/Date shall have a resolution of better than 1 microsecond.
d. Time/Date Synchronization: The DAU time and date shall be user settable via the DTU. The time/date clock shall be triggered to run by a software command from the DTU or by a TTL pulse. The use of a TTL trigger shall allow multiple devices to be accurately synchronized in time (such as synchronizing an acoustic projector and the DAU for high accuracy acoustic time of flight measurements). The user supplied TTL signal shall be provided to the DAU through the RCM RS-422 serial communication port connector.

3.3.5 DAU Channel Requirements:

a. Channel to Channel Crosstalk: Channel to channel crosstalk in the DAU shall be less than -75 dB as measured between any two input channels, either acoustic or engineering. The measurement shall be made by applying reference square waves of 500 Hz, 1 kHz, and 10 kHz at the maximum allowable input voltage of the A/D to the DAU array input. The recorded output voltage of all the acoustic channels in the DAU shall be individually compared to the input reference voltage to determine the crosstalk level in dB. This measurement shall be made at both the DAUs minimum and maximum gain settings.
b. Acoustic Channel Signal Conditioner: Each channel shall have an amplifier with a programmable gain of 0 dB to a minimum of 42 dB in 6 dB steps.
c. Acoustic Channel Spectral Noise: Each DAU channel shall have a maximum input noise level of 5 nanovolts per root-hertz, from 200 Hz to 20 kHz and 10 nanovolts per root-hertz from 5 Hz to 200 Hz. This measurement shall be made by using a spectrum analyzer to observe the input to the channel A/D. The measurement shall be made with the input of the channel being measured terminated to ground.
d. CMRR: Between 5 Hz and 200 Hz CMRR shall be greater than 80 dB per channel. Between 200 Hz and 20 kHz CMRR shall be greater than 90 dB per channel.
e. Acoustic Channel Pre-Emphasis: The DAU shall have for each channel a pre-emphasis filter which is user controllable (on/off) through the DTU. This filter is to flatten the noise spectra below 10 kHz so that a single gain setting can be used to record from 10 Hz to 10 kHz. The filter shall be a high pass filter with a break frequency of 300 Hz and a slope of 6 dB per octave.
f. Engineering Channel Definition: For every 32 acoustic data channels there shall be at least 4 channels of engineering data. Each engineering channel shall record depth, two-axis tilt, magnetic heading, and support two additional sensor channels. Power for the engineering sensors shall be available from the EU through the DAU.
g. Engineering Module Crosstalk: The engineering sensors, their power supply and their output shall not raise the noise floor of the acoustic channels. This measurement shall be made by comparing the DAU channel analog output levels, before the A/D, with and without the engineering module energized and during engineering module power up, if the offerer decides to cycle the engineering module power. This requirement applies to array cable crosstalk and DAU crosstalk requirements. Crosstalk from the engineering modules must be down at least 75 dB.

3.3.6 DAU Sample Requirements:

a. Acoustic Channel Sample Rate: The sample rate for each channel shall be selectable starting in the range of 1000 to 1200 samples per second, doubling in rate until the next doubling exceeds the A/D sample rate. The final sample rate shall then be the maximum sample rate of the A/D.

b. Acoustic Channel Sampling Rate Accuracy: Time variation in the sample initiation rate shall be less than ± 1 microsecond, measured between samples commands and shall drift no more than the drift rate of the master clock.
c. Acoustic Channel Sampling Coherence: All channels shall be sampled simultaneously and synchronized to the same system clock.
d. Acoustic Channel A/D Sampling Dynamic Range: The dynamic range of the A/D shall be equal to or greater than 117 dB. Audio Engineering Society AES17-1991, shall be used to determine the dynamic range of the A/D. Any amplifier gains prior to the A/D are excluded from this measurement.
e. Acoustic Channel Sample Word Size: Word size shall be selectable by the user at 16 bits, and the maximum word size used by the A/D converter.
f. Engineering Channel Sample Rate and Word Size: The sampling rate for the engineering sensors shall be greater than 1 sample per second per channel and less than the acoustic channel sampling rate divided by the number of engineering channels. The word size shall be recommended by the offerer based on the engineering sensor specifications in Section 4.8. The word size shall provide the necessary resolution required to meet the highest sensor resolution requirement.

3.4 Data Storage Unit (DSU):

3.4.1 Unit Definition: The Data Storage Unit (DSU) is defined to be that module which contains the media to which all the information collected by the DAU is stored. It shall interface with the DAU, the EU, the DTU, and with other DSUs in use. The DAU shall provide to the DSU a block formatted digital serial stream of data for storage. The EU shall provide the DSU all power necessary to perform its storage function. The DSU shall require minimum power to operate while deployed. The DSU shall support data uploading to the DTU while on a ship deck and while in a scientific laboratory.

3.4.2 Mechanical Requirements:

a. Pressure housing: The DSU electronics shall be housed in a container with an operating depth in seawater of at least 1000 meters.
b. Connectors: All connectors shall have a minimum operating depth in seawater greater than 1000 meters. Each connector shall be provided with a protective metal end cap rated to the pressure rating of the connector. All connectors shall have either a protective shield or be located such that they are protected from accidental damage during unit movement and deployment of the DSU. At each connector a method of strain relief will be provided which minimizes the stress in the cable conductors and the connector. Each connector shall have a locking mechanism to prevent accidental disconnect.
d. Seals: All pressure vessel joints shall have dual o-ring seals.

d. Finish: All exposed surfaces of the DAU shall be designed to minimize deterioration of the structure by exposure to the ocean environment. As a minimum it shall have two coats of primer and be painted with an epoxy based paint.
e. Attachment/lift points: The DSU or any framework it is mounted in shall be provided with a minimum of three mechanical attachment points for shipboard tie-down/storage and deployment/lifting. . Lift points shall have an operating strength of at least 40,000 newtons.
f. Purge Port: The pressure vessel shall have a purge system which allows the vessel to be filled with dry nitrogen. The system will allow the nitrogen to displace the atmosphere in the pressure vessel.
g. Corrosion Protection: The pressure vessel and any framework used to support it or attach it to other units shall use passive cathodic protection against corrosion. The protection method shall have minimum useful rated usage of one year.

