



**University of
New Hampshire**

**ADEON Calibration and Deployment Good Practice Guide
Version 1.0**

**Atlantic Deepwater Ecosystem Observatory Network
(ADEON): An Integrated System for Long-Term Monitoring of
Ecological and Human Factors on the Outer Continental
Shelf**


Contract: M16PC00003

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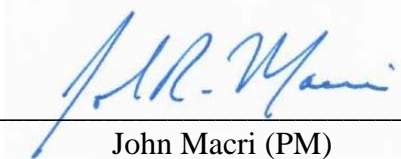
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ADEON Calibration and Deployment Good Practice Guide

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F: JASCO document 00190 Recorder Calibration Procedure

G: ASL Quick Start Deployment and Recovery Checklist

Abbreviations

Non-acoustical abbreviations are listed in Table 1. For acoustical abbreviations see Ainslie et al. (2017).

Table 1 – Non-acoustical abbreviations

Abbreviation	Meaning
ADEON	Atlantic Deepwater Ecosystem Observatory Network
A/D	Analog to Digital
ASL	ASL Environmental Sciences
AZFP	Acoustic Zooplankton Fish Profiler
BOEM	Bureau of Ocean Energy Management
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CTD	Conductivity, Temperature, and Depth sensor
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
EU	European Union
HFM	Hyperbolic Frequency Modulated
HLA	Horizontal Line Array
HSE	Health, Safety, and Environmental plan
JASCO	JASCO Applied Sciences
JSA	Job Safety Analysis
MMPA	Marine Mammal Protection Act
NA	not applicable
NMFS	NOAA National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OASIS	Ocean Acoustical Services and Instrumentation Systems, Inc.
OCS	Outer Continental Shelf
OCV	Open-circuit voltage
ONR	Office of Naval Research
PI	Principal Investigator
SFA	Sustainable Fisheries Act
SI	International System of Units
TNO	Netherlands Organisation for Applied Scientific Research
TS	Target Strength
UNH	University of New Hampshire
UNOLS	University-National Oceanographic Laboratory System
US	United States of America
USNO	US Naval Observatory
UTC	Coordinated Universal Time

1. Introduction

ADEON project

The Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the US Mid- and South Atlantic Outer Continental Shelf (OCS) has been developed and was deployed in the fall of 2017. The lead principal investigator (PI) for this project is Dr. Jennifer Miksis-Olds, University of New Hampshire (UNH). Dr. Miksis-Olds leads a collaborative research team consisting of individuals from UNH, OASIS, TNO, JASCO, Stony Brook University, and NOAA's Southwest Fisheries Science Center.

This observatory network will generate multi-year measurements of both the natural and human factors active in this region, thus informing the ecology and soundscape of the OCS. Long-term observations of living marine resources and marine sound will assist federal agencies, including the Bureau of Ocean Energy Management (BOEM), the Office of Naval Research (ONR), and the National Oceanic and Atmospheric Administration (NOAA), in complying with mandates in the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Sustainable Fisheries Act (SFA).

Objectives

ADEON project objectives

The ADEON project objectives are to:

- Establish an ecosystem observation network that provides baseline monitoring and supports predictive modeling of the soundscape and its relationship to marine life and the environment of the Mid- and South Atlantic Planning Areas.
- Develop standardized measurement and processing methods and visualization metrics for comparing ADEON observations with data from other monitoring networks.
- Assess baseline soundscape and ecosystem conditions in support of predictive environmental modeling and trend analyses in the planning areas.
 - How do soundscape and ecosystem components vary with water depth across the OCS?
 - How do the soundscape and ecosystem components vary with latitude along the OCS?
 - Where are the hot spots of human activity for consideration in ecosystem/habitat health impacts?
- Assess the spatial and temporal distribution of the soundscape and biological scatterers, including their expected variation and correlation with distance from the lander locations.
 - What are the environmental factors that define and constrain the horizontal range of appropriate extrapolation of observations measured at the stationary lander sites?
- Develop and apply new methods for the effective visualization of five-dimensional (5D – time, latitude, longitude, frequency, and depth) soundscape data with interactive visual analysis tools that enable users to explore, analyze, and integrate ancillary ecosystem data streams with the 5D soundscape.
- Develop a robust data management system that archives and provides public access to multiple data streams to encourage future development of ecological models targeted at questions beyond the scope of this study.

Calibration and Deployment Good Practice Guide objectives and scope

This document, the *ADEON Calibration and Deployment Good Practice Guide*, is the third of five standardization products. Its purpose is to provide information to future field scientists who wish to deploy instruments similar to those used in the ADEON project. The contents of this document version reflects details acquired after the first ADEON cruise was completed in December 2017. The scope of these descriptions is limited to the specific instruments used in the ADEON project, however much of the information will be useful regardless of the system manufacturer. This document does not replace manufacturer-provided User's Guides, Deployment Instructions, or Calibration information.

In addition to this *Calibration and Deployment Good Practice Guide*, companion ADEON products specify soundscape measurements (Ainslie et al., 2018), hardware properties (Martin et al., 2018), data processing (Heaney et al., 2017) and terminology (Ainslie et al., 2017). The ADEON Standardization objectives are met by these five products together.

Document structure and terminology

The remainder of this document is structured as follows. In Sec. 2, the deployment and calibration of passive acoustic systems is discussed. Sec. 3 covers the deployment and calibration of active acoustic echo sounders. Environmental information such as hydrographic sensor deployment and calibration is discussed in Sec. 4. Propagation loss experimental procedures and the use of a horizontal line array is the subject of Sec. 5. Sec. 6 details the use of net or trawl gear to collect ground truthing data about the zooplankton and fish occurring in the water column. A series of Appendices providing detailed instructions and information for a variety of topics concludes the report. These appendices include: A: JASCO Project Planning Worksheet; B: ADEON Lander Operations Plan; C: ADEON HSE Plan; D: JASCO document 00716 AMAR G3 Formal Qualification Test Procedure; E: JASCO document 0186 AMAR Mobilization Test Procedure; F: JASCO document 00190 Recorder Calibration Procedure; and G: ASL Quick Start Deployment and Recovery Checklist.

2. Passive Acoustic Data Recorders

Due to the variety of instruments (i.e. hydrophones, electronics, and recording devices) used in passive acoustic studies, it is difficult to write a one-size-fits-all guide given that different recording objectives (i.e. habitats, species of interest) and practical limitations (i.e. deployment depth, battery/memory limits) will dictate many of the specifics of any passive acoustic recorder study. Therefore this section will provide an outline of the different steps in developing a passive acoustic recorder study.

- 1) Document the project requirements, recorder configuration, project risks, field team training requirements, bottom lander design, and master equipment list. Ensure that all project leads agree with these requirements and have signed-off their agreement. For example, see Appendix A - the JASCO Project Planning Worksheet.
- 2) Develop a detailed operations plan for the programming, deployment, and retrieval of the system. For example, see Appendix B – ADEON Lander Operations Plan.
- 3) Develop a detailed health, safety, and environmental (HSE) plan describing the hazards associated with the field work, response plans, and communications protocols. Ensure that all managerial and field team members are briefed on the HSE Plan before leaving for the field work. For example, see Appendix C - ADEON HSE Plan.
- 4) Perform a structured qualification test of the recorder electronic functionality prior to mobilization. For example, see Appendix D – JASCO document 00716 AMAR G3 Formal Qualification Test Procedure.
- 5) Mobilize, calibrate, and test the recorder. For example, see Appendix E - JASCO document 0186 AMAR Mobilization Test Procedure, Appendix F 00190 – Recorder Calibration Procedure).
- 6) Mobilize and test the other lander components (beacons, acoustic releases, hardware, etc) and document their correct operation or installation.
- 7) Before packing the lander lay it out and conduct a practice assembly with the field team.
- 8) Prior to deployment, conduct a field calibration of the passive hydrophone(s). For example, see Appendix F 00190 – Recorder Calibration Procedure).
- 9) Prior to deployment or retrieval, conduct a thorough job safety analysis (JSA) with the field team and vessel crew. Everyone involved with operations should sign the JSA sheet.
- 10) When possible, one field team member (separate from deck crew and deployment lead) should be performing logging duties, acting as safety spotter, and taking photographs of the operation.
- 11) Conduct a lessons learned debrief with everyone involved in the operation.

3. Active Acoustic Echo Sounders

The objective of this specification is to describe the ADEON best practices of deployment and calibration of echo sounder systems that are essential for accurately measuring acoustic backscatter in the water column. This section contains two sub-sections:

- 3.1 Remotely deployed echo sounder systems
- 3.2 Vessel mounted echo sounder systems

For background information on specific echo sounder systems used in the ADEON project and principles of active acoustic echo sounders, see the ADEON Hardware Specification document (Martin et al., 2018), Section 4.

3.1 Remotely Deployed Echo Sounder Systems

3.1.1 *Remote Deployment Hardware Limitations and Trade-offs*

Remotely deployed echo sounder systems can be deployed in a downward, upward, or sideward looking position. In deployment regions where a surface expression can increase overall risk to the instruments, echo sounder systems are typically deployed on a bottom lander looking up or within a sub-surface mooring line oriented slightly off vertical to minimize interference from sensors higher up on the mooring line. ADEON is integrating an echo sounder system into three of the seven constructed bottom lander platforms. The transducers are mounted at an approximate 15° angle off vertical to eliminate interference from the lander sensors and floatation mounted slightly above the transducers.

The remote deployment of an archival echo sounder system requires a tradeoff between power and storage space. Flexibility in battery power comes from balancing the instrument duty cycle, ping rate per sampling cycle, ping duration, and onboard processing (i.e., averaging before storing). Internal storage is maximized through the balance of duty cycle, ping rate per sampling cycle, sampling range, averaging (temporal and spatial resolution). The maximum possible sampling range is determined by the size of the internal data buffer and internal analog-to-digital (A/D) sampling rate. Storage space can also be conserved in some systems by specifying a lockout range. A lockout range can be specified for the region directly in front of the transducer where electronic “ringdown” renders the data unusable. Alternatively, if the user is only interested in a specific depth of the water column, a lockout range can be specified to exclude unwanted regions of the water column.

3.1.2 *Calibration*

Transducers: Each acoustic zooplankton fish profiler (AZFP) is delivered from the manufacturer with a Certificate of Calibration (Figure 1). Upon delivery, each transducer is calibrated with a 38.1 mm diameter standard tungsten carbide calibration sphere in the UNH acoustic tank according to Foote et al. (1987) and Vagle et al. (1996). Each transducer is also calibrated at depth prior to deployment at sea with the same calibration sphere. The transducers are mounted to the conductivity temperature depth (CTD) profiler cage in a downward looking direction and lowered to depth. The sphere is suspended

approximately 4-5 m below the transducer head by a three point harness to ensure that the sphere is centered in the main sonar beam.

AZFP Certificate of Calibration Version : 12.0

10/26/2016	Operator: Jay Milligan	Unit Serial Number: 55127
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Sonar Channel #1:					
Frequency:	38.0 KHz	Transducer Part#:	E23D20	Transducer Serial#:	157
OCV: Voltage on reference:	8.8	Reference TVR:	145.9	Transducer Voltage:	0.248
TVR: Voltage on transducer:	173	Reference OCV:	-213.2	Reference Voltage:	2.0
System Gain and Linearity:					
Voltage on Reference	A/D Counts (N)	Calibration Values	Units	Sphere Check	
*	65000	TVR	174.5	Water Temp	10.12 °C
-10dB	59000	VTX	61.2	Range	310 cm
-20dB	53040	BP	0.02	Measured	-51.3 dB
-30dB	47080	Echo Level	144.3	Expected	-51.0 dB
-40dB	41100	Slope	0.0228	Error	-0.3 dB
-50dB	Not Measured		V/dB		
<p>*This voltage is adjusted to bring N between 64950 and 65050 counts All measurements with 1.0 meter separation in 20°C fresh water unless otherwise noted.</p>					

Figure 1. Example Certificate of Calibration provided for a 125 kHz transducer within the AZFP system. Figure used with Permission from ASL Environmental Sciences (ASL).

OCV (for “open-circuit voltage”) is the hydrophone sensitivity level in dB re 1 V²/μPa². The “Calibration Values” are integrated into the AZFP operation software as unique instrument parameters. The “Sphere Check” lists the results of a target strength calibration measurement, comprising the water temperature (10.12 °C), the distance from the sonar to the target, the measured target strength (-51.3 dB re 1 m²/sr), and the target strength of the calibration sphere (-51.0 dB re 1 m²/sr). The error value (-0.3 dB) is the difference between the “Measured” and “Expected” values of target strength.

EClock: The AZFP contains a real-time clock adjusted to be accurate within several parts per million (ppm) at room temperature. The EClock value is the measured period of microprocessor clock. It is used as the time base for various post-processing calculations and coefficients. The nominal EClock value is **2.50 · 10⁻⁷** seconds.

Orientation sensor: Orientation sensor: The two tilt channels are calibrated during manufacture and are expected to stay stable for many years. Tilt coefficients are measured by ASL by operating the AZFP at 20 different tilt angles, ranging from -45 degrees to +45 degrees, as independently measured using a high-precision inclinometer. The calibration coefficients are computed using a least-squares fitting method to a third-order polynomial equation.

Tilt X Calibration Coefficients:

- X_a; X_b; X_c and X_d (X_c and X_d may be zero)

- $\text{Tilt}_x \text{ (degrees)} = X_a + X_b (N_x) + X_c (N_x)^2 + X_d (N_x)^3$
- Where N_x is the raw counts out of the A/D converter. Counts range from 0 to 65 535.

Tilt Y Calibration Coefficients

- $Y_a; Y_b; Y_c$ and Y_d (Y_c and Y_d may be zero)
- $\text{Tilt}_y \text{ (degrees)} = Y_a + Y_b (N_y) + Y_c (N_y)^2 + Y_d (N_y)^3$
- Where N_y is the raw counts out of the A/D converter. Counts range from 0 to 65 535.

Thermistor: A thermistor is used to record temperature during an AZFP deployment. The thermistor is calibrated with respect to an ice bath at the factory. The thermistor bridge coefficients are $k_a, k_b,$ and k_c . The calibration coefficients are $A, B,$ and C . To convert recorded counts to temperature, first convert counts to volts according to:

$$V_{in} = 2.5 * (\text{counts} / 65\ 535).$$

Then calculate the equivalent bridge resistance in ohms:

$$R = (k_a + k_b * V_{in}) / (k_c - V_{in}).$$

$$\text{Finally the temperature in } ^\circ\text{C} = T = 1 / (A + B * (\ln(R)) + C * (\ln(R))^3) - 273$$

3.1.3 Programming/Processing Specifications

The AZFP has multiple user-selected operation parameters to maximize data collection for a pre-defined mission, see Section 4.1.2.3 of Martin et al. (2018) for more details. The parameters selected for programming all 3 AZFP instruments are listed in Table 2.

Table 2. Deployment parameters for the AZFP. The specified parameters apply to all of the four AZFP frequencies : 38 kHz, 125 kHz, 200 kHz, and 455 kHz.

	Phase 1	Phase 2	Phase 3
Duration (min)	12	48	Repeat
Phase Type	Sampling	Sleep	Repeat
Pulse Length (μs)	750		
Digitization Rate (kHz)	20		
Profile Interval (s)	3		
Ping Period (s)	1		
Pings/Profile (s)	1		
Maximum Range (m)	400		
Lock Out Range (m)	0		

3.1.4 *Deploying the AZFP*

Deployment of ADEON AZFPs will directly follow the best practices for Preparing the AZFP, Preparing the Instrument for Deployment in the Ocean, and Recovery and Cleaning sections of the AZFP Operator's Manual (2016: AZFP Operator's Manual GU-100-AZFP-01-R27). Each AZFP is delivered with an itemized check-sheet for deployment and recovery that will be followed prior to each deployment (Appendix G). In addition, the completion of the AZFP Data Sheet will capture deployment parameters and information related to the deployment and recovery of each instrument.

Prior to the installation of the AZFP instrument tube and transducers on each bottom lander, two activation tests of the AZFP are conducted while safely secured in the bench bracket. 1) While connected to shore power, the AZFP is programmed to deploy in real time, in-air via the RS232 communications cable. Realtime data from the AZFPLink software under the Real Time option is viewed to confirm each transducer is operating and returning echoes. Data output is configured for both RS232 and flash data storage. After ending the deployment, the CompactFlash (CF) card data directory is viewed under the AZFPLink File tab to ensure the CF card was acquiring data correctly. 2) A final bench test is performed where the AZFP is programmed to record data to flash and programmed for a future deployment time of 5 minutes in the future. Once deployed, the RS232 communications cable is removed. This test is conducted to ensure that both the battery and CF card data acquisition is operating correctly. Once the AZFP awakens at the programmed time, the sonar pings can be heard as clicks directly in front of each transducer face. After ending the deployment, the CF card data directory is viewed under the AZFPLink File tab to ensure the CF card was acquiring data correctly. After successfully conducting these bench tests, the AZFP is ready for remote deployment programming and installation into the bottom lander. Note: a spare AZFP sensor is available on board to replace lost or damaged units as needed.

3.2 Vessel Mounted Echo Sounder Systems

3.2.1 *Calibration Guidelines*

Fortunately, vessel-mounted echo sounders are widely used throughout the world in fisheries stock assessment surveys. Calibrations of the echo sounders are conducted regularly (often every cruise) in order to ensure that comparisons of data collected in different regions, different vessels, or from different echo sounder systems can be done in an accurate manner. Because of the work of previous researchers there is a wealth of information on calibration procedures and methods available in the literature, including most recently Foote (2017). We will provide a short overview of these resources here, but recommend that users consult equipment manuals for specific instructions for their systems.

Manufacturers of scientific echo sounder systems often provide instructions, software programs, and guidance on the calibration of their systems. The most common type of calibration is the use of a standard sphere which is lowered in the water column into the beampattern of the transducer and the echoes from the target sphere are recorded. The size, shape, and material properties of the sphere are known so scattering models (or often look-up tables provided by the manufacturer) are used to generate theoretical target strength (TS) of the sphere at a particular frequency. Measurements of the

target sphere are made with the system and the difference between these values is then either added or subtracted in the echo sounder or post-processing software to generate “calibrated” data.

While the conceptual procedures are fairly straight-forward in conducting a calibration, there can be many challenges in doing so in the field. Currents, sea states and wind, presence of scattering layers, and mechanical constraints (in terms of where the sphere can be lowered from/to) can combine to make echo sounder calibration a difficult task. Different echo sounder transducers also provide their own unique challenges. Single-beam systems are unable to detect if the target sphere is in the center of the sonar beam which can result in erroneous calibrations. Split-beam systems avoid this problem as the location of the sphere is one of the measured data outputs. However to properly calibrate the system the sphere must be ensonified throughout the beam pattern which can be difficult in practice. Multi-beam systems present unique logistical challenges relative to down-ward looking echo sounders as outriggers or separate vessels may be needed in order to place the target sphere into the different beams of the echo sounder.

It also must be noted that different sized spheres may be needed for different frequencies of operation due to resonance nulls (or peaks) in the scattered signal. In some cases, multiple spheres may be lowered into the water column simultaneously (usually separated vertically by 1 m or more) to complete system calibrations more efficiently, but this is not always possible.

Calibrations should be conducted in environmental conditions similar to when data are collected. However, often calm, protected locations (e.g., harbors, bays) are used which may or may not be representative of the data collection areas. Perhaps the biggest limitation in conducting standard target calibrations is that the sphere is usually located tens of meters below the surface vertically, however scattering layers are often detected at depths much deeper than where the sphere was located. Users must keep in mind the limitations and accuracies of even a thoroughly calibrated echo sounder system.

For the ADEON project, vessel-based echo sounders will be calibrated once during each cruise. All sites are in the open ocean thus we believe that environmental conditions will be relatively similar at the various station locations. The echo sounders used in this project will be Simrad EK60 or EK80 systems. Manufacturer recommendations and instructions on system calibrations can be found here:

EK60 Documentation

<https://www.simrad.com/www/01/nokbg0240.nsf/AllWeb/B7960D953381AF28C1257A060044292B?OpenDocument>

EK80 Documentation

<https://www.simrad.com/www/01/NOKBG0240.nsf/AllWeb/951C978190B9F6CBC1257E51002A1383?OpenDocument>

3.2.2 *Deployment Guidelines*

The foremost concern with the deployment of vessel-mounted echo sounders is the ability to collect high-quality data that accurately measures the scatterers in the water column. The most frequent

difficulties that users encounter are often noise-related, which can range from electrical noise in power supplies to cross-talk between other active acoustic instruments on the vessel to the presence of other scatterers in the water column (most often bubbles) which produce echoes that might be incorrectly ascribed to biological scatterers.

Users may not have control over many aspects of the echo sounder system, particularly with hull-mounted systems that are fixed on a vessel. However, users installing and designing the placement of their transducers (both for hull- and pole-mounted systems) need to consider several practical factors in order to minimize the noise measured by their systems. In general, deeper locations of transducers relative to the water surface will be less susceptible to bubbles injected into the water column by breaking waves. These bubbles in addition to producing high levels of backscatter can also significantly attenuate the transmitted signal such that water column scatterers may not be detectable. Fairings around transducers can be useful in terms of reducing bubble interference and may make the hydrodynamic flow around the transducer less turbulent which may reduce mechanical stresses on the mounting structures. Additionally, reductions in ship speed and careful choice of ship’s heading can be used to reduce the presence of bubbles or mechanical strain during survey operations. However, both of these will affect the survey coverage and duration.

Table 3. Typical shipboard acoustic echo sounder transducer (Simrad) characteristics and operational parameters. Depth range represents the depth where strong (e.g., fish) water column scatterers can be detected. Maximum detection range (of the seafloor) is greater than the depth range value given in table. Transmitting response of a transducer is defined by Simrad (2000) as “the pressure produced at the beam axis 1 meter from the transducer by a unit electrical input” with units of “dB re 1 μ Pa per A” (Simrad, 1997). Weblinks to transducer data sheets are provided after the table.

Frequency (kHz)	Simrad Transmitter Power Rating (W)	Beamwidth (full width at half maximum) (°)	Ping repetition time (reciprocal of repetition rate) (s)	Typical Pulse duration (μ s)	Simrad Transducer Transmitting Response (dB, see Table 3 caption)	Transducer Mass (kg)	Depth Range* (m)
18	2000	11	2-5	1024	182	85	2000
38-7	2000	7	2-5	1024	184	68	1500
38-10	1500	10	2-5	1024	181	18	1500
70	1000	7	2-5	512	185	7	500
120	1000	7	2-5	512	185	3	300
200	300	7	2-5	512	184	2	150

18 kHz

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/AB3EE80EB23B51FEC12570B40046D811/\\$file/160506_es18.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/AB3EE80EB23B51FEC12570B40046D811/$file/160506_es18.pdf?OpenElement)

38 kHz

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/362B80D8C3B1BD8DC1257F410022CE82/\\$file/408731ac_es38-7_data_sheet_english.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/362B80D8C3B1BD8DC1257F410022CE82/$file/408731ac_es38-7_data_sheet_english.pdf?OpenElement)

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/89755A12AAAAA9EFC12570B6004AD566/\\$file/164404ab_es38-10_product_specification_english.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/89755A12AAAAA9EFC12570B6004AD566/$file/164404ab_es38-10_product_specification_english.pdf?OpenElement)

70 kHz

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/64EDE2345D8803ABC1257F87002F797C/\\$file/359223aa_es70-7cd_data_sheet_english.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/64EDE2345D8803ABC1257F87002F797C/$file/359223aa_es70-7cd_data_sheet_english.pdf?OpenElement)

120 kHz

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/D7D4541E8BC9BC69C12570BB006D1FCF/\\$file/164381ad_es120-7c_product_specification_english.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/D7D4541E8BC9BC69C12570BB006D1FCF/$file/164381ad_es120-7c_product_specification_english.pdf?OpenElement)

200 kHz

[https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/CEC70D2C5D428260C12570BD003F2E80/\\$file/204465ae_es200-7c_product_specification_english.pdf?OpenElement](https://www.simrad.com/www/01/NOKBG0397.nsf/AllWeb/CEC70D2C5D428260C12570BD003F2E80/$file/204465ae_es200-7c_product_specification_english.pdf?OpenElement)

3.2.3 *Additional Resources*

There are a variety of books and manuals that provide additional information on the calibration and deployment of active acoustic echo sounders. These include:

Simmonds, J., & MacLennan, D. N. (2008). *Fisheries acoustics: theory and practice*. John Wiley & Sons.

