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NATIONAL OCEAN SURVEY

DATA ACQUISITION & PROCESSING REPORT

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LOCALITY

State: Michigan

General Locality: Thunder Bay

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CHIEF OF PARTY
Nicholas A. Forfinski

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<u>DATA ACQUISITION & PROCESSING REPORT</u>

to accompany

OPR-E350-NRT4-11
NOAA Navigation Response Team 4
Nicholas A. Forfinski, Team Lead

A. EQUIPMENT

A.1. Vessels

A.1.1. <u>S1211</u>
NRT-4 operated a single vessel, S1211 (see Fig. 1), a 32-foot (overall), gray, aluminum-hull SeaArk Commander. NOAA Survey Vessel S1211 was powered by dual 200-horse power Honda outboards. A Kohler 7.5e generator supplied AC power. A rack-mount APC Smart-UPS (uninterruptable power supply) provided battery backup for the survey-system electronics.

Figure 1: NOAA S1211 (NRT-4)

A.1.1.1. Calibration & Configuration
See section C.1.1 for a description of the full vessel survey.

A.2. Depth Measurement Equipment
NRT-4 acquired bathymetry data with a Kongsberg EM3002 multibeam sonar. Pseudo-side-scan data (not 'snippets') were acquired with the EM3002 for general reference, but the data were not processed as a deliverable. No vertical beam echosounder (VBES) data were acquired.

A.2.1. Kongsberg Simrad EM3002 Multibeam Echosounder

The EM3002 is a 300 kHz (nominal) system with a characteristic operating depth range of 1 to 150 meters water depth. Under ideal, cold water conditions, the range may extend to 200 meters. The swath width is 120°, and the nadir beam is 1.5° x 1.5°. The system has a maximum ping rate of 25 Hz. The processing unit (PU) performs beam forming and bottom detection and automatically controls transmit power, gain, and ping rate. The sonar processor incorporates real time surface sound speed measurements for initial beam forming and steering. The Seafloor Information System (SIS) application, designed to run under Microsoft Windows, provides control and monitoring of the EM3002. The EM3002 is hull-mounted (see Fig. 2).

Figure 2: EM3002 Mount

A.2.1.1. Calibration & Configuration

The SIS installation and characteristic runtime parameter reports are included in Appendix 6. See section C.1.3 for a description of the calibration patch test.

A lead line comparison was conducted on 2/18/11, while at anchor, to verify the configuration of the EM3002. (See section A.2.2 for a description of the lead line.) Although conducting a lead line comparison while at anchor is not ideal, the weather and sea conditions were deemed calm enough to provide a meaningful comparison. The water depth alongside the dock was too shallow for the EM3002 to provide a reliable depth. The average of a port and starboard lead line reading was compared to a fully processed EM3002 depth (see Fig. 5). The lead line comparison revealed a 0.4-m discrepancy; however, the hydrographer had confidence that the EM3002 was properly configured. The lead line comparison was not performed under ideal conditions. The hydrographer surmised that three main factors contributed to the 0.4-m discrepancy: (1) a bottom sample at the site revealed a sticky, silty mud, not a firm sand, (2) concurrent multibeam data revealed a small slope, and (3) the boat experienced about 5-10 meters of anchor swing during the port and starboard lead line readings.

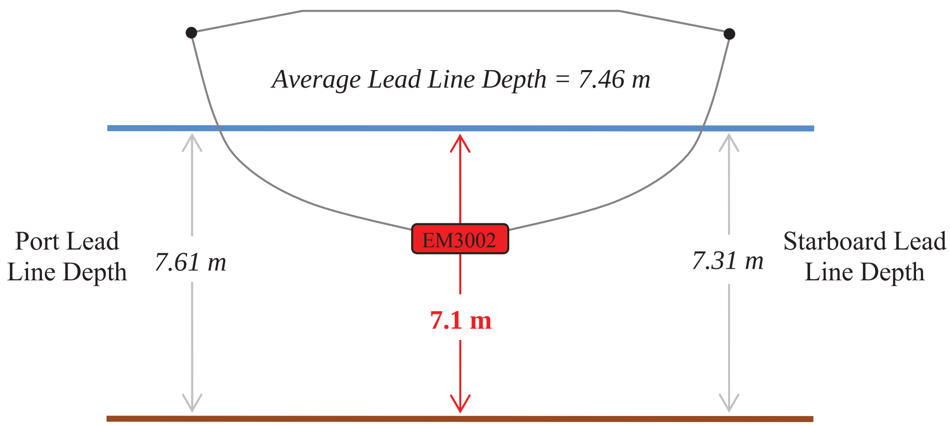


Figure 3: EM3002 Lead Line Comparison

A.2.1.2. Systematic Artifacts

The EM3002 MBES data contain two systematic artifacts, one along-track and one across-track, both of which are shown in Figure 4.

Figure 4: EM3002 Motion Artifacts

Along-track Systematic Error

The EM3002 data contain an along-track pair of depressions centered at nadir (see Fig. 4). Although the magnatude of the depressions can exceed 0.5m, the nominal magnitude is 0.1 to 0.15m. Overall, the artifact is not a significant source of error. Although the underlying PVDL may be quite noisy, the surface is minimally affected (see Fig. 5). Documented in the Kongsberg support manuals, the artifact stems from the acoustic characteristics of the sonar itself, not the overall system integration.

