University of New Hampshire

DRAFT ADEON Calibration and Deployment Good Practice Guide
Version 2

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

Contract: M16PC00003

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ADEON Calibration and Deployment Good Practice Guide

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1. Introduction

1.1 ADEON Project

The Atlantic Deepwater Ecosystem Observatory Network (ADEON) is a five-year study with three years of fieldwork of the US Mid- and South Atlantic Outer Continental Shelf (OCS). The lead P.I. 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. This observatory network will generate long-term measurements of the natural and human factors that describe the ecology and soundscape of the OCS. Ocean processes, marine life dynamics, and human ocean use are each inherently three-dimensional and time-dependent, and each occur at many spatial and temporal scales. No single measurement system (*in situ* or remote) is sufficient for describing any of the ocean state variables, and a “multi-platform, multi-variable” observational approach integrated with models is required (Seim et al., 2009). ADEON combines acoustic information with contextual data from space-based remote sensing, hydrographic sensors, and mobile platforms to fully comprehend how human and natural (biological and abiotic) components create the soundscape and influence ecosystem dynamics of the OCS. Measurements made within this research program serve as a baseline for pattern and trend analyzes of ambient sound and the ecosystem components contributing to the OCS soundscapes.

The outputs of this study will be standardized tools for comparing soundscapes across regions and predictive models for the soundscape and overall ecology of the southeast OCS in water depths between 100–1000 m. The data and models will allow the public to estimate short-term and cumulative effects on the soundscape from changes in human activity as well as ecosystem changes driven by climate change or other environmental factors. The project’s public data management interface will be used by interested parties to create value-added products so that the information is used as widely as possible.

1.2 Calibration and Deployment Good Practices Document Objectives

The objective of this document is to provide information to future field scientists who wish to deploy instruments similar to those used in the ADEON project. The scope of these descriptions are 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.

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, Mooring 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 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. The ADEON HSE Plan has been approved by the program sponsors.

4) Perform a structured qualification test of the recorder electronic functionality prior to mobilization. For example, see Appendix C – JASCO document 00716 AMAR G3 Formal Qualification Test Procedure.

5) Mobilize, calibrate, and test the recorder. For example, see Appendix D - JASCO document 0186 AMAR Mobilization Test Procedure, Appendix E 00190 – Recorder Calibration Procedure).

6) Mobilize and test the other mooring components (beacons, acoustic releases, hardware, etc) and document their correct operation or installation.

7) Before packing the mooring 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 E 00190 – Recorder Calibration Procedure).

9) Prior to deployment or retrieval, conduct a thorough Job Safety Analysis 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

Echo sounders measure and record acoustic returns from the ocean bottom and scatterers in the water column. Scatterers can be biological (fish, zooplankton) or geophysical (sediment, gas plumes) in nature. A time clock triggers pulses at a specified rate to the transmitter (Figure 1 (1)). The transmitter produces an electrical ping of specified duration and frequency (Figure 1 (2)). The transmitter output is received by the transducer as electrical energy and is converted to acoustic energy (or pressure). The acoustic energy is emitted from the transducer into the water column and propagated within the echo sounder beam (Figure 1 (3)). The width of the echo sounder beam is inversely proportional to the frequency of the pings generated. Nominal 3 dB beam widths for single beam echo sounders is typically 5–15°. When the propagating pulse encounters a target in the water column, reflected energy (or echo) is bounced back to the transducer. This backscattered energy or echo is received by the transducer and converted to electrical energy (Figure 1 (4)). The receiver generates the time difference between the electrical signal emission and return for determining distance, and the signal is amplified for display or storage (Figure 1 (4–5)).

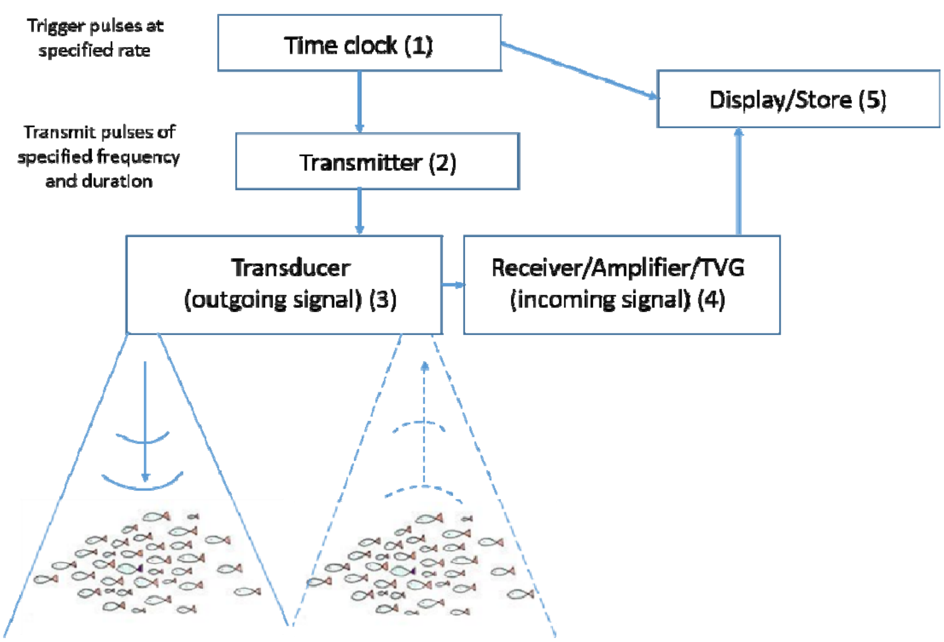

Figure 1. Generalized concept of a downward looking echo sounder. Remotely deployed echo sounders can also be positioned looking upward or sidewards. Returning echoes can be viewed as an echogram on a display or stored within the system for future analysis.

There are three basic categories of scientific echo sounder transducers: single-beam, split-beam, and multi-beam. Single-beam systems are widely-used and cheaper than the other two systems. The data they collect is used to estimate volume backscatter strength (S_v=10log10(s_v) dB, where s_v is the volume backscattering coefficient in m^{-1} sr^{-1}), which is the integrated measure of echo energy for a volume of water at a specific range from the transducer. The volume backscattering coefficient is the volume differential scattering cross section per unit volume of the medium being investigated. Split-beam systems are more expensive, but the received signal is measured along 4 (or in some cases 3) sub-sections of the transducer face. This approach allows split-beam systems to measure the phase difference in the echoes received by the different quadrats, which produces backscatter measurements of single targets within the volume of water ensonified. Thus split-beam systems can collect Target Strength (TS) measurements (including the 3-D position of these targets) in addition to S_v data. The positional information of the TS measurements can be very powerful and may allow for deeper analysis of the data such as tracking the movement of individual targets over multiple pings thus providing information on the behavior of some targets. Multi-beam systems are usually thought of as bottom-mapping sonars; however, there are several models that can collect water column backscatter data (S_v). Many national fishery survey vessels are equipped with these systems. These systems can collect 3-D swaths of the water column, sampling much larger volume of water compared to the smaller beamwidth single- and split-beam systems. However, these systems are larger, more expensive, require fine-scale position and attitude sensor integration, and since targets may be ensonified at angles off-of-vertical (relative to single- and split-beam systems), the interpretation of multi-beam water column backscatter data can be challenging.

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 3 of the 7 constructed bottom lander platforms. The transducers are mounted at an approximate 15^{o} 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 Acoustic Zooplankton Fish Profiler (AZFP)

All technical specifications, tables, and figures related to the AZFP were obtained from the AZFP Operator’s Manual and compiled here for simplicity. (see AZFP Operator’s Manual GU-100-AZFP-01-R27)

The AZFP (ASL Environmental Sciences) is a self-contained instrument designed to measure and record acoustic returns from the water column. The AZFP can be deployed in depths to a maximum of 600 m in its anodized aluminum underwater pressure housing and will operate for extended periods up to a year with its internal battery. A deep water version is available up to 6000 m with advance special order. The instrument is equipped with up to 4 echo sounder channels, each operating at a different acoustic frequency. The ADEON AZFPs will contain transducers operating at 38 kHz, 125 kHz, 200 kHz, and 455 kHz. A four frequency system was selected to maximize the amount of information provided for determining community structure from multiple scattering groups. The transducers for each frequency all have similar nominal beam width of 7-8 degrees, except for the 38 kHz unit, which has a beamwidth of 12 degrees. For each frequency, the AZFP transmits a series of acoustic pulses of programmable duration. In between each pulse the instrument listens for the echoes from targets in the water column up to a programmable distance from the instrument. The AZFP stores acquired data within its non-volatile 32 GB Compact FLASH memory. Communication with the AZFP, and downloading of data, occurs via an RS-232 (or optional RS-422) interface through a bulkhead connector on the pressure housing. An alternative download method is to remove the instrument from its pressure case, eject the Compact FLASH and use a USB card reader to transfer the data to a PC.

For safety measures, when working with the AZFP in the lab or on a ship, a single cylinder bench bracket is recommended for securing the AZFP securely to a lab bench or table. A bench mount cylinder rack from McMaster Carr is part number: 2283T12.

3.1.2.a Deployment Configuration Options

The AZFP systems can be deployed in multiple configurations: upward, downward, or sideward looking orientations (Figure 2). ADEON will deploy the AZFPs on bottom landers where the main sensor housing is deployed lying down in a horizontal position, while the suite of 4 transducers are deployed in an upward looking orientation 15° off vertical to eliminate interference from the lander floatation mounted above the transducers.

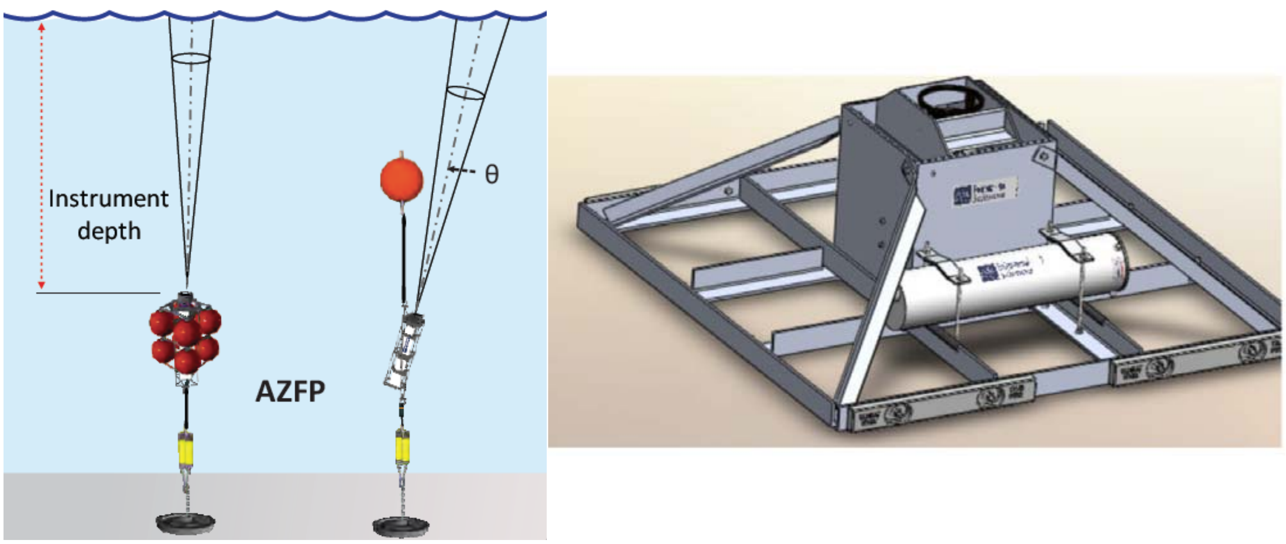

Figure 2. (Right) Two typical sub-surface bottom mooring deployment configurations. (Left) bottom lander deployment configuration where the AZFP instrument is deployed in a horizontal positions, while the transducers are deployed in an upward looking orientation. ADEON will be deploying the AZFPs in a bottom lander mode with transducers deployed 15° off vertical to eliminate interference with the lander floatation.

The AZFP units will properly measure instrument orientation when then instrument is “upright”, i.e. the end cap of the pressure case is oriented towards the surface when the instrument is submerged. This orientation is referred to as the “Upward-Looking Pressure Case” orientation. The instrument will properly sense and record orientations that differ +/-45° from this orientation with an accuracy of +/-

3°. It is important to note that instrument orientation data is recorded, not transducer orientation (which may differ if the transducer is remotely located).

3.1.2.b Calibration

Transducers: Each AZFP is delivered from the manufacturer with a Certificate of Calibration (Figure 3). Upon delivery, each transducer is calibrated with a 38.1mm 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 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	

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)
*	65000
-10dB	59000
-20dB	53040
-30dB	47080
-40dB	41100
-50dB	Not Measured

Calibration Values		Units
TVR	174.5	dB
VTX	61.2	V_{RMS}
BP	0.02	Sr
Echo Level	144.3	dB
Slope	0.0228	V/dB

Sphere Check		Units
Water Temp	10.12	°C
Range	310	cm
Measured	-51.3	dB
Expected	-51.0	dB
Error	-0.3	dB

*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.

Figure 3. *E*xample Certificate of Calibration provided for a 125 kHz transducer within the AZFP system.

OCV (for "open-circuit voltage") is the hydrophone sensitivity level in dB re 1 V/µPa. 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 m^2/sr), and the target strength of the calibration sphere (−51.0 dB re 1 m^2/sr). The error value (−0.3 dB) is the difference between the "Measured" and "Expected" values of target strength.

EClock: 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 $2.50 \cdot 10^{-7}$ 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)
- Tilt_x (degrees) = $X\_a + X\_b\,(NX) + X\_c\,(NX)^2 + X\_d\,(NX)^3$
- Where NX is the raw counts out of the A/D converter. Counts range from 0 to 65535.

Tilt Y Calibration Coefficients

- Y_a; Y_b;Y_c and Y_d (Y_c and Y_d may be zero)
- Tilt_y (degrees) = $Y\_a + Y\_b\,(Ny) + Y\_c\,(Ny)^2 + Y\_d\,(Ny)^3$
- Where Ny is the raw counts out of the A/D converter. Counts range from 0 to 65535.

Thermistor: 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 ka, kb, and kc. 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 * (counts / 65535). Then calculate the equivalent bridge resistance:
R = (ka + kb * V_{in}) / (kc - V_{in}).
Finally the temperature in °C = T = 1 / (A + B * (ln(R)) + C * (ln(R)^3)) - 273

3.1.2.c Programming/Processing Specifications

The AZFP has multiple user-selected operation parameters to maximize data collection for a pre-defined mission. The AZFP may be programmed in the custom AZFP communication software (AZFPLink) to start data collection immediately, or to wake up at a future time. The AZFP offer the pre-programming of deployment phases (12 max) by date or duration with repeat and sleep features. The individual ping or pulse length is selectable from 100 to 1000 microseconds. The ping rate within each phase is also user specified up to 1 Hz depending on frequency and range. Figures 4 and 5 illustrate sample user-specified deployment phases using the AZFPLink terminology for programming burst interval, pings per burst, pulse length, digitization rate, ping period, lockout range, maximum range, and averaging options (see glossary for parameter definitions).

The AZFP offers three A/D digitization rates: 64, 40, or 20 kHz. The maximum possible sampling range is determined by the size of an internal data buffer and the internal analog-to-digital (A/D) sampling rate: it is approximately 160 m at a sampling rate of 64 kHz, 255 m at 40 kHz and 510 m at 20 kHz. The effective maximum range may be much less than the nominal maximum, depending on the acoustic frequencies used by the instrument. The maximum range for the higher frequencies will be limited by the dynamic range of the sounder detection system. The AZFP is also equipped with a range lockout feature to disregard transducer ringdown or close targets.