Foote, K. G. (1982). Optimizing copper spheres for precision calibration of hydroacoustic equipment. *The Journal of the Acoustical Society of America*, 71(3), 742-747.

Foote, K. G., Knudsen, H. P., & Vestnes, G. (1983). Standard calibration of echo sounders and integrators with optimal copper spheres.

Foote, K. G. (1987). Calibration of acoustic instruments for density estimation: a practical guide. *Int. Counc. Explor. Sea. Coop. Res. Rep.*, 144, 57p.

Foote, K. G. (1990). Spheres for calibrating an eleven-frequency acoustic measurement system. *ICES Journal of Marine Science*, 46(3), 284-286.

Foote, K. G. (2017). Standard-Target Calibration of Active Sonars Used to Measure Scattering: Principles and Illustrative Protocols. *IEEE Journal of Oceanic Engineering*.
<https://doi.org/10.1109/JOE.2017.2713538>

ICES Cooperative Research Report (CCR) # 235: Methodology for Target Strength Measurements

ICES Cooperative Research Report (CCR) # 326: Calibration of Acoustic Instruments

Simrad (2000). Instruction manual: Introduction to Underwater Acoustics. pp 254.
<http://linux.geodatapub.com/shipwebpages/manuals/apos/introduction%20to%20underwater%20acoustics.pdf>

4. Environmental Information

4.1 Hydrographic Information

Information on the marine water column is necessary in order to accurately interpret both active and passive acoustic data. As sound travels through the water column, differences in sound speed will affect the path of the sound. Therefore it is important to know how the speed of sound in the water varies both vertically and horizontally. The speed of sound is a function primarily of temperature, salinity, and pressure. These data can be obtained through ocean atlases providing hydrographic information over large spatial and temporal (i.e., seasons) ranges. However, acoustic field studies almost always collect hydrographic information as part of their studies.

The most common instrument used to collect these data is a CTD (conductivity, temperature, and depth sensor). There are many manufacturers and instruments that will collect the necessary data and they range from the large (requiring winches) to the disposable (e.g., XBT or expendable bathythermograph).

4.2 Bottom Lander Systems

Environmental sensors (temperature, salinity, pressure, etc.) deployed on the lander should be calibrated before and after deployments following manufacturer instructions. Sensors should be positioned on the lander such that they have access to flowing seawater and do not interfere with other sampling instruments on the lander.

4.3 Vessel-Mounted Systems

Large oceanographic vessels (such as those operated by UNOLS) collect a variety of hydrographic information ranging from underway, continuous sea surface samplers to vertical profiling systems. Similar systems can be built or bought and mounted on smaller vessels, but the calibration and operation of these systems will be similar to those operated on the UNOLS fleet.

We refer interested users to the documentation provided by the UNOLS system for information on the calibration, operation, and processing of CTD data. In addition, the CalCOFI program provides additional information in terms of vessel-specific operational guidelines.

UNOLS CTD Water Sampling and Deployment (SBE 2012)

<https://unols.org/document/ctd-water-sampling-and-deployment-sbe-2012>

CalCOFI CTD Set-Up and Diagnostics

<https://www.unols.org/document/ctd-set-and-diagnostics-calcofi>

CalCOFI CTD Data Processing Protocol

<http://calcofi.org/data/ctd/165-ctd-processing/330-ctd-data-processing-protocol.html>

5. Propagation Loss Experiment and Horizontal Line Array Sampling

5.1 Transmission Loss Experiment Source Deployment and Good Practice

Acoustic projectors (J-9, J-13) will be deployed from the research vessel to transmit a series of pulses (see HSE document Appendix C for specifications on transmissions) as the vessel drifts slowly away from the ADEON lander. The transmitted signal consisted of fourteen 10 s hyperbolic frequency modulated signals (HFMs) (Ainslie, 2010) spanning from 70.154 Hz to 1781.8 Hz, alternating in up and down sweeps. Following the 140 s of sweeps, 4 sinusoidal tones (103 Hz, 351.49 Hz, 757.49 Hz, 1125.49 Hz) were transmitted concurrently for 100 s. The sweeps were defined by lower and upper bounds provided in Table 4.

Table 4. Hyperbolic Frequency Modulation (HFM) parameters for 14 transmitted sweeps at a series of ranges (e.g., 0, 50, 100, 500, 1000, 2000, 5000 m) from the lander site location. These will be used to calibrate the propagation loss model. As part of the propagation loss experiment, trained marine mammal observers will be deployed before and during the experiments per the HSE documentation.

Sweep #	Start (Hz)	Stop (Hz)	Mean (Hz)
Sweep 1	88.388	70.154	79.271
Sweep 2	88.388	111.362	99.875
Sweep 3	140.308	111.362	125.835
Sweep 4	140.308	176.777	158.542
Sweep 5	222.725	176.777	199.75
Sweep 6	222.725	280.616	251.67
Sweep 7	353.553	280.616	317.08
Sweep 8	353.553	445.449	399.5
Sweep 9	561.123	445.449	503.286
Sweep 10	561.123	707.107	634.011
Sweep 11	890.899	707.107	799.001
Sweep 12	890.899	1122.46	1006.68
Sweep 13	1414.21	1122.46	1268.33
Sweep 14	1414.21	1781.8	1598.005

The power amplifier and monitoring electronics are set up in the lab of the ship. The tandem pair (joined by zip ties ever 2-3m) of source power and monitor hydrophone cabling is run from the lab, through the lab passthroughs to the location where the source is stored during transit. This is best inside, but close enough to the deployment point for easy movement when on station. Prior to

deployment of the source a 1 hour marine mammal watch was observed. If marine mammals are sighted, the clock is reset. The source is deployed with a monitor hydrophone taped to the support line at 1 m from the source. This permits an acoustic measurement of the sound pressure level generated by the source. The source is deployed via a winch, with the source power cable and monitor hydrophone cable manually attached to the deployment line at regular distances of roughly 5m. For the R/V Neil Armstrong, the CTD winch was used. The source is powered down and attached to the winch line. After deployment over the side, the source is turned on and a very short low level acoustic signal is transmitted. After deployment to the full deployment depth of 30 m, the source transmission is begun. All evolutions where equipment goes in the water require communications with and permission from the bridge.

The source is recovered first by powering down the electronics and then raising the winch line and cutting the tape holding the source power and monitor hydrophone cable. Once the source is recovered it is secured for transit.

5.2 Towed Array Deployment and Good Practice

A towed horizontal line array (HLA) will be deployed from a surface vessel to make passive acoustic recordings. A sailboat will be the preferred surface vessel to control for speed to minimize flow noise on the array elements. Towed HLA surveys will take place during the spring/fall seasons when Gulf Stream currents and regional weather are favorable to successful deployments.

The 16 m towed array will be deployed from a 40 ft sailboat to cover the leg between the ADEON landers at HAT (Hatteras) and VAC (Virginia Canyons). The array calibration was conducted several years ago and is beyond the scope of this document. The array is wet-tested in the lab before shipping. Upon arrival at the mobilization facility, the array is tested on the dock by connecting the recording system (a linux laptop) and tapping on each hydrophone. The array is then stored safely for transit. Once off shore, the array is deployed in shallow coastal waters to practice the hand deployment procedure, to confirm it is working, and to measure the flow noise as a function of vessel speed. The array depth as a function of speed and leader cable should also be measured. This data will be analyzed while underway to the HAT deployment site to inform the chief scientist of the speed limitations on the vessel.

The deployment routine consists of the following steps:

1. Connecting the array to the power and recording electronics
2. Deploying the drogue by hand off the back of the boat
3. Deploying the array
4. Deploying the leader cable and recording the results
5. Begin recording acoustic data

If possible it is very beneficial to be able to view and perform simple processing on the array acoustic data in real time as the data are being collected.

6. Ground Truthing Sampling

It is necessary to provide some level of ground-truthing data in order provide information on the accuracy of passive and active acoustic systems in measuring the presence, abundance, or location of biological organisms. This can be incredibly challenging for moored systems that are deployed for long periods of time by themselves. However, it is recommended that ground-truthing efforts be conducted at a minimum when systems are deployed and recovered.

There are many challenges to identifying the scatterers in the water column that are producing the signals measured by echo sounders. Fish and zooplankton are mobile animals ranging in size from the microscopic to tens of meters (e.g., siphonophores) so depending on the species of interest different gears are needed. In general, smaller nets and finer meshes are necessary to capture small zooplankton such as copepods. Larger trawls with greater mouth openings and mesh sizes are needed to capture fish. If users want to sample all types of fish and zooplankton then multiple sampling methods (i.e. different nets and trawls) will be necessary. The location of the organisms (near-surface, mid-water, near-bottom) of interest may also necessitate different sampling gear choices.

One critical piece of information needed to compare and interpret net/trawl data with active acoustic estimates of numerical density or abundance of fish is the swept volume or volume of water filtered by the net or trawl. The use of a flow meter and/or other methods of estimating the sampled volume of the net/trawl is critical to normalize the captured contents to the volume sampled. Because these methods are typically integrated (i.e., we do not know where in the water column organisms were captured by the net), care must be taken when comparing net/trawl data to the more finely resolved acoustic data. The ADEON project will use integrated nets that will be deployed for extended periods of time at specific depth strata to identify scatterers present in specific layers of the water column.

When possible, the use of multiple net systems (which allow stratified sampling of the water column) or opening and closing net systems (which allow for targeted depths to be sampled) can provide much more useful data to ground-truth echo sounder data.

It should be noted that video or camera sampling can be done to sample fish and zooplankton. The primary trade-off is a reduction in sampled volume (relative to nets) and the lack of direct samples (i.e. specimens) of the organisms. And for some species such as large pelagics, hook-and-line fishing methods may be needed to capture individuals.

This project will use mid-water trawls (mouth opening 3-7 m², mesh size 1-5 mm) to capture mesozooplankton and nekton. Trawls will be conducted as oblique tows or held at specific depths to identify scatterers in specific layers. Ring nets (mouth diameter 0.5-1 m, mesh size 0.15 – 0.5 mm mesh) will be deployed in vertical hauls to capture microzooplankton.

Information on different nets for capturing micro- to macro-zooplankton can be found in: Wiebe and Benfield, 2003; Methot, 1986; Devereux and Winsett (1953); Wiebe et al., 1985; Harris et al., 2000.

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APPENDIX A – JASCO Project Planning Worksheet

The following is an internal JASCO Applied Sciences document that is provided as an example of how individual JASCO sensors are tested and verified prior to field deployment. ADEON will use the same preparation and testing procedure for the passive acoustic sensors on each ADEON lander prior to deployment in the field.

APPENDIX B – ADEON Lander Operations Plan

The following Operations Plan is an internal JASCO Applied Sciences document that was used during the development and testing phase of the lander upon which the all ADEON lander deployments will be based.



Operations Plan

2017 ADEON 2 – Refurbishment and Redeployment

Authors:
Carmen Lawrence

24 May 2018

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Version 1.0

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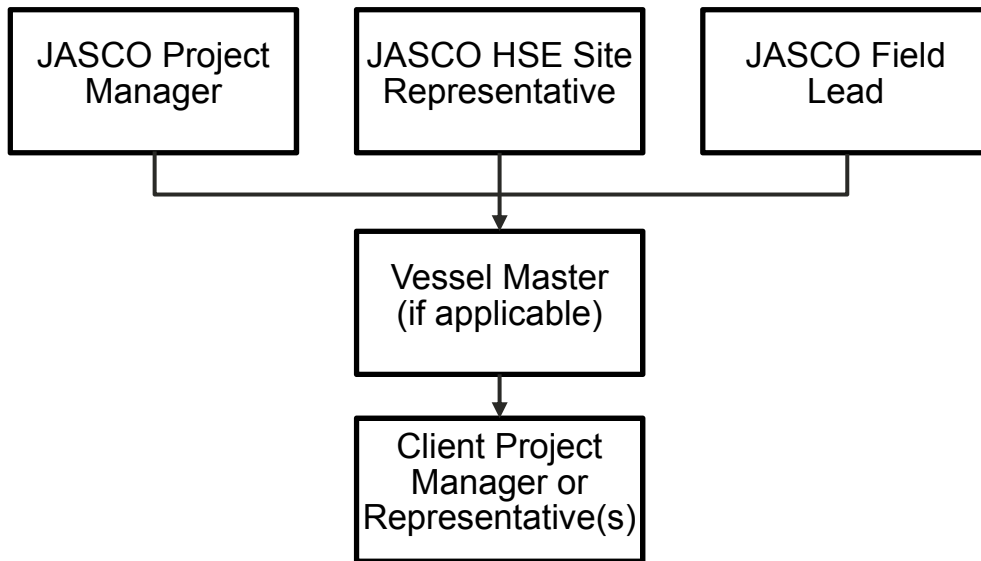


Approval

An operations plan is required for all deployments where JASCO is responsible for personnel safety and/or mooring performance. This Field Operations Plan has been approved by:

Name	Title	Approved DD Mon YYYY
Christopher Whitt	Project Manager	24-05-2018
Eric Lumsden	JASCO HSE Site Representative	24-05-2018
Carmen Lawrence	JASCO Field Lead	24-05-2018
Rhett McMunn	Vessel Master	Sepcor

Complete approvals in the following sequence.



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1. Summary

This operations plan covers the Atlantic Deepwater Ecosystem Observatory Network (ADEON) cruise 2 planned by JASCO Applied Sciences with the University of New Hampshire and Stony Brook University. This plan summarizes JASCO’s operational requirements, the equipment that will be deployed, and the deployment and retrieval methods for that equipment.

The goal of the project is to retrieve each of the seven landers deployed during the previous stage of the project, refurbish the equipment and redeploy in the same location. A spare lander will be utilized in order to perform refurbishment between stations instead of on station. At several stations, some minimal maintenance will need to be done on station.

JASCO will use its Autonomous Multichannel Acoustic Recorders (AMARs) to acoustically monitor for ambient and biological noise at each of the seven stations for a duration of six months. At each station, a new AMAR will be installed and the AMAR from the previous deployment will be shipped back to JASCO at the end of the cruise for data download.

The recorders will be deployed in June, 2018 until October, 2018 for a deployment duration of six months. After six months, the seven landers will be retrieved and redeployed with new sensors for one year.

Table 1. Sound sources that JASCO will monitor.

Sound Source	Frequency (Hz)	Measurement distance to lander (m)
J9 Projector	40 to 20,000	0, 50, 100, 500, 1000, 2000 and 5000
J13 Projector	30 to 3000	0, 50, 100, 500, 1000, 2000 and 5000

2. Schedule of JASCO Operations

This schedule may be adjusted based on weather and operational constraints.

Date	Location	Activity
30-03-2018	Dartmouth	Equipment ships to the field
20-04-2018	San Juan, PR	Equipment arrives at vessel
03-06-2018	San Juan, PR	Field lead arrives in PR
03-06-2018	San Juan, PR	Equipment mobilization aboard the R/V Endeavor
06-06-2018		At sea
25-06-2018	Rhode Island	Endeavor arrives in Rhode Island
27-06-2018	Rhode Island	Demobilization
28-06-2018	Rhode Island	Field lead travels back to Dartmouth

3. Requirements

3.1. Resource Requirements

The following resources are required from the vessel to complete the deployment and retrieval:

- A-frame and crane hook
- 2 deckhands/crew
- Crane Operator
- Crane Signaler
- FRC
- FRC operator
- Long boat hook that can clear vessel's freeboard

Additional requirements:

- Adequate space on deck with covered area to perform lander refurbishment and equipment calibrations

4. Equipment

4.1. Acoustic Recording Configuration

4.1.1. AMAR Configuration

Each AMAR will have 4 hydrophones spaced 50cm apart in an orthogonal array setup. Upon retrieval, the distance between each hydrophone will be measured and again after calibration before the lander is redeployed.

Table 2. AMAR recording schedule

Start Time	Sample Rate (kHz)	N Channels
00:00	375	1
00:01	8	4
00:20	375	1
00:21	8	4
00:40	375	1
00:41	8	4
00:46	AZFP	N/A

4.2. Lander Design

Each lander is approximately 2 meters high and 1.7 meters wide and weights 800 kg with anchor and 450 without the anchor. Each mooring consists of the lander body and 4 arms that extend vertically to a central lift point. The lander is connected via acoustic releases to the anchor, which consists of a steel triangle assembly with 5 20 kg weight plates on each point of the triangle.

Each mooring contains:

- AMAR
- 2 PORT LF acoustic releases, connected to one another through the anchor
- 4 M36 hydrophones set up on an orthogonal arrays attached to the arms of the lift point
- 1 Iridium Kilo beacon
- 1 MMF Infinity flasher beacon
- 1 vemco fish tag receiver (only shallow stations)
- 1 SBE 37-SMP CT-ODO sensor
- 1 AZFP (only shallow stations)
- Anchor (350 kg)

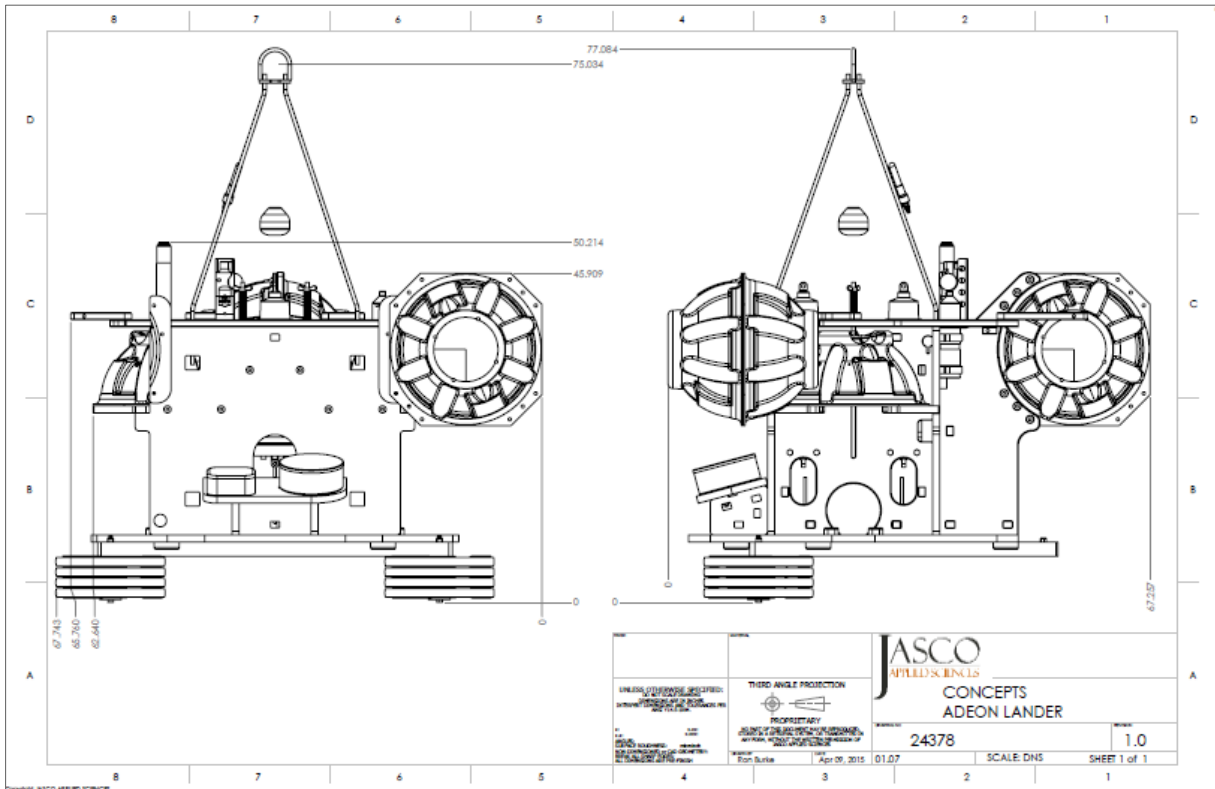


Figure 1. Detail of the lander design layout (only showing 12 anchor plates instead of 15).

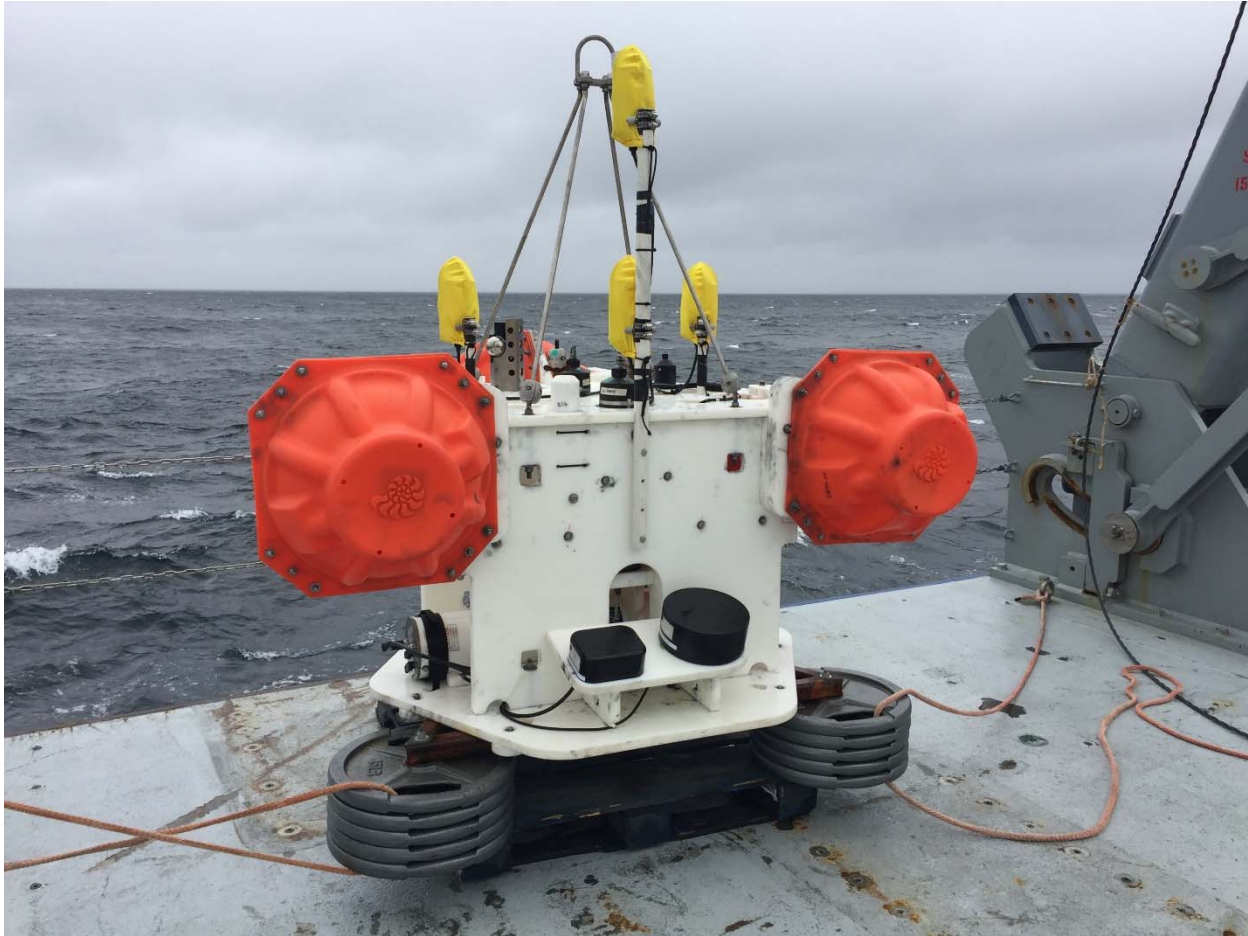


Figure 2. Lander showing orthogonal hydrophone array setup, AZFP & transducer mount and tagline attachments in preparation for deployment.

