TECHNICAL PERFORMANCE SPECIFICATION

FOR

HIGH FREQUENCY ACOMMS SOURCE RECEIVER ARRAY SYSTEM

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1.0 SCOPE

This specification establishes the requirements for a High Frequency Acomms Source Receiver Array (ASRA) system. The baseline ASRA system will be used for over-the side operations from a research vessel and consists of a 100 meter vertical line array, electronics module, and shipboard interface unit. The surface buoy option will enable remote and autonomous deployment of the baseline components. Both configurations will provide acoustic communications (Acomms) platforms for conducting digital acoustic networking through the ocean medium over the 15-25 kHz and 35-55 kHz bands.

The key feature of the ASRA system is that its computer-controlled electronics will transmit and receive arbitrary acoustic signals via a 16-transducer array. The baseline version requires the array to be deployed over the side of a research vessel with the top transducer of the array positioned 20 to 30 meters below the surface. As an option, the array will be anchored to the ocean floor and a surface buoy will be capable of remote and autonomous operations over a period of no less than 36 hours at temperatures as low as 10 degrees C. Under this option, the top of the array will also be positioned 20 to 30 meters below the surface. Both configurations require a method to digitize and record 16 channels of data, and a method to drive the 16 transducers.

When deployed over the side, a shipboard interface unit will provide direct command and control over the ASRA system via hard-wired TCP/IP networking. When deployed using the moored surface buoy option, the ASRA system will be anchored to the ocean floor at bottom depths to 200 meters. As part of this option, wireless networking shall provide continuous communications (for remote monitoring and control) between the ASRA system and the research vessel.

The ASRA system integrator shall design for minimum power consumption, weight, and ease of adaptability by the government for evolving needs. Deployment, recovery, and handling of the ASRA system are critical to the success of the ASRA mission. The use of commercial off-the-shelf (COTS) software and hardware is highly desirable.

All application and integration software will be required to meet this specification. Ease of modification of the application software by the government for evolving research needs is also critical to the success of the ASRA mission.

A conceptual block diagram of the ASRA system is shown in Figure 1 on page 2. Architectural layout may vary as long as the system specifications are met.

1.1 Government Furnished Equipment (GFE)

For the moored option, the government will provide one acoustic release pair and its associated shipboard deck control box so the contractor can integrate them into the ASRA design. The acoustic releases have been modified to include capability of release by an electrical signal (via a pair of relay contacts) controlled by the

Electronics Module. Mooring components below the acoustic release unit (the anchor and anchor line) will be provided by the government.