The AZFP has the capability to perform received data averages in range (minimum bin size is 0.011 m), time, or both. Recorded counts are related to the target strength or volume backscattering strength in the water column that produced the echo signals recorded by the instrument. Frequently, considerations of data storage space or power consumption make it advantageous to store averaged data rather than the individual digitized values. The user may specify averaging over a specified range interval or number of samples, or time-averaging over all the pings in a burst, or a combination of the two. Since the recorded values of N are proportional to the logarithm of the echo intensity, they cannot be directly averaged (the result would in that case be the geometric rather than the arithmetic mean). The AZFP performs a true arithmetic average of the signal amplitude data and stores the result as the data are being collected. The individual raw samples are not saved. Because of the limitations of the on-board processor and integer arithmetic, the conversion between logarithmic and linear values is done using a look-up table, which has a resolution of 0.013 dB. The averages are stored in linear form on board.

The deployment parameters for each ADEON AZFP will be added to this document following the first ADEON cruise and instrument deployments. Deployment parameters will be presented in an inserted Table.

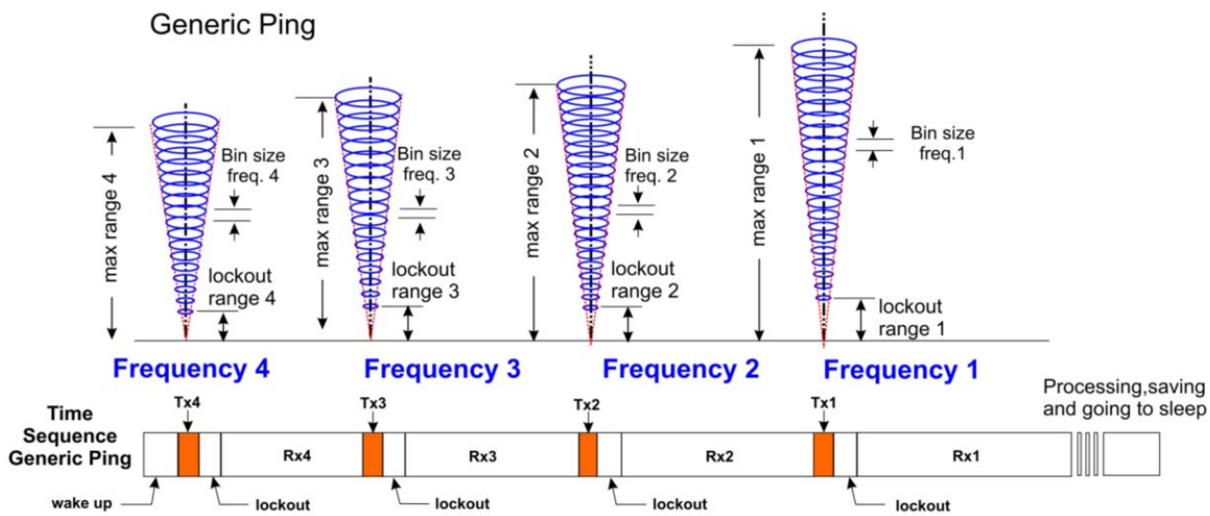

Figure 4. Illustration of a generic ping for a 4-channel AZFP and its associated timing.

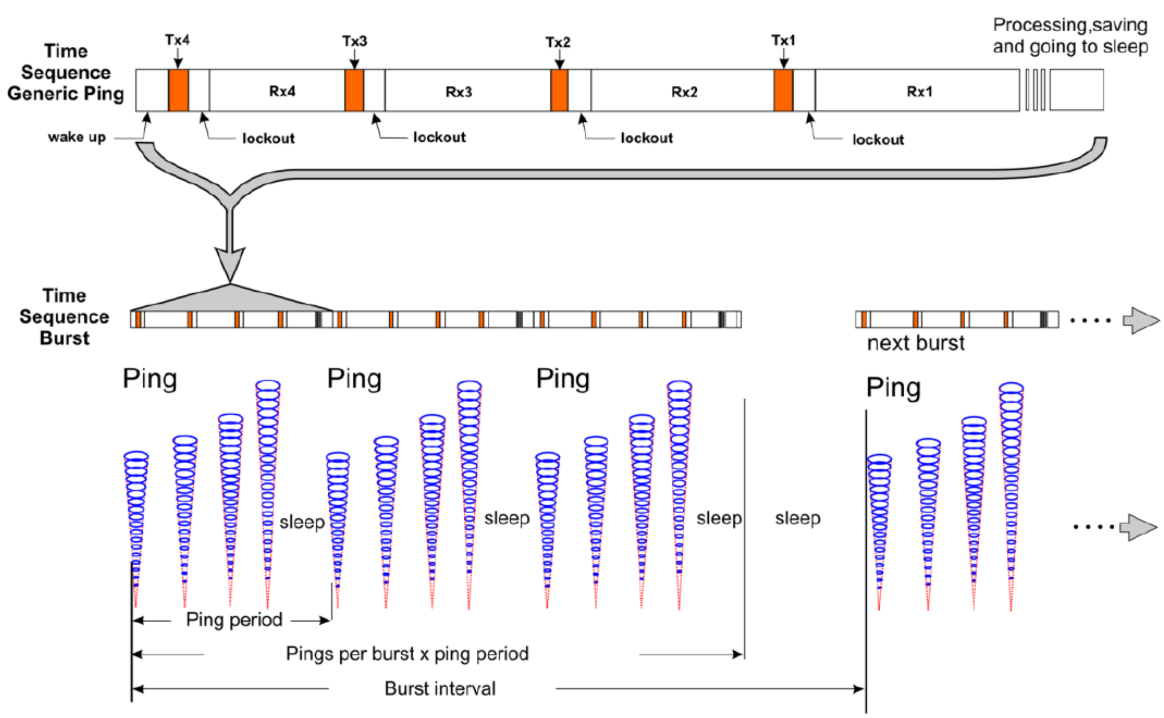

Figure 5. Illustration of burst interval sampling over a single deployment phase.

3.1.2.c 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 F). In addition, the completion of the AWCP 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 realtime, 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 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.

3.2 Vessel Mounted Echo Sounder Systems

3.2.1 Vessel Mounted Hardware Limitations and Trade-offs

Vessel-mounted systems allow for greater spatial survey coverage, but there are several factors that must be considered in their design. The first of which is the method that the transducers are attached to the vessel. The most common methods are: hull-mounted, pole-mounted, or a towfish.
Hull-mounted systems offer many benefits including: fixed position of the transducers relative to the ship; protected location; and cable-runs are in protected space. In addition, lower frequency, narrow-beamwidth transducers (i.e. 18 and 38 kHz, < 20º beamwidth) can be very large and heavy so hull-mounting these is often the only practical approach for using these systems. But there can be some drawbacks: installation/removal of transducers requires removal of the vessel from the water; transducer position is difficult to alter post-installation so bubble-sweepdown or other noise sources can be difficult to fix, and hull-mounted systems (especially on larger vessels) are located at depths of 5-10 m below the sea surface so the "blind zone" of these installations can be quite large. Most manufacturers provide instructions and recommendations for hull-mounting their systems, but even when these are followed challenges may be encountered.

Pole-mounted systems can provide flexibility in that transducers can be used from different platforms. However, the engineering design of the pole can be challenging depending on the number and size of transducers, the sea conditions expected, and the ship being used. Attachment points to decks, gunwales, or other fixed structures on the ship are necessary and raising and lowering the pole-mount system can require the use of cranes or winches. There may be speed limitations to how fast surveys can be done due to mechanical limitations of the pole-mount, but one advantage of pole-mount systems is that the transducers can be placed closer to the sea-surface reducing the "blind zone" of the system.

Towfish deployments are advantageous when there are not suitable structures for mounting a fixed pole-mount system or there is a need for near-surface measurements. Towfish systems can be deployed quite close to the sea surface, but there are challenges in designing a towfish that flies straight and at constant depth, maintains distance from the vessel during ship movements and turns; and how to run the mechanical and electrical connections between the towfish, the transducers, the echo sounders, and the ship without putting strain or wear on power and data cables.

3.2.2 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. We will provide a short overview of these resources here.

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 beampattern 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

3.2.3 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 1 Shipboard acoustic echo sounder transducer 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.

Frequency (kHz)	Power (W)	Beamwidth (full width at half maximum) (^{o})	Ping repetition time (reciprocal of repetition rate) (s)	Typical Pulse duration (μs)	Transmitting Response (dB re 1 μPa m/V)	Transducer Mass (kg)	Depth Range* (m)

18	2000	11	2-5	1024	182.0	85	2000
38-7	2000	7	2-5	1024	184.0	68	1500
38-10	1500	10	2-5	1024	181.0	18	1500
70	1000	7	2-5	512	185.0	7	500
120	1000	7	2-5	512	185.0	3	300
200	300	7	2-5	512	184.0	2	150

18 kHz
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/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

120 kHz
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

3.2.4 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.

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

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

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). 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

CALCOFI Methods Manual
http://cce.lternet.edu/data/methods-manual

CALCOFI Line Handling
http://calcofi.org/references/calcofi-handbook/294-line-handling.html

5. Propagation Loss Experiment and Horizontal Line Array Sampling

Acoustic projectors (J-9, J-13) will be deployed from the research vessel to transmit a series of pulses at a series of ranges (e.g., 0, 50, 100, 500, 1000, 2000, 5000 m) from the lander site location to build and validate propagation within the soundscape modeling effort of ADEON. 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.

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 FINAL document will include the deployment parameters after discussion with the U.S. Navy on approval for public distribution.

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.

6.1 Net or trawl sampling of fish and zooplankton

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 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 m^2, 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), and Harris et al. (2000).

References

Devereux, R. F., & Winsett, R. C. (1953). Isaacs-Kidd Midwater Trawl (No. SIO-Ref-53-3). SCRIPPS Institution of Oceanography, La Jolla, CA.

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., Knudsen, H.P., Vestnes, G., MacLennan, D.N., & Simmonds, E.J. (1987). Calibration of Acoustic Instruments for Fish Density Estimation: A Practical Guide (ICES, Copenhagen, 1987).

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

Harris, R., Wiebe, P., Lenz, J., Skjoldal, H. R., & Huntley, M. (Eds.). (2000). ICES zooplankton methodology manual. Academic Press.

ICES Cooperative Research Report (CCR) # 235: Methodology for Target Strength Measurements https://www.ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/crr235/CRR235.pdf

ICES Cooperative Research Report (CCR) # 326: Calibration of Acoustic Instruments http://ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/crr326/CRR326.pdf

Methot, R. D. (1986). Frame trawl for sampling pelagic juvenile fish. CalCOFI Rep, 27, 267-278.

Seim, H.E., Fletcher, M., Mooers, C., Nelson, J., & Weisberg, R. (2009). Toward a regional coastal ocean observing system: An initial design for the Southeast Coastal Ocean Observing Regional Association. Journal of Marine Systems 77(3), 261-277.

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

Vagle, S., Foote, K.G., Trevorrow, M.V., & Farmer, D.M. (1996). A technique for calibration of monostatic echosounder systems, IEEE J. Ocean Eng., 21 (3), July 1996.

Wiebe, P. H., & Benfield, M. C. (2003). From the Hensen net toward four-dimensional biological oceanography. Progress in Oceanography, 56(1), 7-136.

Wiebe, P.H., Morton, A.W., Bradley, A.M., Backus, R.H., Craddock, J.E., Barber, V., Cowles, T.J. & Flierl, G.D.1. (1985). New development in the MOCNESS, an apparatus for sampling zooplankton and micronekton. Marine Biology, 87(3), pp.313-323.

GLOSSARY

BURST INTERVAL**:** This is the time between bursts (or between pings if the burst interval has been set equal to the ping period). Unit = 1 s.

PING**:** a sequence of single transmissions (at multiple frequencies for capable instruments) from the sonar channels in the instrument.

PINGS PER BURST: This is the number of individual pings in each burst or the number of pings in a profile if ping averaging has been selected. (Pings may be averaged, but this is not mandatory.)

PULSE LENGTH**:** Duration of the transmitted acoustic excitation pulse, usually expressed in microseconds. Unit = 1 s.

DIGITIZATION RATE*:* The rate at which samples are processed by the A/D converter when digitizing the returned acoustic signal. Unit = 1 Hz.

PING PERIOD**:** Time between pings in a profile set. Unit = 1 s.

LOCKOUT RANGE**:** (User selectable from 0 to MAX RANGE –1 meter). This is the distance, rounded to the nearest Bin Size after the pulse is transmitted that over which AZFP will ignore echoes. Unit = 1 m.

MAXIMUM RANGE**:** Distance, Rounded to the nearest Bin Size that the sounder listens for returns. Acoustic returns from objects further away than the MAXIMUM RANGE will not be recorded by the instrument Unit = 1 m.

BIN DEFINITION**:** This describes the division of the water column into discrete “bins” that contain range-averaged samples. The actual number entered into the AZFPLink software is the bin size in meters or samples.

VOLUME BACKSCATTERING STRENGTH: The volume scattering strength evaluated in the backscattering direction. Unit = 1 dB. Reference value = 1 m^{-1} sr^{-1}.

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.

	AMARs & External Battery Packs												Electronics Board										Memory Modules			Hydrophones								Hydrophone Extension Cables				Acoustic releases				Beacons				
Inspection Date	AMAR S/N	AMAR Housing	Last Pressure Test	Last FQT/ Maintenance	IP Address Mob Sheet	IP Address SharePoint	IP Address Unit	Open Issues	Mob Checklist Completed	EXT BATT PACK S/N	Last Pressure Test	Open Issues	Board Id	Board Version	Memory Cap ID	Open Issues	Restrictions on Use	Date Noise Floor Tests	Integration Checklist Completed	Software Version	Test Report Completed	Release Date	Module size (GB)	Module S/N	Open Issues	H-phone S/N	Open Issues	Restrictions on Use	Channel	Sample Rate (ksps)	H-phone Sensitivity (factory)	H-phone Sensitivity (measured)	H-phone Sensitivity (delta)	Serial Number	Continuity Check	Test with Hydrophone	Open Issues	Release Model	Release S/N	Mob Checklist Completed	Open Issues	Beacon Model	Beacon S/N	Mob Checklist Completed	Open Issues	Notes
23-Jul-15	418	G3 PVC	16-Jun-15	N/A	172.20.0.201	172.20.0.201	172.20.0.201	none	√	455	16-Jun-15	none	625	G3-4.3	166	none	none	17-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1292	none	HTI-99-HF-776055	none	none	1	8	-163.26	-163.00	0.26	N/A	N/A	N/A	none	Port LF	42784	√	none	RF	V06-013	√	none	**G3-2X with 48-cell internal battery pack - RCW MD 151**
																							256	1293	none				9	250	-163.26	-163.07	0.19									Kilo	107	√	none	
																							256	1294	none								0.00													
																							256	1295	none								0.00													
																							256	1296	none								0.00													
																							256	1297	none								0.00													
																							256	1298	none								0.00													
23-Jul-15	419	G3 PVC	16-Jun-15	N/A	172.20.0.199	172.20.0.199	172.20.0.199	none	√	456	16-Jun-15	none	623	G3-4.3	36	none	none	17-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1271	none	HTI-99-HF-776071	none	none	1	8	-163.10	-163.04	0.06	N/A	N/A	N/A	none	Port LF	46555	√	none	RF	V06-014	√	none	**G3-2X with 48-cell internal battery pack - RCW MD 151**
																							256	1272	none				9	250	-163.10	-163.07	0.03									Kilo	215	√	none	
																							256	1273	none								0.00													
																							256	1274	none								0.00													
																							256	1275	none								0.00													
																							256	1276	none								0.00													
																							256	1277	none								0.00													
23-Jul-15	420	G3 PVC	16-Jun-15	N/A	172.20.0.203	172.20.0.203	172.20.0.203	none	√	457	16-Jun-15	none	627	G3-4.3	264	none	none	17-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1446	none	HTI-99-HF-776065	none	none	1	8	-163.29	-162.94	0.35	N/A	N/A	N/A	none	Port LF	46556	√	none	RF	V06-020	√	none	**G3-2X with 48-cell internal battery pack - RCW MD 151**
																							256	1447	none				9	250	-163.29	-162.97	0.32									Kilo	216	√	none	
																							256	1448	none								0.00													
																							256	1449	none								0.00													
																							256	1450	none								0.00													
																							256	1451	none								0.00													
																							256	1452	none								0.00													
23-Jul-15	425	G3 PVC	16-Jun-15	N/A	172.20.0.175	172.20.0.175	172.20.0.175	none	√	411	2-Apr-15	none	413	G3-4.3	47	none	none	14-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	462	none	HTI-99-HF-776045	none	none	1	8	-163.40	-162.94	0.46	N/A	N/A	N/A	none	Port LF	46559	√	none	RF	V06-041	√	none	**G3-2X with 48-cell internal battery pack - RCW MD 151**
																							256	463	none				9	250	-163.40	-162.97	0.43													**Last minute change - not enough Kilos to supply this station**
																							256	566	none								0.00													
																							256	567	none								0.00													
																							256	597	none								0.00													
																							256	598	none								0.00													
																							256	594	none								0.00													
29-Jul-15	376	Deep Glass	13-Jul-15	N/A	172.20.0.198	172.20.0.198	172.20.0.198	none	√	N/A	N/A	none	622	G3-4.3	246	none	none	17-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1369	none	HTI-99-HF-776062	none	none	1	8	-163.35	-162.84	0.51	N/A	N/A	N/A	none	Port LF	46560	√	none	MMF	D06-076	√	none	**Glass sphere with 2 x 64-cell internal - RCW MD 146 Single**
																							256	1370	none				9	250	-163.35	-162.77	0.58									Kilo	222	√	none	
																							256	1371	none								0.00													
																							256	1372	none								0.00													
																							256	1373	none								0.00													
																							256	1374	none								0.00													
																							256	1375	none								0.00													
29-Jul-15	377	Deep Glass	13-Jul-15	N/A	172.20.0.213	172.20.0.213	172.20.0.213	none	√	N/A	N/A	none	637	G3-4.3	251	none	none	23-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1453	none	HTI-99-HF-776057	none	none	1	8	-163.06	-162.84	0.22	N/A	N/A	N/A	none	Port LF	46561	√	none	MMF	D06-077	√	none	**Glass sphere with 2 x 64-cell internal - RCW MD 146 Single**
																							256	1454	none				9	250	-163.06	-162.87	0.19									Kilo	225	√	none	
																							256	1455	none								0.00													
																							256	1456	none								0.00													
																							256	1457	none								0.00													
																							256	1458	none								0.00													
																							256	1459	none								0.00													
29-Jul-15	386	Deep Glass	13-Jul-15	N/A	172.20.0.196	172.20.0.196	172.20.0.196	none	√	N/A	N/A	none	620	G3-4.3	8	none	none	17-Jul-15	√	Tesla 2015.04.30	√	30-Apr-15	256	1383	none	HTI-99-HF-776053	none	none	1	8	-163.08	-162.84	0.24	N/A	N/A	N/A	none	Port LF	46562	√	none	MMF	D06-078	√	none	**Glass sphere with 2 x 64-cell internal - RCW MD 146 Single**
																							256	1384	none				9	250	-163.08	-162.77	0.31									Kilo	440	√	none	
																							256	1385	none								0.00													
																							256	1386	none								0.00													
																							256	1387	none								0.00													
																							256	1388	none								0.00													
																							256	1389	none								0.00													