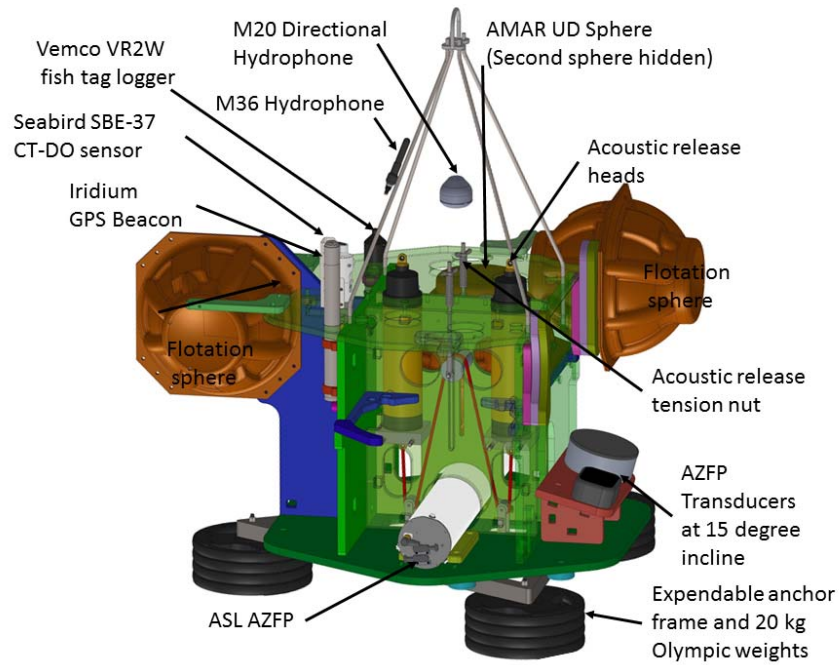


Figure 3. Mooring 201 – ADEON lander (shown with 12 weight plates instead of 15) with M20 directional sensor.

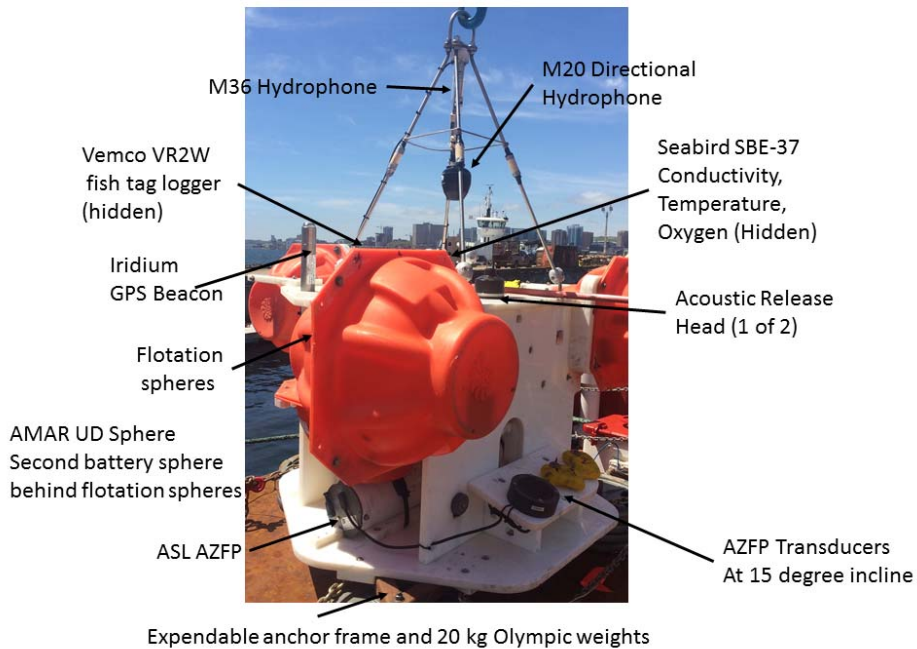


Figure 4. Annotated picture of ADEON lander with M20 directional sensor

5. Measurement Plan

Seven landers will be deployed at seven sites along the eastern seaboard (Figure 3). Three of the seven sites (labelled as *Shallow*, see Table 3) will contain additional sensors: and AZFP and a Vemco fish tag receiver.

The order in which the stations will be conducted will be decided in the field and will depend on weather conditions and the discretion of the ship's crew and project leads. The cruise will begin in the south and work its way north through the stations.

1. Virginia Inter-Canyon (VAC)
2. Hattaras South (HAT)
3. Wilmington (WIL)
4. Savannah Deep (SAV)
5. Charleston Bump (CHB)
6. Blake Escarpment (BLE)
7. Jacksonville (JAX)

Once the first station's lander is retrieved and the spare deployed, the JASCO field lead will begin refurbishing the lander (with the assistance of the ship's crew and other available human resources).

The landers will be deployed on flat sandy or clay bottom in depth ranges from 200 to 800 meters, outlined in Table 3. The shallow sites have additional instrumentation that cannot be deployed in more than 400 m.

Virginia Inter-Canyon and Hattaras deployment locations will require careful consideration once on site. Based on the current profile and direction, the deployment location may need to be adjusted. If the landers at these stations drift significantly, there is a risk of them landing in a too deep location and/or on an undesirable bottom type.

Multibeam surveying will be conducted on the approach to each station to determine the bathymetry and any areas that may need to be avoided for redeployment.

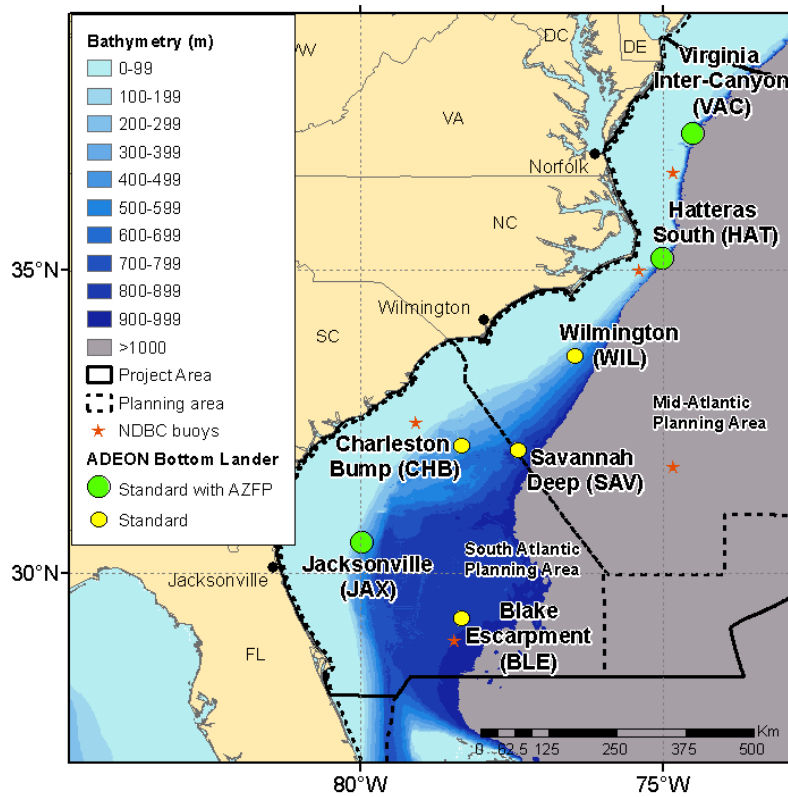


Figure 5. Deployment locations

Table 3. Proposed deployment locations of each recorder.

Site	Abbrev.	Lat	Long	Depth (m)	Type
Wilmington	WIL	33 35.1144 N	076 27.0336 W	461	Deep
Virginia Inter-Canyon	VAC	37 14.7792 N	074 30.8124 W	212	Shallow
Savannah Deep	SAV	32 02.5308 N	077 20.8740 W	790	Deep
Charleston Bump	CHB	32 04.2150 N	078 22.4430 W	404	Deep
Hatteras South	HAT	35 11.9730 N	075 01.2228 W	296	Shallow
Blake Escarpment	BLE	29 15.0588 N	078 21.0450 W	872	Deep
Jacksonville	JAX	30 29.5644 N	080 00.1872 W	317	Shallow

6. Lander Refurbishment

6.1. Retrieval

Before the lander is retrieved, an anchor will be prepared in an open and crane accessible location on deck. When the retrieved lander is being lifted aboard, it will be lowered directly onto the anchor. Performing this step saves effort and a crane lifts and also provides a way of secure the lander. Once lander is secured on anchor, it will be moved to a more secure location on deck.

6.2. During transit – all sites

The transit time between stations will consist of the bulk of the lander refurbishment time and labour.

Refurbishment steps:

1. Precisely measure distance between hydrophones (within 1 mm). Record in log.
2. Stop AMAR and perform retrieval calibration
3. Shut down all active equipment (AMAR, beacon, acoustic releases, flasher, CT-ODO, VEMCO, AZFP).
4. Remove beacon, flasher, CT-ODO, VEMCO (if applicable) and store in a secure location
5. Remove float on the starboard side of the lander (Figure 6) to access the AMAR. Store in safe location.

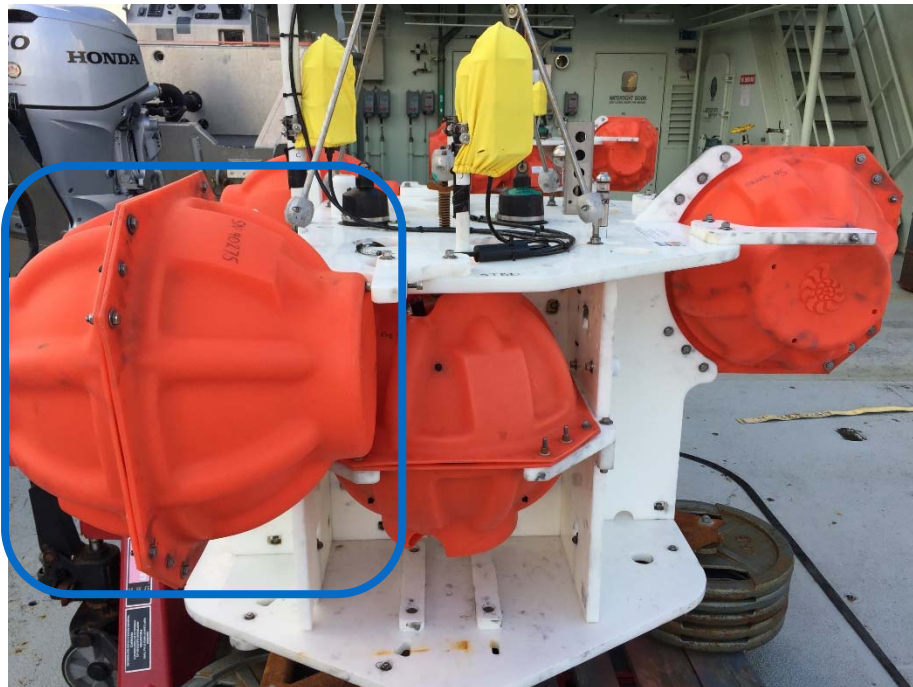


Figure 6. Photo displaying location of float to be removed to replace AMAR

6. Disconnect hydrophone extension cable and unsecure AMAR from mounting brackets. Place AMAR in secure location.
7. Remove disks from bottom of lander that cause scratches in the AZFP
8. Disassemble acoustic release tensioning line assembly and replace hardware
9. Install new acoustic releases and set up tensioning line, tension acoustic release partially
10. Install new AMAR on lander. Steps 6 and 7 will require at least two people to perform, as the AMAR UD is too heavy for one person to lift.
11. Connect AMAR to hydrophone cables and perform calibration on the new system. Secure hydrophones in mast cages.
12. Precisely measure the distance between the hydrophones (within 1 mm)
13. Replace starboard side float
14. Check all hardware on lander and replace any as needed
15. Add new anodes to lift arms and replace those on hydrophone mounts and acoustic release assembly
16. Replace flow shields and secure
17. Thoroughly clean CT-ODO and perform data download and backup
18. Install new CT-ODO, flasher and Kilo beacon on lander.
19. Perform maintenance and battery replacement on retrieved CT-ODO, flasher and Kilo beacon. For CT-ODO's and flashers, lithium battery handling procedure requires working under fume hood and wearing adequate PPE. Used lithium batteries disposed of properly as per the ship's system. All o-rings will be new and prelubed. Record all maintenance and tests in log sheets and upload to equipment folder (if possible).

6.3. Shallow Sites

Three shallow sites will require on site refurbishment for the AZFP and VEMCO receivers. Once the lander is retrieved, both sensors will require data download, maintenance and battery replacement before being installed on the new lander and deployed.

6.4. Remediating known issues

1. AZFP installation:
 - a. Bolt on disk causes scratches on AZFP housing removed during refurbishment
 - b. Alternative securing method required and extra rubber padding for attachment points
 - i. Either with HCL bands or hose clamps (under discretion of principal investigator).
2. Retrieval issues:
 - a. Small target for snap hook during retrieval, but not being updated in the field. Discussion with deck crew and bridge crew to bring up issue so everyone is aware.

7. Deployment Procedure

The following steps outline the procedure for deploying the lander mooring from the R/V Endeavor. The lander will be lowered into the water from the A-frame (Figure 7) of the vessel off the back deck using a TR-7 quick release with two deck crew, the JASCO field lead and a crane operator. This procedure is subject to change based on weather conditions and consultation with the vessel master and crew.



Figure 7. University of Rhode Island R/V Endeavor

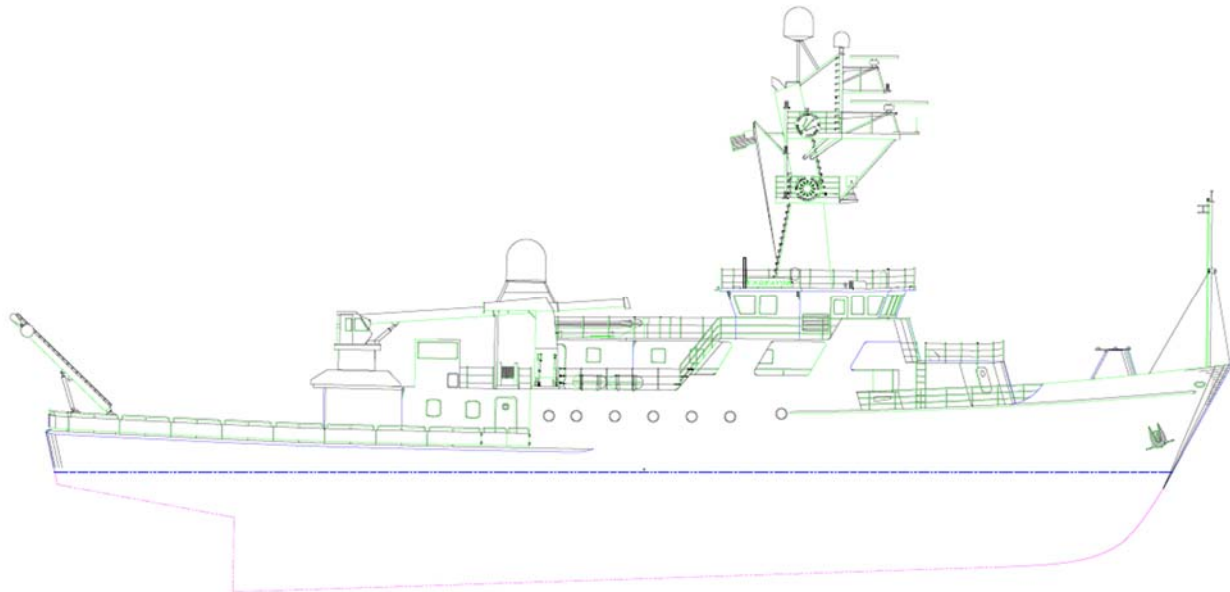


Figure 8. Deck layout of the R/V Endeavor



Figure 9. TR-7 on-load quick release

Prior to deployment at each site, the JASCO technician and project leads will consult with vessel crew for the depth, sediment composition and prevailing current speed and direction of each location. The deployment location may be adjusted slightly based on these parameters. On the approach to each site, multibeam mapping will be conducted to ensure the deployment location is free on any undesirable subsea features.

7.1. Deployment Procedure

Each AMAR will be deployed as follows:

1. Job Safety Analysis meeting with JASCO crew, ship's crew, crane operator, and vessel master.
2. **Prepare the equipment for deployment:**
 - a. Lander moved into deployment location to be deployed by A-frame (Figure 8).
 - b. Equipment startup commences
 - i. AMAR
 - ii. Beacon
 - iii. Flasher

- iv. Vemco fish logger (shallow stations only)
 - v. AZFP (programmed by University of New Hampshire and start up in conjunction with AMAR, shallow stations only)
 - vi. CT-ODO
-
- c. Ensure all systems securely fastened to lander and check hardware for any loose connections
 - d. Check to make sure all anodes have been replaced/added
 - e. Move lander to deployment location on deck
 - f. Secure passthrough taglines through two of the anchor points and wrap around cleat on deck
 - g. Secure TR-7 (Figure 9) to lift point on lander
 - h. All non-essential personnel off the back deck/deployment area
 - i. Lower crane hook from A-frame and secure onto shackle of the TR-7, draw back crane hook until in position to lift lander
 - j. Confirm location on GPS and communicate with bridge that vessel and crew are ready for deployment, vessel declutches.
 - k. Vessel to maintain position using its DP system
- 3. Deploy the lander:**
- a. Crane operator lifts lander with crane hook
 - b. Crew control load with pass-through taglines going through two of three anchor points, ensuring the lander does not swing or spin and one crew member controlling TR-7 lines
 - c. A-frame articulates outboard and positions lander in position above waterline, crane operator lowers lander until the TR-7 is just above the waterline, taglines are removed
 - d. Crew member removed safety pin on the TR-7 quick release
 - e. Confirmation with JASCO field to deploy
 - f. Crew member pulls lanyard on release to deploy lander
- 4. Range and position the lander**
- a. Vessel maintains position
 - b. Vessel declutches, JASCO field lead lowers edgetech transducer through overside and enables one of the two PORT LF acoustic releases
 - c. Range measurements are taken during decent.
 - d. Once justified that the lander is on the bottom (range will discontinue to increase), at least four range measurements are made within a 500m cardinal points around the deployment location to box in the location of the lander. Location is recorded in notes/deployment logs.
 - e. PORT LF acoustic release is disabled.
5. Debriefing meeting to capture lessons learned.
6. Vessel crew initiates NOTMARs for the location of each lander.

8. Retrieval Procedure

The following steps outline the procedure for retrieving the lander mooring from the R/V *Endeavor*. The lander will be recovered via Kong boat hook and lifted aboard the vessel using the main crane. This procedure is subject to change based on weather conditions and consultation with the vessel master and crew.

The AMARs will be retrieved as follows:

1. Job Safety Analysis meeting with JASCO crew, ship's crew, crane operator, and vessel master.
2. Anchor is prepared and moved onto the deck.
3. **Position the vessel:**
 - a. The vessel approaches the location to within 100 m and maintains position. Ship's crew are positioned around the vessel to act as spotters. The crane is made ready, with tag lines attached to the crane hook. The Kong snap hook is attached to a dyneema lifting line with a loop in it for attaching to the crane hook and is secured on a gaff. A second Kong hook setup may be used for the tagline attachment.
 - b. Vessel declutches.
 - c. JASCO lead lowers the Command Unit transducer into the transducer tube on the back deck of the vessel and uses the command unit to enable one of the PORT LF acoustic releases of the lander.
 - d. If needed, JASCO lead brings the transducer back onboard, and return to Step 1.
OR, if the distance is okay for retrieval, continue to Step 4.
4. **Release the mooring:**
 - a. JASCO field lead triggers the acoustic release to let go of the anchor weight so the mooring can float to the surface. Ranges are taken as the lander ascends.
 - b. The ship's crew maintain lookout to spot the lander or flasher beacon on the surface.
 - c. Once the lander is spotted, the Command Unit transducer is retrieved.
7. **Retrieve the mooring:**
 - a. The vessel proceeds slowly and positions the mooring on the vessel's windward side.
 - b. The ship's crew use the Kong boat hook on a gaff to snap onto the lift point of the lander. The lift point is a small target and may require several attempts to attach the Kong hook.
 - c. Once the Kong hook is secured on the lift point of the lander, the Kong hook is detached from the gaff and the gaff is brought aboard.
 - d. The line from the Kong boat hook has a loop in it that attaches to the crane hook and the lander is lifted aboard. At this point, the taglines are attached at the connection point between the floats and the lander using a second Kong hook and gaff.
 - e. Once the mooring is clear of the vessel's side, the ship's crew use tag lines to steady the load as it is lowered onto the deck and onto the new anchor.
 - f. JASCO lead turns off equipment and vessel crew secures lander for transit.
8. Debriefing meeting to capture lessons learned.

9. Reporting

Data from the CT-ODOs and VEMCO receivers will be downloaded and backed up in the field.

10. Health, Safety, and Environment

For the safety of the JASCO team, JASCO requests the vessel crew address the items in this list:

- The JASCO team and crew will conduct a daily safety (toolbox) meeting before any work proceeds including initial equipment loading/unloading periods, which could happen before or after measurement days.
- A complete vessel safety orientation will be provided to the JASCO team before the vessel leaves the dock.
- The JASCO team must be satisfied that the vessel crew is competent. For example, a trained crane operator must be present when one is requested as JASCO teams are not trained or qualified to operate lifting devices.
- Any new, young, or untrained staff, including those that form vessel crews, should be clearly identified to everyone so these individuals can receive additional support as needed.
- First Aid in the form required by local regulations must be present on the vessel. All JASCO team members have Standard First Aid, Adult CPR, and an introduction to AED.
- Where the law requires immersion suits, the suits will be in good condition and properly sized for the JASCO crew.
- Adhere to all environmental and safety laws that apply to the vessel.
- Vessel crew will have and use proper PPE for each part of the work.
- All involved crew members will participate in the JASCO JSA and toolbox meetings or the JASCO team obtains a copy of the documents used by the ship's crew.
- Safety calls and communication plans will be communicated to the JASCO team in advance of the work in order to confirm that such is occurring and to allow for planning time with JASCO's HSE team.
- Disposal at sea will meet all applicable environmental laws.
- To ensure JASCO staff comply with vessel safety requirements, these will be communicated to team members before work begins.

Any issues or concerns with this list need to be raised in before staff travel. Vessel crew reviewers should notify JASCO in advance of any items that cannot be complied with and indicate why.