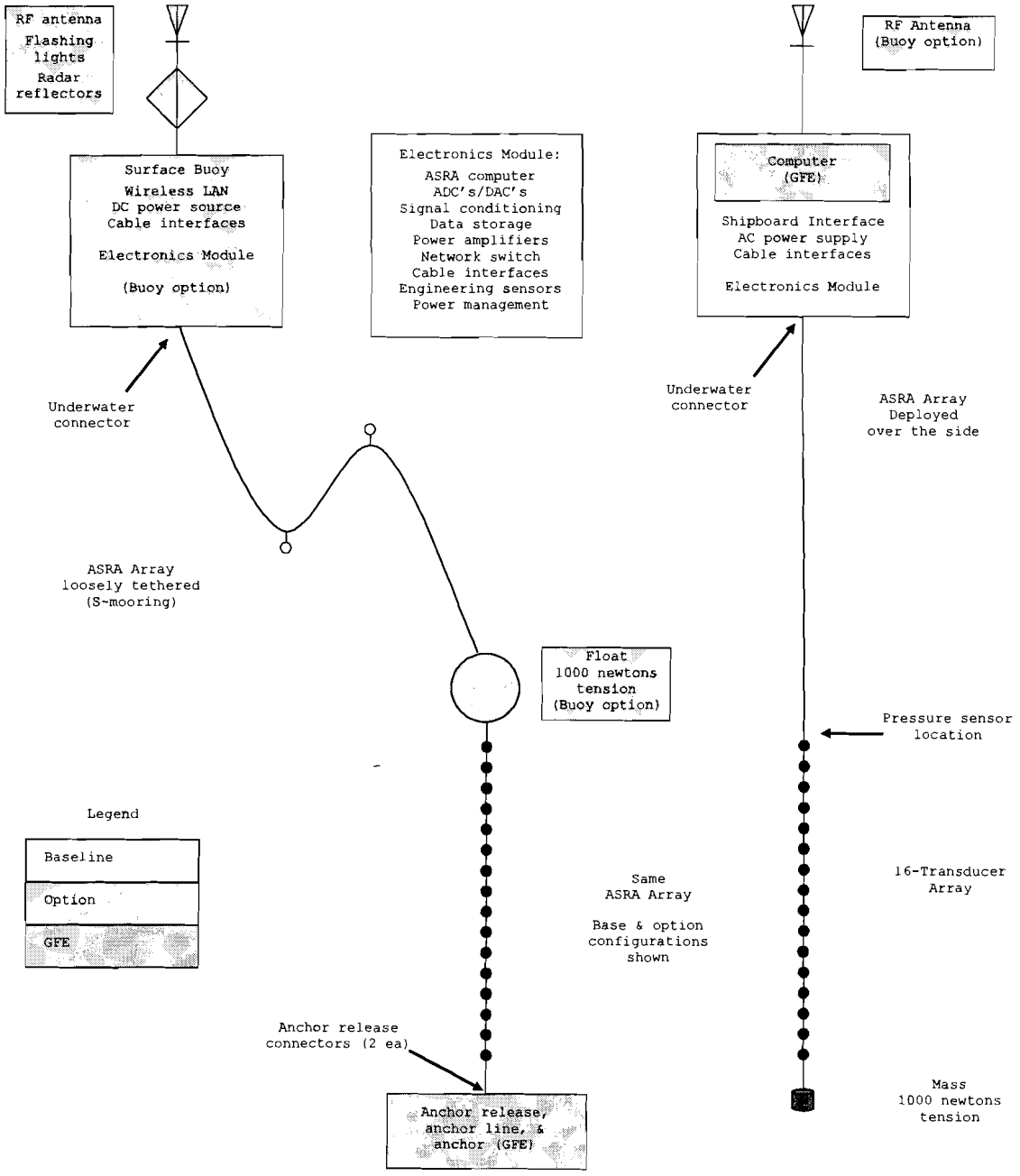

Figure 1. ASRA System Conceptual Block Diagram

2.0 SYSTEM DESCRIPTION

2.1 Vertical Line Array, 15-25 kHz

One vertical line array assembly shall be delivered, consisting of an array cable, 16 transducers, transmit-receive preamplifiers, and a pressure sensor. Overall length of the line array assembly shall be 100 m. (+- 5 meters) The upper part of the array cable (leader) shall be 86-93 m long. The lower part of the array cable shall be 2-4 m long and include a strength member, mechanical termination, and two acoustic release connectors.

The transducer end of the array shall be positionable in the water column with the top element 20-30 meters (m) deep. The 16 transducers shall be equally spaced over an active aperture of 5-10 m. (The government will provide the exact aperture length at the time of contract award.) Pigtails shall permit movement of the transducer attachment point by up to ±0.5 m. Each transducer shall have an omnidirectional radiation pattern. Haired fairing shall be required on the array cable if strum from currents up to 2 knots raises the acoustic noise floor above sea state zero over any portion of the 1 kHz to 60 kHz bandwidth.

Frequency response of the tuning network/transducer assemblies shall be flat ±3 dB over the band 15 kHz to 25 kHz. Each transducer shall be capable of omnidirectional transmission of an arbitrary signal at power levels up to 25 watts acoustic (185 dBA). The government does not intend to operate at an over all acoustic power greater than 160 watts (193 dBA). Examples: (1) 10 watts acoustic from each of the 16 transducers; (2) 20 watts acoustic from any 8 of the 16 transducers; etc. Transmission of each channel at 25 watts acoustic shall be required for 30 seconds. Overall transmission of 160 watts acoustic shall be required for 30 seconds followed by zero power transmission for 45 seconds. The maximum duty cycle will be 40%. Quantization noise and other noise components shall be minimized.