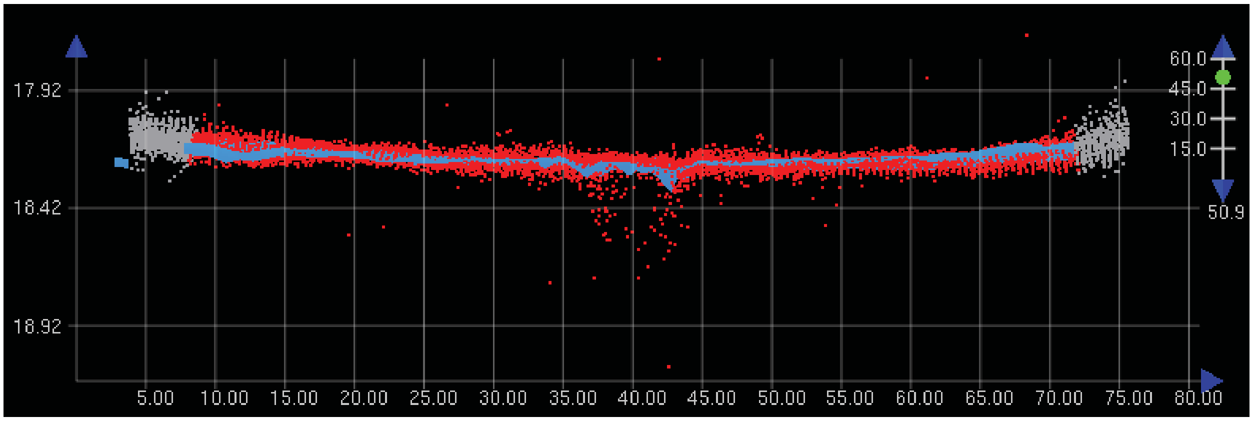


Figure 5: Along-track Artifact (Rear View)

Across-track Systematic Error

The EM3002 MBES data contain an across-track systematic motion artifact (see Fig. #). The amplitude of the artifact worsens with increased distance from nadir and the magnitude of vessel attitude. In general, the artifact, with a nominal amplitude of 0.1-0.2 m, is not considered a significant source of uncertainty; however, sounding data were rejected (via an angle-from-nadir filter) in general areas where the sum of the node vertical TPU and the amplitude of the artifact exceeded the allowable IHO uncertainty. The hydrographer was unable to definitively identify the source of the artifact but suspects that the source is a misalignment between the IMU and vessel coordinate frames. The hydrographer was not able to "back-out" this motion artifact because the data were roll-stabilized in real-time with what was believed to be roll biased by the suspected misalignment.

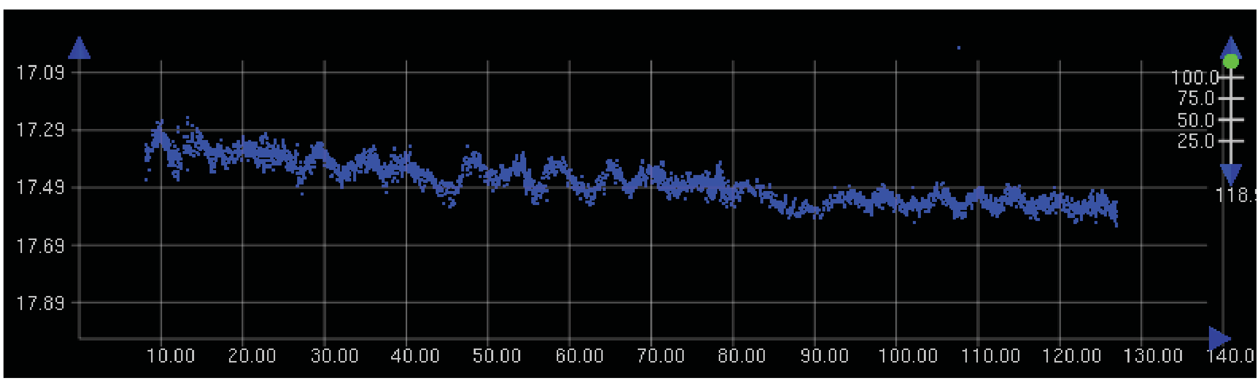


Figure 6: Across-track Artifact (Side Profile View)

A.2.2. Lead line

S1211 is equipped with a traditional tiller-rope lead line. The lead line is graduated with major intervals of 1 meter and minor intervals of 20 cm. Because the lead/shackle assembly is not original, the lead line has a constant 0.09 m bias; therefore, 0.09 meters is subtracted from each lead line sounding. The major and minor graduations, relative to each other, show excellent agreement with a survey tape.

A.3. Imaging Equipment

A.3.1. Klein 3000 Sidescan Sonar

The L-3 Klein System 3000 includes the model 3210 towfish (s/n 413), 25 meters of Kevlar-reinforced tow cable, the transceiver processing unit (TPU) with vxWorks operating system, and a workstation with the acquisition software SonarPro. The Model 3210 towfish (see Fig. 4) operates at nominal frequencies of 500 and 100 kHz. The TPU contains a network card for transmission of the sonar data to the acquisition workstation. Sidescan data were logged using the SDF file format. A Dynapar cable counter data was configured to send data directly into SonarPro through the Klein acquisition computer (refer to the wiring diagram in Appendix 5).

To facilitate a safer, more-convenient deployment procedure, a side-mount was constructed for the Klein 3000 (see Fig. 7) partway through the project.

Figure 7: SSS Transom Mount

Figure 8: SSS Gunwale Mount

A.3.1.1. Calibration & Configuration

Sidescan sonar positioning was evaluated as per section 1.5.7.1.2 (SSS Calibration) of the Field Procedures Manual (April 2010 version). The resulting 95% confidence radius was 3.76 meters (see Fig. 7). The procedure was conducted in 10-12 meters water depth, using a 100-meter range scale, with 6 meters of cable out.