Inventory Transfer	Complete
AMAR	√
External battery pack	√
Boards	√
Memory	√
Hydrophones	√
Hydrophone ext	N/A
Acoustic Releases	√
Projector	N/A
Beacons	√

Shipping		
Item	Packing Slip	Prepared
1	1697	√

Sharepoint	Complete (√)	Notes
Mobilization sheet scanned/uploaded (AMARs)	√	
Calibration log sheet scanned/uploaded (hydrophones)	√	
Integration checklist scanned/uploaded (boards)	√	
Mobilization test record scanned/uploaded (releases)	√	**Annual maintenance & FQT performed on releases prior to mob as they will be deployed for one year**
Mobilization test record scanned/uploaded (beacons)	√	**5 MMFs assigned to mob & on MEL instead of 3 - need to sort which 3 are going on this shipment**
Shop cal vs factory cal acceptable (within 0.75dB)	√	
C of C created	N/A	
Deviation/Waiver (# if applicable)	N/A	
PPW created and kick-off complete (1st gate)	√	**PPW-031**
RCW approved	√	**1 x MD146 Single, 2 x MD146 Dual (unless no splitter cables, then MD146 Single), 4 x MD151 (7 total)**
Mooring design linked to mobilization and approved. No open issues. Mooring Risk status acceptable. (2nd gate)	√	**3 x 146, 4 x 151**
WO approved	√	
MEL approved	√	
Check packing list and pro forma (if required) to MEL for field projects. Check PL to WO and PO for sales orders.	√	**PL-1697**
Current MEL initialed by packer for field projects. PL initialed for sales orders.	√	
Hydrophone boot stabilizer installed for GTI potted hydrophpones, extension cables and splitters.	N/A	
Mobilization meets project requirements	√	
Mooring trial assembly complete (for field projects where we are supplying the mooring)	√	
Ops plan review & walk-through complete for field projects where we are deploying and retrieving gear (3rd gate)	√	

APPENDIX B – Prototype 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 prototype lander upon which the future ADEON landers will be based.

Operations Plan

ESRF Deployments, Aug 2015

Version 1.0

P001276
Document 01047

2015 Jun 16

Author(s):
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Approvals

This Field Operations Plan has been approved by the following:

Name	Title	Approved
1) Julien Delarue (cruise 1)	Field Team Lead	
2) Jeff MacDonnell (cruise 2)	Field Team Lead	
2) Eric Lumsden	HSE Tech/Field Team Member	
3) Bruce Martin	Principal Investigator	
4) Dave Smart	Project Manager	31 July 2015
5) Herb Nash/Lloyd Normore	Vessel Owners	Forwarded
6) Client	N/A	PM can fwd

References and Process

This document will be submitted to the JASCO HSE Representative for referral when preparing HSE documentation for the project.

Document	Referral Number	Approved
HSE Project Plan	P001276.001	1.0
HSE Checklist	n/a	n/a

Contents

Tables

Figures

1. Summary

The proposed project relates to the deployment of acoustic recorders along the eastern Canadian coast as part of an ESRF-funded study designed to assess ambient noise, man-made noise and monitor for marine mammals at 20 selected locations. The project area includes the Scotian Shelf, Cabot Strait and Strait of Belle-Isle, Grand Banks and Labrador Shelf. The project consists of two one-year deployments. Deployments will be broken down into two cruises starting in Glace bay, NS (Cruise 1), and L'Anse-au-Loup, NL (Cruise 2). This Operations Plan refers to the first set of deployments for both cruises.

2. Schedule of JASCO Operations

This schedule may be adjusted based on weather and operational constraints. It assumes 8 kts travel speed and 1 hour on station for each deployment.

2.1. Cruise 1 – Glace Bay

Date	Time	Location	Activity
5 Aug	AM	Halifax/ Travel Day	JASCO field team travels to Glace Bay, NS; load equipment on vessel in PM
6 Aug	AM	Glace Bay	Departure; first leg to deploy Station 1, 8, 9, 2, 3, 5, 4. Distance 880 nmi, Estimated time 5 days.
11 Aug	AM	Glace Bay	Back in port; Refuel; load equipment.
11 Aug	PM	Glace Bay	Departure for leg 2 to deploy Station 6, 15, 7, 17, 18, 19 +2 DFO recorders; Distance 925 nmi, Estimated time 5.5 days
17 Aug	AM	St John's	Back in port; JASCO team to fly back to Halifax in the evening
18 Aug	PM	St John's/Halifax	Alternate travel day

2.2. Cruise 2 – L’Anse-au-Loup

Date	Time	Location	Activity
31 Jul	PM	Halifax/Cape Breton	Travel to Sydney
1 Aug	AM	Cape Breton/NFLD; Travel Day	JASCO field team takes ferry to L’Anse-au-Loup, NFLD; overnight in Corner Brook
2 Aug	PM	NFLD/Labrador; travel day/load-out	Team travels to L’Anse-au-Loup, NL; load-out on vessel
3 Aug	AM	L’Anse-au-Loup	Departure; Leg 1 to deploy Station 10, 11, 12, 13. Distance 850 nmi, Estimated time 4.5 days.
7 Aug	PM	Cartwright	Refuel; load equipment; Spend the night in Cartwright
8 Aug	AM	Cartwright	Departure for leg 2 to deploy Station 14, 15, 20; Distance 680 nmi, Estimated time 3.75 d (3.5 d travel + 1 hr at each station)
12 Aug	AM	L’Anse-au-Loup	Arrival; pack gear; Take ferry across to NFLD if possible
13 Aug		Travel Day	
14 Aug		Travel Day	Return to Halifax

3. Requirements

Resource Requirements

Ref: https://www.tc.gc.ca/eng/marinesafety/tp-tp14609-2-marine-acts-regulations-617.htm

3.1.1. Cruise 1

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

- 1 Vessel certified beyond 200 nm and boom capable of safely lifting 450 kg
- 2 Deckhands
- 1 Vessel Master and vessel certified intermediate coastal, Class II Fishing Master, Coastal Voyages within 200 nm from shore.
- 1 Boom operator

Figure 1: Photo of *F/V Shirley & Philip*, vessel intended for deployment of AMARs for ESRF Cruise 1.

3.1.2. Cruise 2

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

- 1 Vessel w/ boom capable of safely lifting 230 kg
- 2 Deckhands
- 1 Vessel Master and vessel certified intermediate coastal, Class II Fishing Master, Coastal Voyages within 200 nm from shore.
- 1 Boom operator

Figure 2: Photo of F/V Labrador Venture, vessel intended for deployment of AMARs for ESRF Cruise 2.

Data Requirements

JASCO requires the following information to interpret the acoustic data:

- Accurate latitude and longitude information of each deployed AMAR

4. Equipment

Acoustic Recording Configuration

RCW MD 146 single, RCW MD 146 dual, RCW MD 147, RCW MD 150, RCW MD 151 and RCW MD160:

See PPW 0030 & PPW 0031 & PPW 0042

Mooring 147: ESRF Shallow Mooring 1 (Figure 3)

Deployment kit includes:

- 180 m ½" Nylon Double Braid (670 kg WLL)
- 1/2" Shackle (1360 kg WLL)
- (2) Edgetech PortLF Acoustic release (180 kg WLL), Tandem kit
- (2) 5/16" Shackle (680 kg WLL)
- 0.5 m 5/16" Grade 80 Chain (2040 kg WLL)
-

Economy Bottom Plate Assembly includes:

- JASCO G3 AMAR & 48 cell battery pack in 2X housing (250 m depth rating)
- 96-cell Battery Pack in 2X pressure housing (250 msw depth rating)
- Vemco VR2W receiver (500 m depth rating)
- Hydrophone mounted in shrouded cage
- Custom deployment ring

Pop-up Outrigger Assembly (180 kg WLL) includes:

- EdgeTech SPORT LF Acoustic Release with Pop-up Package (max depth 150 m)
- 180 m 5/16" Nylon Double Braid, (260 kg WLL, effective when lifted by line)
- 5/16" Shackle inside (680 kg WLL)
- 9" of 5/16" GR80 Chain inside (2040 kg WLL)
- Outrigger plate
- 2 x 20 kg Olympic plate

Weight: 147 kg in air, 54 kg in water

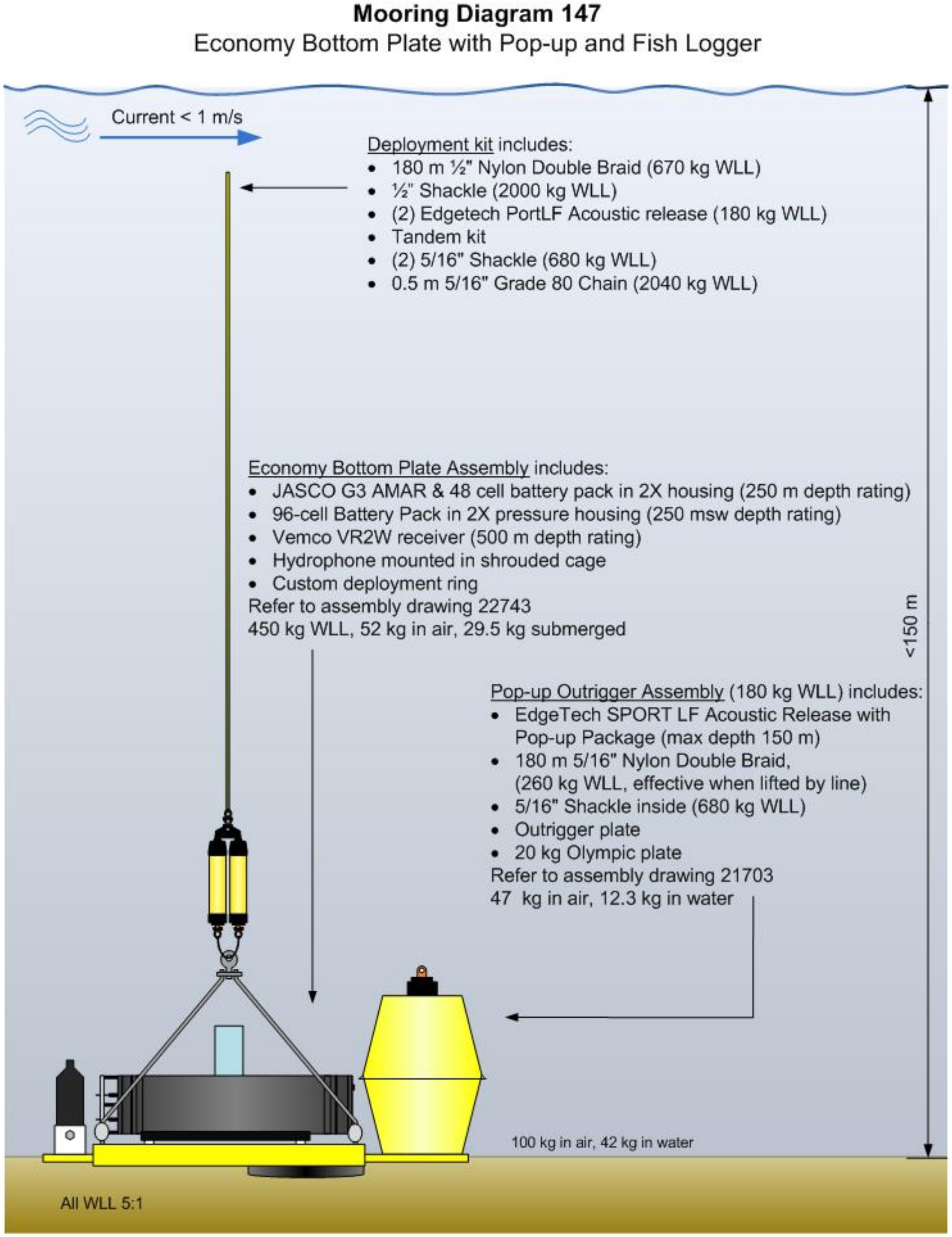

Figure 3: Mooring 147 – Station 3, 7, 9

Mooring 151: ESRF Shallow Mooring 2 (

Figure 4)

Beacon Mast + Recorder Assembly includes:

- 36" Fiberglass mast
- GPS/Iridium position tracking beacon; XEOS Kilo (max depth 2 500 m)
- Flasher Beacon; XEOS XMF-11K (max depth 11 000 m)
- Vemco VR2W Acoustic Receiver (depth rating 500 m)
- (6) Beacon Clamps
- Balmoral OF4 Syntactic Float (52.8 kg buoyancy, 1000 m depth rating)
- 40" Strongback (1000 kg WLL)
- Centre Post Assembly with Lift Ring (316 SS, 1000 kg SWL)
- Universal Joint (1000 kg WLL)
- (2) Eyepins (316 SS, 2000 kg WLL)
- ½" Shackle (2000 kg WLL)
- JASCO G3 AMAR + 48 cell battery in 2X housing (mass 21 kg, 4 kg in water, depth rating 250 m)
- 96 cell battery pack in 2X housing (mass 26.6 kg, 10 kg in water, depth rating 250 m)
- HTI 99-HF Hydrophone
- 60" Strongback (1000 kg WLL)
- (4) Saddle clamps·
- Eyepin (2000 kg WLL)
- ½" Shackle (2000 kg WLL)
- 20 m of 5 mm Vectran Rope with reinforced thimble and stopper (800 kg WLL)
- 17" Glass float in hardhat (23.3 kg in air, 25.4 kg buoyant, depth rating 6700 m)
- Single float attachment kit
- (2) ½" Shackles (2000 kg WLL)
- (2) eyepins