10.1. Lithium Battery Handling in the Field

Lithium metal batteries will be shipped to the field in their original packaging and will remain isolated until their immediate use. Once removed from their original packaging, the cells shall be placed on an ESD tray or surface under a fume hood. The field member handling the batteries shall wear all appropriate PPE for lithium battery handling. All leads on used cells shall be isolated immediately and transported to the designated storage area.

11. Contacts

11.1. JASCO Contacts

Name	Role	Contact numbers	Email address
Christopher Whitt	Project Manager	Tel: +1-902-405-3336 x1005 Cel: +1-902-402-1729	christopher.whitt@jasco.com
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Eric Lumsden	HSE Representative	Tel: +1-902-405-3336 x1013 Cel: +1-902-401-5508	eric.lumsden@jasco.com

11.2. Client Contacts

Name	Role	Contact numbers	Email address
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Dr. Jennifer Miksis-Olds	Principle Investigator	Tel: +1-603-862-5147 Cel: +1-408-580-0218	J.MiksisOlds@unh.edu

11.3. Vessel Contacts

Name	Role	Contact numbers	Email address
Rhett McMunn	Master	Office: 401-874-6120	endeavorcaptain@etal.uri.edu

APPENDIX C – ADEON HSE Plan



ADEON HSE Requirement Document

**Atlantic Deepwater Ecosystem Observatory Network (ADEON):
An Integrated System**


Contract: M16PC00003

**Jennifer Miksis-Olds
Lead PI**


**John Macri
Program Manager**

01 August 2017

Approvals:



Jennifer Miksis-Olds (Lead PI) 01 August 2017
Date



John Macri (PM) 01 August 2017
Date

Overview

This report contains information on how ADEON is addressing all HSE requirements and concerns relating to the five scheduled ADEON cruises. Acoustic exposure aspects of the cruise activities were addressed with the Office of Protected Resources at NMFS Incidental Take Program and the Environmental Compliance office at ONR. Procedures related to vessel safety, hazardous chemicals, and research safety will follow the UNOLS Research Vessel Safety Standards.

ADEON Acoustics Transmissions

Acoustic Zooplankton Fish Profilers

Three of the seven ADEON bottom landers will be equipped with a 4-frequency Acoustic Zooplankton Fish Profile (AZFP) echo sounder system. The four operational frequencies are 38 kHz, 125 kHz, 200 kHz, and 455 kHz. These instruments will sample for 10 min every half hour with 1 ping/sec/frequency. The AZFP is a Commercial-Off-The-Shelf (COTS) instrument, and specifications are available at <http://www.aslenv.com/brochures/AZFP.pdf>. Discussion with the Office of Protected Resources at NMFS concerning the deployment of these instruments under the specified operation was deemed de minimus. Email confirmation of this decision from Benjamin Laws (NOAA OPR) was sent to Dr. Rebecca Green (BOEM) on 2/27/2017.

Sound Propagation Loss Experiment Transmissions

During ADEON Cruise 1 aboard the R/V Armstrong in Nov-Dec 2017, a sound propagation loss experiment will take place for one day at each of two locations: near Charleston, SC and Jacksonville, FL. Both of the locations fall within the Navy Atlantic Fleet Training and Testing (AFTT) regions and will be in compliance with the current AFTT incidental take permit from NAVSEA. Low frequency transmission from the J-13 transducer (50-550 Hz) will occur on a 50% duty cycle at 160 dB and will be treated as de minimis without any limits on the number of transmission hours. Mid-frequency transmissions of the J-9 transducer (750-1500 Hz) will occur on a 50% duty cycle at 170 dB. Verification of this approval from the ONR Environmental Compliance office (email dated 7/26/17) is appended below. There will be 3 certified marine mammal observers on the cruise. Two observers will be on watch during the duration of the sound propagation loss experiment transmissions. A required post-experiment report will be submitted detailing the transmission start/end times and hourly ship position. We expect the total duration of the experiment will be 48 hours, well below the 200 hour limit for the permitted J-9 source.

Vessel Mounted Echo Sounder Systems

Hull- or pole-mounted scientific echo sounders will be used during the ADEON project during finescale echo sounder surveys at each ADEON station location. The systems used will be Simrad EK60 (or EK80 depending on the vessel and frequency) echo sounders operating at 18, 38, 70, 120, and 200 kHz. Systems will operate at standard parameter settings: full power, ping interval ranging from 0.5 to 5 seconds (depending on depth), pulse lengths ranging from 256 to 8096 microseconds. The first ADEON cruise on the R/V Armstrong will use the ship-owned and operated Simrad systems. Operation of these systems falls within the approved operation of the ship. For ADEON cruises aboard the R/V Endeavor in 2018, a pole mount with the same systems will be used. The pole mount system will operate at the same frequencies as the systems on the R/V Armstrong. Specifications on these systems can be found on the manufacturer's website:

EK60 Documentation

<https://www.simrad.com/www/01/nokbg0240.nsf/AllWeb/B7960D953381AF28C1257A060044292B?OpenDocument>

EK80 Documentation

<https://www.simrad.com/www/01/NOKBG0240.nsf/AllWeb/951C978190B9F6CBC1257E51002A1383?OpenDocument>

Miksis-Olds, Jennifer

From: Soukup, Raymond J CIV ONRA, 32 <raymond.soukup@navy.mil>
Sent: Wednesday, July 26, 2017 4:22 PM
To: Miksis-Olds, Jennifer
Cc: Becker, Kyle CIV ONR, 322; Kevin Heaney
Subject: Item 17-42: Phonecon with Kevin Heaney

Kevin will do his TL tests off of Charleston and/or Jacksonville, within the AFTT area.

Low Frequency Transmits: 50-550 Hz, 60 seconds on, 60 seconds off (50% duty cycle) at 160 dB. These will be treated as de minimis. No limit on hours from my end. No mitigation (lookout) or reporting requirements.

Mid Frequency Transmits: ~ 750-1500 Hz, 60 seconds on, 60 seconds off (50% duty cycle) at 170 dB. We'll get permitted hours for this (donation from NAVSEA). For permitted source there would be a required lookout during source ops (trained via CD) and rules on shutdown when animals enter the mitigation zone. There is also a post-test reporting requirement (source ops start and end times, hourly ship position). Note that if there is an animal stranding within 72 hours or 100 nm of your source, it will be reported to NMFS. I will generate something called a "PMAP report" which could add additional responsibilities within certain geographical areas. I can get up to 200 hours for the permitted source hours. Note that if you transmit for 1 hour with a 50% duty cycle, it counts as an hour, not a half-hour. If you pick up the source and spend a couple of hours moving it elsewhere, the time during moving doesn't count.

Raymond Soukup
Ocean Acoustics Program Officer
Code 32 Environmental Liaison
Office of Naval Research
Arlington VA
703-696-4203

Research Vessel Safety

All ADEON personnel will be required and adhere to the UNOLS Research Vessel Safety Standards document located at

https://www.unols.org/sites/default/files/2009RVSS_web2012updates%281%29.pdf. This 18 chapter document thoroughly reviews safety and health issues ranging from personal behavior and safety to electrical and fire safety protocols. All ADEON personnel will also be required to complete a Shipboard Scientific Personnel Form at least 1 month prior to each cruise. In completing and signing this form, the cruise participant must review and accept the alcohol, drug, radioactive materials, hazardous materials, and staying aboard vessel policies.

APPENDIX D – JASCO document 00716 AMAR G3 Formal Qualification Test Procedure



AMAR FORMAL QUALIFICATION TEST AND MAINTENANCE PROCEDURE

2017 June 5

Document 00716-0.16

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Revision History

Version	Date	Name	Change
0.1	2013 Nov 29	D Freeman	Initial draft
0.2	2014 Feb 14	D Freeman	Updated with review comments
0.3	2014 Sep 08	S Fenton	Updated with additional comments, rearranged some steps, added in maintenance steps, added section for difference for the G2/G3A AMARs
0.4	2014 Oct 08	S Fenton	Additional updates as test record was created
0.5	2014 Oct 20	S Fenton	Moved setting of PRV to after end cap installed in housing and secured by bolts
0.6	2014 Nov 19	S Fenton	Updated to include Glass Sphere section
0.7	2014 Nov 21	S Fenton	Updates after review – added memory stack ty-wrap P/N as reference
0.8	2014 Nov 24	S Fenton	Updates after QA review
0.9	2015 Mar 13	S Fenton	Updated to include check for memory cap board if opened
0.10	2015 Apr 02	S Fenton	Updated to reference new AMAR assemblies as well
0.11	2015 Apr 15	B Stuart	Remote offices do not need to perform sections 3 & 4 between deployments
0.12	2016 Jan 15	S Fenton	Update for h-phone power connector checks
0.13	2016 Feb 19	S Fenton	Update to include hyperlink to FQT deploymentInfo file for h-phone test fixture
0.14	2016 Feb 23	D Freeman	Updated value to align with Spectroplotter output
0.15	2016 April 15	S Fenton	Updated to record board model and NAND module serial numbers
0.16	2016 Jun 20	S Fenton	Rearranged to take electronics checks out of G2 legacy/G3A and AMAR-UD sections, electronics checks can be done a board by itself

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PREAMBLE

Purpose

This document defines the procedures for qualifying the Autonomous Multi-channel Acoustic Recorder (AMAR) from field deployment, including the quality testing of electronic and mechanical components, to ensure that all AMARs are in working order before returning the units to stock.

Scope

These procedures apply to all AMARs during initial assembly and after demobilization (and the stored data has cleared data quarantine). Familiarity with the AMAR and AMARlink operation is required prior to performing this procedure.

Remote offices do not need to perform the Electronics Validation or Burn-In portions (Sections 3 and 4) of this procedure between deployments; however, AMARs must be returned to the Dartmouth office annually for maintenance and full FQT.

Applicable Documents

00883	00883 AMAR Integration Assembly Procedure
00306	NAND FLASH Memory Module FAT/FQT
00755	AMAR G3 FQT Test Record
5113	AMAR G3 Electronics housing assembly drawing
00752	AMAR Power Consumption Matrix
00175	AMAR G2 User Guide
00294	AMAR G3 User Guide
00182	AMAR Hydrostatic Pressure Testing Plan
00211	AMAR Periodic Maintenance Test Sheet
00372	AMAR Software Installation Instructions
00536	AMAR PLL Calibration Instructions
N/A	FQT Test fixture GTI 0dB deploymentInfo - 16-bit
N/A	FQT Test fixture GTI 0dB deploymentInfo - 24-bit

Supplemental Documents

Not Applicable

Associated Documents

Not Applicable

Review

This procedure shall be reviewed by the following before release:

Dale Freeman
Steve Fenton
Craig Hillis
Trent Johnson

Approved By:

Bruce Stuart

Quality Assurance Manager

Definitions

To be completed

Abbreviations and Acronyms

AMAR	Automated Multi-channel Acoustic Recorder
Comms Cable	Communications Cable
DC	Direct current
DQ	Data Quarantine
DUT	Device under test
ESD	Electro-static discharge
FQT	Formal Qualification Test
IP	Internet Protocol
LED	Light emitting diode
PCB	Printed circuit board
PRV	Pressure relief valve
QA	Quality Assurance
QC	Quality Control
RTC	Real time clock
S/N	Serial number
VI	Virtual Instrument (LabVIEW application)
WAV	Waveform Audio File Format

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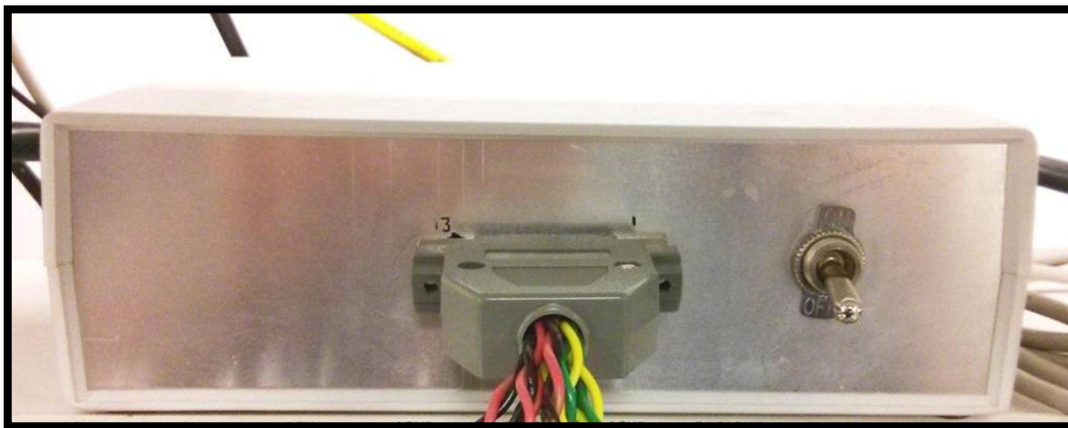
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Required Equipment/Software

Bench top power supply set to 12V, 0.5A min, current limit capable)	Putty or similar communication software
Digital Multimeter	NI LabVIEW V8.0 or greater
Signal Generator (Keithley 3390 or similar)	AMAR Power Measurement VI for LabVIEW
Power Measurement Fixture (Figure 1)	GTI Hydrophone Simulator Test Jig
AMAR COMMs Box	

Figure 1: Power Measurement Fixture



1. AMAR G3 Post Demob Verification

NOTE: Follow ESD protocols.

NOTE: If performing an FQT on a G2 or G3A AMAR, refer to section 6 for details on differences.

NOTE: If performing an FQT on a Glass Sphere AMAR, refer to section 7 for details on differences.

NOTE: If any inspection step fails in the procedure, create an issue in the issues list, set AMAR to issues quarantine and stop this procedure.

Record all results in the appropriate tab in a copy of template Document [00755](#).

1.1. Issue Verification

1. Verify the system has cleared Data Quarantine. If not, return unit back to the Data Quarantine shelf. **Do not disassemble housing or remove any attached accessories.**
2. Verify the completed demobilization record, if not contact QA.
3. In Share point - verify there are no unresolved or open issues against any components. If issues exist, resolve the issues before any of the components can be removed.

NOTE: If any components have issues against them that cannot be resolved, those components will need to be replaced with new ones that have passed their individual FQT procedure and SharePoint will have to be updated accordingly.

4. If the system can proceed through FQT, remove attached hydrophone(s) to have the Hydrophone FQT performed. **Ensure SharePoint inventory is updated for both the hydrophone(s) and the AMAR to reflect removal and status.**
5. Record on the results sheet the internal wiring code installed. This determines the channels to be tested during the FQT.
6. Record on the results sheet the IP address of the AMAR board. Configure an AMAR '**Alias**' in AMARlink with the IP address of the board. Recommended alias format is AMARxxxx, where 'xxxx' is AMAR serial number.

1.2. Maintenance Verification

1. Verify 5 year maintenance is not due for a minimum of 4 months from current date. If due within 4 months, perform 5 year maintenance procedure in section 2.6.
2. **Record** date of last pressure test.

NOTE: It is not necessary to perform the regular maintenance (section 2.4) before completing the 5 year maintenance.

2. Maintenance

NOTE: If performing an FQT on a G2 or G3A AMAR, refer to section 6 for details on differences.

NOTE: If performing an FQT on a Glass Sphere AMAR, refer to section 7 for details on differences.

2.1. Housing

Record all results in a copy of template Document [00755](#).

1. Inspect bottom endcap. Ensure all bolts are tight and inspect for corrosion.
 2. Inspect the connectors and PRV and ensure they are firmly installed into the bottom endcap.
 3. Inspect the top endcap and ensure all handling ring spacers are installed and not damaged; ensure handling ring is not damaged.
 4. Visually inspect all exterior housing surfaces. Ensure there are no nicks or chips that could jeopardize the structural integrity.
 5. Replace any anodes that exhibit 10% or more corrosion.
 6. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, undamaged and properly lubricated.
 7. Replace the PRV core (will be set later). **Record** PRV S/N.
-

2.2. Connectors

Record all results in a copy of template Document [00755](#).

NOTE: If any connectors exhibit signs of corrosion, contact QA for evaluation. Replacement may be required.

1. Thoroughly inspect the Activation Plug bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug.
2. Thoroughly inspect the Comms bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug.
3. Thoroughly inspect the hydrophone bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug (or dust cap if not available).

DO NOT leave hydrophone connector pins exposed and unprotected.

4. Thoroughly inspect the external power input bulkhead connector contact pins for corrosion (if applicable). Clean and reapply dielectric grease if necessary. Re-install dummy plug.
-

2.3. Internal checks

Record all results in a copy of template Document [00755](#).

1. Remove the top end cap from the AMAR housing.
 2. If installed, remove the auxiliary internal battery pack.
 3. Remove desiccant packs from the internal chassis to be re-activated. Activated desiccant packs will be installed just prior to the enclosure “button-up”.
 4. Verify AMAR electronics board ID matches board listed in SharePoint. **Record** board ID and model.
-

5. Inspect the AMAR NAND flash memory stack.
 - a. Ensure all the modules are well seated and the stack is completely vertical.
 - b. Check the strap that holds the stack in place. Ensure that the strap is tight and well seated in the top and bottom channels. (Ty-wrap P/N 298-1064-ND, Digi-Key)
 - c. Verify number of modules installed matches number indicated in SharePoint for the board. **Record** number of modules installed.
 - d. Verify serial numbers of modules installed (if possible without removing the stack) and **record**.
 - e. Verify the size of memory modules installed from SharePoint. **Record**.
 - f. Verify serial number of memory cap board installed. **Record**.
 6. Replace electronics board coin cell battery if necessary. RTC battery has a 2 year life span, replace if due within 6 months. **Record** last battery replacement date on checklist.
 7. Inspect the electronics chassis for signs of damage.
 8. Inspect all board stand-offs and ensure they are secure, all screws for the board are present and secure.
 9. Inspect chassis mounting to ensure all nuts are present and secure.
 10. Inspect wires from top end cap to electronics board; ensure all connections are secure and undamaged.
 11. Inspect hydrophone power MicroFit connector to ensure a dummy crimp pin is installed in location 2. Install if required.
 12. Inspect hydrophone power pin to ensure crimp pin is not splayed or misshapen. Replace or repair pin(s) if required.
-

2.4. Regular Maintenance

Record all results in a copy of template Document [00755](#).

NOTE: It is not necessary to perform the regular maintenance if the 5 year maintenance is being performed.

The following steps are performed as part of regular maintenance after each deployment cycle.

1. Verify all external serial number markings are legible on the housing and the ends caps, remark/label if necessary.
 2. Carefully remove the top end cap o-rings. Thoroughly clean the o-rings using soap/water mixture, rinse with plain water.
 3. Thoroughly inspect the o-rings under a magnifying glass for nicks, cuts or other damage. Replace if suspect. Set aside for re-installation or obtain new o-rings as per AMAR Assembly Drawing 5113.
TIP: O-rings should be replaced **at least once per year** on the top end cap.
 4. Inspect top end cap o-ring race under magnifying glass for dirt, scratches or irregular appearance.
 5. Thoroughly clean the o-ring race using soap/water mixture. Rinse with plain water.
 6. Lube the o-rings using a small amount of Parker Super-O lube, there should not be an excess of lube on the o-rings, they should appear shiny.
-

7. Carefully install the o-rings, be careful not to damage or contaminate the o-rings during installation.
-

2.5. Bottom Mount Mooring Requirements

As a precaution for bottom type moorings that were deployed in muddy bottom locations, a sample inspection of bottom end cap o-rings may be required upon their return. Consult with mechanical engineer and/or Quality Manager to determine if this is required.

2.6. 5 Year Maintenance

The following steps are performed every 5 years of AMAR service life.

NOTE: It is not necessary to perform the regular maintenance if the 5 year maintenance is being performed.

Record all results in a copy of template Document [00211](#).

1. Verify all external serial number markings are legible on the housing and the ends caps, remark/label if required.
 2. Carefully remove and discard the top end cap o-rings.
 3. Inspect top end cap o-ring race under magnifying glass for dirt, scratches or irregular appearance.
 4. Thoroughly clean the o-ring race using soap/water mixture. Rinse with plain water.
 5. Obtain new o-rings as per AMAR Assembly Drawing 5113.
 6. Lube the o-rings using a small amount of Parker Super-O lube, there should not be an excess of lube on the o-rings, they should appear shiny.
 7. Carefully install the o-rings on the top end cap, be careful not to damage or contaminate the o-rings during installation.
 8. Repeat steps 2 through 7 for the bottom end cap
-

2.7. Pressure Test Requirements after Maintenance

10% of the pressure housings that have had the 5 year maintenance performed should randomly be selected for re-test and re-certification for pressure rating.

Perform pressure test as per document [00182](#) if required.

2.8. G3 Electronics housing (Internal "Button-up")

Record all results in a copy of template Document [00755](#).

1. Install one new desiccant pack on underside of electronics chassis.
-

Figure 2: Desiccant Location



CAUTION: Be careful to make sure that the desiccant is installed tightly and will not interfere with the o-rings as end cap is inserted into housing.

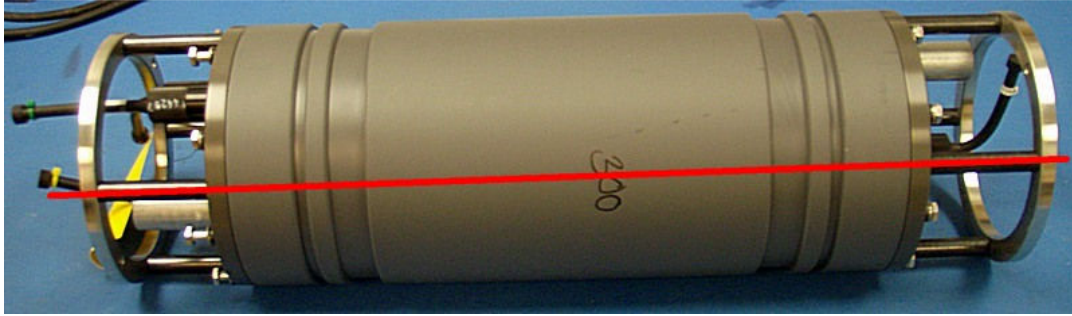
2. Verify hydrogen combiner pellets are installed and container is not damaged. Replace as required.

Figure 3: Hydrogen Combiner Location



3. Insert top endcap into pressure housing, ensuring that no wires are pinched and that the bolts/washers do not nick or damage the O-ring surface.
4. Ensure that the endcap handling rings are properly aligned when installing the top end cap on the G3 housing.

Figure 4: Endcap Alignment



5. Install the bolts finger tight on the endcap.
6. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.
7. Adjust the PRV core to fully closed, and then open by exactly 4.5 turns with PRV tool.

3. Electronics Validation

Record all results in a copy of template Document [00755](#).

3.1. AMARlink Communication

1. Connect the AMAR through a COMMs Box to a computer running AMARlink. AMARlink and the board firmware are linked, please consult software group for the correct version of AMARlink that goes with the installed firmware if in doubt.
2. Attach the 2-pin connector, of the Power Measurement Fixture (see **Figure 5**), to the power adapter cable of the AMAR. Plug the adapter cable into the 6-pin power connector of the AMAR.
3. Install the Activation plug in the AMAR. Turn on the Power Measurement Fixture.
4. Press and hold the button on the COMMs Box to set the AMAR to Stop Mode. Ensure both LEDs are lit on the COMMs Box.
5. Connect to the AMAR, through AMARlink, and select the System Info tab. Ensure the board serial number and software revision match the inventory records. **Record** serial number and software version on the checklist.
6. Verify that the correct number of memory modules is being reported and the installed sensors match the internal wiring configuration. **Record** number of modules reported by AMARlink on checklist.
7. Verify amount of memory reported matches module size x number of modules. **Record** total memory reported.
8. Using AMARlink, send the following recording configuration to the AMAR.