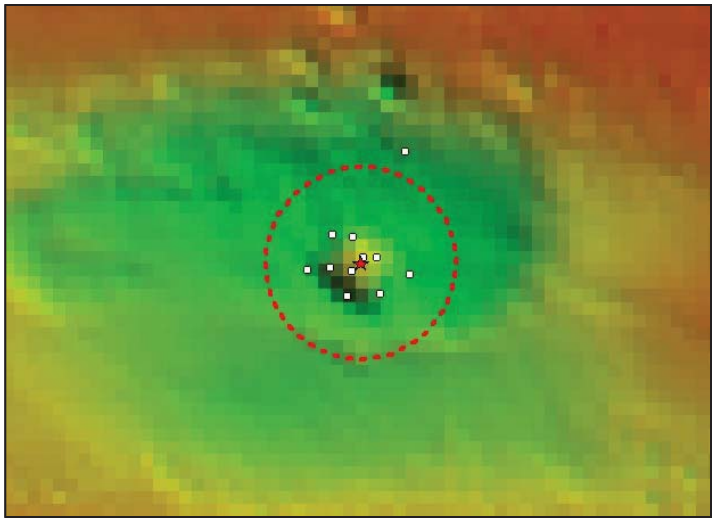


Figure 9: SSS Position Check

The internal magnetic compass was calibrated as per the compass calibration procedures described in section 4.31 of the Klein 3000 user manual (revision 5A). The procedure was conducted shoreside at the Virginia Institute of Marine Science boat basin in Gloucester Point, VA, during February 2011. Although the internal magnetic compass was calibrated, the towfish gyro was not used during sidescan processing, because of a consistent offset relative to the boat gyro (see Fig. 8). Ignoring the high frequency fluctuations of the SSS gyro, the SSS gyro is consistently offset from the boat gyro by about 10-15°. When processed with the SSS gyro, the 95% confidence radius was 14 meters.

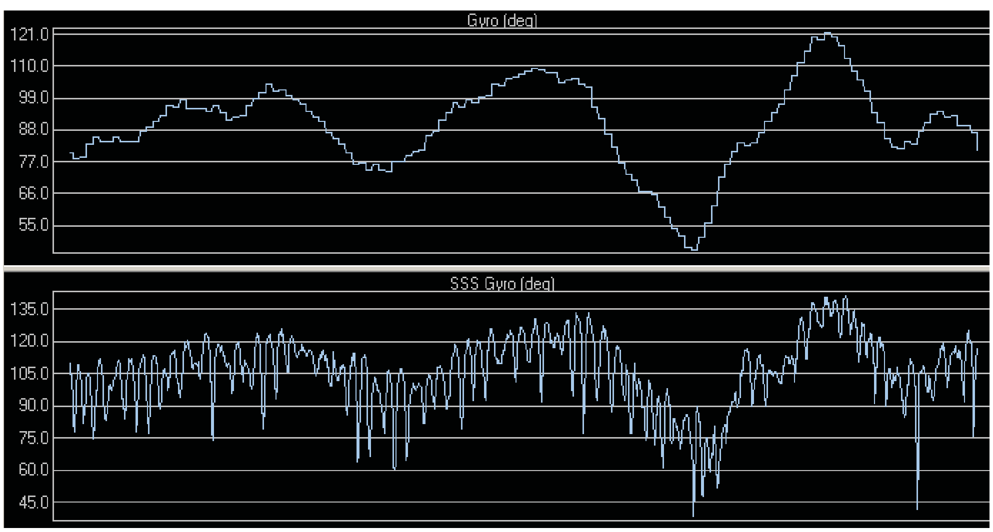


Figure 10: SSS Gyro Offset

A.4.

A.5. Vessel Position and Orientation Equipment

A.5.1. <u>TSS POS/MV Position & Orientation Sensor</u>
S1212 is equipped with an Applanix POS/MV 320 version 4. The POS/MV consists of dual Trimble BD950 GPS receivers (with corresponding Zephyr antennas), an inertial motion unit (IMU), and a POS computer system (PCS). The two antennas are mounted approximately 1.5 meters apart atop the launch cabin (see Fig. 9). The primary receiver (on the port side) is used for position and velocity, and the secondary receiver is used to provide heading information as part of the GPS azimuthal measurement sub-system (GAMS).

Figure 11: POS/MV Antenna Installation

The IMU contains three solid-state linear accelerometers and three solid-state gyros, which together provide a full position and orientation solution. The IMU is mounted on the top of the sonar housing (see Fig. 10), beneath a removable deck plate, forward of the generator compartment (see Fig. 11).

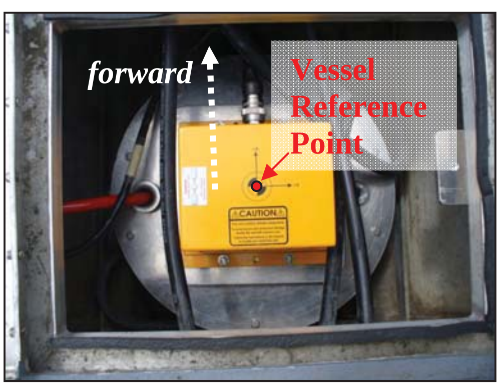


Figure 12: IMU Installation (a)

Figure 13: IMU Installation (b)

A.5.1.1. Calibration & Configuration

The initial GAMS calibration was performed on 2/11/11, on the York River near Gloucester Point, VA. A second GAMS calibration was performed after the installation of the new EM3002 sonar head because the installation of the new sonar head required the removal of the IMU. See Table 1.