Frequency response of the preamplifiers shall be flat ±1 dB over the band 1 kHz to 60 kHz. Electronic self noise floor shall not exceed the equivalent acoustic noise floor at sea state zero. The preamplifier's output shall employ differential drive technology that minimizes crosstalk and external interference. Preamplifier gain shall achieve approximately -140 dB re 1 volt per MicroPascal at the postamplifier input. Preamplifier/transducer frequency response, equivalent electronic noise (referred to the input), and sound pressure sensitivity shall be specified in the proposal.

Postamplifier signal conditioning shall provide a range of -140 to -110 dB re 1 volt per MicroPascal at the analog to digital converter (ADC). Individual postamplifier channel gain, envisioned as 6 dB steps, shall be controlled over this range by the ASRA PC. Post-amplifier noise (referred to the input) shall be specified in the proposal.

Transmit-receive (T-R) switches and preamplifiers shall be positioned within 0.5 m of the transducers. Pressure vessels or potted assemblies may be used to house the T-R switch and preamplifier electronics. The T-R switch shall employ diode steering, transition from transmit to receive mode in less than 50 microseconds, isolate both power amplifier drive lines, provide 100% coupling of the received transducer signal, and employ a low-noise differential interface for low-level signals received from the transducer. The government has proprietary T-R switch technology that may be used by the contractor to meet this specification. The pressure vessels or potted assemblies may also contain other components such as the ADC, but the overall size of these assemblies shall be minimized. The pressure vessels or potted assemblies shall be designed for minimal effect on the acoustic sound field over the band 15 kHz to 60 kHz. Multiplexing digitized signals to reduce array cable size is permissible and, if used, then means shall be provided to synchronize the sampling across all 16 channels.

Transmit response curves shall be provided in electronic format for each power amplifier, matching network, and transducer channel. Receive response curves shall be provided in electronic format for each transducer/preamplifier pair. Pressure vessels or potted assemblies shall be serialized and underwater connectors shall be provided for separation from the array for maintenance/replacement.

For over the side operations, a contractor-delivered mass shall be located 2-4 m below the bottom of the array. It shall have sufficient weight to provide 1,000 newtons (200 lbs) of tension across the array transducers during research vessel drift operations.

For the moored option, the GFE dual acoustic release shall be located 2-4 m below the bottom of the array. The contractor shall integrate two electrical connectors to actuate each of the GFE acoustic releases. A contractor-delivered floatation sphere shall be attached above the array aperture and provide 1,000 newtons (200 lbs) tension across the array transducers. A pressure sensor shall be installed near the top transducer. The array assembly shall connect to the shipboard interface unit or optional surface buoy via an underwater connector rated for depths greater than 200 m.

The offeror shall specify a procedure for deploying and retrieving the baseline (over-the-side) ASRA system.

2.2 [Option] Vertical Line Array Components, 35-55 kHz

As an option, 16 tuning network/transducer assemblies shall be delivered. The specifications shall be similar to the 15-25 kHz array with the exception of the frequency band which shall be 35 kHz to 55 kHz. The frequency response shall be flat ±3 dB over this band. The government is willing to relax the frequency response to ±6 dB, but a convincing argument must be offered that rules out the cost-effectiveness of meeting the ±3 dB requirement. The same line array cable member may be used for both sets of tuning networks and transducers. The proposal shall specify method for removal and

replacement of components when changing frequency bands on the deck of the research vessel.

2.3 Electronics Module

The ASRA array assembly shall interface with an Electronics Module, which will include a compact computer (ASRA PC), standby controller, digital-to-analog converters, analog-to-digital converters, data storage, power amplifiers, system monitoring, power management, etc. The Electronics Module shall be a separable part of the shipboard interface unit and shall be deployable in the optional surface buoy.

The Electronics Module (via the ASRA PC or Standby Controller) shall provide user control for power (on/off) to each of the 16 power amplifiers. The Standby Controller shall provide user control for power (on/off) to the ASRA PC, interface with the engineering sensors, and activate the acoustic releases.

In the optional surface buoy configuration, energy will be delivered by the power source described in section 2.8. Energy management is critical to the success of the mission so low power, efficiency, and thermal dissipation are key factors in the ASRA system design.