Table 1: Power Consumption Schedule

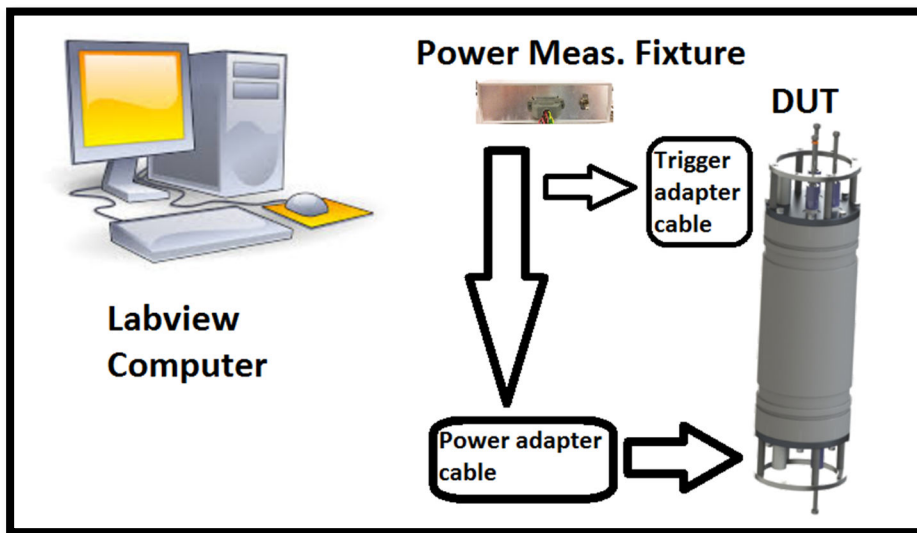
Step	Type	Detail	Channel	Duration
1	Sleep			5 sec
2	Record	64 ksps	1	120 sec
3	Sleep			∞

9. Verify that the configuration has been sent to the AMAR correctly by refreshing the AMAR connection and observing reported configuration by the ‘View Schedule’ tab.
 10. Check software version installed from the Systems Tab in AMARlink. Upgrade software to latest release if required. Follow User Guide instructions to upgrade through AMARlink, or follow AMAR Software Installation Instructions document ([00372](#)) to perform a clean install software upgrade if necessary.
 11. Turn off the Power Measurement Fixture.
-

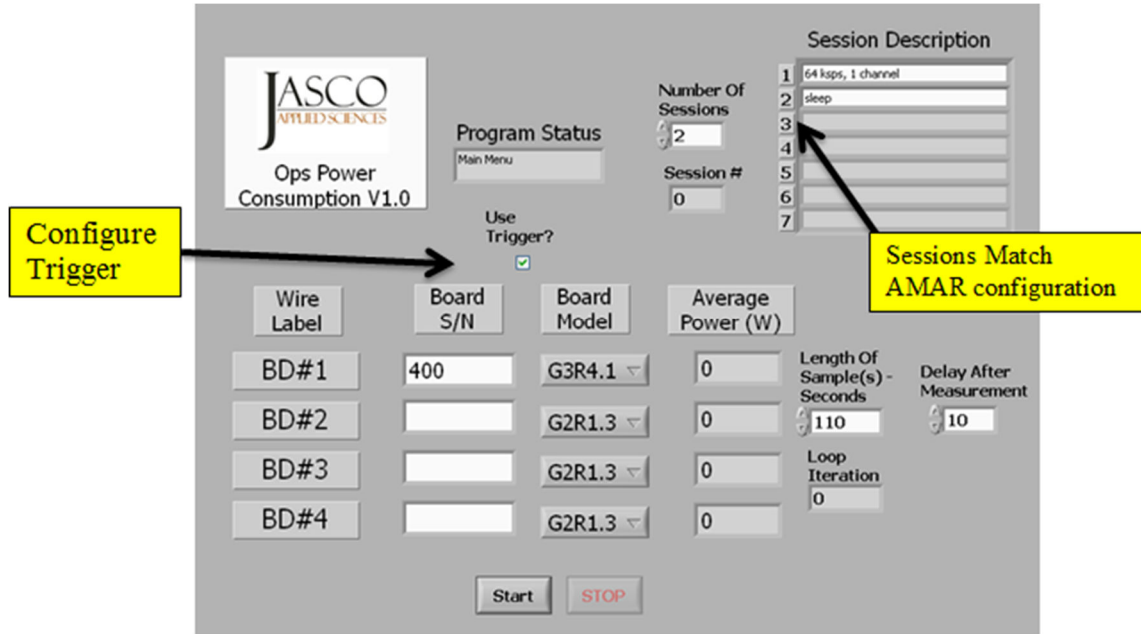
3.2. Power Consumption

Refer to interconnect diagram (**Figure 5**) for wiring details

Figure 5: Power Measurement Connection



1. Launch “AMAR Power Measurement (triggered)” VI and configure the main screen accordingly.

Figure 6: Power Measurement VI Main Menu

2. **Record** the AMAR's serial number in the Board S/N field of LabVIEW.
3. Plug the fixture's trigger cable into COMMs connector of the AMAR. Ensure that the "Use Trigger" box is checked in LabVIEW.
4. Turn on the Power Measurement Fixture, and after 3 seconds, press the "START" button on the VI. The Program Status should say "Waiting For Trigger", and after a few seconds say "Measuring Power".
5. After approximately 2 minutes, the VI's program status will say "Waiting For Trigger" and will be waiting for an activation event on the sleep session. To measure the sleep power, unplug the trigger cable. 2 minutes later the VI will exit, and all power measurements will be captured.
6. Compare the power consumption of both the 64kps record and sleep mode with the minimum/maximum values listed in the AMAR Power Consumption Matrix (Doc [#00752](#)), under the **Limits** tab. **Record** the values in the test record.
7. Reinstall the COMMs Box on the DUT. Press and hold the button to enter Stop mode.
8. Turn off the Power Measurement Fixture. Disconnect the AMAR from the Power Measurement Fixture.

3.3. PLL Calibration Check

1. Apply power DUT using an external AC adapter or power supply connected to the 6-pin power connector of the AMAR, Telnet to the AMAR and login.
2. Enter the following command line to read the PLL calibration values:
 - a. `/root/pll_calibration -r`
3. A response of all zeros indicates that the PLL calibration has not been completed. **Record** PLL check Pass/Fail.
4. Perform a PLL calibration as per [00536 - AMAR PLL Calibration Instructions](#).

NOTE: The PLL calibration procedures takes approximately 30 minutes to complete.

-
5. **Record** PLL check Pass/Fail.
 6. Turn off power to the DUT.
-

3.4. Memory QA Test

NOTE: This test takes approximately 25 minutes per module installed.

1. Apply power DUT using an external AC adapter or power supply connected to the 6-pin power connector of the AMAR, Telnet to the AMAR and login.
2. Follow the NAND FLASH Memory Module FAT/FQT Procedure (Document ID #[00306](#)) and **Record** the results of the test.
 - a. Replace any modules that fail the amar_qa test, place an issue against the appropriate modules and update SharePoint accordingly.
 - b. If modules have been replaced, repeat the amar_qa procedure to ensure that all module(s) pass.
3. Erase AMAR memory.
4. Turn off power to the DUT.



CAUTION

The remaining tests, in section #3: *Electronics Validation*, can only be performed on an AMAR that uses voltage drive hydrophones. If the AMAR is wired for current loop hydrophones these tests cannot be performed.

NOTE:

There is currently no current loop GTI hydrophone simulator test jig.

3.5. Channel Validation

The following section of test requires the use of the GTI Hydrophone Simulator jig. Power the GTI Hydrophone Simulator jig from a 9-cell auxiliary battery pack (minimum open circuit voltage to be 11 VDC); the AMAR is powered from a bench supply.

3.5.1. Signal Connection & Temperature Check

1. Program all the attached channels to the following configuration. Ensure that each channel is operated separately.
 - First 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 30 seconds
 - Next 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 30 seconds

⇩

⇩

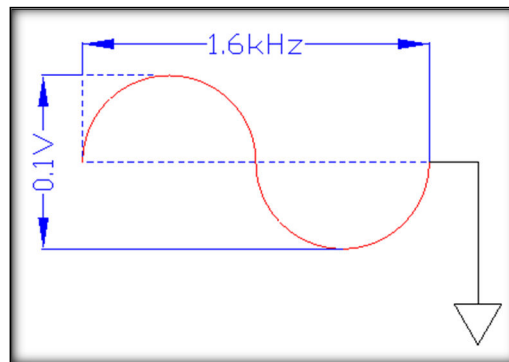
 - Last 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 30 seconds
 - **16-bit channel 9 @ 687.5ksps, AC coupled, 0dB gain + Temp, duration 30 seconds
-

- Sleep, infinite

** - Disregard if 16-bit channel has not been attached

2. **Record** the ambient temperature.
3. Attach the GTI Hydrophone simulator to the hydrophone input connector Configure the simulator to “Input Signal” mode and attach its input to function generator’s output connector.
4. Set the signal generator to output a sine wave at 1.6 kHz with an amplitude of 0.1 Vpp voltage (as shown below).

Figure 7: Signal Properties



5. Cycle power to the AMAR and ensure that it begins recording.
6. Measure the hydrophone voltage on the simulator. Verify that the voltage being supplied by the AMAR is $V_{supply} - 0.9V \pm 0.1V$.
7. After the AMAR has entered sleep mode (30 seconds times number of channels), press the Stop button on the COMMs box, and download the files to be analyzed.

Note: Download the files to the following location: <\\jso-dmfs02\Products\Amar\testing\FQT> and place the files in the appropriate AMAR or Bareboard location.

8. Verify that each channel has a separate 30 seconds recording.
9. Use Spectral Plotter to analyze each audio file. Confirm the FFT size match the sample rate, the # of averages =16 and a Blackman-Harris analysis window is being used.

Figure 8: Spectral Plotter Configuration

	Requested	Actual	Resolution	
Real FFT samples	<input type="text" value="64000"/>	64000	1.0Hz	
# of averages	<input type="text" value="16"/>	16		
Advance samples	<input type="text" value="32000"/>	34739		<input type="button" value="Recalc"/>
Window Type	<input type="text" value="Blackmann Harris"/>			
Samples in selection		585087		
Samples used in calc		544000	585085	

Note:

Use appropriate Deployment Info file based on a M8E, 0dB hydrophone (nominal curve), ensure you use the 24-bit version for the 24-bit channels and the 16-bit version for the 16-bit channel.

Files are located [here](#).

10. Ensure each of the 24-bit files has 1.6 kHz signal at +169.60, +/-0.5 dB re 1uPa.
11. Verify that the 16-bit file (if applicable) has a 1.6 kHz signal at +168.0, +/-0.5 dB re 1uPa.
12. Review the first and last temperature files recorded. Ensure there are no erroneous spikes in the data, and the temperatures are within +/-2°C of the ambient temperature.
13. Erase AMAR memory.

3.5.2. Signal Integrity (Shorted input)

1. With the GTI Hydrophone simulator and the COMMs Box still attached to the DUT, configure the simulator to “Shorted Input” mode.
2. Disconnect the Ethernet cable from the bottom of the COMMs Box and unplug the coax cable from the front of the GTI Hydrophone simulator to eliminate potential noise interference.

Cycle power to the AMAR and, after the COMMs Box LEDs indicate the DUT has entered sleep mode (30 seconds times number of channels), press the Stop button. Reattach the Ethernet cable and download the files to be analyzed.

Note: Download the files to the following location: [\\jso-dmfs02\Products\Amar\testing\FQT](#) and place the files in the appropriate AMAR or Bareboard location.

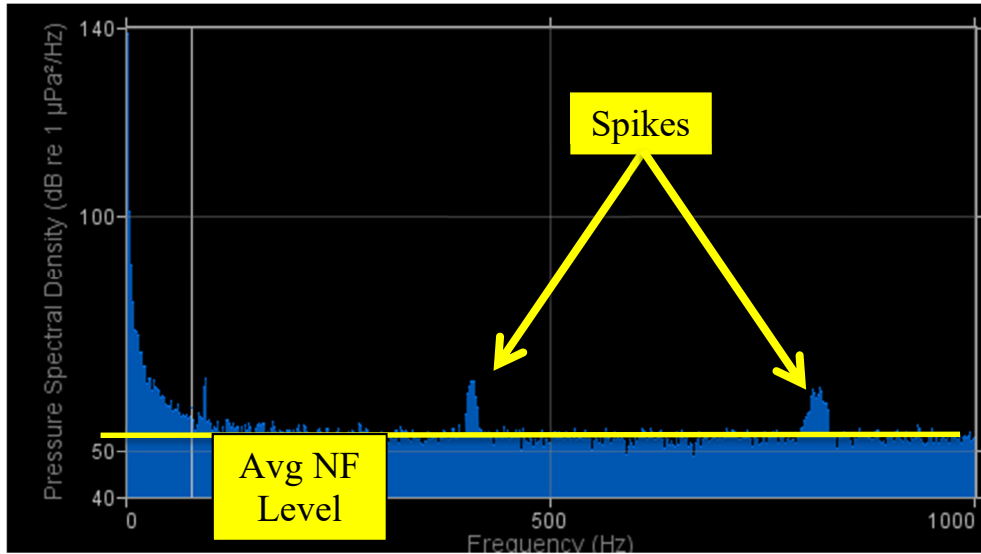
3. Verify that the correct number of files are present (1 file per active channel), and each audio file is 30 seconds long in duration.
4. Use Spectral Plotter (or another audio program) to analyze a 10 second sample (~10-20 second mark) of each of the audio files. Ensure the FFT size match the sample rate, the # of averages =16, and a Blackman-Harris analysis window is being used, as shown in **Figure 8**.
5. Ensure all the following criteria are met for a “Pass” result.

Table 2: Shorted-Input Criteria

Criteria	Channels	Sample Rate (ksps)	NF Value (dB re 1uPa)	Max # Noise *Spikes	Max peak of feature above NF (dB)	Max Noise Hump Width (kHz)
1	1-8	64	+54	3	+ 25	
2	9	687.5	+60	3	+ 25	
3	9	687.5		1 hump	+ 25	20

*Spikes are usually created by idle tones in the ADC. They are harmonically related and appear as narrow bandwidth (~10-20 Hz) features rising 10-15 dB above the average NF level. Due to board, component and temperature variability, the quantity and location of these spikes change from test to test, but usually appear below 1 KHz, as shown below...

Figure 9: Noise Spikes

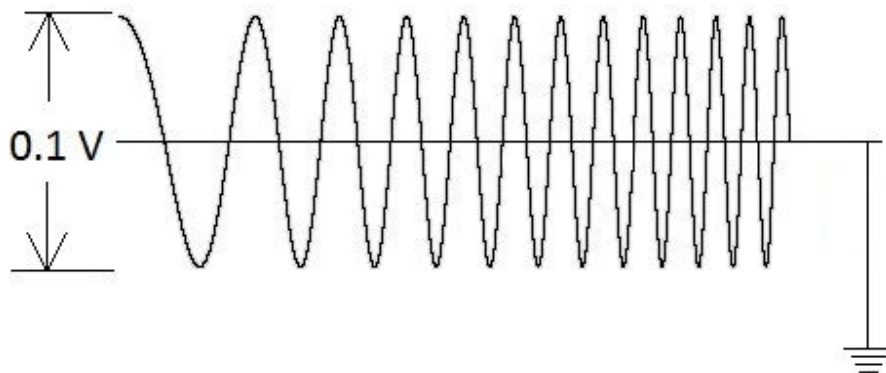


6. **Record** a “Pass” or “Fail” result in a copy of template document [00755](#).
 - “Failed” - Boards should have an issue placed against them, and set aside for trouble shooting.
7. Erase AMAR memory.

3.5.3. Signal Integrity (Swept Sine)

1. With the GTI Hydrophone simulator and the COMMs Box still attached to the DUT, configure the simulator to “Input Signal” mode.
2. Set the signal generator to output a swept sine wave from 10 Hz to 20 kHz, with an amplitude of 0.1 Vpp voltage (as shown below). Adjust the linear sweep duration to 5 minutes.

Figure 10: Swept Sine wave



3. Program all the attached channels to the following configuration. Ensure that each channel is operated separately.
 - First 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 6 minutes
 - Next 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 6 minutes
 - ⇩
 - ⇩
 - Last 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 6 minutes

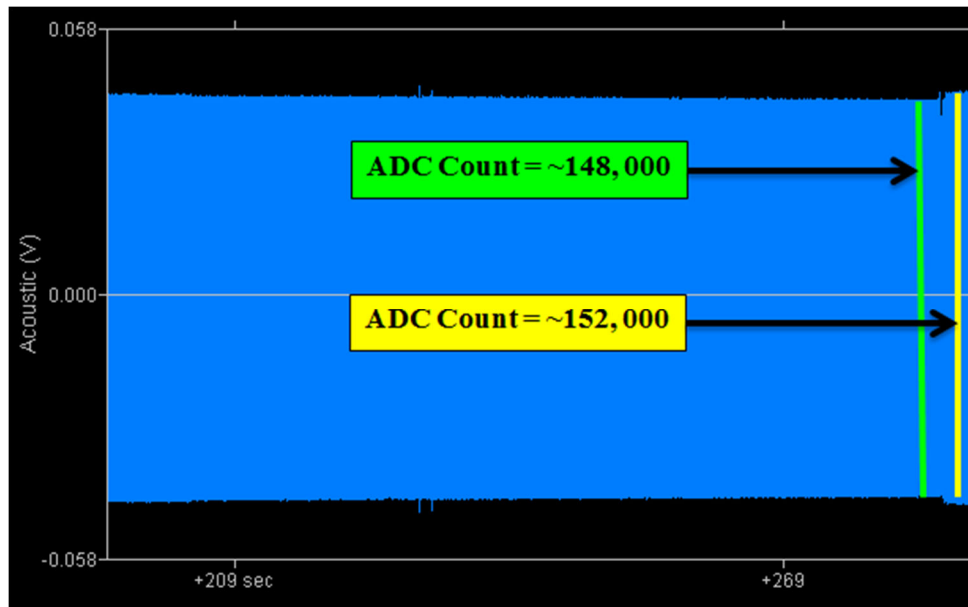
- **16-bit channel 9 @ 687.5ksps, AC coupled, 0dB gain + Temp, duration 6 minutes
- Sleep, infinite

4. Disconnect the Ethernet cable from the bottom of the COMMs Box.
5. Cycle power to the AMAR and after the COMMs Box LEDs indicate the DUT has entered sleep mode (6 minutes times number of channels), press the Stop button. Reattach the Ethernet cable and download the files to be analyzed.

Note: Download the files to the following location: [\\jso-dmfs02\Products\Amar\testing\FQT\](#) and place the files in the appropriate AMAR or Bareboard location.

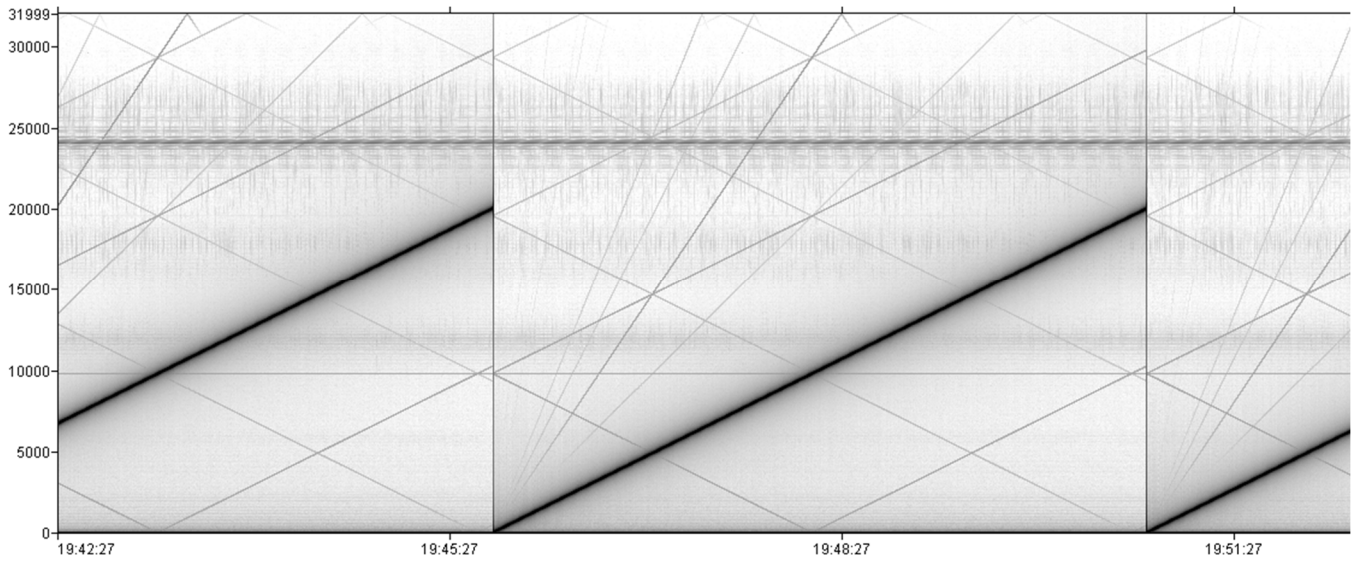
6. Verify that the correct number of files are present (1 file per active channel), and each audio file is 6 minutes long in duration.
7. Analyze each file in Spectral Plotter. Verify that the peak-peak value of the waveform is constant over the entire length of the recording (**Figure 11**).

Figure 11: Pk-Pk Voltage Waveform



8. Ensure the resulting Spectral ramp is linear and free of any step functions (**Figure 12**).

Figure 12: Linear Sweep Spectral Ramp

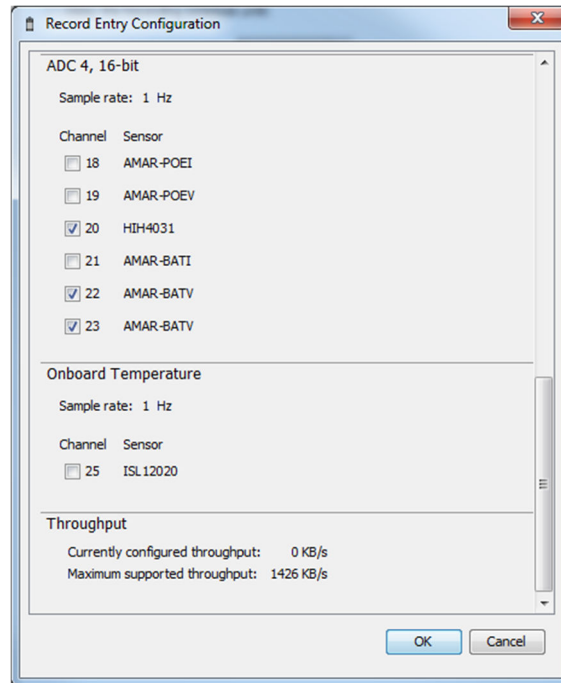


9. Record a “Pass” or “Fail” result in a copy of template document [00755](#).

3.5.4. DC Voltage and Humidity Verification

1. While still connected to the AMAR, through AMARlink, enable the following channels for a 30 second recording schedule.
 - Channel #20 (HIH4031) On-board relative humidity sensor
 - Channel #22 (AMAR-BATV) Battery input voltage (H2) – Next to mounting hole
 - Channel #23 (AMAR-BATV) Battery input voltage (H3) – Next to Ethernet connector

Figure 13: NAD Sensor Setup



2. **Record** AMAR input voltage.
3. Cycle power to the AMAR and ensure that it begins recording.
4. After the AMAR has entered sleep mode, press the Stop button on the COMMs Box, and download the files to be analyzed.