Table 1: GAMS Calibration Results

Baseline Vector	*Original*	*Post Sonar Installation*
X (m)	0.01	0.008
Y (m)	1.982	1.987
Z (m)	0.004	0.008

The POS/MV is configured, operated, and monitored via the POS/MV controller software (v5.1.0.2), which is installed on the acquisition computer (see section A.2.1). The primary GPS-to-reference point lever arm and heave-leave arm were accounted for in the POS/MV controller. A POS/MV configuration report detailing lever arms, input/output settings, and operational settings is contained in Appendix 9.

The controller software was also used to initiate Ethernet logging of the POSPac datagram bundle, which was used for post-processing of true heave in Caris and for monitoring of various navigation parameters, such as real-time positioning RMS errors, in POSPac Mobile Mapping Software (MMS).

A.5.2. <u>Trimble DSM212L DGPS Receiver</u>

The POS/MV receives differential (RTCM) correctors from a Trimble DSM212L GPS receiver that includes a dual-channel low-noise MSK beacon receiver, capable of receiving U.S. Coast Guard (USCG) differential correctors. The DSM212L can also accept RTCM messages from an external source such as a user-established DGPS reference station, but typically USCG beacon correctors are used.

A.5.2.1. Calibration & Configuration

Trimble's TSIP Talker was used to configure the GPS antenna supplying Coast Guard differential correctors to the POS/MV. Due to COM port limitations, TSIP Talker was not installed on a separate laptop, not the main acquisition computer.

A.5.3. <u>Trimble GeoXH GPS Receiver</u>

A Trimble GeoExplorer 2008 series GeoXH is used to position fixed, non-bathymetry features, such as piers, dolphins, and vertical control benchmarks. NRT4 typically uses the GeoXH with a Trimble Zephyr antenna mounted on a 2-meter, bipod-equipped range pole. The Trimble GeoXH combines an L1/L2 GPS receiver with a field computer powered by Microsoft Windows Mobile. TerraSync software is used to aquire data, and Pathfinder software is used to post-process data and apply differential corrections. See the software inventory in Appendix 2 for version information.

A.6. Sound Speed Equipment

S1211 is equipped with an Odom Digibar Pro surface sound speed sensor to measure sound speed at the flat-face multibeam transducer head. For water column sound speed profiles NRT-4 uses an Odom Digibar Pro sound speed sensor and a Seabird SBE19+ CTD profiler. Speed of sound through water is determined by a minimum of one cast every four hours, in accordance with the NOS Specifications and Deliverables for Hydrographic Surveys.

A.6.1. Odom Digibar Pro – Surface Sound Speed

An Odom Digibar Pro (s/n 98150) provides surface sound speed data to the flat-face EM3002 for beam steering and beam forming. The unit is lowered into a tube that is mounted on the transom, between the two motors (see Fig. 12). The unit was configured to output an AML datagram to SIS, which was installed on the acquisition computer (see wiring diagram in Appendix 5).

Figure 14: Surface Sound Speed Digibar Installation

A.6.2. Odom Digibar Pro – Profile Sound speed

NRT4 also had a spare Odom Digibar Pro (s/n 98445); however, this Digibar Pro had not been calibrated within a year prior to the project (see section A.4.3.1). This Digibar Pro was not used during OPR-E350-NRT4-11.

A.6.3. Seabird SBE19+ CTD Profiler

A Seabird SBE19+ CTD (s/n 4674) was used to obtain sound speed profiles of the entire water column. The raw profile data file was first uploaded to the acquisition computer via Velocwin. The raw file, containing conductivity, temperature, and pressure data, was then processed using Velocwin. As with Digibar-Pro profiles, Velocwin generated an .asvp file, which was loaded into SIS for real-time ray tracing.

A.6.3.1. Calibration & Configuration

A sound-speed cast comparison for all three instruments was performed on 3/9/11. The two sensors that had been recently calibrated (Digibar Pro 98150 and Seabird SBE19+) showed excellent agreement (see Fig. 13). The Digibar that was due for calibration did not show excellent agreement with the other two sensors. Calibration reports for all three sound speed sensors are included in Appendix I.

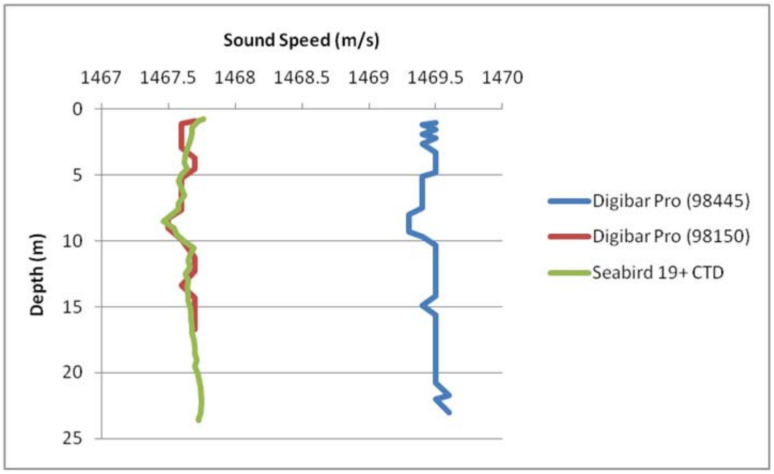


Figure 15: Sound-Speed Profile Comparison

A.7. Tides & Leveling Equipment

NRT-4 has a Sokkisha B1 automatic optical level and a Mount City fiberglass survey rod. The level was used only to determine vessel dynamic draft (see section C.1.2.)

A.8. Software

A complete list of software and versions is included in Appendix 2.