Acoustic Release Assembly includes:

- Edgetech PortLF Acoustic Release (180 kg WLL, depth rating 3500 m)
- (2) 5/16" Shackle (680 kg WLL)

- (2) ½" Shackle (2000 kg WLL)

105 kg Anchor Assembly includes:

- Crosby Master Link in eye of wire below
- 3 m of 3/8" Coated wire strop w/ thimbles and anode
- 2 m of 3/8" Coated wire strop w/ thimbles and anode as stinger
- 2" Anchor stem post with (5) 20 kg Olympic plates

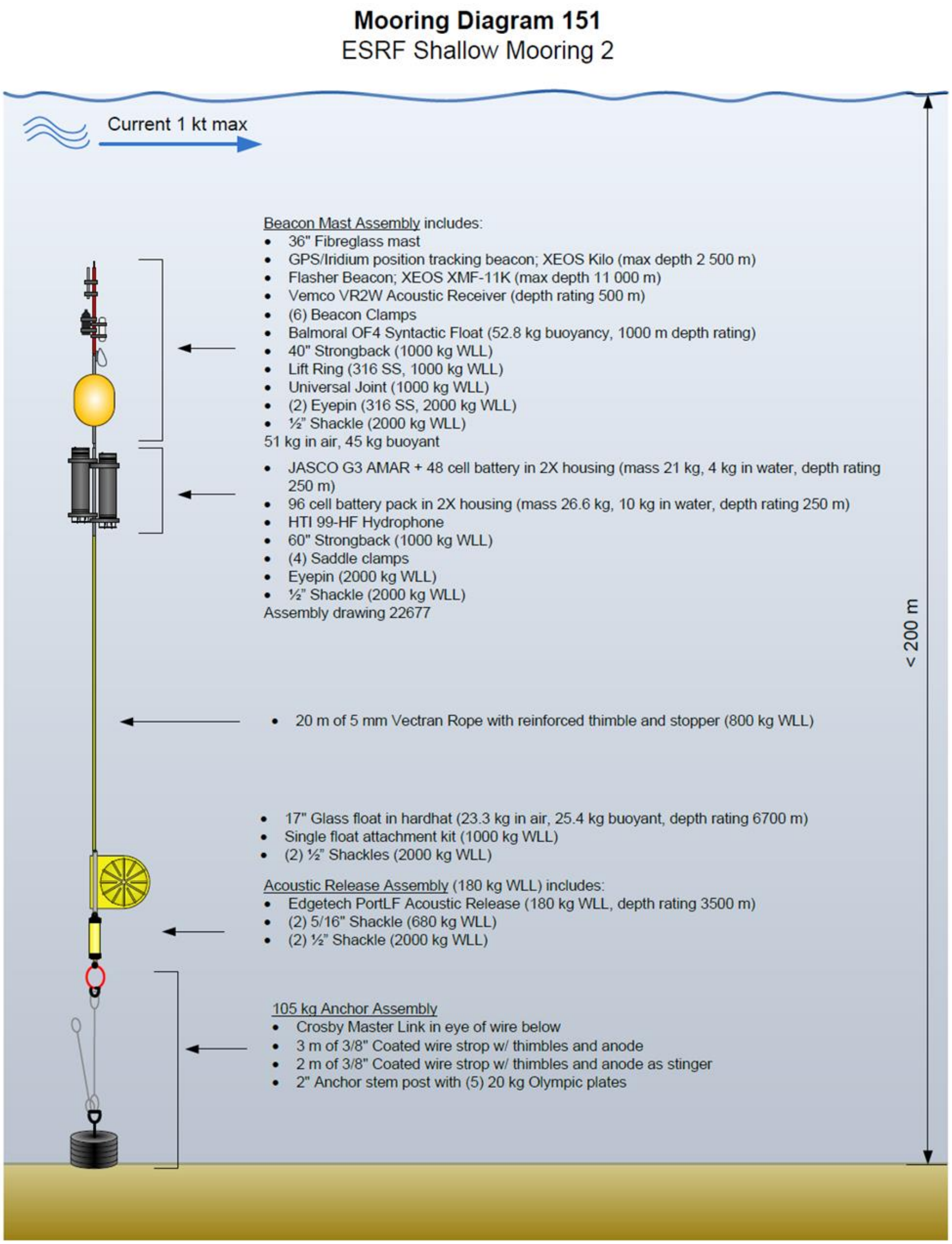

Figure 4: Mooring 151 – Station 1, 2, 10, 11, 12, 18, 20.

Mooring 146: ESRF Deep Mooring (Figure 5)

Beacon Mast + Recorder Assembly includes:

- 36" Fiberglass mast
- GPS/Iridium position tracking beacon; XEOS Kilo (max depth 2 500 m)

- Flasher Beacon; XEOS XMF-11K (max depth 11 000 m)
- (4) Beacon Clamps
- Balmoral OF4 Syntactic Float (37.6 kg buoyancy, 3000 m depth rating)
- 60" Strongback (1000 kg WLL)
- Lift Ring (316 SS, 1000 kg SWL)
- (3) 5 lb. Counterweights
- Eyepin (316 SS, 2000 kg WLL)
- ½" Shackle (2000 kg WLL)
- 2 m of 5 mm Vectran Rope w/reinforced thimble and stopper (800 kg WLL)
- JASCO Deep AMAR 2x64 Batteries in Hardhat (mass 38.3 kg, 0.5 kg in water, depth rating 5000 m)
- HTI 99-HF Hydrophone
- Flat Strongback + hardhat attachment set (1000 kg WLL)
- (2) ½" Shackles (2000 kg WLL)
- 20 m of 5 mm Vectran Rope with reinforced thimble and stopper (800 kg WLL)
- Benthos 17" Glass float in hardhat (depth rating 6700 m)
- Single float attachment kit (1000 kg WLL)
- (2) ½" Shackles (2000 kg WLL)

Acoustic Release Assembly includes:

- Edgetech PortLF Acoustic Release (180 kg WLL, depth rating 3500 m)
- (2) 5/16" Shackle (680 kg WLL)
- ½" Shackle (2000 kg WLL)

125 kg Anchor Assembly includes:

- Crosby Master Link in eye of wire
- 3 m of 3/8" Coated wire strop w/ thimbles and anode
- 2 m of 3/8" Coated wire strop as stinger
- 2" Anchor stem post with (6) 20 kg Olympic plates

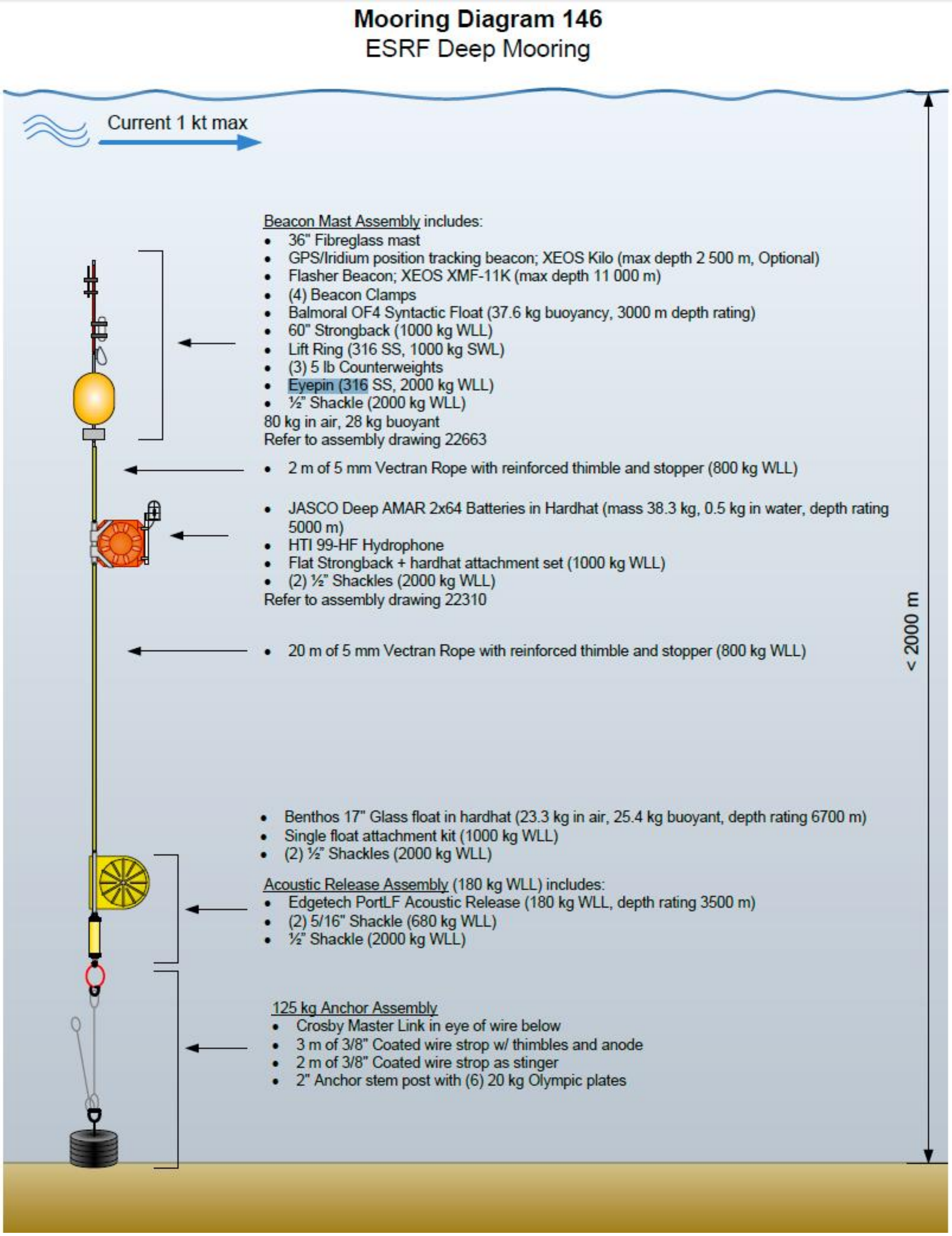

Figure 5: Mooring 146 – Stations 4, 5, 6, 13, 14, 15, 16, 17, 19.

Mooring 150: ESRF Deep Mooring 2 (Figure 6)

Beacon Mast + Recorder Assembly includes:

- 36" Fiberglass mast
- GPS/Iridium position tracking beacon; XEOS Kilo (max depth 2 500 m)
- Flasher Beacon; XEOS XMF-11K (max depth 11 000 m)
- Vemco VR2W Acoustic Receiver (max depth 500 m)
- (6) Beacon Clamps
- Balmoral OF4 Syntactic Float (52.8 kg buoyancy, 1000 m depth rating)
- Balmoral OF3 Syntactic Float (24.3 kg buoyancy, 1000 m depth rating)
- 60" Strongback (1000 kg WLL)
- Lift Ring (316 SS, 1000 kg WLL)
- Universal Joint (1000 kg WLL)78 kg in air, 66 kg buoyant
- JASCO Extended Deep AMAR (mass 60 kg, 29 kg in water, depth rating 2500 m)
- HTI 99-HF Hydrophone
- 72" Strongback + Saddle clamps (1000 kg WLL)
- (3) Eyepins (2000 kg WLL)
- ½" Shackle (2000 kg WLL)74 kg in air; 37 kg in water
- 20 m of 5 mm Vectran Rope with reinforced thimble and stopper (800 kg WLL)
- 17" Glass float in hardhat (23.3 kg in air, 25.4 kg buoyant, depth rating 6700 m)
- Single float attachment kit (1000 kg WLL)
- (2) ½" Shackles (2000 kg WLL)

Acoustic Release Assembly (180 kg WLL) includes:

- Edgetech PortLF Acoustic Release (180 kg WLL, depth rating 3500 m)
- (2) 5/16" Shackle (680 kg WLL)
- ½" Shackle (2000 kg WLL)

125 kg Anchor Assembly includes:

- Crosby Master Link in eye of wire below
- 3 m of 3/8" Coated wire strop w/ thimbles and anode
- 2 m of 3/8" Coated wire strop w/ thimbles and anode as stinger
- 2" Anchor stem post with (6) 20 kg Olympic plates

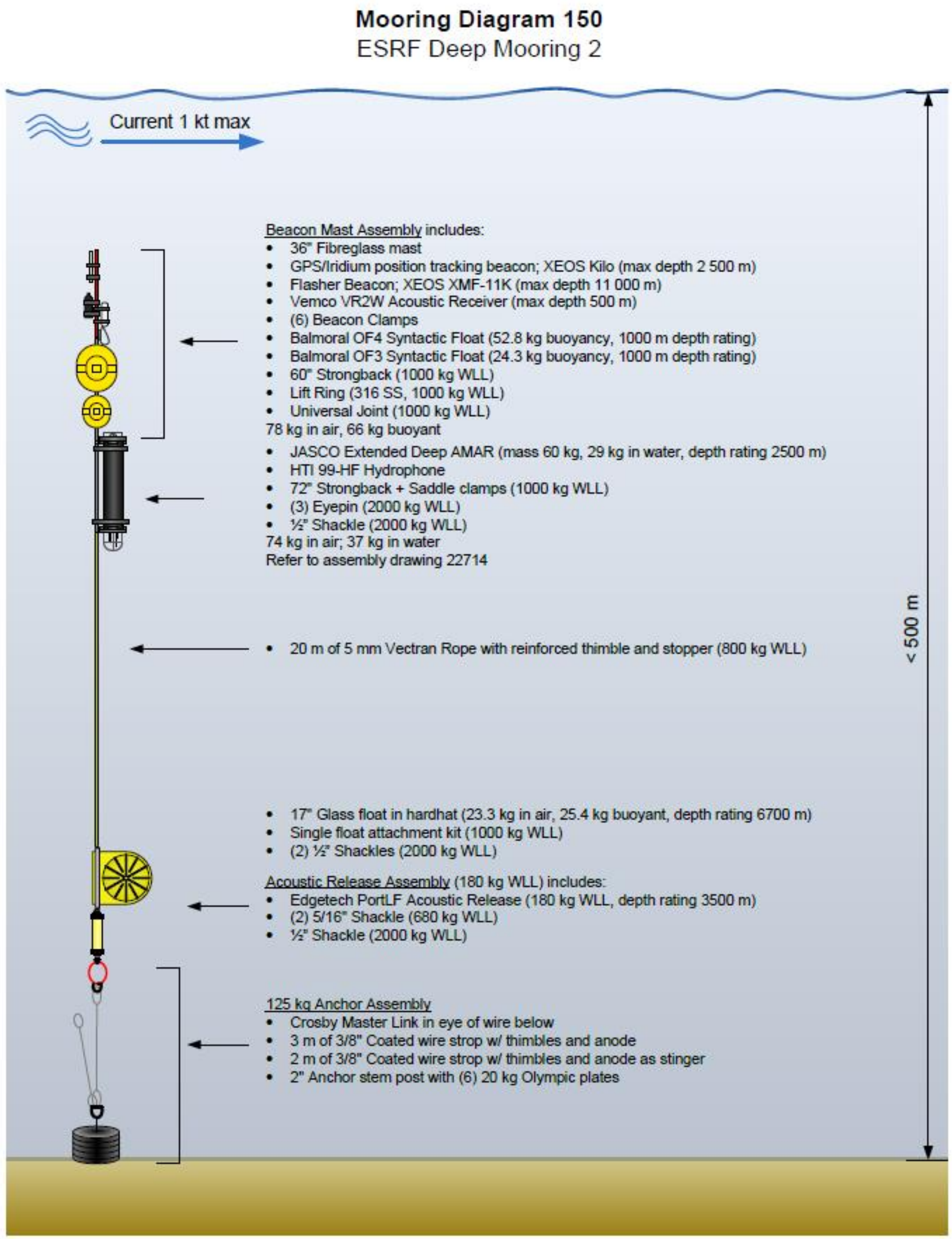

Figure 6: Mooring 150 – Station 8 (North Slope Cabot Strait)