Note: Download the files to the following location: <\\jso-dmfs02\Products\Amar\testing\FQT> and place the files in the appropriate AMAR or Bareboard location.

5. **Record** measured input voltage from channels 22 and 23.
6. Verify that one of the voltage channels (#22 or #23) displays the approximate input voltage $V_{in} \pm 0.2V$.
7. Ensure that the other voltage channel displays approximately ***half** of $V_{in} \pm 3V$.

*NOTE: This voltage is created through the reverse bias current flowing through the steering diodes (D8 or D9) and may vary greatly from board to board.
8. Review and **record** the value indicated by the relative humidity sensor.
 - a. **G3 housing:** Ensure the sensor indicates a value of $< 25\%$ Relative Humidity.
 - b. **G3A housing & bareboards:** Ensure the sensor indicates a value within 20% of ambient Relative Humidity.
9. Erase AMAR memory.

4. Burn-in Testing

A 16 hour duration burn-in test of the electronics board is to be performed on each DUT.

Record all results in a copy of template document [00755](#).

1. Configure the AMAR to record each of the externally wired ADC channels in sequence for 120 minutes each, AC coupling, 0 dB gain. Set sample rates for each channel as per the following table.

Table 3: Burn-in Recording Schedule

Session	Type	Sample Rate (ksps)	Channel	Duration (Mins)
1	Record	2	All wired 24-bit, + Temp	120
2	Record	8	All wired 24-bit, + Temp	120
2	Record	16	All wired 24-bit, + Temp	120
3	Record	48	All wired, 24-bit, + Temp	120
4	Record	64	Wired ones on Bank 1, + Temp	120
5	Record	64	Wired ones on Bank 2 + Temp	120
6	Record	687.5	9 + Temp (High-pass Filter) (Gain must be 21 dB)	120
7	Record	687.5	9 + Temp	120
8	Sleep			∞

2. Place the appropriate shorting plug (current or voltage signalling type) on the hydrophone connector for the duration of the recording session.
Note: Ensure the correct type of shorting plug is installed before the next step.
3. Cycle power to the AMAR and when the recording has begun, disconnect the COMMs Box.
4. After the burn-in has completed (approximately 16 hours), reconnect the COMMs Box, place the AMAR into communications mode.
5. Verify that there are 8 sessions present, and each session is approximately 2 hours in duration. Download the data for analysis. If not correct do not proceed further without trouble shooting. Create an issue in issues list and place unit in issues quarantine, as required.
6. Complete Data Transfer and Archive entry. This triggers uploading of the test data to Data Warehouse, creation of a Data Quarantine task and analysis of the test data. **Record** Date Quarantine task number.
7. The results of the test will be entered into the Data Quarantine task after analysis by the science team, once the results are known verify or entered any channel restrictions into SharePoint under the electronics board list.

5. Final Unit Check

Record all results using a copy of template Document [00755](#).

1. Once the AMAR has cleared Data Quarantine, set the following schedule for storage.

Table 4: Storage Schedule

Step	Type	Detail	Channel	Duration
1	Sleep			∞

2. Erase AMAR Memory.
3. Inspect Comms dummy plug tether for damage and usability. Replace as required. Ensure dummy plug is properly lubricated and securely installed on Comms connector on top endcap.
4. Inspect Activation Plug (Red) tether for damage and usability. Replace as required. Ensure Activations Plug is properly lubricated and is **NOT** installed.
5. Ensure dummy plug (Green) is properly lubricated and securely installed on the Activation Plug connector.
6. Ensure external power dummy plug is lubricated and securely installed.
7. Ensure a hydrophone dummy plug is properly lubricated and securely installed on the hydrophone connector if available. If no dummy plug is available, ensure that red dust cap is installed to protect connector from dust and contamination.
8. Inspect the hydrophone mount for damage and usability. Replace if required.
9. Verify the electronics board IP address is legible on the endcap and matches the information found on Share Point. If not present/legible, affix a P-touch label (6 mm, white) with the IP address to the top endcap.
10. Store completed test results document on Share Point Equipment Inventory site in the log folder associated with the AMAR being tested.

6. AMAR G2/G3A Differences

To perform the FQT procedure on the G2 legacy or G3A AMARs, there are some changes to the procedure that are required.

The maintenance section steps can be followed but the o-ring part numbers are different for the G2 legacy/G3A housings.

PVC housing o-rings:

JASCO P/N	MFR P/N	Description
0231	2-252	O-RING 70DURO 5-1/4" ID ,5-1/2" OD,1/8" CS

Aluminum housing o-rings:

JASCO P/N	MFR P/N	Description
6070	2-253	O-RING 70DURO 5-3/8" ID ,5-5/8" OD,1/8" CS
6071	8-253	Parbak ring, 90DURO 5.393" ID ,0.118" CS

For AMAR G2 boards, the coin cell battery replacement is required every 1 year.

The AMAR G2 legacy/G3A housings do not have the ability to power them from an external power supply. Because of this G2 legacy/G3A housings will have all electronics boards removed and tested separately.

Do not install fresh desiccant in the housing as the housing needs to be opened again at mobilization time to install batteries.

Reinstall the end cap in the housing using the clamps, do not install securing bolts.

7. Glass AMAR Differences

To perform the FQT procedure on the Glass AMARs, there are some changes to the procedure that are required.

Glass sphere must be protected in its hardhat assembly during FQT. Ensure that the sealing surfaces of both hemispheres are protected by masking them with tape. Hardhat bolts need be only finger tight to keep the sphere from moving within it during testing.

7.1. Pressure Housing recertification

There is no specific 5 year maintenance for the Glass Sphere AMARs; however a recertification of the pressure housing should be performed in accordance with section 2.7.

7.2. Maintenance

7.2.1. Housing

Record all results in a copy of template Document [00755](#).

1. Remove the bottom hardhat (non-connector side). Remove the bottom glass hemisphere and place back in bottom hardhat for safety.

2. Inspect both hemispheres for cracks, chips or other damage.
3. Inspect the sealing surface of each hemisphere for chips or damage. Mask sealing surface if not already done.
4. Keep hemispheres separated for following section.

7.2.2. Connectors

Record all results in a copy of template Document [00755](#).

1. Thoroughly inspect the Activation Plug bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug.
2. Thoroughly inspect the Comms bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug.
3. Thoroughly inspect the hydrophone bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary. Re-install dummy plug (or dust cap if not available).

DO NOT leave hydrophone connector pins exposed and unprotected.

4. Thoroughly inspect the external power input bulkhead connector contact pins for corrosion (if applicable). Clean and reapply dielectric grease if necessary. Re-install dummy plug.

7.2.3. Internal checks

Record all results in a copy of template Document [00755](#).

1. If installed, remove the battery pack(s).
2. Remove desiccant packs from the support plate to be re-activated. Activated desiccant packs will be installed at mobilization.
3. Inspect the electronics support plate for signs of damage.
4. Inspect all stand-offs and ensure they are secure, all screws for the board are present and secure.
5. Inspect electronics support plate mounting to ensure all hardware is present and secure.
6. Inspect wires from top end cap to electronics board; ensure all connections are secure and undamaged.
7. Inspect hydrophone power MicroFit connector to ensure a dummy crimp pin is installed in location 2. Install if required.
8. Inspect hydrophone power pin to ensure crimp pin is not splayed or misshapen. Replace or repair pin(s) if required.

7.2.4. Regular Maintenance

Record all results in a copy of template Document [00755](#).

The following steps are performed as part of regular maintenance after each deployment cycle.

1. Verify all serial number markings are legible on both hemispheres.
2. Remove vacuum port sealing screw and o-ring. Carefully inspect o-ring for damage, replace if required.

NOTE: DO NOT lubricate vacuum port sealing screw o-ring.

3. Reinstall vacuum port sealing screw and o-ring; tighten to the point where the o-ring just seats on the inner surface of the port.
4. Place the bottom (non-connector) hemisphere back on the top hemisphere. Reinstall the bottom protective hardhat. Tighten bolts finger tight to secure the glass sphere in the hardhat.
5. Continue FQT procedure at section 5.

APPENDIX E – JASCO document 0186 AMAR Mobilization Test Procedure



AMAR MOBILIZATION PROCEDURE

2017 June 5

Document 00186-0.71

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Revision History

Version	Date	Name	Change
0.55	2014 Sep 12	S Fenton	Rewrite to incorporate changes required due to FQT procedure.
0.56	2014 Oct 29	S Fenton	Update to include tests for battery pack connections and other internal NAD channels.
0.57	2014 Nov 7	S Fenton	Added additional reference doc for updating the sensors.xml file
0.58	2014 Nov 21	S Fenton	Update for Glass AMAR mobilizations, update for addition of power cycle to verify AMAR sales IP has been set correctly
0.59	2014 Dec 1	S Fenton	Updates after QA review
0.60	2015 Jan 7	S Fenton	Update in time sync procedure and NTP server to use
0.61	2015 Mar 30	S Fenton	Update for G3-2X and G3-3X internal battery packs.
0.62	2015 Apr 15	S Fenton	Update to include recording of AMARlink version used during mobilization
0.63	2015 Jul 20	S Fenton	Update for new vacuum pressure setting
0.64	2015 Sep 21	S Fenton	Update for battery load test; update G3-2X/3X diode test
0.65	2015 Oct 06	S Fenton	Updated connector locations diagram for G3 board
0.66	2016 Jan 12	S Fenton	Update for HTI-99-HF regulator board
0.67	2016 Apr 1	S Fenton	Updated glass sphere vacuum gauge values to match deck box gauge
0.68	2016 Apr 6	S Fenton	Updated to add new reference document for Vitrovex Deck Purge Box and self-sealing vacuum port operation
0.69	2016 Sep 14	S Fenton	Update to capture diagnostic data from AMARlink as record of config
0.70	2016 Nov 30	S Fenton	Update to make use of data capture from JASCO Inventory Management tool
0.71	2017 Feb 06	S Fenton	Updated for new pressure sensor module vacuum procedure

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Preamble

Purpose

This document defines the procedures for mobilizing an Autonomous Multi-channel Acoustic Recorder (AMAR) for field deployment.

Scope

These procedures apply to all mobilizations of AMARs. This procedure is to be performed after completion of the AMAR Integration Assembly Procedure.

Applicable Documents

Documents

00175	AMAR G2 User Guide
00294	AMAR G3 User Guide
-	SWP Opening AMAR Pressure Housings
00585	AMAR Pre-deployment Time Sync
00883	AMAR Integration Assembly Procedure

Supplemental Documents

00185	Certificate of Compliance - AMAR
00189	YYYY-MM-DD AMAR XXXX Mobilization Test Record
00236	Quality Control Mobilization Checklist
00840	AMAR Supported Sensors and Devices
131008	Handling Procedures for Vitrovex Glass Spheres
Manual	Vitrovex Deck Purge Box Manual
00372	AMAR Software Installation Instructions
TBD	Glass Sphere AMAR Assembly Drawing

Associated Documents

Not Applicable

Review

This procedure shall be reviewed by the following before release:

Dale Freeman
Trent Johnson

Approved By:

Bruce Stuart

Definitions

To be completed

Abbreviations and Acronyms

AMAR	Automated Multi-channel Acoustic Recorder
Comms Cable	Communications Cable
DC	Direct current
ESD	Electro-static discharge
FQT	Factory Qualification Test
GPS	Global Positioning System
IP	Internet Protocol
LED	Light emitting diode
PCB	Printed circuit board
PRV	Pressure relief valve
QA	Quality Assurance
QC	Quality Control
RCW	Recorder Configuration Worksheet
RTC	Real time clock
S/N	Serial number
WAV	Waveform Audio File Format

NOTE:

Please refer to the appropriate section for the type of AMAR you are mobilizing:

- 1 - Mobilization Procedure – G3
- 2 - Mobilization Procedure – G2/G3A
- 3 - Mobilization Procedure - Glass Sphere

1. Mobilization Procedure – G3

NOTE: Record all results in a copy of template document 00189.

TIP: If an internal auxiliary battery pack and more/less memory modules need to be installed, perform the two operations at once to minimize the number of times the housing has to be opened after FQT.

TIP: If an HTI-99-HF hydrophone is going to be installed, an adapter board needs to be installed inside the AMAR, perform this at the same time as a memory module adjustment and/or an auxiliary battery install.

1.1. Electronics Housing Initial

1. Verify AMAR has completed FQT.
2. Verify the 5 year maintenance record is complete and valid to the end of the expected deployment duration. **Record** date of last pressure test.
3. **Record** AMAR electronics board ID, IP address, and software version from SharePoint.
4. Ensure installed software version matches RCW requirement. Perform software upgrade using AMARlink, or follow the AMAR Software Installation Instructions ([00372](#)), if required. **Record** AMARlink version being used.
5. Verify amount of memory installed meets or exceeds the RCW requirement through SharePoint inventory. **Record** number of modules, and size of modules. Perform memory module adjustment as in section 1.2.2 if memory installed does not meet RCW requirement.

NOTE: When selecting AMARs for mobilization, whenever possible select a device that has the same amount of memory already installed as the RCW request. This will avoid, as much as possible, opening the housing to install or remove memory modules.

6. Determine the type of hydrophone that will be installed from the RCW requirement. If it is a HTI-99-HF type, then the HTI-99-HF-REG board needs to be installed in series with the hydrophone power. Refer to section 12 for details. Perform this at the same time as the auxiliary battery pack install and/or the memory module adjustment.

1.2. Auxiliary Battery Pack/Memory Adjustment

NOTE: The next two subsections are to be performed in a single session if both are required.

1.2.1. Internal Auxiliary Battery Pack

NOTE: Installing the internal auxiliary battery requires the pressure housing to be opened. Care must be taken not to damage or contaminate o-rings during this process.

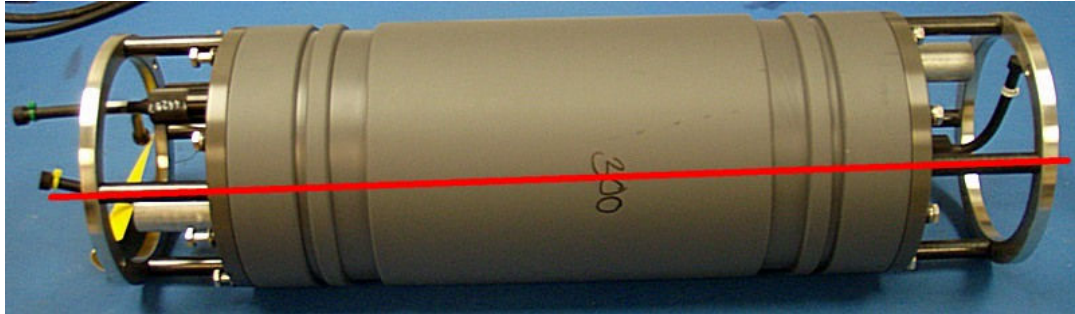


CAUTION: This portion of the procedure must be completed in one session; otherwise the desiccant pack will need to be replaced.

1. Refer to the SWP (Opening AMAR Pressure Housings) and the User Guide for detailed instructions on opening the housing of either the G2 Legacy/G3A or G3 housings.
2. Remove the top end cap from the housing as per instructions in the User Guide.
3. Verify that the total voltage across the battery pack at the power connector is at least 13.5 V and has the correct polarity. **Record** the voltage.
4. Install auxiliary battery pack as shown, secure with three sets of cable-ties.
5. Connect battery pack to electronics board as per appropriate wiring diagram in section 13.



6. Insert top end cap into pressure housing, ensuring that no wires are pinched and that the battery, bolts/washers do not nick or damage the O-ring surface.
7. Ensure that the end cap handling rings are properly aligned when installing the top end cap on the G3 housing.



8. Install the bolts finger tight on the end cap.
9. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.

1.2.2. Internal 48-cell or 96-cell battery pack (G3-2X, G3-3X)



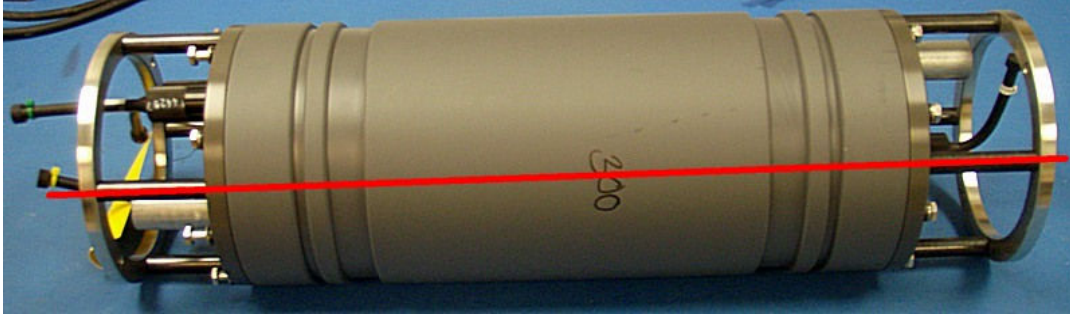
CAUTION: This portion of the procedure must be completed in one session; otherwise the desiccant pack will need to be replaced.

1. Refer to the SWP (Opening AMAR Pressure Housings) and the User Guide for detailed instructions on opening the housing of either the G2 Legacy/G3A or G3 housings.
2. Remove the bottom end cap from the housing as per instructions in the User Guide for the top end cap.



CAUTION: Care must be taken when removing the bottom end cap from the housing, there are cables that are attached to the electronics board that could be damaged if the end cap is removed too quickly or taken out too far.

3. Disconnect the battery extension cable from the battery pack.
4. Load battery frame as per User guide instructions. Verify individual stack voltages $\geq 6V$ as per User Guide instructions.
5. Verify that the total voltage across the battery pack at the power connector is at least 12 V and has the correct polarity. Ensure the measurement is made using the battery load test jig. **Record** the voltage.
6. Using an external power AC adapter, verify the total output voltage at the battery pack to board connector is ≥ 14.5 VDC. Ensure the measurement is made using the battery load test jig.
7. Connect battery pack to electronics board via the battery cable extension as per appropriate wiring diagram in section 13 (refer to cable tags to match connectors)
8. Insert bottom end cap into pressure housing, ensuring that no wires are pinched and bolts/washers do not nick or damage the O-ring surface.
9. Ensure that the end cap handling rings are properly aligned when installing the top end cap on the G3 housing.



10. Install the bolts finger tight on the end cap.
11. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.

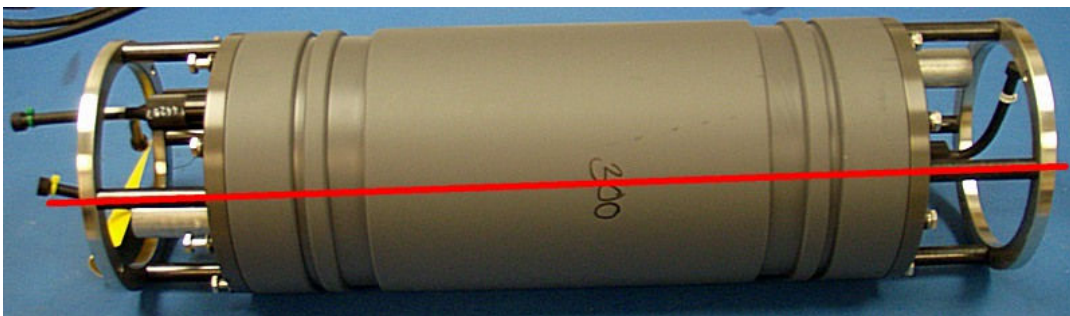
1.2.3. Memory Modules Adjustment

NOTE: Installing/removing memory modules requires the pressure housing to be opened. Care must be taken not to damage or contaminate o-rings during this process.



CAUTION: This portion of the procedure must be completed in one session; otherwise the desiccant pack will need to be replaced.

1. Refer to the SWP (Opening AMAR Pressure Housings) and the User Guide for detailed instructions on opening the housing of either the G2 Legacy/G3A or G3 housings.
2. Remove the top end cap from the housing as per instructions in the User Guide.
3. Remove securing cable-ties from the memory stack and carefully remove the top memory cap board.
4. Remove or install memory modules to meet the RCW requirement.
5. Ensure SharePoint inventory is updated for the electronics board to indicate the correct number and (serial numbers) of installed modules. Place removed memory modules back in stock, and update inventory.
6. Reinstall the memory cap board, secure memory with cable-ties. (Ty-wrap P/N 298-1064-ND, Digi-Key).
7. Insert top end cap into pressure housing, ensuring that no wires are pinched and that the battery, bolts/washers do not nick or damage the O-ring surface.
8. Ensure that the end cap handling rings are properly aligned when installing the top end cap on the G3 housing.



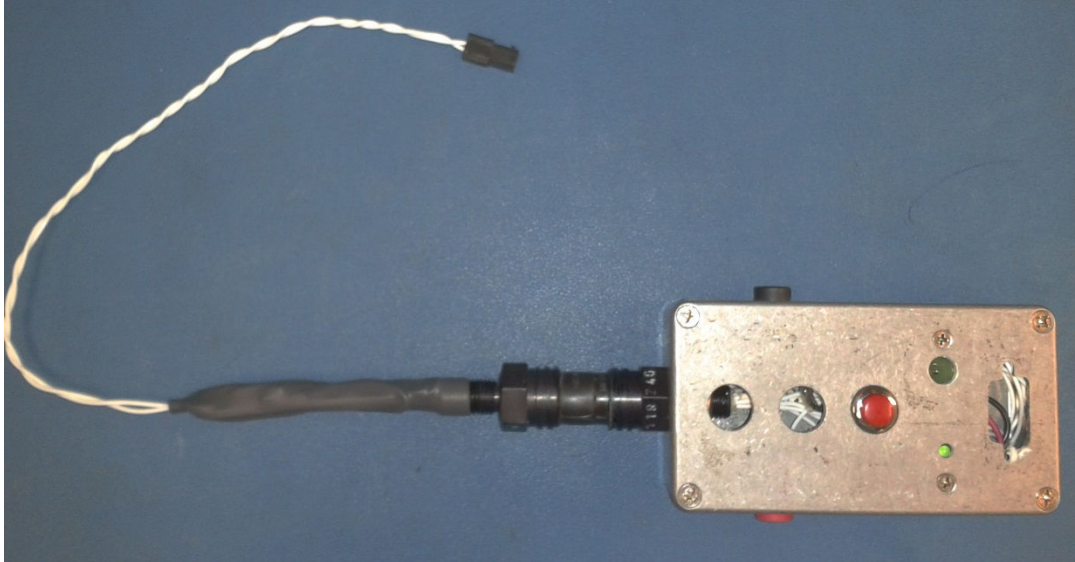
9. Install the bolts finger tight on the end cap.
 10. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.
-

1.3. Electronics Housing Inspection

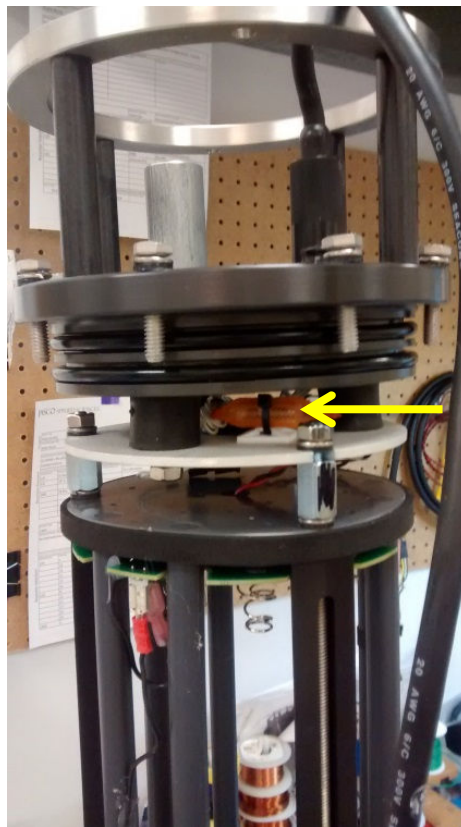
1. Inspect bottom end cap. Ensure all bolts are tight. Ensure that bottom end cap accessories are as specified in the RCW.
 2. Inspect the connectors and PRV for debris, clean if necessary, and ensure they are firmly installed into the top end cap.
 3. Inspect the top end cap; ensure the four (4) bolts are finger-tight. Ensure locking clamps are oriented correctly and holes line up. Ensure the top-end cap accessories are as specified in the RCW.
 4. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, sound, and properly lubricated.
 5. Replace and adjust the PRV core to fully closed, then open by exactly 4.5 turns with PRV tool.
Record PRV S/N.
-

1.4. External Battery Pack

1. Inspect the O-ring surface inside the pressure housing tube and ensure it is clean and undamaged.
2. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, sound, and properly lubricated.
3. Replace and adjust the PRV core to fully closed, then open by exactly 4.5 turns with PRV tool.
Record PRV S/N.
4. Load battery frame as per User guide instructions, or install shrink wrapped 48 cell battery pack. Verify individual stack voltages $\geq 6V$ (non-shrink wrap pack) as per User Guide instructions.
5. Verify that the total voltage across the battery pack at the power connector is at least 12 V and has the correct polarity. Ensure the measurement is made using the battery load test jig. **Record** the voltage.