B. QUALITY CONTROL

B.1. Multibeam Echosounder Data

B.1.1. <u>Acquisition Operations</u>

B.1.1.1. Coverage Schemes

Multibeam coverage schemes include mainscheme and development acquisition. The intent of mainscheme operations is to obtain bathymetry over an entire area, and the intent of development operations is to obtain the least depth of a particular feature or shoal. Mainscheme multibeam data are acquired using one of two methods – "skunk-stripe" or "paint-the-bottom". Development data are acquired using a pattern of tightly spaced short lines.

Mainscheme Skunk-Stripe – The skunk-stripe scheme refers to the pattern of MBES coverage resulting from running MBES concurrently with sidescan sonar (SSS) operations. Because SSS operations are conducted with a set line-spacing optimized for sidescan coverage, the corresponding MBES coverage is often a series of parallel, non-overlapping swaths. Skunk-stripe MBES data are acquired using a Hypack line plan originally created in MapInfo.

Mainscheme Paint-the-Bottom – The paint-the-bottom scheme is used during "complete" or "object detection" MBES operations. Unlike a traditional line-plan approach, paint-the-bottom is an adaptive line-steering technique, whereby the coxswain viewed a real-time coverage map in Hysweep and accordingly adjusted line steering to ensure adequate overlap. Because of the operational efficiency afforded by the real-time coverage map, holidays, or gaps in the coverage, are often addressed the same day. When holidays are not addressed the same day, they were acquired based on a traditional line plan. The coxswain strove to avoid abrupt changes in direction and speed, but abrupt changes in direction and speed were unavoidable in certain areas due to current and/or confined areas. In areas were abrupt changes in direction were unavoidable, speed was reduced to minimize motion-related artifacts.

Developments – Developments are run with enough overlap to ensure the least depth comes from the near-nadir region of the swath. Developments can be run for features originally identified in either SSS or MBES data.

B.1.1.2. Sound Speed Profiles

Sound speed casts were acquired as per HSSD section 5.2.3.3. Unlike with the traditional, RESON processing scheme, the EM3002 system is designed to apply sound speed data (and attitude data) in real-time. Because sound speed is applied real-time, a sound speed profile must be loaded into SIS before data acquisition; however, a sound speed profiles can be manually changed while logging. Re-applying sound speed data was not possible in Caris post-processing at the time of the project, because the depths logged by Hypack were already ray-traced.

B.1.2. Processing Workflow

Multibeam processing was based on the BASE surface/directed-editing paradigm described in FPM section 5.2, Bathymetry Processing. The multibeam processing workflow had four main components: conversion, preliminary processing, surface generation, and surface review/data cleaning (see Fig. 14). Note that the surface generation and surface review/data cleaning steps are iterative.

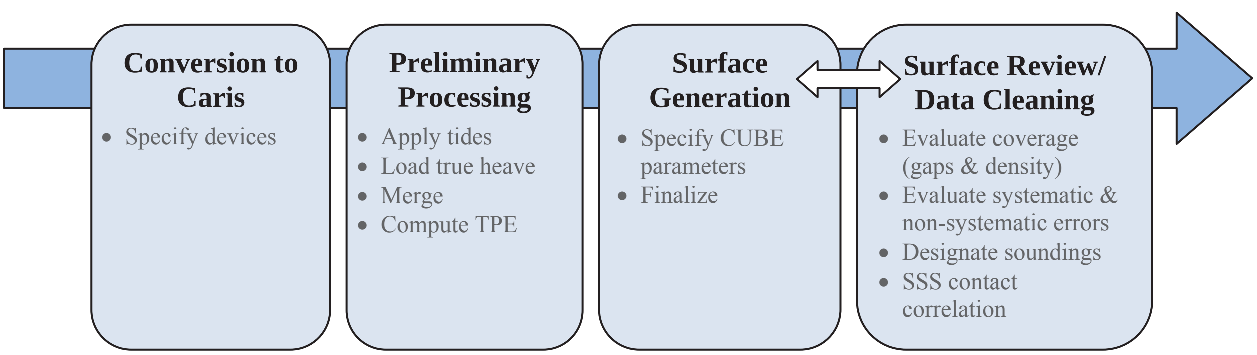


Figure 16: Multibeam Processing Workflow

B.1.2.1. Conversion

Raw multibeam .HSX data were converted to HDCS format in Caris HIPS. Device conversion parameters are shown in Figure 15.

Figure 17: Device Conversion Parameters

B.1.2.2. Preliminary Processing

After conversion, preliminary processing consisted of applying tide corrections and PPK navigation data, merging, and computing total propagated uncertainty (TPU). Unlike with traditional NOAA hydrographic processing schemes, the converted data for OPR-E350-NRT4-11 were already corrected for sound speed; therefore, the data were not sound-speed corrected in Caris post processing. The only correctors that were applied in Caris were PPK navigation, dynamic draft, patch test biases, and tide.

Applying Tides

Tide correctors were applied using a TCARI implementation in Pydro. See section C.3 for a detailed description of the tide correctors for OPR-E350-NRT4-11.

Merging

The merge process in Caris combines the observed depths (created during conversion) with the loaded tide file, the navigation data, the HVF draft sensor (containing dynamic draft values), and the HVF swath1 sensor (containing patch test biases) to compute the final processed depths. The “Apply refraction coefficients” and “Apply GPS tide” options were not checked, and no smoothed sensors were applied, during the merge process.

Computing TPE

The TPE computation process assigns each sounding a horizontal and vertical uncertainty, or estimate of error, based on the uncertainties of the various data components, such as position, sound speed, and loading conditions. Table 2 lists the HVF TPE values used for OPR-E350-NRT4-11.