During the acoustic transmit duty cycle, the total Electronics Module power shall not exceed 500 watts at the rated 160-watt acoustic transmission power. When not transmitting, the power shall not exceed 120 watts with all power amplifiers on but at zero acoustic transmission power. With the ASRA PC on and all power amplifiers off, the power shall not exceed 50 watts. The ASRA system shall recover from an indefinite power loss upon reapplication of the power.

The Electronics Module shall implement status sensors:

- ASRA Array Pressure: 0 to 1 MPa, with ±1% accuracy over range Pressure shall be converted to depth in m
- Internal Temperature: 0 to 60° C, with ±1% accuracy over range
- Leak detector: Presence of water in the optional buoy

2.4 ASRA Personal Computer

2.4.1 ASRA PC Hardware

A single, compact computer shall generate the 16 channels of transmit signals and record the 16 channels of receive signals.

a. Signal Generation: Up to sixteen channels of signals shall be generated from arbitrary waveform files at sample rates up to 240 ksps. All 16 channels of data conversion shall be synchronized. Sample resolution shall be 14 bits, minimum. Analog signals shall be low-pass filtered at or below the Nyquist frequency.

b. Signal Recording: All sixteen channels received from the transducer preamplifiers shall be conditioned, digitized, and stored onto hard disk memory. Signal data shall be converted at sample rates up to 240 ksps. All 16 channels of data conversion shall be

synchronized. Sample resolution shall be 16 bits, minimum. Analog inputs shall be low-pass filtered at or below the Nyquist frequency.

c. Data Storage: Up to five notebook-type hard disk drives, totaling a minimum 800 GB or more of storage shall be provided. The multiple disk package shall use hot-swappable technology such as USB or firewire to facilitate ease of integration.

d. Clock accuracy: The computer's oscillator shall be accurate to better than 1 part in 10^6 over a 1-day period (0.1 sec per day). System time and date shall be readable and settable via the network.

2.4.2 ASRA PC Software

Contractor-developed application software shall be delivered to integrate the transmit, receive, signal conditioning, and data storage functions of the Electronics Module.

ASRA PC software shall be written in a commercially available language such as LabView, C, Perl, Python, etc. Development licenses, original media, and source code shall be delivered under this contract. In addition, all software development tools required to modify, compile, and execute the application software shall be delivered. Ease of application software modification by the government is a key element in the proposal evaluation.

a. Transmit any combination of up to 16 user-specified waveforms on a user-supplied arbitrary schedule or on demand. The waveforms to be transmitted will be supplied by the user and will contain critical information such as sample rate, signal amplitude, signal initiation time, specific active/inactive channels, and the signal data. The user shall be able to individually/collectively turn on/off power to each of the 16 transmit power amplifiers via the arbitrary schedule or on demand. The initial status and all subsequent changes in transmit power amplifier on/off, transmitted waveform filename, etc. shall be logged in a file. Synchronization of the active channels of signal generation shall be hardware controlled to within 0.01 milliseconds (ms) of the current system time. Provision for a repetitive transmit cycle shall be provided via the scheduler.

b. The ASRA PC shall continuously record to its disk storage area the received/digitized signals from the 16-transducer array at a user-specified sample rate by a user-supplied schedule or on demand. Software control of each individual channel's postamplifier gain as well as collective (all 16 channels) shall be provided. Each channel's post-amplifier gain, sample rate, and the current system time shall be logged in the header of each received data file as described in section 2.4.3. Synchronization of the 16 channels of transducer signal recording shall be hardware controlled to within 0.01 ms of the current system time. Each received hydrophone data file shall contain the initiation/start time and file sequence number for the current recording event such that the user can determine the real time for any data sample thereafter to within 0.01 ms. The initial recording parameters and all subsequent

changes in the sample rate, preamplifier gains, new recording, etc. shall be logged in a file. This parameter log shall include changes initiated via the schedule or on demand, and include the initiation/ start time and a file sequence number. For each channel, the peak and average signal level in dB re 1 volt/MicroPascal shall be displayed at a minimum rate of once every five seconds. A continuous FFT power spectrum average shall be displayed for a user-selected channel (any one of the 16 channels) at a minimum rate of once every five seconds. The number of points in the FFT shall be user selectable.

c. User control of the ASRA computer control/scheduling software shall be provided via TCP/IP networking through such means as "Remote Desktop" or other "Virtual Network Console" software. Data transfer of transmit/record/scheduling files shall be provided via FTP or other standard network file sharing protocol.