3.4.3 Storage Capacity:

a. Initial Capacity: The initial capacity of a single DSU shall be a minimum of 780 gigabytes.
b. Expansion Capacity: A single DSU shall be expandable to a minimum 1.8-Terrabytes in approximately 200-GB increments.

3.4.4 Expansion Capability: The deployment and operation of multiple DSUs shall be supported.

3.4.5 Connectivity:

a. The DSU shall connect to the DAU via a single high-speed serial interface (minimum 15-MB/sec).
b. Multiple DSU units shall be “daisy-chained” via a second high-speed serial interface (minimum 15-MB/sec).
c. When multiple DSUs are deployed, only a single DSU shall be in operation at any given time.

3.4.6 Data Transfer Rate:

a. The DSU shall accept and record data from the DAU at a minimum rate of 15 MB/second while deployed.
b. The DSU shall retrieve and transfer data to the DTU at a minimum rate of 15 MB/second in the laboratory and on board ship.
c. There shall be a single high-speed serial connection between the DSU and either the DAU or DTU.

3.5 Data Transfer Unit (DTU):

3.5.1 Unit Definition: The DTU is visualized as a high speed UNIX based or Microsoft Windows NT 4.x/5.x computer system with customized software and hardware interfaces.

a. The DTU shall support shipboard/laboratory data download/transfer from the Data Storage Unit (DSU).
b. The DTU system shall be capable of powering the entire SGAMS system (i.e., the DSU and the DAU) with out the use of the EU.
c. The DTU shall connect to the DSU Data input/output interface.
d. The DTU shall connect to the DAU Data input/output interface.
e. The DTU shall connect to the DAU command and control interface.
f. The DTU shall connect to the topside acoustic telemetry modem in order to send command and control operations to the deployed system.
g. The DTU shall connect to the topside acoustic telemetry modem in order to receive data from the command and control interface of the deployed DAU.
h. The DTU system shall include a shipboard deck leader(s) to connect all necessary interfaces between itself and other components of the SGAMS system:
    - power
    - high-speed serial data I/O
    - command and control interface
i. The DTU shall be capable of downloading all of the recorded data or partial data sets from a single DSU and support storage on disk files, 4mm DAT, 8mm EXABYTE, DLT, and a NRL owned AMPEX DIS-120i tape drive. The AMPEX DIS-120i and documentation shall be provided by NRL to the contractor upon request.
j. The DTU data format shall be identical to the DSU data format and shall support both big-endian and little-endian hardware architectures.
k. All custom (i.e., non-commercial) software packages developed for the DTU shall include complete source codes, documentation, and all of the necessary development environments and tools required to modify/build the custom software and documentation.
l. In addition to data transfer functions the DTU shall also perform system checkout and setup prior to deployment.
m. After deployment the DTU shall interface with the acoustic telemetry system, generating all acoustic commands and decoding and displaying all received information.

3.5.2 Command and Control Functions: The DTU shall be the end-user interface to the deployed system. Through it all programmable system functions shall be addressable and all requested system status shall be displayed.

a. Programmable Functions: The following operational parameters of the system shall be controllable by input to the DTU, which shall transfer them to the DAU by either a hardwired link(shipboard/laboratory only) or by the use of an acoustic telemetry link(deployed only): system power (on/off), channel sample rate, channel gain, system clock, hydrophone sensitivity, acoustic channel pre-emphasis (on/off), number of acoustic channels and engineering channels recorded. The operator shall be able to designate which acoustic and engineering channels are recorded.

b. System Status Parameters: The following system status information shall at a minimum be available through both the hardwired link and the acoustic telemetry communication port: EU supply voltages, recorder usage percentage, detected faults in the DSU, status of all pressure vessel leak detectors, and readout of at least 10 seconds of data for any acoustic channel or engineering channel.

3.5.3 Expansion Options: The DTU shall be capable of being substituted for the DSU and connect directly to the DAU in a cable-to-shore based recording operation.

3.5.4 Mechanical Requirements: The DTU (computer, monitor, and remote system power supply) shall be enclosed in a ruggedized rack mountable chassis and include a portable equipment rack.

3.5.5 Stored Data Format:

a. Acoustic data shall be stored in a blocked format.
b. All digitized data shall be packed to conserve storage space in the DSU and the DTU (e.g., four 24-bit data samples shall be stored in three 32-bit long words rather than four 32-bit long words; eight 20-bit data samples shall be stored in five 32-bit long words rather than eight 32-bit long words). An algorithm for packing and unpacking data shall be provided.
c. Engineering data shall be interleaved with the acoustic data blocks to conserve space.
d. Each data block shall contain an accurate Julian time/date stamp character string of the form (YYYYDDDHHMMSS.microsecond).
e. Each data block shall contain a time-stamp which allows digitized data to be referenced with a minimum 0.1 microsecond accuracy.
f. Each data block shall contain a channel header description consisting of the following information: hydrophone number or engineering sensor type and number, pre-amplifier gain, sample rate, number of data points in block, etc. When changes are commanded over the acoustic telemetry system, the changes shall be implemented at the beginning of a new data block.
g. The number of data points in each data block shall be a power of 2 per digitized channel.