6. Connect battery pack to bulkhead Molex connector.
7. Verify hydrogen combiner is installed, undamaged and secure. Replace if required.



8. Install AMAR to external battery pack cable (6-pin MCIL-M to 6-pin MCIL-F) to bulkhead. Measure pack output voltage (between pins 1 and 2) at the female end of the cable after connected. Ensure the measurement is made using the battery load test jig. Verify pack voltage matches that recorded in step 5 above and is correct polarity (pin 1 ground, pin 2 positive).



9. Insert top end cap into pressure housing, ensuring that no wires are pinched and nothing nicks or damages the O-ring surface. Install end cap bolts and torque as per assembly drawing 5111.

Proceed to section 4 for hydrophone installation.

2. Mobilization Procedure – G2/G3A

NOTE: Record all results in a copy of template document 00189.

2.1. Housing

1. Verify AMAR has completed FQT.
2. Verify the periodic maintenance record is complete and valid to the end of the expected deployment duration. **Record** date of last pressure test.
3. **Record** AMAR electronics board ID, IP address, and software version from SharePoint. Ensure software version matches RCW requirement, perform software upgrade using AMARlink, or follow the AMAR Software Installation Instructions ([00372](#)) if required. **Record** AMARlink version being used.
4. Verify amount of memory installed meets or exceeds the RCW requirement through SharePoint inventory. If not, memory module adjustment will need to be performed at this time.
 - a. Remove securing cable-ties from the memory stack and carefully remove the top memory cap board.
 - b. Remove or install memory modules to meet the RCW requirement.
 - c. Ensure SharePoint inventory is updated for the electronics board to indicate the correct number and (serial numbers) of installed modules. Place removed memory modules back in stock, and update inventory.
 - d. Reinstall the memory cap board, secure memory with cable-ties.

5. Inspect bottom end cap. Ensure all bolts are tight. Ensure that bottom end cap accessories are as specified in the RCW.
6. Inspect the connectors and PRV for debris, clean if necessary, and ensure they are firmly installed into the top end cap.
7. Inspect the top end cap; ensure the four (4) bolts are finger-tight. Ensure locking clamps are oriented correctly and holes line up. Ensure the top end cap accessories are as specified in the RCW.
8. Clean and inspect the O-ring surface on the pressure housing tube and ensure it is free of nicks, debris, and dirt.
9. Remove all O-rings from the top end cap. Clean and inspect the O-ring seating grooves on the top end cap, and ensure they are smooth and free of burrs, dirt, and debris.
10. Visually inspect o-rings for damage, replace if required. Lubricate O-rings and install on top end cap.



CAUTION: Be careful to use the correct o-ring for the housing. G2 legacy/G3A PVC, G3A Aluminum housings and G3 housings use different o-rings. Refer to Bill of materials or assembly instructions for correct part number.

11. Clean any excess O-ring lubricant from assembly.

2.2. Battery Pack—Main

1. Gently pull on the battery pack wires to ensure the terminations are seated correctly. Inspect the connector latch for stress or damage that would not enable it to latch properly.
2. Install batteries as per AMAR User Guide - Document 00175.
3. For each stack (column) of batteries, verify polarity and confirm the voltage is at least 6 V.
4. Verify that the total voltage across the battery pack at the power connector is at least 12 V and has the correct polarity. **Record** the voltage.

2.3. Battery Pack—Auxiliary (if applicable)

1. Gently pull on the battery pack wires to ensure the terminations are seated correctly. Inspect the connector latch for stress or damage that would not enable it to latch properly.
2. Install battery pack and secure with cable-ties as below.



3. Verify that the total voltage across the battery pack at the power connector is at least 13.5 V and has the correct polarity. **Record** the voltage.
4. Connect battery pack to electronics board as per appropriate wiring diagram in section 13.

2.4. Connectors

1. Thoroughly inspect the Power/Status Plug bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
2. Thoroughly inspect the Comms bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
3. Thoroughly inspect the hydrophone bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
4. Thoroughly inspect the external power input bulkhead connector contact pins for corrosion (if applicable). Clean and reapply dielectric grease if necessary.
5. Ensure wires from the top end cap connectors are secure and undamaged. Verify all terminations are secure and not loose. If applicable, check Phoenix screw terminal is tight and securely holding the wire hydrophone power wire on G2 legacy housings. Inspect the connector latch on all MicroFit connectors for stress or damage that would not enable it to latch properly.
6. Inspect the hydrophone power connector to ensure it has terminal pins installed in both spots.
7. Determine the type of hydrophone that will be installed from the RCW requirement. If it is a HTI-99-HF type, then the HTI-99-HF-REG board needs to be installed in series with the hydrophone power. Refer to section 12 for details.

2.5. Entire Assembly

1. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, sound, and properly lubricated.

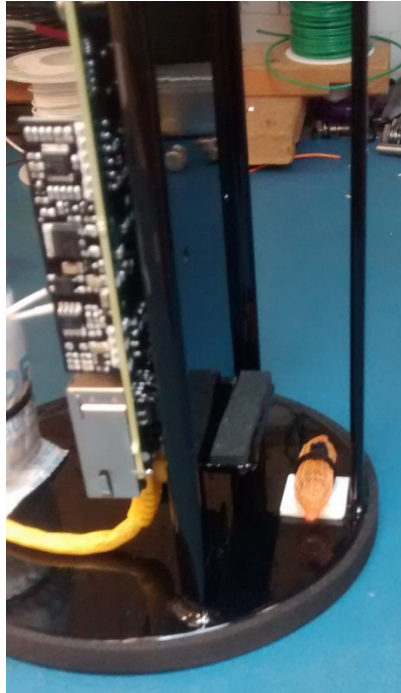
2. Replace and adjust the PRV core to fully closed, then open by exactly 4.5 turns with PRV tool.
Record PRV S/N.
5. Install assembled battery pack onto electronics chassis. Connect battery pack to electronics board as per appropriate wiring diagram in section 13.
3. Install 2 new desiccant packs on electronics chassis.



CAUTION: Be careful to make sure that the desiccant is installed tightly and will not interfere with the o-rings as end cap is inserted into housing.



4. Verify hydrogen combiner pellets are installed and container is not damaged. Replace if required.



5. Insert top end cap into pressure housing, ensuring that no wires are pinched and that the battery, bolts/washers do not nick or damage the O-ring surface. Close the locking clamps.

Proceed to section 4 for hydrophone installation.

3. Mobilization Procedure - Glass Sphere

NOTE: Record all results in a copy of template document 00189.

3.1. Housing

1. Verify AMAR has completed FQT.
2. Verify the periodic maintenance record is complete and valid to the end of the expected deployment duration. **Record** date of last pressure test.
3. **Record** AMAR electronics board ID, IP address, and software version from SharePoint. Ensure software version matches RCW requirement, perform software upgrade using AMARlink, or follow the AMAR Software Installation Instructions ([00372](#)) if required. **Record** AMARlink version being used.
4. Verify amount of memory installed meets or exceeds the RCW requirement through SharePoint inventory. If not, memory module adjustment will need to be performed at this time.
 - a. Remove support plate and disconnect all connections from AMAR board.

-
- b. Remove securing cable-ties from the memory stack and carefully remove the top memory cap board.
 - c. Remove or install memory modules to meet the RCW requirement.
 - d. Ensure SharePoint inventory is updated for the electronics board to indicate the correct number and (serial numbers) of installed modules. Place removed memory modules back in stock, and update inventory.
 - e. Reinstall the memory cap board, secure memory with cable-ties.
 - f. Reconnect all connections to the AMAR board from the bulkhead and power connectors. Verify correct connections as per diagram in section 13.2.
 - g. Reinstall the support plate as per assembly drawing TBD.
5. Inspect bottom hemisphere for signs of cracks, chips or damage.
 6. Inspect the connectors and vacuum port for debris, clean if necessary, and ensure they are firmly installed into the top hemisphere.
 7. Inspect the top hemisphere for signs of cracks, chips or damage.
-

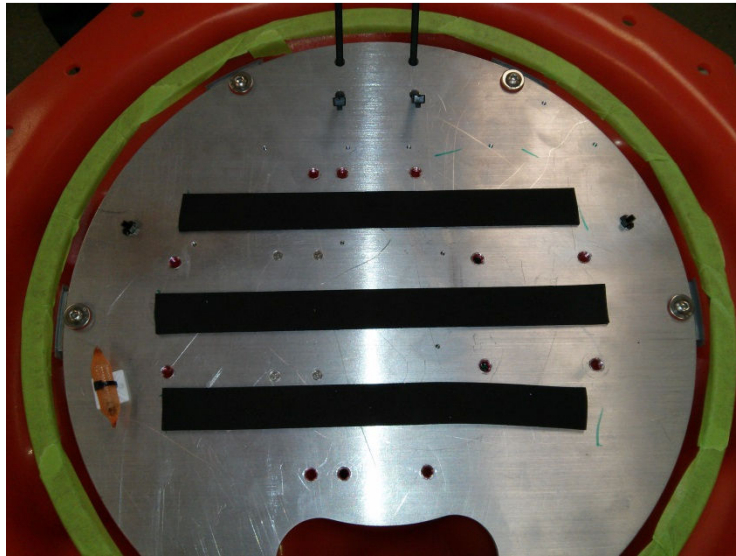
3.2. Connectors

1. Thoroughly inspect the Power/Status Plug bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
 2. Thoroughly inspect the Comms bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
 3. Thoroughly inspect the hydrophone bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
 4. Thoroughly inspect the external power input bulkhead connector contact pins for corrosion (if applicable). Clean and reapply dielectric grease if necessary.
 5. Ensure wires from the top end cap connectors are secure and undamaged. Verify all terminations are secure and not loose. Inspect the connector latch on all MicroFit connectors for stress or damage that would not enable it to latch properly.
 6. Determine the type of hydrophone that will be installed from the RCW requirement. If it is a HTI-99-HF type, then the HTI-99-HF-REG board needs to be installed in series with the hydrophone power. Refer to section 12 for details.
-

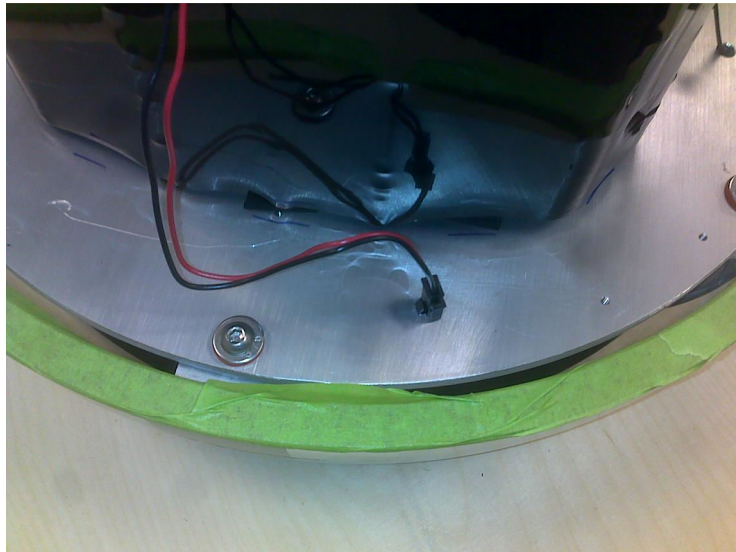
3.3. Battery Pack—Main

1. Gently pull on the battery pack(s) wires to ensure the terminations are seated correctly. Inspect the connector latch for stress or damage that would not enable it to latch properly.
2. Verify that the total voltage across the battery pack at the power connector is at least 12 V and has the correct polarity. **Record** the voltage(s).
3. Inspect foam padding on battery support plate and battery securing plate to ensure it is not damaged. Replace as required.

4. Verify hydrogen combiner pellets are installed and container is not damaged. Replace if required.



5. Install and secure the battery pack(s) as per assembly drawing XXXX.
6. Connect battery pack to bulkhead Molex connector(s) on support plate.



7. Place electronics hemisphere into hardhat temporarily to allow installation of the hydrophone and calibration.

Proceed to section 4 for hydrophone installation.

4. Hydrophone

1. Verify hydrophone has completed FQT testing since last deployment.

2. Verify no open issues against the hydrophone.
3. Verify that the hydrophone serial number is clearly labelled. **Record** hydrophone model and serial number.
4. Inspect hydrophone for damage.
5. Repeat steps above steps for each hydrophone attached to the system.
6. **Record** hydrophone extension cable or hydrophone splitter cable serial number if applicable.
7. Install hydrophone stabilizer boot if required.

5. Sensors file update

NOTE: Record all results using template Document 00189.

IMPORTANT: Refer to document [00840 - AMAR Supported Sensors and Devices](#) to obtain the acceptable sensor descriptions for use in the sensors.xml file updates.

1. Ensure that the sensors.xml file has been set to reflect the installed sensors.
2. The sensors.xml file will be uploaded to the AMAR SharePoint log folder as part of the calibration process.

6. Recording Configuration

1. Configure the AMAR recording channels and schedule as per the RCW information.
2. Perform a time sync using the NTP server method if possible, PC time if not.
 - a. Use 216.239.32.15 (time.1.google.com) as the address of the NTP server in AMARlink.
3. **Record** RCW number, sample rate(s) and, channels used.

7. Calibration

NOTES:

- The calibration should be done with the unit in its deployment configuration. This is the last chance to test to the unit in its deployment configuration before shipping. Sometimes the deployment configuration duty cycle timing may have long cycle times. In this case it is acceptable to change the cycle timing to allow for calibration in a timely manner.

IMPORTANT: You must return to the original timing as per RCW and verify configuration prior to sign-off of calibration complete.

- Default recorder setup is to enable all battery info and humidity NAD channels; however, there are some deployments which are power-critical and may not have these channels enabled. In this

case it is desirable to enable at least the DCIN2 and DCIN1 NAD channels during calibration to ensure battery pack connections.

IMPORTANT: You must return to the original NAD channel setup as per RCW and verify configuration prior to sign-off of calibration complete

- AMARlink 3.3 and above will allow calibration through a temporary streaming mode, use this method whenever possible to avoid any changes to the set configuration.

1. **Record** Ambient temperature.
2. Perform Recorder Calibration Procedure as per Document 00190.
3. Store the raw calibration data on the network - <\\jso-dmfs02\Products\AMAR\mobilizations>. Create a new directory specific to the mobilization project as per accepted format.
4. Verify all active NAD channels were recorded. **Record** humidity (CH20), primary supply current (CH21), DC Input voltage 2 (CH22), DC Input voltage 1 (CH23) and RTC Temp (CH25).
5. Verify RTC temperature reading is within $\pm 2^{\circ}\text{C}$ of ambient.
6. Verify that the recording configuration still matches the RCW after calibration has been completed.
7. Upload to AMAR SharePoint log folder the sensors.xml and deployment.xml files from the AMAR using the JASCO Inventory Management Tool “Create Record > Online Records” button.

NOTE: This procedure reads the files from the AMAR directly, uploads and names the files in one step.

8. Update SYSGAIN field on SharePoint record for AMAR.
9. Verify calibration test record completed and uploaded to SharePoint AMAR log folder.
10. Secure the top end cap clamps (G2/G3A only) with the locking bolts.

8. Sales Configurations

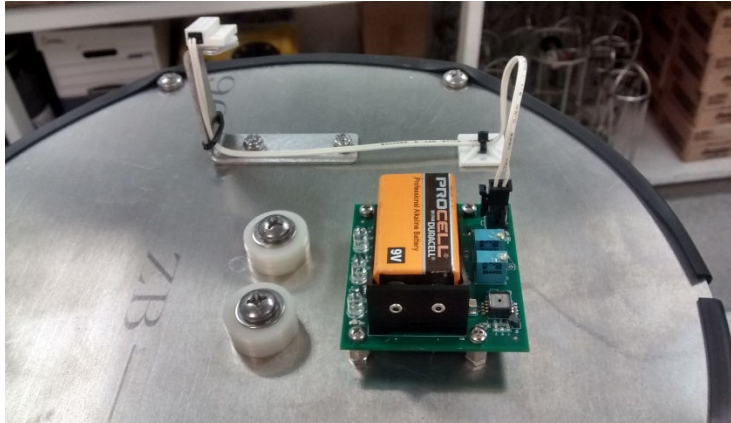
NOTE: Record all results using template Document 00189.

For units that will be sold to customers, the following steps must be taken prior to final check.

1. Power the AMAR and connect to it using AMARlink application.
2. Set AMAR IP address to 192.168.2.1.
3. Set Gateway IP to 192.168.2.100.
4. Set Name Server IP to 192.168.2.235.
5. Cycle power on the AMAR and reconnect to it using AMARlink application.
6. Verify connection made is on sales IP of 192.168.2.1.
7. Erase the AMAR’s memory.
8. Power down the AMAR and re-install all dummy plugs.
9. Update SharePoint Inventory list for AMAR electronics board IP address change to sales default.

9. Glass Sphere Final Assembly and Sealing

1. Remove protective masking tape from glass sphere sealing surfaces.
2. Fully clean the mating glass sphere surfaces with Surface Cleaner.
3. Verify pressure sensor operational (activate with magnet, LED lights).



4. Install two desiccant packs; be careful to ensure that the edges of the packs will not interfere with the glass sealing surface.



5. Perform the closing procedure of a Vitrovex glass sphere as per instructions in [Vitrovex Handling Procedures for Glass Sphere Housings \(document 131008\)](#) and [Vitrovex Deck Purge Box Manual section 6.0 – Operation](#).

NOTE: Use a vacuum of **8 psi** below current ambient pressure (0.6 bar) instead of the stated 0.75 - .85 bar in the Vitrovex/Nautilus procedure. This is done to protect the alkaline batteries. 8 psi equates to the green LED activating on the pressure sensor module when magnet is applied.

- a) Turn on the deck purge box (set to vacuum) and watch the gauge and the pressure sensor module LEDs. Vacuum the sphere until the pressure sensor module green LED indicates (will be approximately 0.6 bar).

NOTE: To allow for installation of the sealing screw (if applicable), the green LED must still be activated after the screw is installed. This may require initial vacuuming until the yellow LED is activated.

- b) Quickly remove the vacuum pump hose and place your finger over the opening of the vacuum port.
- c) Quickly insert the sealing screw with the o-ring installed into the vacuum port. Begin tightening until no air is entering. The total time that air leaks back into the sphere in should be less than 2 seconds. If this takes longer than a total of 2 seconds, reconnect the vacuum hose and repeat. Relieve any additional vacuum until the green LED activates with sealing screw fully installed.

NOTE: The self-sealing purge port does not require the insertion of a sealing screw and o-ring.

- d) The pressure sensor module LED should be green at the end of the procedure.

NOTE: Vacuum port sealing screw should be set as follows (if applicable):

- Tighten screw with (o-ring installed) until the o-ring just touches the inner sealing surface (approximately 12 turns). Using just two fingers to hold the screw driver will help with identifying the first contact point.
 - Tighten an additional $\frac{3}{4}$ turn for final setting.
 - **CAUTION: DO NOT OVERTIGHTEN**
6. **Record** status of pressure sensor LED when activated.
 7. Install glass sphere in top protective hardhat (connector side). This is to protect the sphere during the vacuum test.
 8. Allow the vacuum sealed unit to sit for at least 12 hours to verify that the internal vacuum reading is unchanged from that recorded above. **Record** status of pressure sensors LED at end of test.
 9. Install remaining half of hardhat, install all bolts and tighten.

10. Final Unit Check

NOTE: Record all results using template Document 00189.

1. Inspect Comms dummy plug tether for damage and usability for deployment duration as per Recorder Configuration Worksheet. Replace as required. Ensure dummy plug is properly lubricated and securely installed on Comms connector on top end cap.
2. Inspect Power/Status or Activation plug tether for damage and usability for deployment duration as per Recorder Configuration Worksheet. Replace as required. Test Power/Status plug using test jig to ensure it is operational. Ensure Power/Status plug or Activation plug is properly lubricated and is **NOT** installed as this will activate the unit.
3. Ensure dummy plug is properly lubricated and securely installed on the Activation connector.

4. Ensure external power dummy plug is lubricated and securely installed if applicable.
5. Ensure external power interconnect cable is lubricated and securely installed if applicable between external battery pack and electronics housing. If shipping unconnected, ensure dummy plugs are lubricated and securely installed on battery pack and electronics housings.
6. Ensure a hydrophone dummy plug is installed on any unit that does not ship with a hydrophone attached.
7. Inspect hydrophone tether for damage and usability for the deployment duration as per the Recorder Configuration Worksheet. Replace as required.
8. Compare accessory configuration against Recorder Configuration Worksheet requirements to ensure all requested accessories are installed.
9. Verify the electronics board IP address from SharePoint. Affix a P-touch label (6 mm, white) with the electronics board IP address to the top end cap if not already present (or not the same IP address).
10. Store completed test results document on SharePoint Equipment Inventory site in the log folder associated with the AMAR being tested.
11. Notify Quality Assurance that mobilization of unit has been completed.

11. Quality Assurance

The following steps are to be performed by Quality Assurance or a designate prior to releasing the unit to the project and shipping.

1. Complete the Quality Control (QC) Check Sheet – form 00236 (one for all units being mobilized).
2. Complete Certificate of Compliance – form 00185 (one for each unit being mobilized). Complete for all sales units, and only those JASCO field projects if it is a requirement of the project.
3. Store QC Check Sheet and Certificate of Compliance (if required) to project SharePoint website.
4. Release unit(s) for shipping by updating the shipping entry to ‘Approved’ status. This automatically notifies shipper and Project Manager that units are released for shipment.