2.4.3 Digitized Data Storage Format

a. Acoustic data shall be stored in a blocked format. Details and examples will be provided by the government upon request.

b. Each data block shall begin with a 32-byte (minimum) header containing the following information on each input channel:
   - Channel gain (preamplifier plus postamplifier)
   - Sample rate
   - Number of data points in the block/file
   - Number of data points since initiation of the current sampling sequence

c. Header data shall include a date/time character string of the form (YYYYDDDHHMMSS.microsecond) indicating the time of the first sample in the current file to within 0.01 ms of the current system time.
   - YYYY Year
   - DDD Julian Day
   - HHMM Hour and minute
   - SS.SSSSSS Second (1 us resolution)

d. Each data block shall contain samples taken sequentially from the transducer channels. Preamplifier order shall be 1-16, and number of data points shall be 32,768 per channel. (Each data block will be slightly larger than 1 MB.)

e. Gain and sample rate changes shall not be implemented until the beginning of a new data block/file.

2.5 Standby Controller

Contractor-developed application software will be required to integrate the engineering functions of the Electronics Module.

The Standby Controller's software shall provide the following functionality:

a. Measure/record the Electronic Module's primary DC power source, including current, voltage, and calculated power.

b. Measure/record the array depth, temperature, and provide seawater leak detection for deployment in the optional surface buoy.

c. Provide on/off control for the ASRA PC. Report the on/off status of this load.

d. Independently activate either of the two acoustic releases. Monitor the status of the acoustic releases (released/not released).

Engineering measurements, system time, and date shall be recorded to a data file at a minimum rate of once every ten seconds, but may be read by the user at any time. The data file shall retain a minimum of 65,536 events in nonvolatile storage for later retrieval by the user. Recording shall begin when power is applied to the Standby Controller.

The Standby Controller shall facilitate TCP/IP communications for interrogation and control of all engineering functions, and copying and clearing the data file.

2.6 Shipboard Interface Unit

The shipboard interface unit shall operate as a docking station for the Electronics Module, including power supply and interface with the deployed ASRA line array assembly. It shall also facilitate the Electronics Module's interface via TCP/IP networking and the optional wireless LAN. It shall operate on shipboard 120 Vac/60 Hz line power.

2.7 Anchor Release Unit [GFE]

For moored operations, the ASRA system shall be anchored to the ocean floor with a mass provided by the government. The government will also provide a dual acoustic release assembly, which shall attach to the bottom of the ASRA line array assembly. The Standby Controller shall include means to independently actuate either release via a pair of relay contacts. Provision shall be made for sending release signals over the wireless LAN and actuated by the Standby Controller.

2.8 [Option] Surface Buoy

As an option, one surface buoy shall be delivered for deploying the ASRA system in the moored mode. The surface buoy shall house the Electronics Module in a pressure vessel. In addition, the surface buoy shall provide power, wireless LAN communications, employ visibility features (flashing lights and radar reflectors), and connect to the ASRA line array assembly using an underwater connector. The visibility features shall meet or exceed U.S. Coast Guard and international maritime regulations and recommendations.

The surface buoy shall incorporate a power source for operating the system for 36 hours at 10 degrees C, which shall be supplied by lightweight batteries, fuel cells, or other energy source. A means to renew the power source shall be provided, which shall not require retrieval of the moored ASRA system. This is envisioned as a battery

pack change-out or addition of methanol-based fuel to the fuel cell tank from a service craft (e.g. RHIB boat). The power source requirements are: 60 kg (max) weight, compact, efficient, and easy to replenish. The government is willing to relax the weight restriction to 150 kg to allow the use of alkaline battery technology, but a convincing argument must be offered that rules out the lighter weight technologies. Energy pack features, including change-out at the moored system, are key elements in the proposal evaluation.