3.6 Energy Unit:

3.6.1 Unit Definition: The Energy Unit shall be the main source of power for the SGAMS system. It shall provide all the voltages, at the required current capacities, for DAU, DSU, acoustic arrays and engineering sensors. The EU shall be modular, allowing the end-user to configure an energy package to support deployments from one week to one month.

3.6.2 Electrical Requirements:

a. Capacity: The basic EU shall supply enough energy to operate a 64 channel SGAMS system for at least one (1) week. The EU may consist of several modules interconnected to provide the energy required for a week of operation. All modules shall be identical in size, in shape, and in electrical configuration.
b. Expanded Capacity: The energy capacity of the EU shall be capable of being increased up to a one (1) month capacity. Modules used to increase the EUs capacity shall be identical to those in Section 3.6.2.a.
c. Failsafe: Each basic unit/module shall contain circuitry to prevent an internal failure in one unit/module (low voltage, internal short) from effecting the ability of other units/modules to supply power to SGAMS.
d. Refurbishment: The EU shall be refurbishable at-sea on the deployment vessel. Maximum refurbishment time of the EU shall be 12 hours.
e. Cables: All cables necessary to configure an EU and connect it to a DAU and DSU shall be supplied. The cabling design shall support multiple DAU, EU and DSU modules.

3.6.3 Mechanical Requirements:

a. Pressure housing: The EU electronics shall be housed in a container with an operating depth in seawater of at least 1000 meters.
b. Connectors: All connectors shall have a minimum operating depth in seawater greater than 1000 meters. Each connector shall be provided with a protective metal end cap rated to the pressure rating of the connector. All connectors shall have either a protective shield or be located such that they are protected from accidental damage during unit movement and deployment of the EU. At each connector a method of strain relief will be provided which minimizes the stress in the cable conductors and the connector. Each connector shall have a locking mechanism to prevent accidental disconnect.
c. Seals: All pressure vessel joints shall have dual o-ring seals.
d. Finish: All exposed surfaces of the DAU shall be designed to minimize deterioration of the structure by exposure to the ocean environment. As a minimum it shall have two coats of primer and be painted with an epoxy based paint.
e. Attachment/lift points: The EU or any framework it is mounted in shall be provided with a minimum of three mechanical attachment points for shipboard tie-down/storage and deployment/lifting. Lift points shall have an operating strength of at least 40,000 newtons.
f. Purge Port: The pressure vessel shall have a purge system which allows the vessel to be filled with dry nitrogen. The system will allow the nitrogen to displace the atmosphere in the pressure vessel.
g. Corrosion Protection: The pressure vessel and any framework used to support it or attach it to other units shall use passive cathodic protection against corrosion. The protection method shall have minimum useful rated usage of one year.

3.7 Test Plan:

1) a. The contractor shall develop a Test Plan for system performance and acceptance testing. The test plan shall detail system testing at the contractor's manufacturing facility of all performance specifications in Sections 3.3 to 3.6.3.g inclusive. The plan shall detail how the manufacturer intends to prove that the system meets the specifications as defined in the RFP.

b. Testing of the following specifications and functions shall be incorporated in the test plan:

i) Measurement of the power required to operate the procured DAU, DSU and arrays. This measurement shall include all voltages and currents from the EU to the DAU and DSU. The contractor is to define a minimum energy package which shall demonstrate that the EU supports the seven day deployment. This package shall be used to quantify the EU design. The package shall power the system for at least 12 hours continuously during the test.

ii) Measurement of the input noise level of the DAU. This measurement shall be made at both amplifier minimum gain and maximum gain for a DAU channel.

c. The test plan shall be delivered to the COR for approval no later than 45 days prior to start of the factory test.

d. The offerer shall provide training on the assembly, dis-assembly, configuration, and operation of all aspects of the SGAMS system for a group of seven (7) end-users at the factory acceptence test.

2) a. The contractor shall develop a Test Plan for specified optional items for system performance and acceptance testing. The test plan shall detail system testing at the contractor's manufacturing facility of all performance specifications as detailed below. The plan shall detail how the manufacturer intends to prove that the system meets the specifications as defined in the RFP.

b. Testing of the following option item specifications and functions shall be incorporated in the appropriate test plan:

i) Option 4 shall be tested in a lab environment by use of a hardware link between the surface unit and the underwater unit to confirm operation in accordance with Technical Performance Specification requirements and specifically the controllability of the command and control parameters of the DAU and DTU via the acoustic telemetry as confirmed by use of a hardware link.

ii) Option 8 shall be tested to verify performance in accordance with the Technical Performance Specification, paragraph 4.9

iii) Options 9,10,11,12 shall be tested verify performance in accordance with Technical Performance Specification sections 4.10, 4.11, 4.12 and 4.13 respectively. The testing shall also verify cross-talk and noise levels in accordance with specified requirements.

c. Upon exercise of the option, a test plan shall be delivered to the COR for approval no later than 45 days prior to start of the factory test.

d. The offerer shall provide training on the assembly, dis-assembly, configuration, and operation of all aspects of the SGAMS system for a group of seven (7) end-users at the factory acceptance test.

3.8 Deployment/Recovery Plan and Hardware:

a. Deployment/Recovery: The contractor shall furnish a deployment/recovery plan for the basic one week system. The plan shall detail all hardware, procedures and specifications for any equipment identified as required to deploy a system in 200 meter water. The deployment shall consist of one vertical array, 185 meters in length, a horizontal array 200 meters in length, DAU, DSU and EU. The vertical array shall have a minimum line tension of 4500 newtons. The DAU and DSU shall be suspended in the water column, but the EU may set on the ocean floor, contractor choice. EU recovery is required. The plan shall contain the specifications for all equipment required for deployment and recovery of SGAMS.
b. Deployment Hardware: A complete set of hardware required to deploy the system shall be supplied. This includes all floats, shackles and sacrificial anchors.