12. HTI-99-HF Regulator Board Install

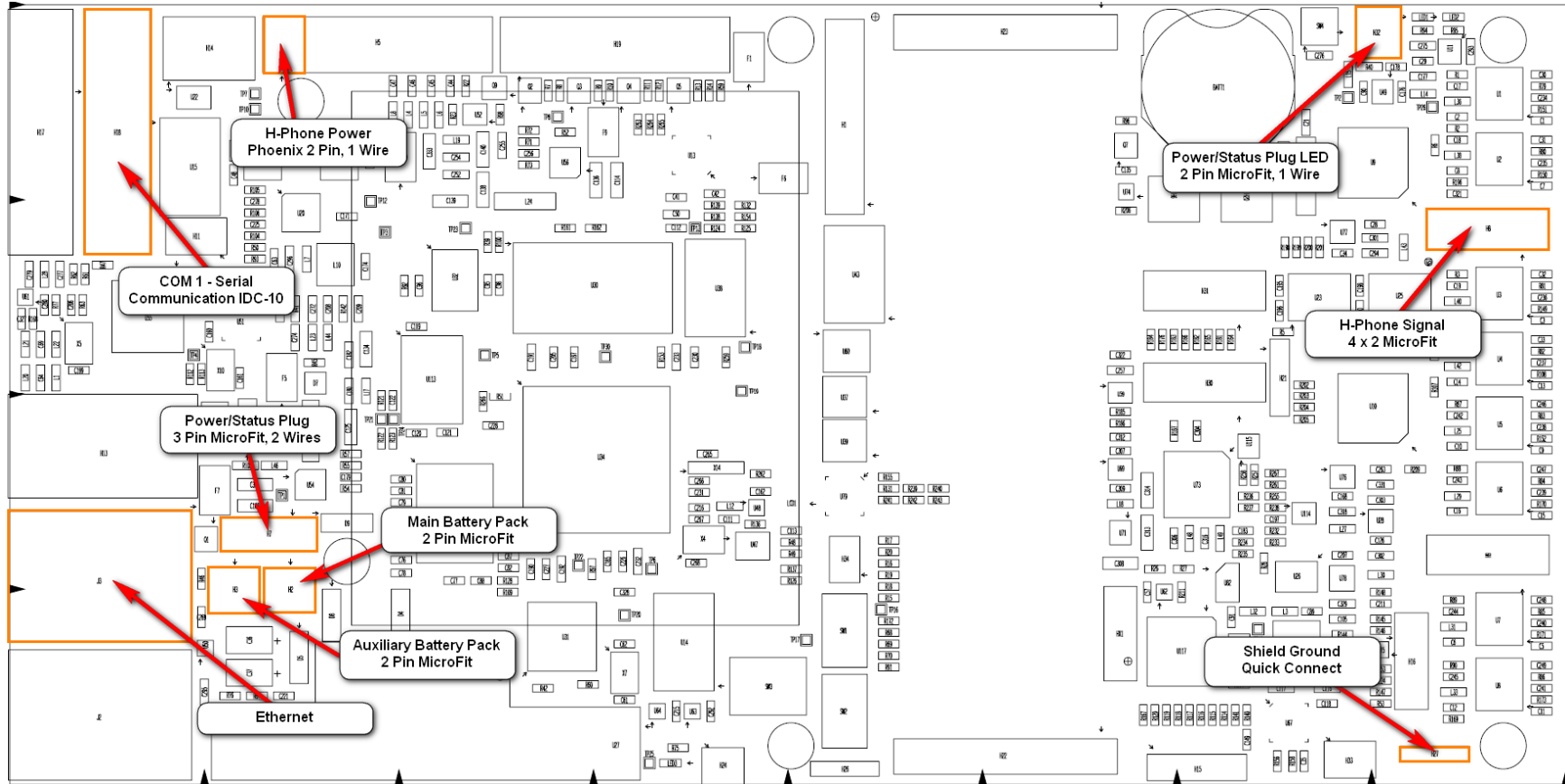
The following steps are performed at the same time as a memory module adjustment or an auxiliary battery pack install to reduce the number of times the housing has to be opened during mobilization.

1. Refer to the SWP (Opening AMAR Pressure Housings) and the User Guide for detailed instructions on opening the housing of either the G2 Legacy/G3A or G3 housings.
2. Once the housing is open, install the HTI-99-HF-REG board assembly in line with the hydrophone power connector. The HTI-99-HF-REG assembly goes between the hydrophone power header on the AMAR (H42 usually, but defined in the sensors.xml file) and the bulkhead hydrophone power wire.

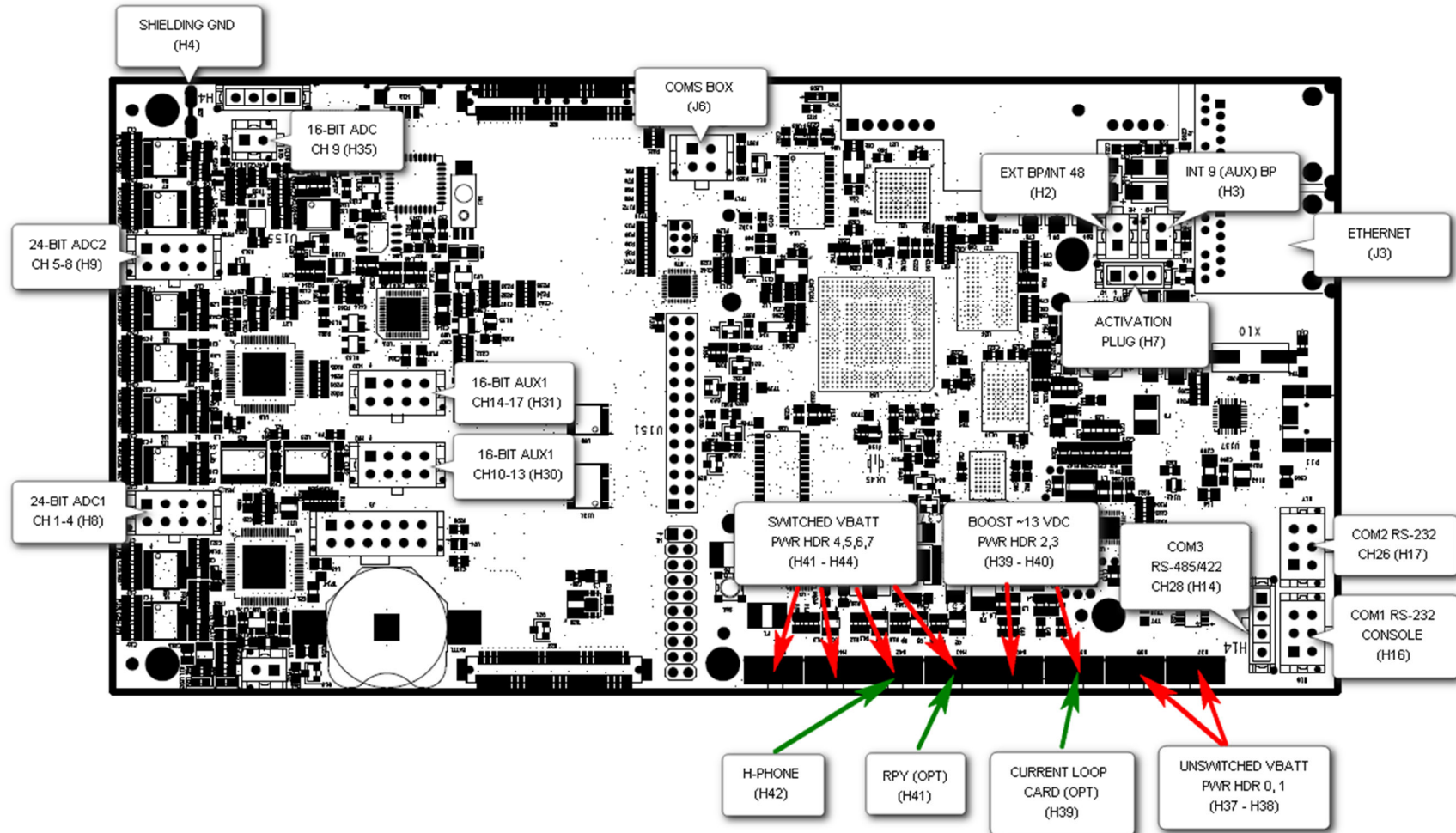
3. Close the housing as per standard procedures once all operations are completed.

13. Wiring Connection Locations

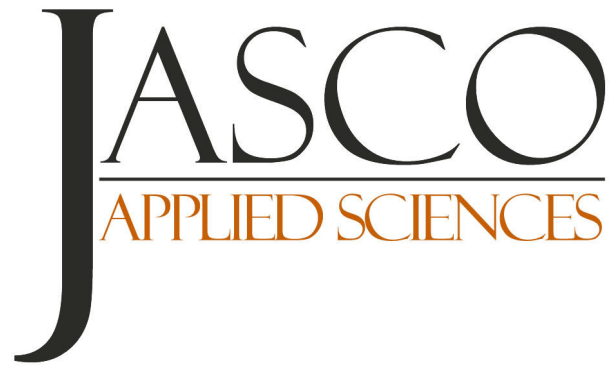
13.1. G2 Electronics Board Connections



13.2. G3 Electronics Board Connections



APPENDIX F – JASCO document 00190 Recorder Calibration Procedure



RECORDER CALIBRATION PROCEDURE

2017 June 5

Document 00190-0.15

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Revision History

Version	Date	Name	Change
0.9	2011 Jun 21	S Fenton	Placed into 00024- JASCO Procedure Template format
0.11	2011 Sept 22	S Fenton	Add section to AMAR calibration with a filter board installed
0.12	2012 Jun 13	B Gaudet	Various typo fixes
0.13	2013 Mar 07	S Fenton	Updated G2/G3 cal section for high pass filter method
0.14	2013 Mar 19	S Fenton	Updated to include a link to SharePoint location of Calibration Curve Calculator
0.15	2013 Jul 25	S Fenton	Update to break out procedure for G2 and G3

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Preamble

Purpose

This document defines the procedures for performing recording system calibrations. These procedures shall be followed to ensure consistency in the performance of calibrations and to facilitate comparison of calibrations over time, among equipment and over varying environmental conditions.

Scope

These procedures apply to all recording system calibrations of Autonomous Multi-channel Acoustic Recorders (AMARs), Autonomous Underwater Recorders for Acoustic Listening (AURALs), and Sound Devices Recorders (SDs), be they performed in the lab or in the field. Each recording system has a unique procedure for calibration that is outlined here.

In general, “bench calibrations” occur in the lab during mobilization, demobilization, and annual servicing of the recorders. “Field calibrations” occur before deployment and after retrieval of recorders. During field calibrations, verification of the recording configuration is recommended when possible (without opening the unit in the case of AMARs and AURALs).

Refer to the manufacturer’s instructions for details on the operation of equipment as listed in Supplemental Documents section.

Applicable Documents

Documents

- 00191 Calibration Log Sheet
- [Calibration Curve Calculator Excel spreadsheet](#)
- Initiation Log for project
- Deployment Logs for project

Supplemental Documents

- AURAL-M2 Manufacturer’s Instructions/User Guide
- GRAS Pistonphone User Manual
- 00175 AMAR User Guide

Associated Documents

Not Applicable

Review

This procedure shall be reviewed by the following before release:

YYYY-MM-DD	Bruce Martin	Applied Sciences Manager
YYYY-MM-DD	Trent Johnson	Software Engineering Manger

Approved By:

YYYY-MM-DD	Bruce Stuart	Quality Assurance Representative
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Definitions

Not Applicable

Abbreviations and Acronyms

AMAR	Automated Multi-channel Acoustic Recorder
AURAL	Autonomous Underwater Recorders for Acoustic Listening
Comms Cable	Communications Cable
GPS	Global Positioning System
LED	Light emitting diode
SD	Sound Devices Recorder
S/N	Serial number
WAV	Waveform Audio File Format

1. Calibration Setup - General

Where possible, perform calibrations in a quiet location, away from low-frequency sound sources (*e.g.*, ship's engines, power tools, air vents).

The following equipment is required to calibrate a recording system:

- Pistonphone Calibrator Kit—includes pistonphone (GRAS 42AA or 42AC), hydrophone adapters and couplers
- Barometer—*e.g.*, shop standardized barometer, GPS, ship barometer.
- Recorder with hydrophone—AMAR, AURAL, or SD
- AMAR comms box (G3) or AMAR coms cable (G2)
- Calibration Log sheet

For Lab calibrations the following equipment is also required:

- PC to run software (CalGUI, Recorder Setup, Terminal Emulator)
 - Local copy of the Calibration Curve Calculator Excel spreadsheet (see link above)
-

2. AURAL-M2 Calibration Procedures

2.1. Bench Calibration

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
 2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
 3. Remove AURAL chassis from pressure housing as per manufacturer's instructions (if not already removed).
 4. Verify setup matches Initiation Log or Deployment Log requirements.
 5. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
-

6. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
7. Start a recording session.
8. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
9. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
10. Stop the recording session.
11. Carefully remove the hydrophone from the calibrator. Disassemble the calibrator and return it to the Calibrator Kit.
12. Shutdown and then power-off the AURAL.
13. Download the calibration audio file—ensure a valid calibration signal is present and rename the WAV file (prefix test date to filename in format YYYY-MM-DD).
14. Analyze the WAV file using CalGUI—omit the first 15 seconds of the calibration tone during which time the calibrator is equalizing; **record** calculated system gain on Calibration Log.
15. Using the Calibration Curve Calculator, calculate the hydrophone sensitivity, digitization gain and Volts/Bit—**record** on Calibration Log.
16. Update Equipment Inventory Calibration site and store the calibration WAV file and CalGUI file on the file server—**record** pathname on Calibration Log.
17. If required, reinsert AURAL chassis into the pressure housing as per manufacturer’s instructions.

2.2. Field Calibration

Perform this calibration just before deployment.

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
4. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
5. Start a recording session.
6. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
7. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.

8. Carefully remove the hydrophone from the calibrator. Disassemble the calibrator and return it to the Calibrator Kit.
9. Recorder is ready to deploy.

3. AMAR G2/G3 Calibration Procedures

3.1. Bench Calibration

The AMAR may contain a high pass filter board option, therefore there are two bench calibration procedures described here.

3.1.1. No High Pass Filter board installed

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
4. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
5. Connect the communications cable:
 - a. Use AMAR comms box for G3A or G3 AMARs
 - b. Use AMAR coms cable for G2 AMARs
6. Power-on the AMAR by installing the power/status plug.
7. Verify setup matches Initiation Log or Deployment Log requirements.
8. Verify that AMAR recording has started:
 - a. For G2, LED of power/status plug flashes once every 10 seconds.
 - b. For G3, Red LED on AMAR comms box lights, Green LED is off.
9. Disconnect the AMAR Coms Box or communications cable.
10. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
11. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
12. Connect the AMAR comms box or communications cable and stop the recording session.

13. Carefully remove the hydrophone from the calibrator. Disassemble the calibrator and return it to the Calibrator Kit.
14. Download the calibration data files:
 - a. AMAR G2 requires download and parse of the raw data files.
 - b. AMAR G3 requires use of AMARlink to download wav files.
15. Analyze the WAV file using CalGUI—omit the first 15 seconds of the calibration tone during which time the calibrator is equalizing; **record** calculated system gain on Calibration Log.
16. Using the Calibration Curve Calculator, calculate the hydrophone sensitivity, digitization gain and Volts/Bit—**record** on Calibration Log.
17. Update Equipment Inventory Calibration site and store the calibration WAV file and CalGUI file on the file server—**record** pathname on Calibration Log.

3.1.2. High Pass Filter board installed

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
4. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
5. Connect the communications cable:
 - a. Use AMAR comms box for G3A or G3 AMARs
 - b. Use AMAR coms cable for G2 AMARs
6. Verify setup matches Initiation Log or Deployment Log requirements.
7. Verify that AMAR recording has started:
 - a. For G2, LED of power/status plug flashes once every 10 seconds.
 - b. For G3, Red LED on AMAR comms box lights, Green LED is off.
8. Disconnect the AMAR Coms Box or communications cable.
9. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
10. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
11. Connect the AMAR comms box or communications cable and stop the recording session.

12. Carefully remove the hydrophone from the calibrator. Disassemble the calibrator and return it to the Calibrator Kit.
13. Place speaker connected to 10 KHz sound source as close to hydrophone as reasonably possible.
14. Select configuration on AMAR to sample both 24-bit channel and 16-bit channel simultaneously. Ensure sample rates of both channels are sufficient to capture the 10 KHz signal.
15. Start recording on AMAR, verify AMAR is in record mode:
 - a. For G2, LED of power/status plug flashes once every 10 seconds.
 - b. For G3, Red LED on AMAR comms box lights, Green LED is off.
16. Disconnect the AMAR Coms Box or communications cable.
17. Turn on 10 KHz source. **Record** the Cal start time on the Calibration Log.
18. Turn off the 10 KHz source after 2-3 minutes. **Record** the Cal stop time on the calibration Log.
19. Connect the AMAR comms box or communications cable and stop the recording session.
20. Download the calibration data files:
 - a. AMAR G2 requires download and parse of the raw data files.
 - b. AMAR G3 requires use of AMARlink to download wav files.
21. Analyze the 24-bit channel pistonphone WAV file using CalGUI—omit the first 15 seconds of the calibration tone during which time the calibrator is equalizing; **record** calculated system gain on Calibration Log.
22. Using the Calibration Curve Calculator, calculate the hydrophone sensitivity, digitization gain and Volts/Bit—**record** on Calibration Log.
23. Analyze the 24-bit channel 10 KHz sound source WAV file using CALC_SPL to determine the sound source level of the 10 KHz signal, using the system gain calculated in step 21 above.

NOTE: CALC_SPL requires the following settings in the calc_spl.ini file:

1. DATFILE – filename and location of input ‘wav’ data file
2. OUTFILE – use same name as input file with ‘.spl’ as extension
3. SYSGAIN – as calculated above
4. WINLEN – use 1 second
5. STEPLEN – use 0.5 second
6. WINFUN – use 1.

24. Analyze the 16-bit channel 10 KHz sound source WAV file using CalGUI and the SPL determined in step 23 above, **record** calculated system gain on Calibration Log.
25. Using the Calibration Curve Calculator, calculate the hydrophone sensitivity, digitization gain and Volts/Bit—**record** on Calibration Log.
26. Update Equipment Inventory Calibration site and store the calibration WAV file and CalGUI file on the file server—**record** pathname on Calibration Log.

3.2. Field Calibration

Perform this calibration just before deployment.

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
4. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
5. Power on AMAR by installing the power/status plug—ensure unit is in recording mode (LED of power/status plug flashes once every 10 seconds).
6. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
7. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
8. Carefully remove the hydrophone from the calibrator. Disassemble the calibrator and return it to the Calibrator Kit.
9. Recorder is ready to deploy.

4. SD-OBH Calibration Procedures

4.1. Bench Calibration

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Remove SD-OBH endcap assembly from the pressure housing.
4. Power-on the SD recorder.
5. Verify setup matches Initiation Log or Deployment Log requirements.

6. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
7. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
8. Start a recording.
9. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
10. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
11. Stop the recording.
12. Carefully remove the hydrophone from the calibrator.
13. Repeat Steps 6–12 if more than one hydrophone is installed on the recorder.
14. Disassemble the pistonphone calibrator and return it to the Calibrator Kit.
15. For each calibration: Download the calibration audio file—ensure a valid calibration signal is present and rename the WAV file (prefix test date to filename in format YYYY-MM-DD).
16. For each calibration: Analyze the WAV file using CalGUI—omit the first 15 seconds of the calibration tone during which time the calibrator is equalizing; **record** calculated system gain on Calibration Log.
17. For each calibration: Update Equipment Inventory Calibration site and store the calibration WAV file and CalGUI file on the file server—**record** pathname on Calibration Log.
18. Insert the SD-OBH endcap assembly back into the pressure housing.

4.2. Pre-Deployment Field Calibration

Perform this calibration just before deployment.

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Remove SD-OBH endcap assembly from the pressure housing.
4. Power-on the SD recorder.
5. Verify setup matches Initiation Log or Deployment Log requirements.
6. Start a recording.
7. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
8. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.

9. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
10. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
11. Carefully remove the hydrophone from the calibrator.
12. Repeat Steps 7–11 if more than one hydrophone is installed on the recorder.
13. Disassemble the pistonphone calibrator and return it to the Calibrator Kit.
14. Insert the SD-OBH endcap assembly back into the pressure housing.
15. Recorder is ready to deploy.

4.3. *Post-Retrieval Field Calibration*

Perform this calibration immediately after retrieval if there is any chance the unit is still recording.

1. **Fill out** all applicable sections of the Calibration Log in the project and equipment sections.
2. **Record** the date, location, air temperature, recorder temperature, and ambient pressure.
3. Dry-off the hydrophone(s).
4. Attach appropriate hydrophone adaptor and coupler to the pistonphone calibrator.
5. Insert hydrophone into the calibrator assembly—ensure the calibrator is placed on a stable platform during calibration and the hydrophone is inserted to the proper depth.
6. Turn on the pistonphone calibrator (LED should be green; red or orange indicates batteries likely need replacement). **Record** the Cal start time on the Calibration Log.
7. Turn off pistonphone calibrator after 2–3 minutes. **Record** the Cal stop time on the Calibration Log.
8. Carefully remove the hydrophone from the calibrator.
9. Repeat Steps 4–8 if more than one hydrophone is installed on the recorder.
10. Disassemble the pistonphone calibrator and return it to the Calibrator Kit.

APPENDIX G – ASL Quick Start Deployment and Recovery Checklist



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Generic Acoustic Water Column Profiler Quick Start: Deployment

- Load AWCP5Link software onto PC: (If not already done)
From the CD run "Setup.exe" to install the operating software on your PC. The CD also contains copies of the Operators and AWCP5Link Manuals as well as the unit's Calibration Coefficient file.
- If necessary connect the battery
 - Place pack in pressure case
 - Secure pack with 5/16" nut Lock washer and fender washer
 - Pull Battery connector through hole in bottom of chassis and plug into orange header on digital board
- Add desiccant pack to the pressure case then ensure all O-rings are clean, greased and free of nicks and abrasions
- Place chassis into pressure case. Line up holes correctly, slowly put even pressure on the top of the end cap to secure the chassis to the pressure case.
- Attach the Transducer/Sensor guard (if supplied) , anodes and mounting hardware to the end cap.
- Test Anode continuity.
- Place the purge plug in the hole on top of the chassis
- Plug one end of the Interface cable into the bulkhead connector on the AWCP and the other end in to the COM port of your PC. Plug in the supplied AC adapter to the interface cable.
- Initiate communications with the instrument.
- When communication is established check the time of the instrument. Reprogram if necessary.
- Deploy the Instrument with the desired paramaters
- A faint click can be heard from the top of the transducer when the unit is running (transmitting acoustic pulses). No clicking will be heard for a delayed start. An AM radio is also useful for detecting the pulses
- Remove the Interface cable and place a dummy plug on the bulkhead connector. The unit is now ready for deployment.
- MAKE SURE THE PURGE PLUG IS IN PLACE and All Bolts Tightened!**



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Generic Acoustic Water Column Profiler Quick Start: Recovery

- REMOVE THE PURGE PLUG FIRST (Use the 7/16" Wrench)**
- Remove the dummy plug from the bulkhead serial interface connector.
- Attach one end of the Interface Cable to the bulkhead connector and the other to the COM port of your computer. Use a USB adapter if necessary. Plug the DC wall adapter into an A/C outlet
- Initiate communications with the unit by using AWCP5Link and end the deployment
- View the FLASH files
- Download the FLASH Files (if they are small)
- The FLASH card can be removed from the instrument. Unplug the Interface Cable and DC power supply first.
- Process the data using AWCP5Link