Table 2: TPE Values

Data Component	*TPE Value*	*Data Component*	*TPE Values*
Motion Gyro	0.02°	X, Y, & Z Offsets	0.001 m
Heave % Amplitude	5%	Vessel Speed	0.03 m/s
Heave	0.05 m	Loading	0.01 m
Roll	0.02°	Draft	0.03 m
Pitch	0.02°	Delta Draft	0.03 m
Position Nav	1 m	MRU Align StdDev gryo	0.2°
Timing Transducer	0.01 s	MRU Align StdDev Roll/Pitch	0.2°
Nav Timing	0.01 s	Sound Speed Surface	0.5 m/s
Gyro Timing	0.01 s	Sound Speed Profile	2 m/s
Heave Timing	0.01 s	Tide measured	n/a*
Pitch Timing	0.01 s	Tide zoning	n/a*
Roll Timing	0.01 s		

**tide uncertainly is incorporated into the TCARI model*

B.1.2.3. Surface Generation

The multibeam sounding data were modeled using the CUBE BASE surface algorithm implemented in Caris HIPS. CUBE BASE surfaces were generated using the parameters outlined in Hydrographic Surveys Technical Directive 2009-02 (CUBE Parameters). The resolutions of the finalized surfaces were based on the complete MBES coverage resolution requirements specified in the Specs and Deliverables (5.2.2.2). The deeper limit of certain ranges was extended to avoid gaps between surfaces on particularly steep slopes. Surfaces are finalized with the "Greater of the Two" option, to maintain a conservative error estimate.

B.1.2.4. Surface Review/Data Cleaning

Rather than a traditional line-by-line review and a full subset-cleaning, the data cleaning/quality review process for OPR-E350-NRT4-11 consisted of a combination of the directed-editing approach described in FPM section 5.2 and a full subset-review (not full subset-cleaning). All the sounding data were viewed in subset, but unlike in the traditional workflow, where every sounding deemed to be "noise" is rejected, only the soundings that negatively impacted the CUBE surface were rejected. Surface review also consisted of evaluating holidays (both coverage and density holidays) and systematic errors and designating soundings. Sounding designation was in accordance with Specs and Deliverable section 5.2.1.2.

In general, the hydrographer referenced the SSS data when cleaning MBES data and designating soundings. In situations where the MBES data were ambiguous, consulting the SSS data often helped to determine a course of action. If consulting SSS data did not resolve the issue, more MBES were acquired over the item in question.

B.2. Sidescan Sonar Data

B.2.1. Acquisition Operations

The SSS towfish was deployed from a davit arm located on the starboard quarter using a Dayton electric-hydraulic winch spooled with approximately 25 meters of cable. The tow cable at the winch was connected electro-mechanically to a deck cable through a slip ring assembly. Cable out was controlled manually and was computed by the DynaPro cable counter by the number of revolutions of the cable drum sheave. Cable-out was adjusted to 4.0 meters before deployment of the towfish to account for the distance from the towfish to the towpoint, which was defined to be the top of the sheave.

Line spacing for side scan sonar (SSS) operation was prepared as directed in the NOAA Field Procedures Manual and Spec's and Deliverables. To minimize towing gear stress, and reduce strumming, towed SSS operations were typically limited to approximately 6 knots speed-over-ground. During turns to port, speed was increased to prevent the tow cable from swinging into the outboard propellers; the higher speed created a force on the cable that kept the cable at a safe distance from the stern. A towfish altitude of 8-20% of the range scale was maintained during data acquisition. Altitude was adjusted by cable out and vessel speed.

Confidence checks were performed daily by observing changes in bottom features extending to the outer edges of the digital side scan image, features on the bottom in survey area, and by passing aids to navigation. Daily rub tests are also conducted.

B.2.2. <u>Processing Workflow</u>

Sidescan processing was based on the boat-day concept documented in section 4.3 of the Field Procedures Manual (Imagery Processing). The sidescan processing workflow had four main components (see Fig. 16): conversion, preliminary processing, mosaicing, and contact selection. Feature classification and correlation is addressed in section B.3, "Feature Data."

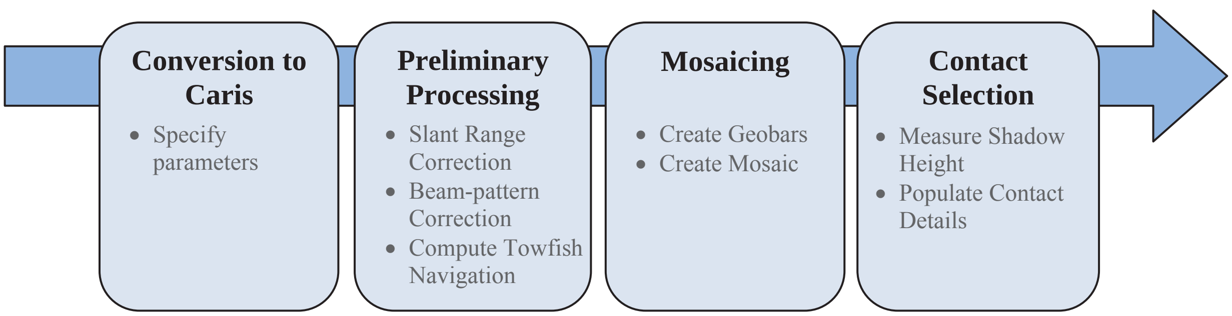


Figure 18: Sidescan Processing Workflow

B.2.2.1. Conversion

Raw sidescan .sdf data were converted to HDCS format in Caris HIPS/SIPS. The significant conversion parameters are shown in Figure 17.