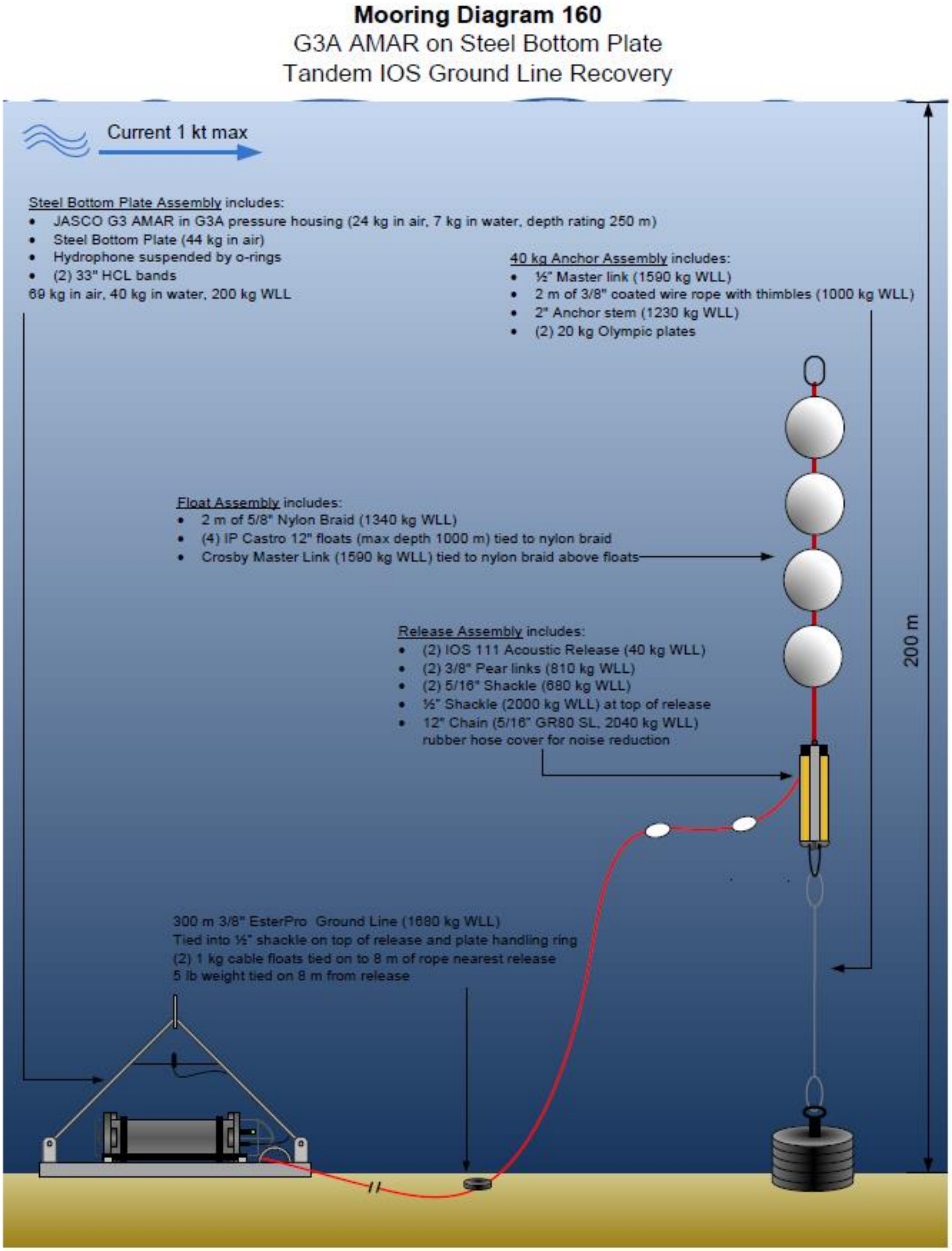

Figure 7: Draft/place holder Mooring 160, DFO CT and DFO ST

5. Deployment Locations

Table 1 and Figure 8 present the deployment locations.

Table 1. Proposed deployment locations of each recorder (Deg/Min) with corresponding mooring designs.

Station ID	Location	Lat	Long (W)	Depth	Mooring Design
3	Sable	44.048608	60.595424	30	147 (with Sport pop-up)
9	West NFLD	48.927758	58.879531	40	147 (with Sport pop-up)
7	Central Grand Banks	45.699893	51.234765	80	147 (with Sport pop-up)
10	Belle Isle	51.270954	57.540040	110	151
18	Hibernia	46.907932	48.502559	110	151
2	Louisburg Line	45.426035	59.764379	140	151
12	Nain Bank	57.250000	60.000000	140	151
11	Makkovik Bank	55.600000	57.750000	160	151
1	Cape Breton	46.990171	60.023960	180	151
20	Funk Island Bank	50.750000	52.343472	230	151
8	North Slope Cabot Strait	47.493651	59.410325	420	150
14	S Hamilton Bank	53.014889	53.455575	560	146 with Port
17	Lily Canyon	44.972502	48.732665	1350	146 with Port
19	Avalon East Shelf Break	48.728586	49.380774	1300	146 with Port
16	Desbarres Canyon	44.191938	53.274338	1600	146 with Port
6	Mouth Laurentian Ch.	44.854035	55.270660	1700	146 with Port
4	SW Sable	43.110063	60.492682	2000	146 with Port
5	Deep SW Nova	42.511454	62.192600	2000	146 with Port
13	Labrador Offshore	55.250270	54.106546	2000	146 with Port
15	W Orphan Knoll	50.409106	49.198629	2000	146 with Port
21	DFO CT Lilly Canyon	44.918015	49.297502	142	160
22	DFO ST Carson Canyon	45.46215	48.790197	136	160

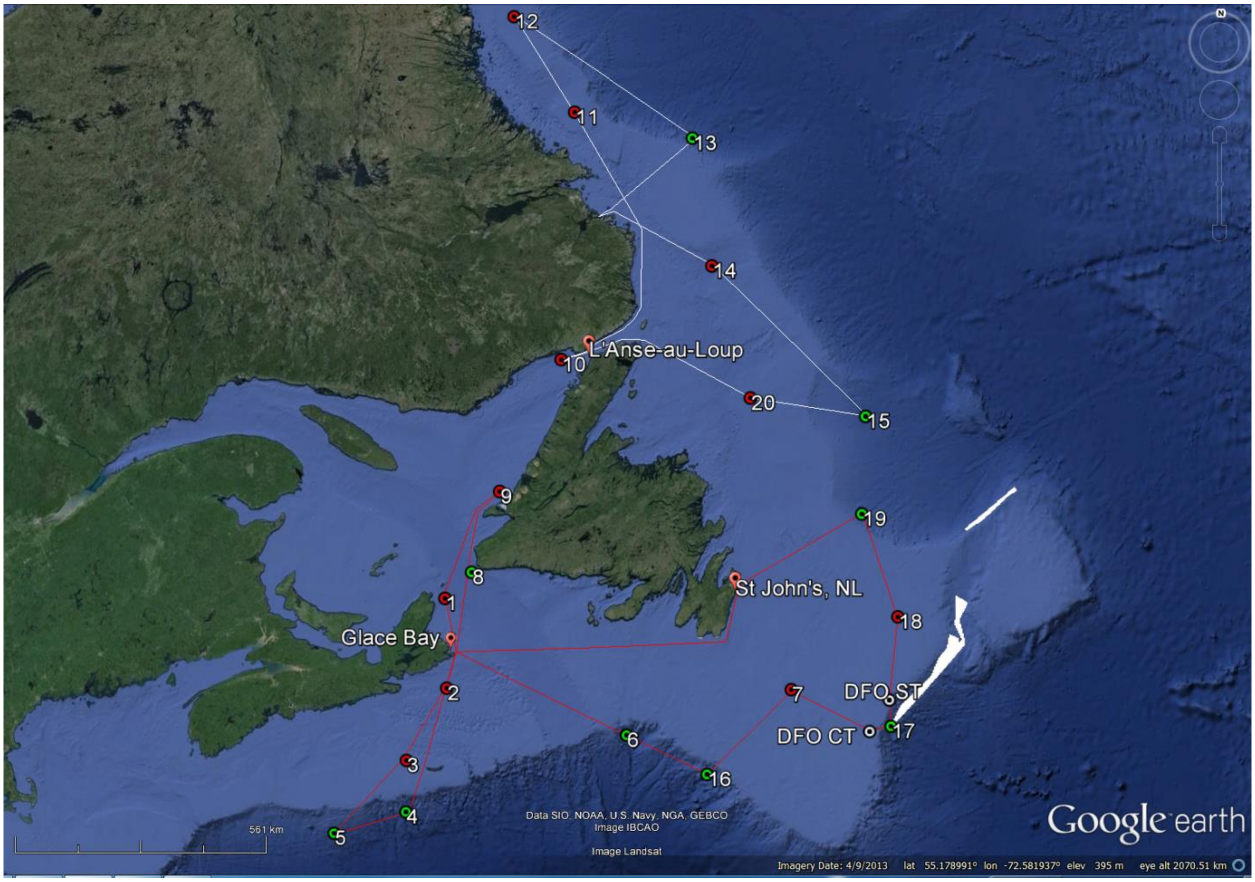

Figure 8. Summer 2015 deployment locations and cruise plan. Cruise 1 in red and Cruise 2 in white.

6. Deployment Procedure

The following steps outline the procedure for deploying the AMAR mooring stations from the F/V Shirley & Philip (Cruise 1) and F/V Labrador Venture (Cruise 2). These procedure are subject to change based on weather conditions and consultation with the vessel Masters and crews.

6.1. Stations 3, 9, and 7 – Cruise 1. Mooring 147.

a. Move the economy base plate mooring assembly to the deployment position, stern/side of vessel, close to the railing, and secure.

b. Attach the top of the tandem PortLF lowering release to the lowering line and secure, move in position over the bottom plate frame on deck. Once atop of the bottom plate mooring, pass the release chain through the lowering ring and re-secure to the PortLF tandem release kit. Maintain minimum strain on lowering boom line and secure in place.

c. Attach pass-through taglines through the eye-ring on the anchor plate assembly frame or frame assembly. Secure one end to vessel; ensure other end of lowering line is coiled on deck or in a coiling bucket or free from entanglement.

d. Once JASCO is satisfied with the coordinates of the intended recorder position and currents are accounted for, the field team will lower the bottom plate via boom to the waterline, remove pass-through taglines, and take a waypoint (WP) once in position. The order to lower the mooring to the bottom will be given after WP is taken. Once the mooring is on bottom, another on-bottom WP is taken, enable and subsequent release code activated and retrieval of the tandem PortLF release via hauler. GPS tracking to be maintained throughout.

6.2. Stations 18, 2, and 1 – Cruise 1, and stations 12, 11, 10 and 20 – Cruise 2. Mooring 151.

a. Fully assemble mooring.
b. Move the anchor plate assembly, acoustic release assembly, and glass float in hardhat to the vessel's port/stbd side aft, close to the railing, and secure near the glass float. This anchoring attachment will be under minimal strain once over boarding of the top mooring assembly is accomplished.
c. Attach TR-7 to boom block shackle and secure to center post assembly lift ring. Attach one pass-through tagline through the top bail battery pack AMAR. Slowly hoist the entire mast, strongback assembly and JASCO Deep AMAR off the deck while second JASCO member holds the tagline to prevent swinging. Swing the boom outboard while controlling the top mooring assembly via tagline. Place the top mooring assembly via boom ~ 1 m from the waterline on the leeward side of vessel.
d. Slowly lower the top mooring assembly to the water surface and hold. Second JASCO member to pull through tagline and stow for next use. First JASCO member to pull TR-7 release pin once satisfied with the top mooring assembly position relative to the ship. Pull release line on TR-7 quick release and allow top mooring assembly to drift down stream.
e. Attach TR-7 release to the 2-m stinger affixed to the anchor post assembly and maintain minimum strain with boom until secure point around glass float is untied.
f. Place pass-through taglines through bottom of 3-m coated wire strop and maintain in position while hoisting with boom.
g. Pass lowering line (EstroPro or weighted lead line) through stinger and maintain strain on line via cleat while lowering away.
h. Hoist anchor assembly, release assembly, and glass float on strongback to side of vessel, over railing at waist level.
i. JASCO member to remove release pin from TR-7 release.
j. Order given to lower bottom mooring assembly to waterline ensuring assembly is not entangled with top mooring and separation is maintained.
k. Deck crew to remove pass-through tagline from 3-m coated wire and stow it away.
l. Secure the free end of the stinger lowering line on deck cleat and lower the mooring until strain on the lowering line matches strain on the winch wire and TR-7.

m. Activate TR-7 quick release, remove, and stow.
n. Once JASCO is satisfied with the position of the mooring, the lowering line will be let out until downward pressure is observed on the Benthos glass float, thereby ensuring no shock load situation is present.
o. Release free end of lowering line. If it becomes entangled, cut the line.
o. Second JASCO member to take WP.

6.3. Station 8 – Cruise 1. Mooring 150.

a. Fully assemble mooring
b. Move the anchor plate assembly, acoustic release assembly, and glass float in hardhat to the vessel's port/stbd side aft, close to the railing, and secure near the glass float. This anchoring attachment will be under minimal strain once over boarding of the top mooring assembly is accomplished.
c. Attach TR-7 to boom block shackle and secure to center post assembly lift ring. Attach one pass-through tagline through the bottom bail on extended deep AMAR. Slowly hoist the entire mast, strongback assembly and JASCO Deep AMAR off the deck while second JASCO member holds the tagline to prevent swinging. Swing the boom outboard while controlling the top mooring assembly via tagline. Place the top mooring assembly via boom ~ 1 m from the waterline on the leeward side of vessel.
d. Slowly lower the top mooring assembly to the water surface and hold. Second JASCO member to pull through tagline and stow it. First JASCO member to pull TR-7 release pin once satisfied with the top mooring assembly position relative to the ship. Pull release line on TR-7 quick release and allow top mooring assembly to drift down stream.
e. Attach TR-7 release to the 2m stinger affixed to the anchor post assembly and maintain minimum strain with boom until secure point around glass float is untied.
f. Place pass-through taglines through bottom of 3m coated wire strop and maintain position while hoisting with boom.
g. Pass lowering line (EstroPro or weighted lead line) through stinger and maintain strain on line via cleat while lowering away.
h. Hoist anchor assembly, release assembly, and glass float on strongback to side of vessel, over railing at waist level.
i. JASCO member to remove release pin from TR-7 release.
j. Order given to lower bottom mooring assembly to waterline ensuring assembly is not entangled with top mooring and separation is maintained.
k. Deck crew to remove pass-through tagline from 3m coated wire and stow tagline.
l. Secure the free end of the stinger lowering line on deck cleat and lower the mooring until strain on the lowering line matches strain on the winch wire and TR-7.

m. Activate TR-7 quick release, remove, and stow.

n. Once JASCO is satisfied with the position of the mooring, the lowering line will be let out until downward pressure is observed on the Benthos glass float, thereby ensuring no shockload situation is present.

o. Release free end of lowering line. If it becomes entangled, cut the line.

p. Second JASCO member to take WP.