3.9 Documentation:

a. Operation Manual: This manual shall describe in detail how to operate SGAMS. It shall contain the procedures to be used for predeployment checkout, hardware and system preparation, detail the sequence of events for a deployment and provide a system check list for all mechanical and electric connections required for a successful deployment. The manual shall describe what SGAMS functions are programmable over the hardwired DAU interface and acoustic communication port and shall provide a step by step description of how to program SGAMS for deployment. If the acoustic modem option is exercised, the manual shall include instructions for reprogramming SGAMS and command data transmission to the support ship.
b. Technical Manual: Technical manual/manuals shall be provided for the DAU, DSU, EU and DTU. It is the manufacturers choice whether to provide one manual for the system or individual manuals for each unit. The manual/manuals shall describe in detail the design of each unit, its hardware and provide a functional description of all circuitry and software. Included shall be a detailed list of all parts/components used in SGAMS. The list shall identify all vendors, vendor part numbers, vendor addresses, telephone numbers and web sites.
c. Software: Source code listings of software used in SGAMS shall be provided in both hard copy and electronic form. Copies of all custom software and its development system and all commercial software shall be provided.
d. Technical Drawings: Detailed drawings shall be provided for all custom hardware required by SGAMS.
e. Documentation Form: Three hard copies of each manual listed above shall be supplied, along with an electronic copy of each manual. Electronic copies shall be provided on 3.5 inch PC formatted disk or CDROM. Information provided in electronic form shall be a Microsoft Word 6.0 or higher document.

4.0 OPTION REQUIREMENTS

4.1 Acoustic Mooring Releases: The contractor shall provide as an option the acoustic releases and deck unit identified in the contractor provide deployment/recovery plan.

4.2 Acoustic Positioning System: The offerer is requested to propose a long baseline acoustic positioning system which shall be capable of providing the location of the deployed system with an rms accuracy of 20 meters in a 500 meter depth of water, when using Differential GPS as an aid. The system shall be capable of using GPS navigation as a reference to refine the geodetic location of SGAMS. At sea, the user shall supply either standard or differential GPS data in NEMA format for use by the acoustic positioning system. Integration of this requirement into the acoustic mooring release option is acceptable. The system shall have an operating depth greater than 1000 meters.

4.3 Acoustic Array Element Navigation: The acoustic array element navigation system shall operate in the 10 kHz to 16 kHz frequency region. Array element navigation shall be accomplished using a long baseline acoustic positioning system. The system shall consist of, at a minimum, three baseline transponders, one responder and a shipboard control unit. The shipboard control unit shall be able to interrogate the baseline transponders and establish their positions, it also shall be able to interrogate the responder to establish its position within the baseline net. The responder shall be able to operate in two modes: one, respond to interrogations from the shipboard unit; two, upon electronic command from SGAMS, initiate an interrogation of the baseline network. The offerer is not responsible for any array element navigation software. Implementation of this option shall require that a selected number of elements in the vertical array must have a fixed sample rate, set at the maximum sample rate of the A/D. For bidding use, the number of channels set to the higher sample rate shall be six. Integration of this requirement into the Acoustic Positioning System and/or Acoustic Mooring Releases is acceptable.

4.4 Acoustic Telemetry: The system shall support bidirectional data transmission rates at 2400 baud minimum and operate in the 25 kHz to 40 kHz frequency band to prevent interference with the ocean acoustic measurements. The system shall provide user selectable modulation schemes, which may reduce the baud rate, but increase data transfer reliability. The system shall also have a transmission mode for use in high multi-path environments which allows delays between data packet transmissions. The system shall interface with the DAU through an RS-232 serial communication port. This port shall be bi-directional, allowing remote programming of selected system functions from a support vessel and enable transfer of data from SGAMS to the support vessel. The system shall include both the underwater unit and the deck equipment needed to communicate with the underwater unit. The deck unit shall interface with the DTU for command and control functions.

4.5 Storage Capacity Up-grade: The contractor shall provide an up-grade to increase the storage capacity of the DSU in storage increments greater than 180 gigabytes. It is recognized that the upper boundary may be set by the storage media type and system. The up-grade shall include all electronic hardware, cabling, additional connectors, and pressure vessels.

4.6 EU Capacity Up-grade: The Contractor shall provide an energy up-grade for SGAMS which shall increase the energy capacity in one week increments to 28 days.

4.7 Engineering Modules: Vertical arrays shall have positions for four engineering modules. Location along the array shall be provided by the COR upon exercise of an array option.

4.8 Basic Vertical Array Engineering Module: Each basic vertical array engineering module shall consist of a depth sensor, a compass, and a two-axis tilt sensor. All engineering sensors shall be sampled at a minimum 1 Hz rate. Data from all engineering modules shall be multiplexed into the acoustic data stream for storage in the DSU.

a. Depth Sensor: Depth sensor resolution shall be less than 0.05 meters with a accuracy of 0.3 meters over the full operating depth of SGAMS.
b. Compass: A compass shall be provided which shall provide a measurement of heading to an accuracy of ±1 degree minimum through a tilt angle of ± 45 degrees.
c. Tilt Sensor: A two-axis tilt sensor shall be provided for each engineering module. Minimum tilt measurement accuracy in each axis shall be ± 0.5-degrees with operating angle of ±45-degrees.