If rechargeable Zinc Matrix, Lithium Iron Phosphate, or comparable battery technologies are proposed, then means to recharge the battery pack on deck and a transportation plan (as in the case of lithium batteries) shall be provided. An additional battery pack shall be proposed as an option under section 7.6, which shall facilitate change-out at sea. It is envisioned as a detachable pressure vessel and associated hardware required to replace the battery pack with the aid of a RHIB boat.

Fuel cell technology may be proposed as long as the government can be assured that the technical approach is reliable, practical, and durable. Techniques to avoid membrane poisoning, such as air filtration or use of compressed gas, shall be addressed. The contractor shall specify how these requirements will be met, including the seaworthiness of the design.

The ASRA buoy shall retain at least 50% of its surface displacement when submerged to 100 meters depth. The buoy's reserve buoyancy shall be sufficient to support a minimum of 50% flooding of the electronics/ power source spaces.

IEEE 802.11g components shall provide for communications between the surface buoy and the research vessel at ranges up to 4 nm. This specification is envisioned as being met by a pair of access points, bidirectional power amplifiers rated for 1 watt, one 10-12 dB mast-mounted antenna, and one 8-dB buoy-mounted antenna. Minimum thirty meters of low-loss (e.g. LMR-400) cable shall be provided for the shipboard antenna, which will be temporarily installed by the government to the research vessel's mast. The buoy-mounted antenna shall remain vertical ±30 degrees in sea state 3 conditions (15 kts wind/1.2 m average wave height) using a gimbaled or spar buoy design.

The offeror shall specify a procedure for deploying, retrieving, and replenishing the optional (surface buoy) moored ASRA system.

2.9 [Option] Application Software for Remote ASRA Operation

As an option, contractor-developed application software shall provide a high-level integrated remote interface to the deployed ASRA system and shall operate on a GFE PC. The GFE PC will normally be located shipboard and connected to the ASRA system via the network. Functionality shall include the ability to monitor the deployed system, transfer files, and control operations without the use of a "Remote Desktop" or "Virtual Network Console". The functionality of

this remote monitoring control software shall support all features and controls described in section 2.4 and section 2.5.

The remote ASRA operation software shall be a written in a commercially available language such as LabView, C, Perl, Python, etc. Development licenses, original media, and source code shall be delivered under this contract. In addition, all development tools required to modify, compile, and execute the application software shall be delivered. Ease of application software modification is a key element in the proposal evaluation.

3.0 MECHANICAL REQUIREMENTS

3.1 Array Components

a. Marine Connectors: Shall be designed for a seawater environment and have a minimum operating depth greater than 200 m. Each connector shall be provided with a waterproof protective end cap with pressure rating equivalent to that of the connector. Connectors shall have either a protective mechanical guard or be located such that they are protected from accidental damage during movement, deployment, and shipping. A method of strain relief shall be provided which minimizes stress in the cable conductors and the connector. Each connector shall have a locking mechanism to prevent accidental disconnect.

b. Array Cable: Shall include strength members rated for an operating strength of at least 10,000 newtons force (2,000 lbs).

3.2 Electronics Module

a. Temperature:
- Operating: -5°C to 50°C
- Magnetic media: 5°C to 50°C
- Storage: -40°C to 65°C
- Fan: Temperature-regulated circulation

b. Shock and Vibration (minimum operating specs):
- Shock: 150 G for 2 ms (half sine wave)
- Vibration: 0.67 G over 5-500 Hz (random RMS)
  1.0 G 0-peak 5-500 Hz (swept sine RMS)

3.3 [Option] Surface Buoy Components

a. Pressure Vessel: Shall be designed for depths to 200 m.

b. Seals: All pressure vessel joints shall have dual o-ring seals. Backup o-rings (2-piece o-ring seals) and triple o-ring seals are permissible.

c. Finish: All exposed surfaces shall be designed to minimize deterioration of the structure by exposure to the ocean environment. Aluminum materials shall receive a yellow Iridite finish. An equivalent surface preparation shall be used for other metallic

materials. Exposed metal surfaces shall receive a marine polyamide epoxy followed by a topcoat, international orange in color. The buoy shall be marked with ownership information supplied by the government.