6.4. Stations 17, 19, 16, 6, 4, and 5 – Cruise 1, and stations 13, 14, and 15 – Cruise 2. Mooring 146.

a. Fully assemble mooring.

b. Move the anchor plate assembly, acoustic release assembly, and glass float in hardhat to the vessel's port/stbd side aft, close to the railing, and secure near the glass float. This anchoring attachment will be under minimal strain once over boarding of the top mooring assembly is accomplished.

c. Attach TR-7 to boom block shackle and secure to center post assembly lift ring. Attach one pass-through tagline around the strongback between OF4 and counterweight. Slowly hoist the entire mast, strongback assembly and JASCO Deep AMAR off the deck while second JASCO member holds the tagline to prevent swinging. Swing the boom outboard while controlling the top mooring assembly via tagline. Place the top mooring assembly via boom ~ 1 m from the waterline on the leeward side of vessel.

d. Slowly lower the top mooring assembly to the water surface and hold. Second JASCO member to pull through tagline and stow. First JASCO member to pull TR-7 release pin once satisfied with the top mooring assembly position relative to the ship. Pull release line on TR-7 quick release and allow top mooring assembly to drift down stream.

e. Attach TR-7 release to the 2m stinger affixed to the anchor post assembly and maintain minimum strain with boom until secure point around glass float is untied.

f. Place pass-through taglines through bottom of 3m coated wire strop and maintain in position while hoisting with boom.

g. Pass lowering line (EstroPro or weighted lead line) through stinger and maintain strain on line via cleat while lowering away.

h. Hoist anchor assembly, release assembly, and glass float on strongback to side of vessel, over railing at waist level.

i. JASCO member to remove release pin from TR-7 release.

j. Order given to lower bottom mooring assembly to waterline ensuring assembly is not entangled with top mooring and separation is maintained.

k. Deck crew to remove pass-through tagline from 3m coated wire and secure on deck.

l. Secure the free end of the stinger lowering line on deck cleat and lower the mooring until strain on the lowering line matches strain on the winch wire and TR-7.

m. Activate TR-7 quick release, remove, and stow.

n. Once JASCO is satisfied with the position of the mooring, the lowering line will be let out until downward pressure is observed on the Benthos glass float, thereby ensuring no shockload situation is present.
o. Release free end of lowering line. If it becomes entangled, cut the line.
p. Second JASCO member to take WP.

6.5. Stations DFO CT and DFO ST – Cruise 1. Mooring 160.

a. Move the base plate mooring assembly to the deployment position, aft side of vessel, close to the railing, and secure.

b. Attach the top of the tandem PortLF lowering release to the lowering line and secure, move in position over the bottom plate frame on deck. Once atop of the bottom plate mooring, pass the release chain through the lowering ring and re-secure to the PortLF tandem release kit. Maintain minimum strain on lowering boom line and secure in place.

c. Attach pass-through taglines through the D-ring on the bottom plate assembly frame or frame assembly. Secure one end to vessel; ensure other end of lowering line is coiled on deck or in a coiling bucket or free from entanglement.

d. Secure the weighted end of the ground line to the lowering ring and ziptie the residue ground line to the bottom of the A-frame to ensure it does not become entangled upon deployment.

e. Flake the ground line out on deck and ensure no personnel are in the bite of the lines.

f. Secure the opposite end of ground line, containing 2 x cable floats, to the top of the tandem IOS release assembly’s 7/16 shackle via double clove hitch and ziptie the ends.

g. Attach the TR-7 quick release to the Crosby Master Link atop the release/weight assembly forward on the vessel near the hydraulic line hauler.

h. Once JASCO is satisfied with the coordinates of the intended recorder position and currents are accounted for, the field team will lower the bottom plate via boom to the waterline, remove pass-through taglines, and take a waypoint (WP) once in position. Simultaniously the anchor assembly will be hoisted over the side and lowered until the TR-7 release is visible and at the ready at the waterline. Secure lowering and release line.

i. The order to lower the mooring to the bottom will be given after WP is taken. Once the mooring is on bottom, another on-bottom WP is taken, the enable and subsequent release code is activated. Retrieve the tandem PortLF release via hauler while allowing the vessel to drift. JASCO team to ensure flaked-ground line overboards unimpeded and under no strain.

j. Once ~10m of ground line is left on-deck, the order to release the anchor/release assembly is given. WP is taken for on-bottom anchor position.

k. GPS tracking to be maintained throughout.

7. Marine Mammal Observations

When on transit and if time and duties allow, the field team should attempt to survey for marine mammals, fish and sea turtles. The targeted fish species include basking shark, sunfish, and other large pelagics. Observations should be conducted from the top of the wheelhouse if permitted by the skipper, or from inside the wheelhouse otherwise. In case an observation software is not available, the following information should be recorded for each sighting:

Date, Time, Lat/Long, Species, number of individuals

Sea state, wind speed, visibility, cloud cover

If the observed individuals are close to the boat and if species ID is difficult to resolve (e.g. beaked whales), the field team should attempt to take photographs. Record frame numbers in relation with sighting observations. The vessel tracks should be recorded. Identification photographs of the following species should be attempted: Blue whale, North Atlantic right whale, beaked whales, humpback whales. Also try to get dorsal fin shots of basking sharks.

8. Deliverables

Once the recorders are retrieved, the data will be downloaded and backed up. After the download, the JASCO Analysis Team will analyze the acoustic data and write the draft report.

9. Contacts

JASCO Contacts

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APPENDIX C – 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 N0v 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 deployements
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

Contents

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 intital 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 deplymentInfo - 16-bit
N/A	FQT Test fixture GTI 0dB deplymentInfo - 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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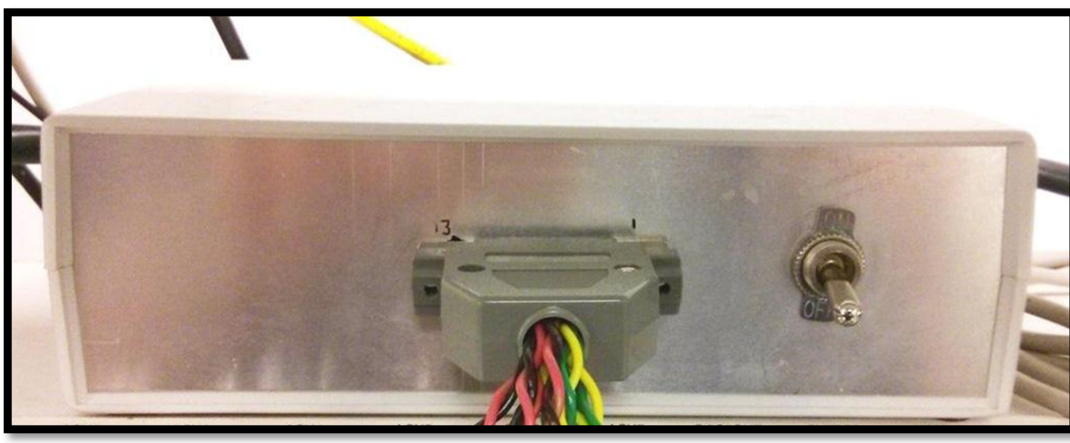
Required Equipment/Software

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: <u>It is not necessary to perform the regular maintenance if the 5 year maintenance is being performed.</u>

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 **<u>at least once per year</u>** 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.

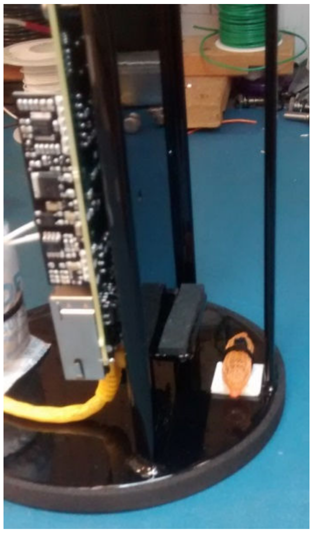
1. Install one new desiccant pack on underside of electronics chassis.

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.

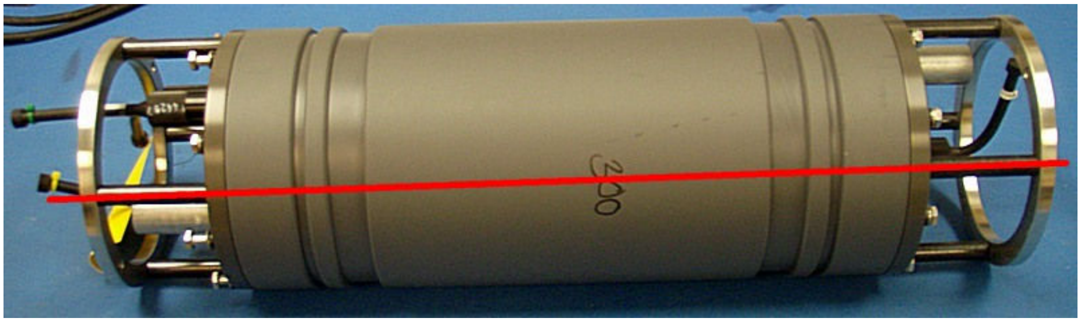
2. Verify hydrogen combiner pellets are installed and container is not damaged. Replace as required.

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 though 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

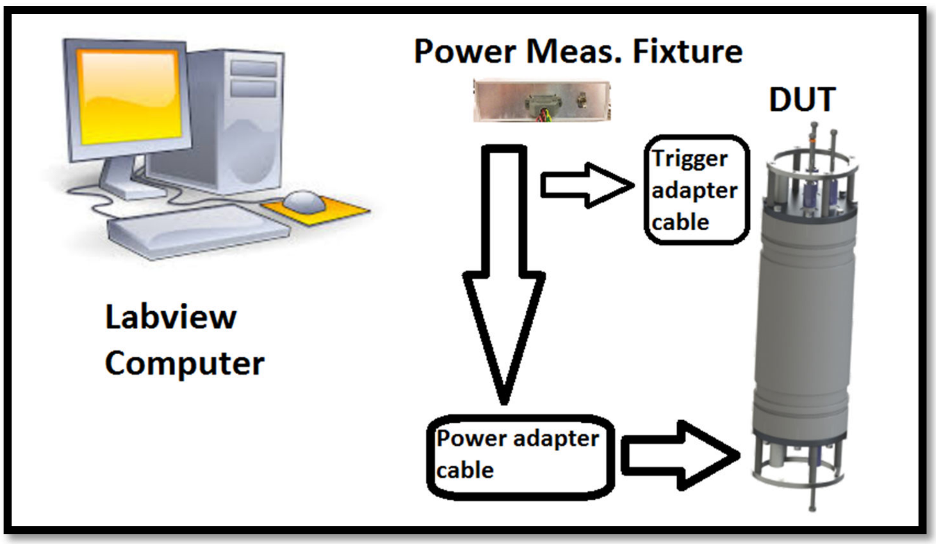
Step	Type	Detail	Channel	Duration
1	Sleep			5 sec
2	Record	64 ksps	1	120 sec
3	Sleep			∞

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

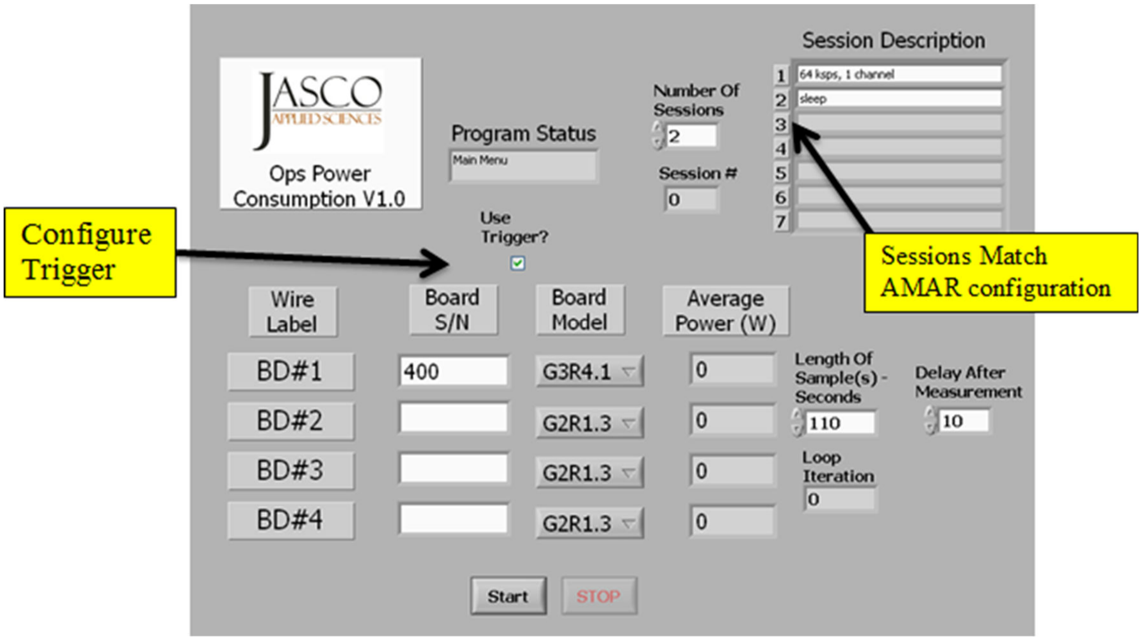
Refer to interconnect diagram (**Figure 5**) for wiring details

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 64ksps 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

   ⇩

   ⇩

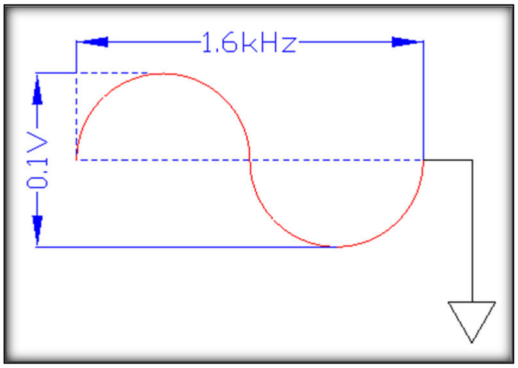
   - Last 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 30 seconds
   - **16-bit channel 9 @ 687.5ksps, AC coupled, 0dB gain + Temp, duration 30 seconds

- 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).

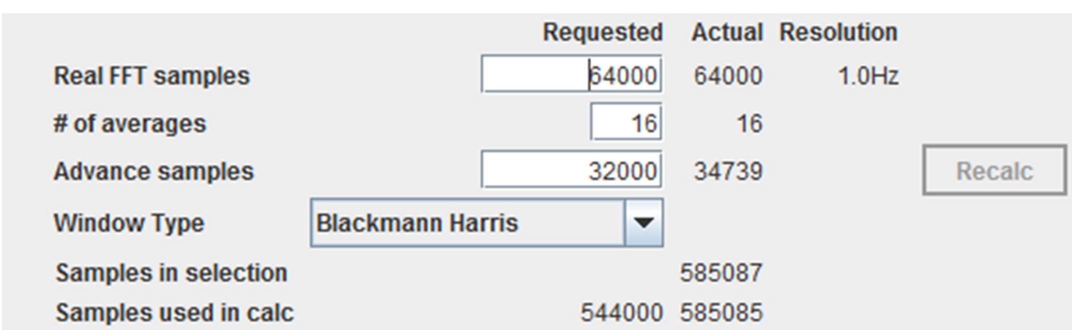
Figure 7: Signal Properties



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 Vsupply - 0.9V +/- 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



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.