4.9 DAU Basebanding Option: Basebanding high frequency limited bandwidth acoustic signals is a method of reducing the data transfer rate and the amount of data to be stored. Because of the end use of the recorded data, any basebanding used by SGAMS shall result in a quadrature detected output capable of reconstructing the phase and amplitude the original signal.

a. Basebanding Increments: The basebanding process shall have a programmable center frequency, selectable in approximately 1 kHz increments, over the frequency span of 1 kHz to 20 kHz. Also, bandpass filters of 1 kHz, 2 kHz, 4 kHz and 5 kHz, centered at the selected center frequency shall be user selectable. The basebanding process shall also not aliases any out of band signals.
b. Low Pass filters: Each quadrature detector shall have an output lowpass filter with selectable bandwidths of 1 kHz, 2 kHz, 4 kHz and 5 kHz. The bandwidth of the filter shall be software selectable. The filter rolloff at the selected frequency shall be down no more than 3 dB and the filter skirt shall have slope of at least 30 dB per octave.
c. Noise Floor: The basebanding process shall not raise the noise floor of the processed signal more than 3 dB, referenced to the signal to noise ratio of basebanded signal.

d. Channel and Word Size Requirements: The basebanding process shall be capable of processing 64 channels at the maximum sample rate of the A/D, without loss of data or throughput capacity.
e. Word Size: The output word from each quadrature detector shall have the same number of bits as the word selected for the A/D output.
f. Bandpass Data Format: When quadrature detection is used the data shall be packed as a double word with the sine component (Real) first and the cosine component (Imaginary) second.
g. Basebanding Command and Control: All programmable parameters of the basebanding process shall be controllable through the remote control and monitoring ports.

4.10 Vertical Array Option 1:

a. Number of Hydrophones: The array shall have no fewer than 32 hydrophones.

b. Array length: The length of the array, measured from the DAU connector to the supporting float will not be less than 50 meters and will not exceed 185 meters. The length will be provided by the COR upon exercise of the option.

c. Hydrophone positions and spacing: The location of each of the hydrophones along the array will be specified by the COR upon exercise of the option. The sensing elements of the hydrophones will located at these positions to a tolerance of ± 5 centimeters.

d. Operational Depth: The array shall function and meet all specifications when deployed in the ocean to any depth less than or equal to 500 meters.

e. Inter-channel crosstalk: The signal crosstalk figure measured between any pair of acoustic or engineering signal channels shall be no greater than -60 decibels. Thus if a 1 volt root mean square signal is supplied by a sensor on any signal channel with no signals applied by the sensors on other channels, the crosstalk to these other channels shall be no greater than - 60 dB re 1 volt root mean square. The measurement shall be made with the system fully assembled and test signals used shall be continuous wave signals at any frequency throughout the operating range of the system. The signal input measurement point shall be at the sensor location and the signal output point shall be at the input to the analog-to-digital converter. The array and other components of the syustem shall be constructed so that this measurement can be made in a laboratory benchtop environment.

f. Fairing: The array shall be faired along its entire length with a haired fairing. The length of this fairing strands shall be at least 4 times the cable diameter. The linear density of the fairing shall conform to customary industry practice for effective reduction of current-induced strum.

4.10.1 Array Electromechanical Cable:

a. Mechanical Strength: The array shall have a working strength of at least 20,000 newtons force and a breaking strength of at least 40,000 newtons force. The array cable shall not be damaged electrically or mechanically by being deployed through a sheave of diameter 75 centimeters under conditions of a 90 degree cable bend with a cable tension of 20,000 newtons.

b. Mechanical Terminations: Separate electrical and mechanical terminations shall be used to provide strain relief for the electrical connector and to enable the electrical connector(s) to be connected and disconnected while maintaining a working strength tension on the assembled mechanical terminations. Mechanical terminations shall be provided at both ends of the array.

c. Electrical Terminations: The array shall be connected electrically to the DAU via one or more waterproof multipin electrical connectors. This connector shall have a screw-on or twist-lock strain relief cap to prevent disconnection of the connector(s) due to a tension of 1000 newtons when the unit is assembled.

4.10.2 Hydrophones.

4.10.2.1 Attachment to the array: The hydrophones shall be mounted external to the array cable and shall be designed so they are readily removable from and replaceable onto the array for purposes of testing and repair. The mechanical attachment shall be of a shock-mount type and shall conform to standard industry practice for shock-mounting hydrophones. Electrical attachment to the array shall be made by using waterproof electrical connectors which have strain relief caps. These strain relief caps will withstand a force of 500 newtons without disconnecting the connector or compromising its electrical integrity.

4.10.2.2 Hydrophone sensitivity and electrical performance.

a. Preamplifiers: The hydrophone units shall have signal preamplifiers with a current-source output. Conversion of the current-source signal to a voltage signal (for instance, by a resistor) shall take place within the DAU signal conditioning electronics unit.

b. Sensitivity: The nominal sensitivity of the hydrophone sensors measured at the current-to-voltage converter shall be at least -180 decibels relative to 1 volt per micropascal acoustic signal pressure. The hydrophone sensitivity shall be selectable between this nominal sensitivity and a 40 decibel lower sensitivity (for use with high-level acoustic signals) by reversal of the preamplifier power supply polarity. The absolute sensitivity calibration (referred to 1 micropascal) of each hydrophone to an accuracy of 0.5 decibels shall be provided over the frequency range 20 Hz to 5 kHz in intervals no larger than 1/3 octave intervals. This information shall be provided in a word-

processing compatible table and in hard-copy form. This calibration data shall contain information necessary to associate the data with each of the corresponding hydrophones via indelible marks on the exterior of the hydrophone units.

c. Passband Flatness and channel-to-channel uniformity: As measured at the current-to-voltage converter within the DAU, each hydrophone shall have a constant sensitivity to:
   1) within ± 1 dB over the acoustic signal frequency range 20 Hz to 1.5 kHz,
   2) within ± 3 dB over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
   3) within ± 6 dB over the acoustic signal frequency range 5 kHz to 10 kHz.