d. Attachment/Lift Points: The buoy shall be fitted with a minimum of three mechanical attachment points for shipboard tie-down/storage and lifting/deployment. Lift points shall have an operating strength of at least 10,000 newtons (2,000 lbs).

e. Purge Port(s): The pressure vessel shall provide for a government-supplied purge system that will allow the vessel to be cross-flow purged or evacuated and back-filled with a dry gas. This requirement can be met by two purge ports, nominally 16 mm (0.625 inch) diameter. The government will provide details on its purge system. Alternative purge port implementation is permissible.

f. Corrosion Protection: Passive cathodic protection against corrosion shall be provided for the metallic components of the surface buoy. The protection method shall have a minimum rated usage of one year.

g. Visibility: The surface buoy's topside structure shall incorporate radar reflectors, yellow flashing lights, and a mast for mounting the wireless LAN antenna. Two radar reflectors and two flashing lights are envisioned as guaranteeing visibility at any aspect, including fault conditions where the buoy may be heeled over.

h. Seaworthy: The surface buoy shall operate in seas up to sea state 3 (15 kts wind/1.2 m wave height), but shall survive for a minimum of five days in sea state 5 (25 kts wind/3.6 m wave height).

4.0 ELECTRICAL REQUIREMENTS

4.1 ASRA Vertical Line Array Assembly

a. Channel-to-Channel Crosstalk: Crosstalk between preamplifier channels shall be less than -60 dB as measured between any two channels. This specification shall be measured by applying reference square waves of 20 kHz and 45 kHz at the preamplifier's input connectors. The postamplifier output voltage of the two adjacent acoustic channels shall be individually compared to the channel under test to determine the crosstalk level in dB. This measurement shall be made for each of the 16 receive channels.

b. Common Mode Rejection Ratio (CMRR): CMRR shall be greater than 60 dB per channel. This specification shall be measured by applying reference sine waves of 20 kHz and 45 kHz at the preamplifier's output connectors. The postamplifier output voltage of the channel under test shall be used to determine the CMRR level in dB. This measurement shall be made for each of the 16 receive channels.

c. Receive Channel-to-Channel Uniformity: Shall not vary more than ±1 dB over the acoustic signal frequency range of 1 kHz to 60 kHz. This specification shall be measured by applying a swept sine wave

pattern to the preamplifier's input connectors and cross correlating with the postamplifier's output signal.

d. High-Pass Filter: Each preamplifier shall employ a high-pass filter at its front end to attenuate low-frequency pickup. The filter's corner frequency shall be approximately 200 Hz with a roll-off slope of 6 dB per octave (1 pole).

e. Low-Pass Filter: Each postamplifier or ADC shall employ a low-pass filter to attenuate signals above the Nyquist sampling frequency.

f. Transmit Channel-to-Channel Uniformity: Shall not vary more than ±3 dB over the design bandwidth: (a) 15-25 kHz; or (b) 35-55 kHz. This specification shall be measured by applying a swept sine wave pattern to each channel's tuning network input connectors and cross correlating with the voltage across the input connectors of the respective transducer. The achieved sound pressure levels shall be calculated using the transducers' transmit voltage response (TVR) curves. TVR curves shall be traceable to a U.S. Government reference standard.

4.2 Electronics Module and Optional Surface Buoy Components

a. Electrical Components: Shall be isolated from shock and vibration, and mounted for convenient removal and servicing. Minimum power consumption and maximum power efficiency shall be primary design goals.

b. Internal Connectors: Shall employ positive engagement mechanisms.

c. Voltage Loss: All conductors shall be sized to maintain voltage loss to less than 0.25% at maximum operational current flow.

d. Transducer Drive Voltage Loss: The maximum round-trip voltage loss for transducers driven at 25 watts acoustic shall be less than 10%.