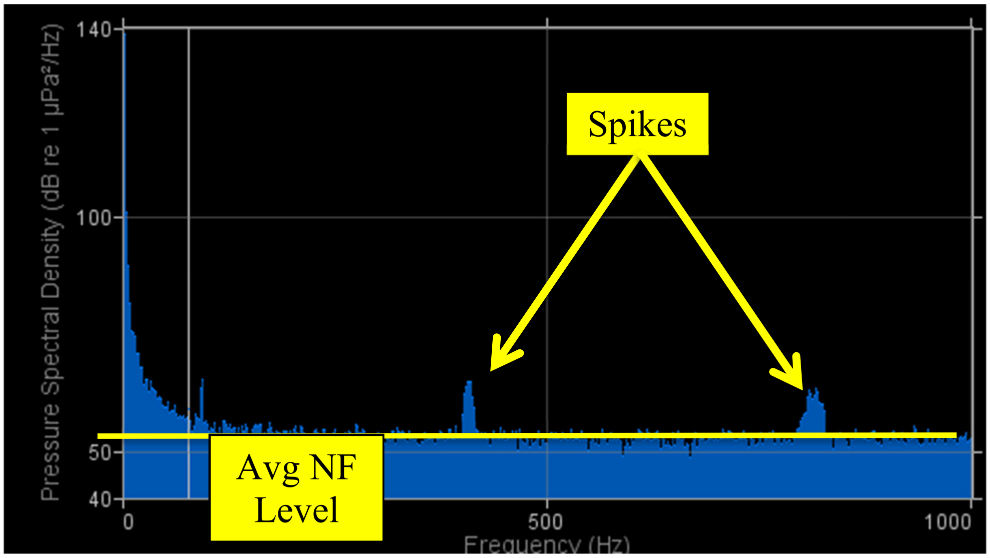
   Note: Download the files to the following location: \\jso-dmfs02\Products\Amar\testing\FQT\ **and place the files in the appropriate AMAR or Bareboard location.**
3. Verify that the correct number of files are present (1 file per active channel), and each audio file is 30 seconds long in duration.
4. 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

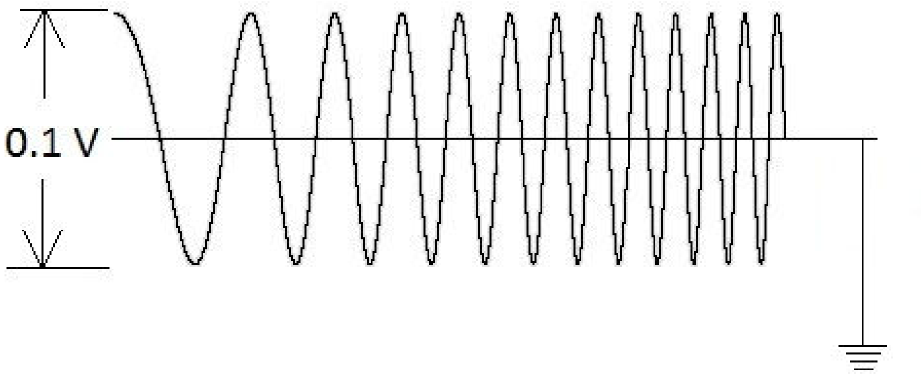


6. **Record** a "Pass" or "Fail" result in a copy of template document 00755.
   - "Failed" - Boards should have an issue placed against them, and set aside for trouble shooting.
7. Erase AMAR memory.

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

⇩

⇩

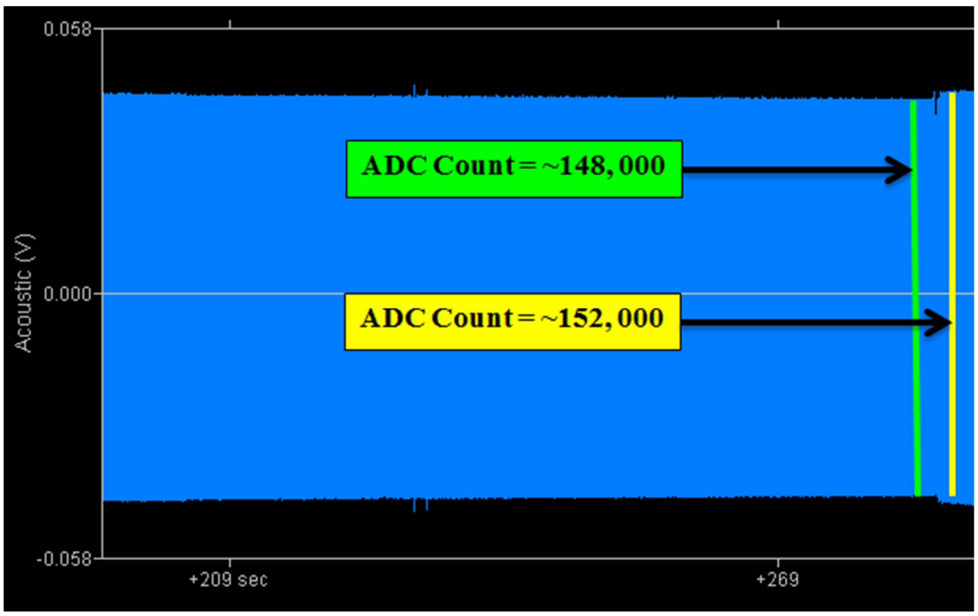
   - Last 24-bit channel @ 64ksps, AC coupled, 0dB gain + Temp, duration 6 minutes

- **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.

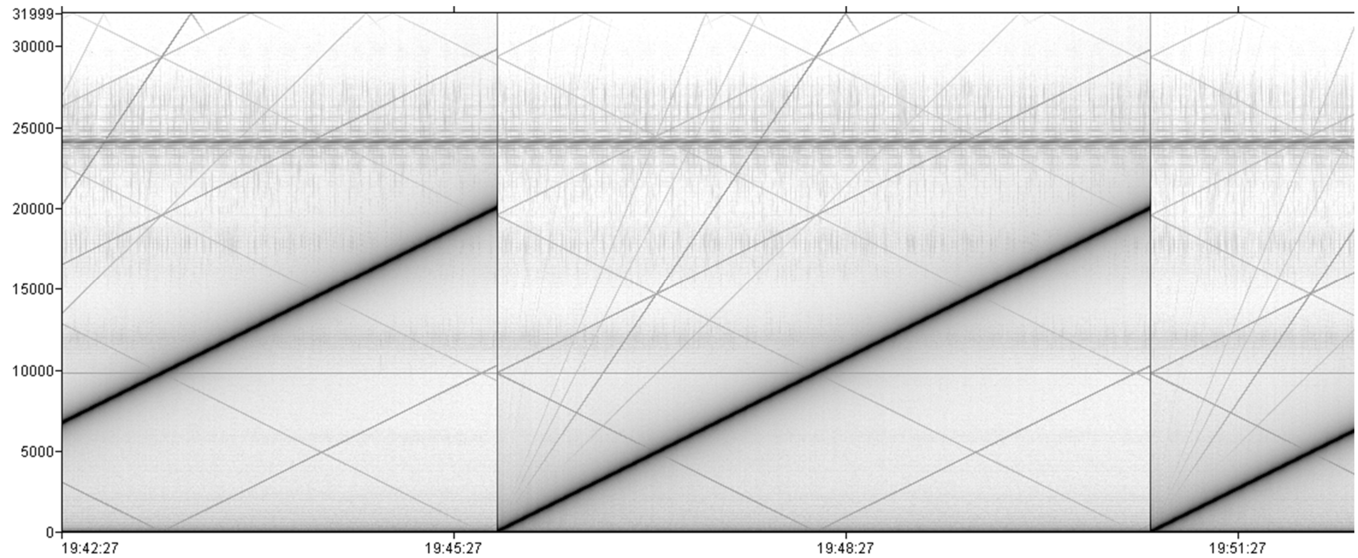
   Note: Download the files to the following location: \\jso-dmfs02\Products\Amar\testing\FQT\ **and place the files in the appropriate AMAR or Bareboard location.**
6. Verify that the correct number of files are present (1 file per active channel), and each audio file is 6 minutes long in duration.
7. 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

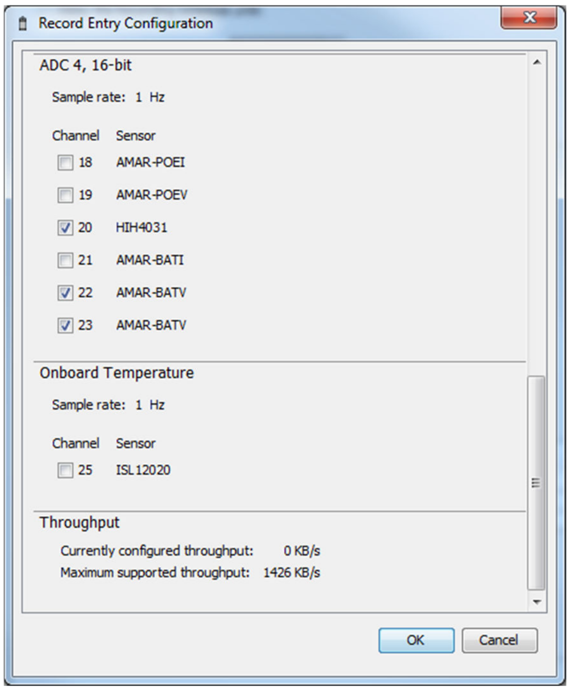


9. **Record** a "Pass" or "Fail" result in a copy of template document 00755.

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 Vin +/- 0.2V.
7. Ensure that the other voltage channel displays approximately ***half** of Vin +/- 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 D – 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

Contents

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.

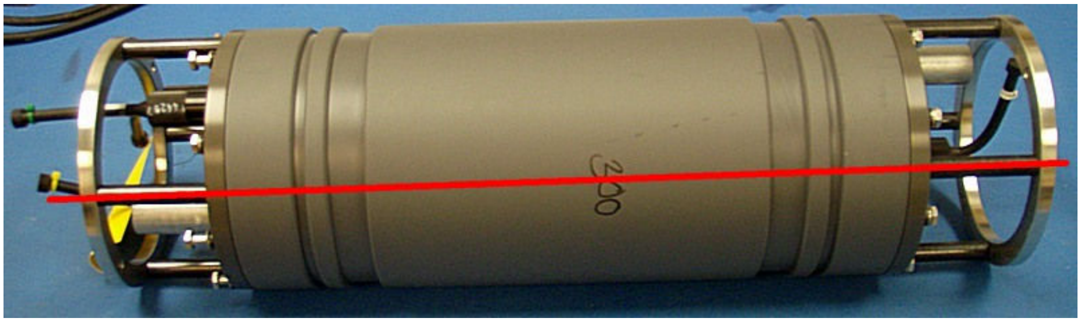
1.2.1. Internal Auxiliary Battery Pack

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.



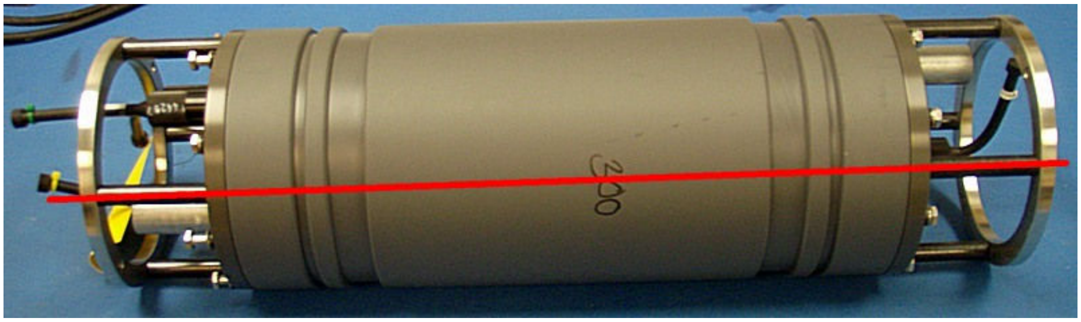
8. Install the bolts finger tight on the end cap.
9. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.

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 batter pack.
4. Load battery frame as per User guide instructions. Verify individual stack voltages ≥ 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.



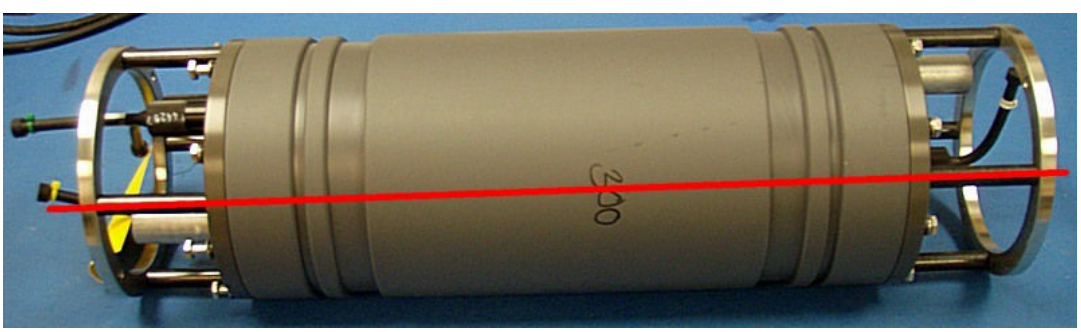
10. Install the bolts finger tight on the end cap.
11. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.

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.



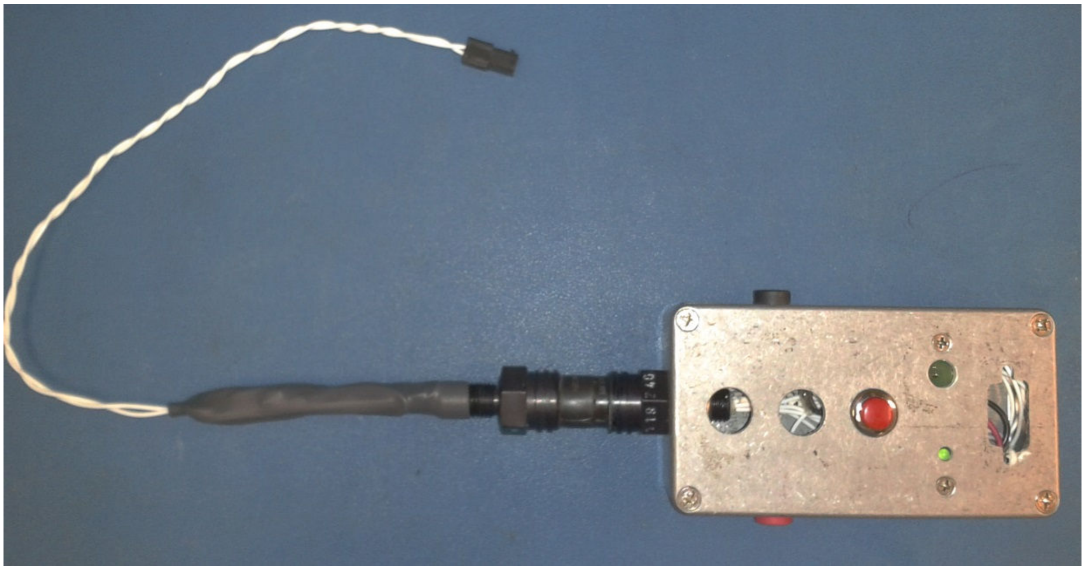
9. Install the bolts finger tight on the end cap.
10. Torque the bolts on the top end cap, as specified in the 5113 drawing instructions.