d. The differences in sensitivity of any acoustic channel, with decibel sensitivity values averaged over the linearly-weighted frequency band, to the similarly-averaged sensitivity of any other acoustic channel shall not vary by more than:
   1) ± 1 dB when averaged over the acoustic signal frequency range 20 Hz to 1.5 kHz,
   2) ± 3 dB when averaged over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
   3) ± 6 dB when averaged over the acoustic signal frequency range 5 kHz to 10 kHz.

e. Laboratory calibration signal: A provision shall be made for injecting a user-provided calibration signal through each and every one of the hydrophone preamplifiers (i.e., one at a time and all simultaneously) with the array connected electrically to the DAU and the amplifiers powered by the DAU electronics in a laboratory setting. For each of the hydrophones, the calibration signal shall be applied to the preamplifier input in series with the hydrophone crystal element.

f. Hydrophone self noise: The electrical self-noise of the assembled hydrophones/preamplifier/array/DAU system, when operated in the system's highest gain state, shall be sufficiently low that this self noise, as measured at the input to the analog-to-digital converter within the DAU, shall not exceed the following equivalent acoustic noise levels when the electrical amplification gains and hydrophone sensitivities are accounted for. The levels are: 45 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 50 Hz to 500 Hz and 25 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 500 Hz to 10 kHz.

4.11 Vertical Array Option #2:

a. Number of Hydrophones: The array shall have no fewer than 64 hydrophones. The number of hydrophones is the principal difference between the specifications for Vertical Array #1 and Vertical Array #2

b. Array length: The length of the array, measured from the DAU connector to the supporting float will not be less than 50 meters and will not exceed 185 meters. The length will be provided by the COR upon exercise of the option.

c. Hydrophone positions and spacing: The location of each of the hydrophones along the array will be specified by the COR upon expercise of the option. The sensing elements of the hydrophones will located at these positions to a tolerance of ± 5 centimeters.

d. Operational Depth: The array shall function and meet all specifications when deployed in the ocean to any depth less than or equal to 500 meters.

e. Inter-channel crosstalk: The signal crosstalk figure measured between any pair of acoustic or engineering signal channels shall be no greater than -60 decibels. Thus if a 1 volt root mean square signal is supplied by a sensor on any signal channel with no signals applied by the sensors on other channels, the crosstalk to these other channels shall be no greater than - 60 dB re 1 volt root mean square. The measurement shall be made with the system fully assembled and test signals used shall be continuous wave signals at any frequency throughout the operating range of the system. The signal input measurement point shall be at the sensor location and the signal output point shall be at the input to the analog-to-digital converter. The array and other components of the syustem shall be constructed so that this measurement can be made in a laboratory benchtop environment.

f. Fairing: The array shall be faired along its entire length with a haired fairing. The length of this fairing strands shall be at least 4 times the cable diameter. The linear density of the fairing shall conform to customary industry practice for effective reduction of current-induced strum.

4.11.1 Array Electromechanical Cable:

a. Mechanical Strength: The array shall have a working strength of at least 20,000 newtons force and a breaking strength of at least 40,000 newtons force. The array cable shall not be damaged electrically or mechanically by being deployed through a sheave of diameter 75 centimeters under conditions of a 90 degree cable bend with a cable tension of 20,000 newtons.

b. Mechanical Terminations: Separate electrical and mechanical terminations shall be used to provide strain relief for the electrical connector and to enable the electrical connector(s) to be connected and disconnected while maintaining a working strength tension on the assembled mechanical terminations. Mechanical terminations shall be provided at both ends of the array.

c. Electrical Terminations: The array shall be connected electrically to the DAU via one or more waterproof multipin electrical connectors. This connector shall have a a screw-on or twist-lock strain relief cap to prevent disconnection of the connector(s) due to a tension of 1000 newtons when the unit is assembled.

4.11.2 Hydrophones

4.11.2.1 Attachment to the array: The hydrophones shall be mounted external to the array cable and shall be designed so they are readily removable from and replaceable onto the array for purposes of testing and repair. The mechanical attachment shall be of a shock-mount type and shall conform to standard industry practice for shock-mounting hydrophones. Electrical attachment to the array shall be made by using waterproof electrical connectors which have strain relief caps. These strain relief caps will withstand a force of 500 newtons without disconnecting the connector or compromising its electrical integrity.

4.11.2.2 Hydrophone sensitivity and electrical performance

a. Preamplifiers: The hydrophone units shall have signal preamplifiers with a current-source output. Conversion of the current-source signal to a voltage signal (for instance, by a resistor) shall take place within the DAU signal conditioning electronics unit.

b. Sensitivity: The nominal sensitivity of the hydrophone sensors measured at the current-to-voltage converter shall be at least -180 decibels relative to 1 volt per micropascal acoustic signal pressure. The hydrophone sensitivity shall be selectable between this nominal sensitivity and a 40 decibel lower sensitivity (for use with high-level acoustic signals) by reversal of the preamplifier power supply polarity. The absolute sensitivity calibration (referred to 1 micropascal) of each hydrophone to an accuracy of 0.5 decibels shall be provided over the frequency range 20 Hz to 5 kHz in intervals no larger than 1/3 octave intervals. This information shall be provided in a word-processing compatible table and in hard-copy form. This calibration data shall contain information necessary to associate the data with each of the corresponding hydrophones via indelible marks on the exterior of the hydrophone units.

c. Passband Flatness and channel-to-channel uniformity: As measured at the current-to-voltage converter within the DAU, each hydrophone shall have a constant sensitivity to:

1) within ± 1 dB over the acoustic signal frequency range 20 Hz to 1.5 kHz,
2) within ± 3 dB over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
3) within ± 6 dB over the acoustic signal frequency range 5 kHz to 10 kHz.

d. The differences in sensitivity of any acoustic channel, with decibel sensitivity values averaged over the linearly-weighted frequency band, to the similarly-averaged sensitivity of any other acoustic channel shall not vary by more than:

1) ± 1 dB when averaged over the acoustic signal frequency range 20 Hz to 1.5 kHz,
2) ± 3 dB when averaged over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
3) ± 6 dB when averaged over the acoustic signal frequency range 5 kHz to 10 kHz.

e. Laboratory calibration signal: A provision shall be made for injecting a user-provided calibration signal through each and every one of the hydrophone preamplifiers (i.e., one at a time and all simultaneously) with the array connected electrically to the DAU and the amplifiers powered by the DAU electronics in a laboratory setting. For each of the hydrophones, the calibration signal shall be applied to the preamplifier input in series with the hydrophone crystal element.

f. Hydrophone self noise: The electrical self-noise of the assembled hydrophones/preamplifier/array/DAU system, when operated in the system's highest gain state, shall be sufficiently low that this self noise, as measured at the input to the analog-to-digital converter within the DAU, shall not exceed the following equivalent acoustic noise levels when the electrical amplification gains and hydrophone sensitivities are accounted for. The levels are: 45 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 50 Hz to 500 Hz and 25 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 500 Hz to 10 kHz.

4.12 Horizontal Array Option 1:

a. Number of Hydrophones: The array shall have no fewer than 32 hydrophones.

b. Array length: The length of the array, measured from the DAU connector to the mechanical termination at the opposite end will not be less than 50 meters and will not exceed 200 meters. The length will be provided by the COR upon exercise of the option.

c. Hydrophone positions and spacing: The location of each of the hydrophones along the array will be specified by the COR upon exercise of the option. The sensing elements of the hydrophones will located at these positions to a tolerance of ± 5 centimeters.

d. Operational Depth: The array shall function and meet all specifications when deployed in the ocean to any depth less than or equal to 500 meters.

e. Inter-channel crosstalk: The signal crosstalk figure measured between any pair of acoustic or engineering signal channels shall be no greater than -60 decibels. Thus if a 1 volt root mean square signal is supplied by a sensor on any signal channel with no signals applied by the sensors on other channels, the crosstalk to these other channels shall be no greater than - 60 dB re 1 volt root mean square. The measurement shall be made with the system fully assembled and test signals used shall be continuous wave signals at any frequency throughout the operating range of the system. The signal input measurement point shall be at the sensor location and the signal output point shall be at the input to the analog-to-digital converter. The array and other components of the syustem shall be constructed so that this measurement can be made in a laboratory benchtop environment.

4.12.1 Array Electromechanical Cable:

a. Mechanical Strength: The array shall have a working strength of at least 20,000 newtons force and a breaking strength of at least 40,000 newtons force. The array cable shall not be damaged electrically or mechanically by being deployed through a sheave of diameter 75 centimeters under conditions of a 90 degree cable bend with a cable tension of 20,000 newtons.

b. Mechanical Terminations: Separate electrical and mechanical terminations shall be used to provide strain relief for the electrical connector and to enable the electrical connector(s) to be connected and disconnected while maintaining a working strength tension on the assembled mechanical terminations. Mechanical terminations shall be provided at both ends of the array.

c. Electrical Terminations: The array shall be connected electrically to the DAU via one or more waterproof multipin electrical connectors. This connector shall have a a screw-on or twist-lock strain relief cap to prevent disconnection of the connector(s) due to a tension of 1000 newtons when the unit is assembled.

4.12.2 Hydrophones

4.12.2.1 Attachment to the array: The hydrophones shall be mounted external to the array cable and shall be designed so they are readily removable from and replaceable onto the array for purposes of testing and repair. The mechanical attachment shall be of a shock-mount type and shall conform to standard industry practice for shock-mounting hydrophones. Electrical attachment to the array shall be made by using waterproof electrical connectors which have strain relief caps. These strain relief caps will withstand a force of 500 newtons without disconnecting the connector or compromising its electrical integrity.

4.12.2.2 Hydrophone sensitivity and electrical performance

a. Preamplifiers: The hydrophone units shall have signal preamplifiers with a current-source output. Conversion of the current-source signal to a voltage signal (for instance, by a resistor) shall take place within the DAU signal conditioning electronics unit.

b. Sensitivity: The nominal sensitivity of the hydrophone sensors measured at the current-to-voltage converter shall be at least -180 decibels relative to 1 volt per micropascal acoustic signal pressure. The hydrophone sensitivity shall be selectable between this nominal sensitivity and a 40 decibel lower sensitivity (for use with high-level acoustic signals) by reversal of the preamplifier power supply polarity. The absolute sensitivity calibration (referred to 1 micropascal) of each hydrophone to an accuracy of 0.5 decibels shall be provided over the frequency range 20 Hz to 5 kHz in intervals no larger than 1/3 octave intervals. This information shall be provided in a word-processing compatible table and in hard-copy form. This calibration data shall contain information necessary to associate the data with each of the corresponding hydrophones via indelible marks on the exterior of the hydrophone units.

c. Passband Flatness: As measured at the current-to-voltage converter within the DAU, each hydrophone shall have a constant sensitivity to:

1) within ± 1 dB over the acoustic signal frequency range 20 Hz to 1.5 kHz,
2) within ± 3 dB over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
3) within ± 6 dB over the acoustic signal frequency range 5 kHz to 10 kHz.

d. Laboratory calibration signal: A provision shall be made for injecting a user-provided calibration signal through each and every one of the hydrophone preamplifiers (i.e., one at a time and all simultaneously) with the array connected electrically to the DAU and the amplifiers powered by the DAU electronics in a laboratory setting. For each of the hydrophones, the calibration signal shall be applied to the preamplifier input in series with the hydrophone crystal element.

e. Hydrophone self noise: The electrical self-noise of the assembled hydrophones/preamplifier/array/DAU system, when operated in the system's highest gain state, shall be sufficiently low that this self noise, as measured at the input to the analog-to-digital converter within the DAU, shall not exceed the following equivalent acoustic noise levels when the electrical amplification gains and hydrophone sensitivities are accounted for. The levels are: 45 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 50 Hz to 500 Hz and 25 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 500 Hz to 10 kHz.