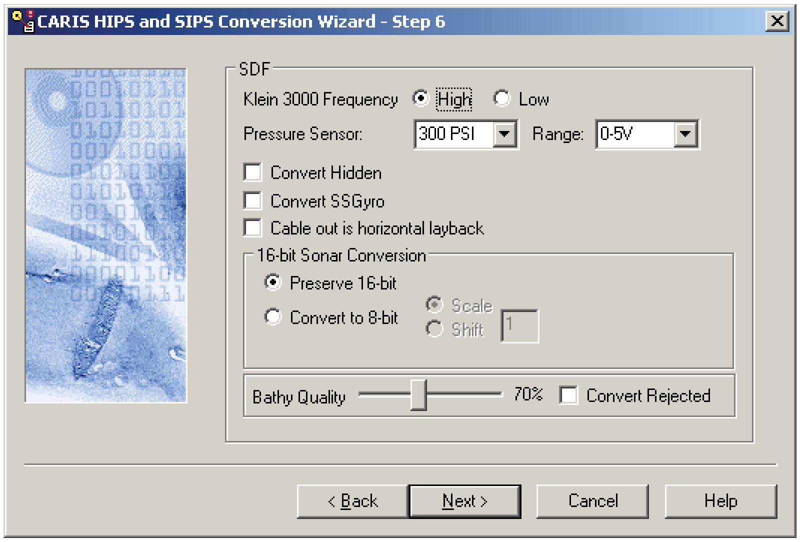


Figure 19: Sidescan Conversion Parameters

B.2.2.2. Preliminary Processing

After conversion, preliminary processing consisted of slant-range correction, beam-pattern correction, and towfish navigation computation.

Slant-range Correction

Slant-range correction was performed using a resolution of 0.1 m and a nominal sound speed of 1500 m/s. The data reduction setting was set to "Keep 16 Bit Data."

Beam-pattern Correction

Beam-pattern correction was performed using a beam-pattern correction file based on a beam-pattern "patch-test" line. As per the HIPS & SIPS Users Guide recommendation, the towfish height was varied throughout the expected range.

Towfish navigation Computation

Towfish navigation was calculated in Caris SIPS, which uses the "follow-the-dog" algorithm (see Caris HIPS & SIPS 7.0 Users Guide). Contact positions were recomputed whenever towfish navigation was recomputed.

B.2.2.3. Mosaicing

Creating mosaics was a two-step process. First, Caris "GeoBars" (<u>Geo</u>referenced <u>Ba</u>ckscatter <u>R</u>asters) were created for each line (with interpolation), and then the GeoBars were consolidated into a mosaic.

B.2.2.4. Contact Selection

Sidescan contacts were selected as per the Specs and Deliverables section 6.3.2 and the Field Procedures Manual section 4.3.4.1. Once selected, contacts were exported from Caris, including a speed-corrected, geo-referenced, and raw image of the contact. The shadow-height field for every contact was populated, but the length, width, and remarks field were populated only when deemed informative by the hydrographer.

B.3. Feature Data

General feature management consisted of two main workflows (see Fig. 18): Pydro features and Non-Pydro features. The distinction between the Pydro and Non-Pydro workflows is due to different acquisition procedures and processing capabilities. Whereas Pydro features are point features derived from the bathymetry data or vessel navigation data (e.g., DPs), Non-Pydro features are point, line, or area features typically acquired using a Trimble GeoXH GPS or digitized from an orthophoto, CUBE surface, or mosaic. The spatial feature type (point versus line or area) is important because Pydro does not have the capability to easily manipulate line and area features.