4.3 [Option] Surface Buoy

a. Minimal Load: Shall include the Standby Controller, wireless LAN, engineering sensors, and power monitoring.

b. Common and Ground: Signal ground shall be connected to the pressure vessel at one point to ensure the metallic container acts as an effective faraday shield. A "star" ground shall be employed to reduce ground loops and enhance low-noise performance.

c. Energy Renewal: Change-out at sea shall be facilitated by an external battery pack or means to refuel an alcohol-based fuel cell stack. If a battery pack is proposed, then a complete spare set of hardware shall be specified to facilitate a quick change-out. If a fuel cell is proposed, then a spare fuel tank or means to fill the buoy's fuel tank shall be specified.

d. Energy Pack: One fully charged energy system shall be delivered.

e. On/Off: ASRA system power shall be controlled via an on/off switch, such as shorted pins on a marine connector.

5.0 DOCUMENTATION

5.1 Operation Manual

This manual shall describe in detail how to operate and deploy the ASRA system. It shall contain procedures to be used for predeployment all circuitry and software shall be included. A detailed list of all parts and components shall also be included. For each unit of software and hardware, the part/model number and vendors' address, telephone number, and web site shall be provided.

5.3 Software

Offeror shall provide a written procedure to edit, compile, and execute program changes to contractor-developed software along with the development software and hardware.

5.4 Drawings

Assembly, mechanical, block, wiring, schematic, etc. drawings shall be provided for all hardware. Drawings shall be in accordance with acceptable commercial standards.

5.5 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 in Microsoft Word 2000 (or higher) format.

6.0 TEST PLAN

a. The offeror shall develop a test plan for system performance and acceptance testing. This plan shall detail system testing at the offeror's manufacturing facility of all performance specifications. The plan shall detail how the manufacturer intends to prove that the system meets this Technical Performance Specification.

b. The offeror shall conduct an operational test of the ASRA system for at least 36 hours. This is a full end-to-end test to verify operation, including full power output (160 watts acoustic equally spread over the 16 transducers, 40% duty cycle), and the recording of 16 channels of received data. Sample rates for ADC's and DAC's shall be 240 ksps. File transfer to/from the GFE shipboard terminal PC during the test period shall be demonstrated.

c. The test plan shall be delivered to the Contracting Officer's Representative (COR) for approval no later than 45 days prior to start of the factory test.

d. The offeror shall provide training on the assembly, disassembly, configuration, and operation of all aspects of the ASRA systems for up to seven (7) end users at the factory acceptance test site.

7.0 OPTIONS

7.1 Transducer Array Components, 35-55 kHz

The offeror shall provide Electronics Module and ASRA array components to implement the 35-55 kHz band. See section 2.2.

7.2 Surface Buoy

The offeror shall provide one surface buoy for remote and autonomous moored operations. See section 2.8.

7.3 Application Software for the Remote ASRA Operation

The offeror shall provide high-level remote interface software that will operate on a GFE PC and communicate over the network with the Electronics Module. See section 2.9.

7.4 Additional ASRA Array, 35-55 kHz

The offeror shall provide one 35-55 kHz array, including 16 tuning network/transducer assemblies and 16 T-R preamplifier pressure vessels or potted assemblies.

7.5 Additional ASRA Surface Buoy

The offeror shall provide one additional ASRA Surface Buoy and Electronics Module.

7.6 Additional Surface Buoy Battery Pack

If a battery technology is selected, the offeror shall provide one additional ASRA Surface Buoy battery pack. This option shall include the pressure vessel, floatation, and all hardware required for a complete energy pack change-out at the buoy. See section 2.8. The mechanical requirements of section 3.3 shall be met for this additional ASRA Surface Buoy battery pack.

8.0 GLOSSARY OF TERMS

ASRA	Acoustic Communications Source Receiver Array
Acomms	Acoustic communications
ADC	Analog-to-digital converter, analog/digital converter
CMRR	Common mode rejection ratio
COR	Contracting officers representative
COTS	Commercial off the shelf
DAC	Digital-to-analog converter
dB	Decibel
FFT	Fast Fourier Transform
FTP	File Transfer Protocol
GB	Gigabytes (1 GB = 1024 megabytes)
GFE	Government furnished equipment
Hz	Hertz
kHz	Kilohertz
LAN	Local area network
lbs	pounds
m	meter
MB	Megabytes (1 MB = 1,048,576 bytes)
MPa	Megapascal
NM	Nautical mile
NRL	Naval Research Laboratory
PC	Personal computer
rms	Root mean square