1.3. Electronics Housing Inspection

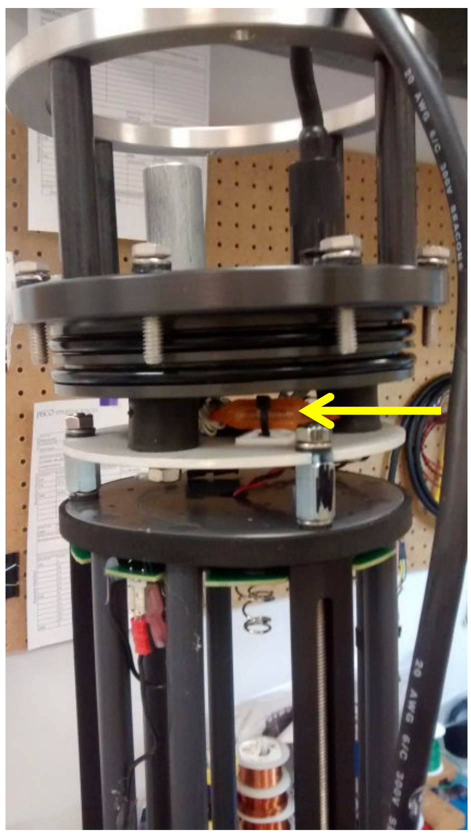
1. Inspect bottom end cap. Ensure all bolts are tight. Ensure that bottom end cap accessories are as specified in the RCW.
2. Inspect the connectors and PRV for debris, clean if necessary, and ensure they are firmly installed into the top end cap.
3. Inspect the top end cap; ensure the four (4) bolts 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

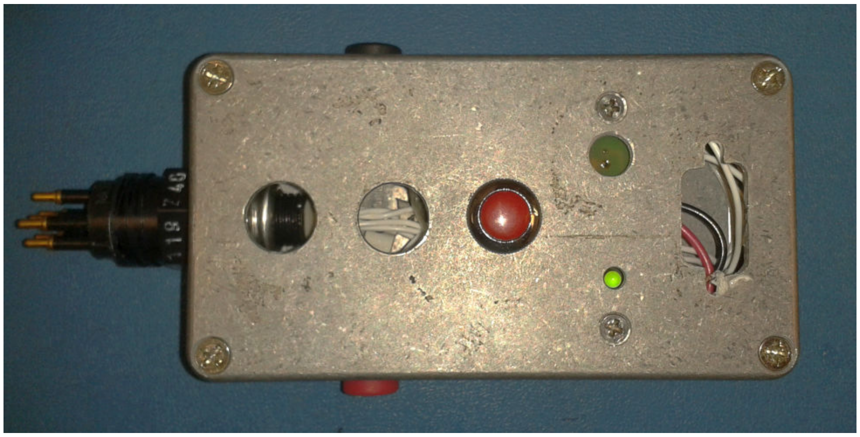
1. Inspect the O-ring surface inside the pressure housing tube and ensure it is clean and undamaged.
2. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, sound, and properly lubricated.
3. Replace and adjust the PRV core to fully closed, then 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 ≥ 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 form 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

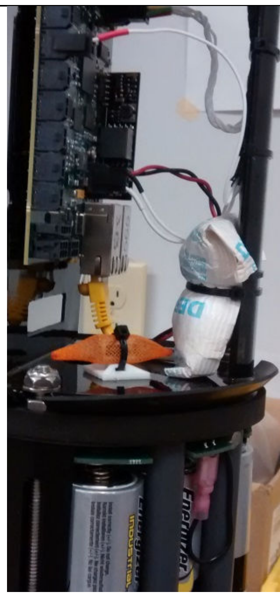
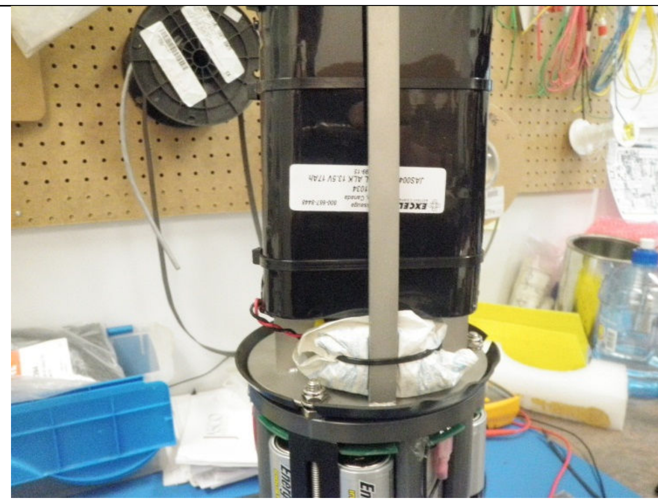
1. Thoroughly inspect the Power/Status Plug bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
2. Thoroughly inspect the Comms bulkhead connector contact pins for corrosion. Clean and reapply dielectric grease if necessary.
3. Thoroughly inspect the hydrophone 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

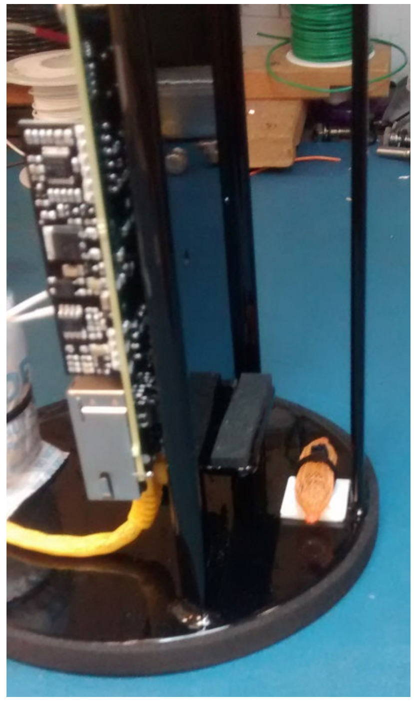
1. Remove the PRV core using PRV tool and inspect the internal O-ring and O-ring surface to ensure they are clean, sound, and properly lubricated.

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.

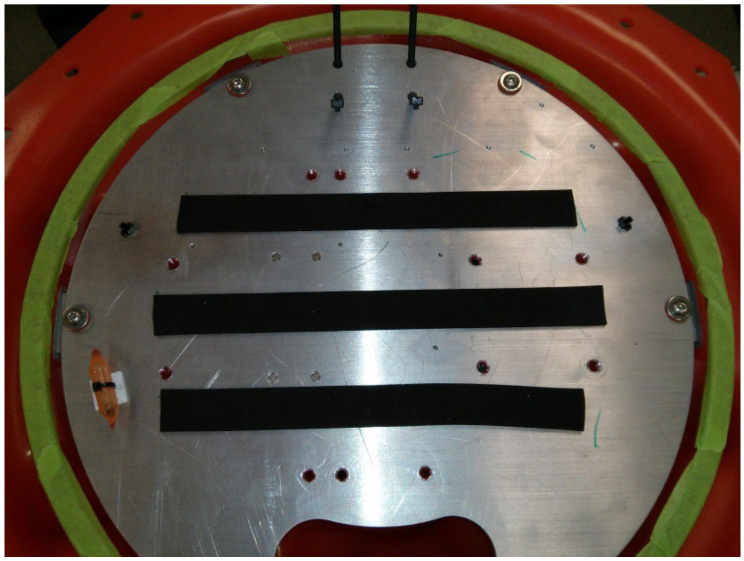
3.2. Connectors

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.

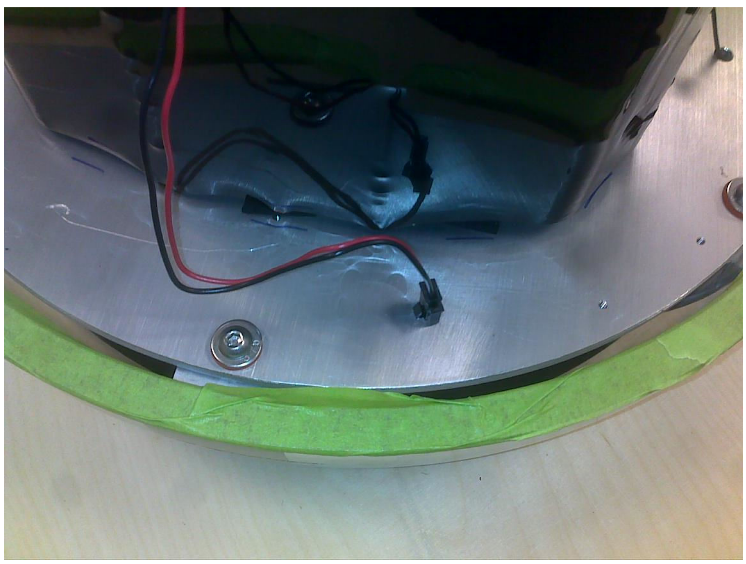
3.3. Battery Pack—Main

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 ± 2°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

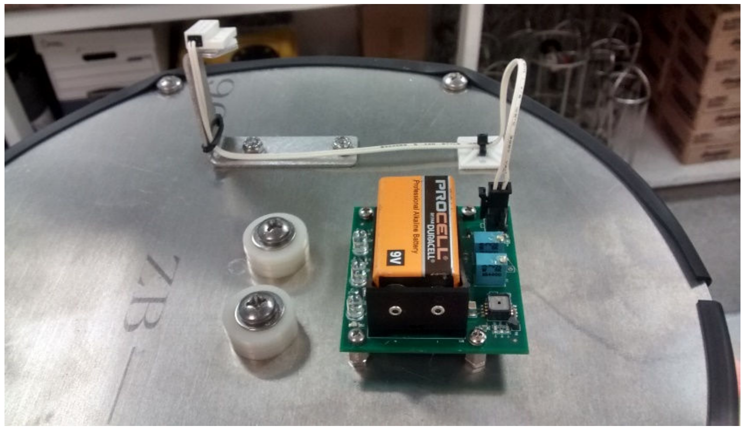
NOTE: Record all results using template Document 00189.

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 ¾ 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

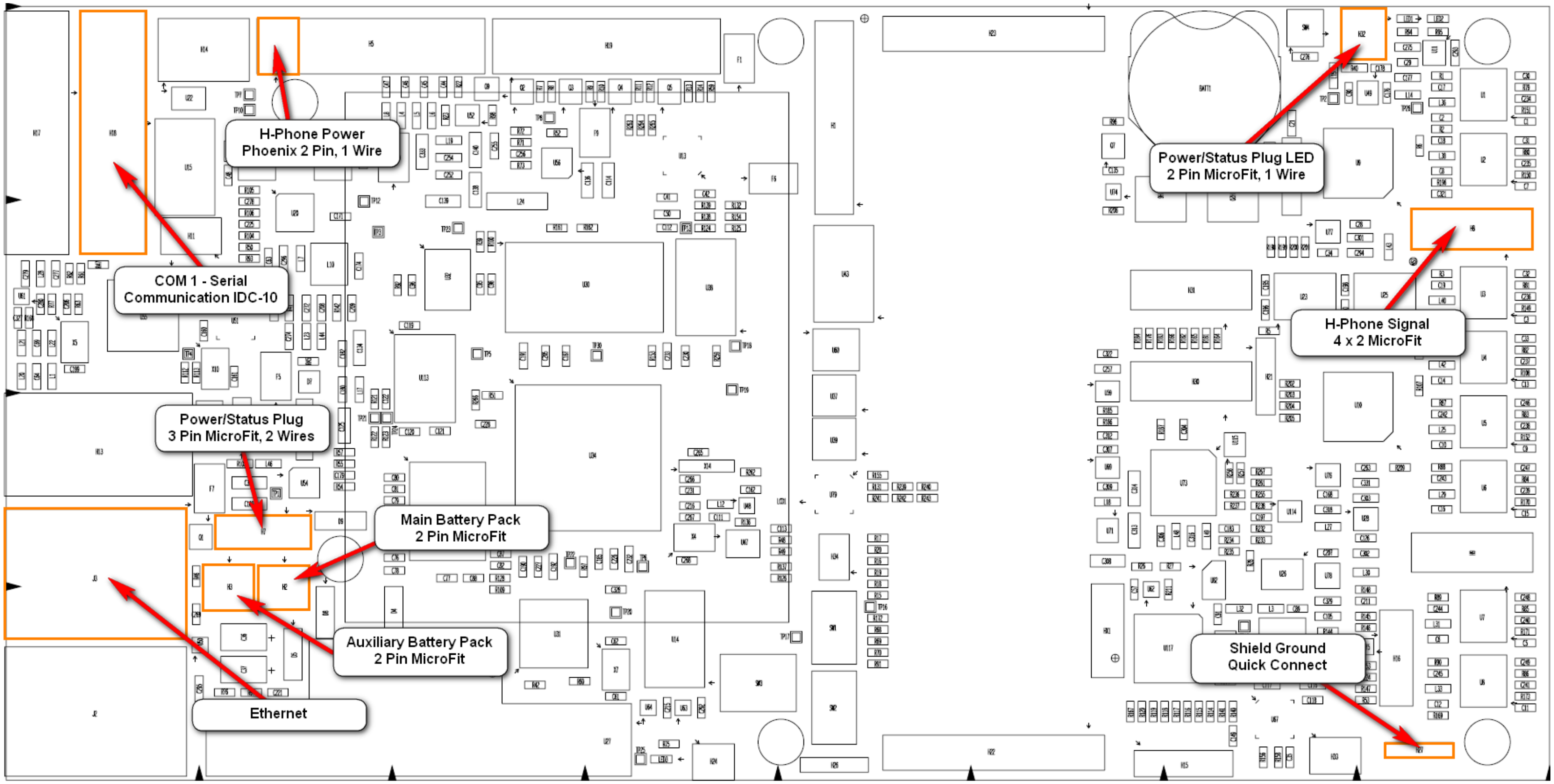
The following steps are performed at the same time as a memory module adjustment or an auxiliary battery pack install to reduce the number of times the housing has to be opened during mobilization.

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.

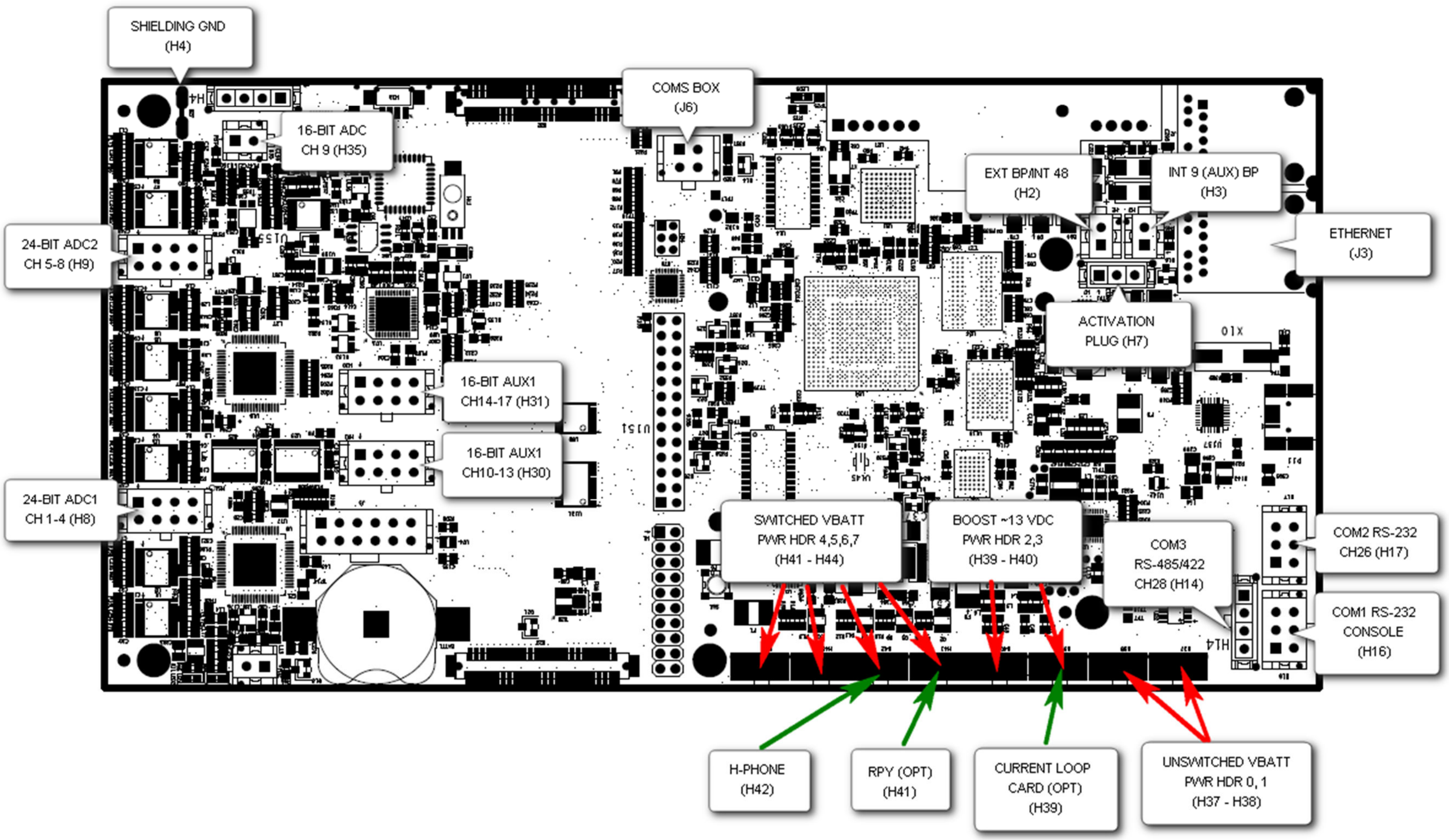
3. Close the housing as per standard procedures once all operations are completed.

13. Wiring Connection Locations

13.1. G2 Electronics Board Connections



13.2. G3 Electronics Board Connections



APPENDIX E – 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

Contents

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

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 F – ASL Quick Start Deployment and Recovery Checklist

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Canada V8L 5Y3
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Fax: 250-656-0177
Support: Support @aslenv.com

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