4.13 Horizontal Array Option 2:

a. Number of Hydrophones: The array shall have no fewer than 96 hydrophones.

b. Array length: The length of the array, measured from the DAU connector to the mechanical termination at the opposite end will not be less than 200 meters and will not exceed 1500 meters. The length will be provided by the COR upon exercise of the option.

c. Hydrophone positions and spacing: The location of each of the hydrophones along the array will be specified by the COR upon exercise of the option. The sensing elements of the hydrophones will located at these positions to a tolerance of ± 5 centimeters.

d. Operational Depth: The array shall function and meet all specifications when deployed in the ocean to any depth less than or equal to 500 meters.

e. Inter-channel crosstalk: The signal crosstalk figure measured between any pair of acoustic or engineering signal channels shall be no greater than -**40** decibels. Thus if a 1-volt root mean square signal is supplied by a sensor on any signal channel with no signals applied by the sensors on other channels, the crosstalk to these other channels shall be no greater than -60 dB re 1 volt root mean square. The measurement shall be made with the system fully assembled and test signals used shall be continuous wave signals at any frequency throughout the operating range of the system. The signal input measurement point shall be at the sensor location and the signal output point shall be at the input to the analog-to-digital converter. The array and other components of the syustem shall be constructed so that this measurement can be made in a laboratory benchtop environment.

4.13.1 Array Electromechanical Cable:

a. Mechanical Strength: The array shall have a working strength of at least 20,000 newtons force and a breaking strength of at least 40,000 newtons force. The array cable shall not be damaged electrically or mechanically by being deployed through a sheave of diameter 75 centimeters under conditions of a 90-degree cable bend with a cable tension of 20,000 newtons.

b. Mechanical Terminations: Separate electrical and mechanical terminations shall be used to provide strain relief for the electrical connector and to enable the electrical connector(s) to be connected and disconnected while maintaining a working strength tension on the assembled mechanical terminations. Mechanical terminations shall be provided at both ends of the array.

c. Electrical Terminations: The array shall be connected electrically to the DAU via one or more waterproof multi-pin electrical connectors. This connector shall have a screw-on or twist-lock strain relief cap to prevent disconnection of the connector(s) due to a tension of 1000 newtons when the unit is assembled.

4.13.2 Hydrophones

4.13.2.1 Attachment to the array: The hydrophones shall be mounted external to the array cable and shall be designed so they are readily removable from and replaceable onto the array for purposes of testing and repair. The mechanical attachment shall be of a shock-mount type and shall conform to standard industry practice for shock-mounting hydrophones. Electrical attachment to the array shall be made by using waterproof electrical connectors which have strain relief caps. These strain relief caps will withstand a force of 500 newtons without disconnecting the connector or compromising its electrical integrity.

4.13.2.2 Hydrophone sensitivity and electrical performance

a. Preamplifiers: The hydrophone units shall have signal preamplifiers with a current-source output. Conversion of the current-source signal to a voltage signal (for instance, by a resistor) shall take place within the DAU signal conditioning electronics unit.

b. Sensitivity: The nominal sensitivity of the hydrophone sensors measured at the current-to-voltage converter shall be at least -180 decibels relative to 1 volt per micropascal acoustic signal pressure. The hydrophone sensitivity shall be selectable between this nominal sensitivity and a 40 decibel lower sensitivity (for use with high-level acoustic signals) by reversal of the preamplifier power supply polarity. The absolute sensitivity calibration (referred to 1 micropascal) of each hydrophone to an accuracy of 0.5 decibels shall be provided over the frequency range 20 Hz to 5 kHz in intervals no larger than 1/3 octave intervals. This information shall be provided in a word-processing compatible table and in hard-copy form. This calibration data shall contain information necessary to associate the data with each of the corresponding hydrophones via indelible marks on the exterior of the hydrophone units.

c. Passband Flatness: As measured at the current-to-voltage converter within the DAU, each hydrophone shall have a constant sensitivity to:

1) within ± 1 dB over the acoustic signal frequency range 20 Hz to 1.5 kHz,
2) within ± 3 dB over the acoustic signal frequency range 1.5 kHz to 5 kHz, and
3) within ± 6 dB over the acoustic signal frequency range 5 kHz to 10 kHz.

d. Laboratory calibration signal: A provision shall be made for injecting a user-provided calibration signal through each and every one of the hydrophone preamplifiers (i.e., one at a time and all simultaneously) with the array connected electrically to the DAU and the amplifiers powered by the DAU electronics in a laboratory setting. For each of the hydrophones, the calibration signal shall be applied to the preamplifier input in series with the hydrophone crystal element.

e. Hydrophone self noise: The electrical self-noise of the assembled hydrophones/preamplifier/array/DAU system, when operated in the system's highest gain state, shall be sufficiently low that this self noise, as measured at the input to the analog-to-digital converter within the DAU, shall not exceed the following equivalent acoustic noise levels when the electrical amplification gains and hydrophone sensitivities are accounted for. The levels are: 45 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 50 Hz to 500 Hz and 25 decibels relative to 1 micropascal-squared per Hz throughout the frequency range 500 Hz to 10 kHz.

4.14 Increased array depth: Options to increase the specified depth from 500 to 1000 meters in sections 4.10 through 4.13 inclusive.

4.15 Vertical Array Cable: Provide an option to purchase at least 2 kilometers of vertical cable.

4.16 Horizontal Array Cable: Provide an option to purchase at least 2 kilometers of horizontal cable.