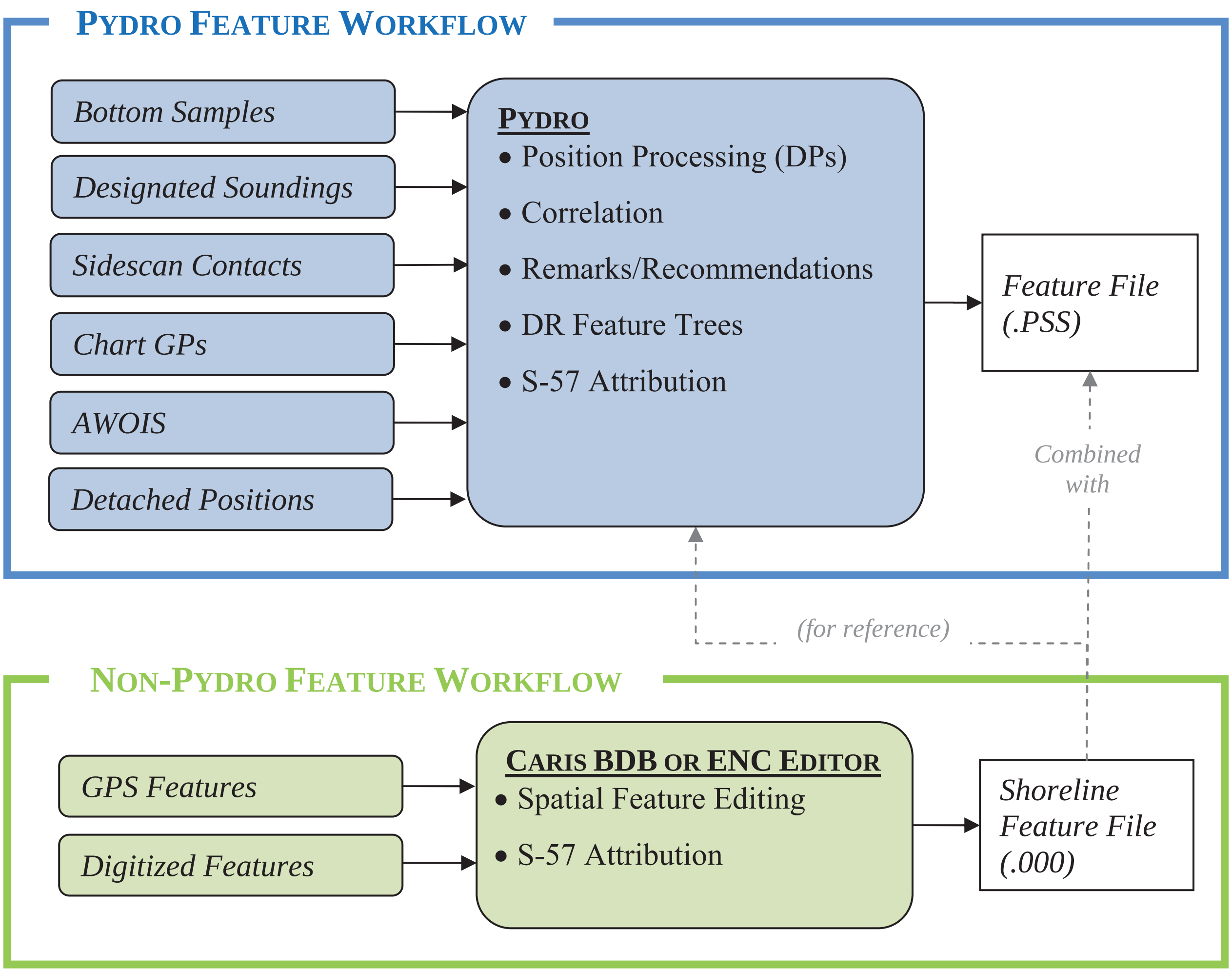


Figure 20: Feature Management Workflow

B.3.1. Pydro Feature Workflow

B.3.1.1. Pydro Feature Types

Pydro features consist of bottom samples, designated soundings, sidescan contacts, GPs, and AWOIS items.

Bottom Samples

Bottom sample features were created in Caris Bathy Database. SBDARE point features were created at the position of each bottom sample and then attributed with the appropriate NATSUR/NATQUA attributes. The SBDARE features were then exported to a .000 file and imported into PYDRO for inclusion in the feature file deliverable.

Designated Soundings

The least depth of charted features and significant uncharted features were flagged “designated” in Caris HIPS to ensure that the depth is portrayed in the final BASE surface. Soundings that were flagged designated were then imported into PYDRO as bathy features. Once in PYDRO, these bathy features were then correlated with other features and given the appropriate S-57 attribution.

Sidescan Contacts
Sidescan contacts were selected as per the HSSD section 6.3.2 and the Field Procedures Manual section 4.3.4.1. In an effort to guide the contact selection process in areas with a high density of features, the hydrographer also applied the generalization logic for designated soundings (HSSD 5.2.1.2) to sidescan contact selection. Once selected, contacts were exported from Caris, including a speed-corrected, geo-referenced, and raw image of the contact. The shadow-height field for every contact was populated, but the length, width, and remarks field were populated only when deemed informative by the hydrographer.

Chart GPs
Pertinent ENC features were added to the Pydro PSS (Pydro Survey Session) as chart GPs (geographic positions), as a convenient way to manage and correlate already-charted features.

AWOIS
The AWOIS items received as part of the project instruction package are inserted into the Pydro PSS as AWOIS features.

Detached Positions (DPs)
Detached positions are features the position of which is calculated from a range and bearing from the vessel reference point. Typically, DPs are created by first creating a target in the Hypack Survey program and then applying the range and bearing to that target via a function built into Pydro.

B.3.1.2. Pydro Feature Processing
Feature processing in Pydro consisted of three main steps: correlation, attribution, and export.

Feature Correlation
Feature correlation consisted of establishing the primary/secondary relationships among the various feature types for a given real-world item. For example, for a real-world item (e.g., a shipwreck) that was represented in the PSS by a bathymetry feature, multiple sidescan contacts, an ENC chart GP, and an AWOIS feature, the bathy feature was given a status of ‘primary’, and all the other, or correlating, features were given a status of ‘secondary’.

Feature Attribution
Feature attribution consisted of two main steps. First, the primary feature for a given reportable real-world item would have been given a combination of Pydro flags according to one of the four appropriate DR templates: DR_DtoN, DR_AWOIS, DR_Charted, and DR_Uncharted (see 2010 FPM section 4.4.8.1). Second, each primary reportable feature was given S-57 attribution using Pydro’s S-57 Editor.

Feature Export
After all features were correlated and attributed, the “Report” feature set (i.e., the field-verified CSF) is exported from Pydro to an S-57 .000 file.

B.3.2. <u>Non-Pydro Feature Workflow</u>

B.3.2.1. Non-Pydro Feature Types

Non-Pydro features consist of GPS features (GPs acquired with a hand-held or pole-mounted GPS) and digitized features.

GPS Features

All GPS features are collected using an S-57 data dictionary installed on a GeoXH handheld. A minimum of 10 minutes of carrier-phase lock on point features and the initial vertex of line and area features. For each subsequent vertex of line and area features, 2-minute observations are obtained. A GPS position is collected once every 5 seconds throughout each observation.

GPS data are post processed in Trimble Pathfinder using the H-Star processing routine, typically set to use a single base provider. Once the GPS shoreline feature data are post-processed, the feature data are exported from Pathfinder as a shapefile and then imported into either Caris Bathy Database or Hypack ENC Editor (see section B.3.2.2).

Digitized Features

In Caris Bathy Database, features can be digitized from CUBE surfaces, sidescan mosaics, or orthophotos. Examples of features digitized from surfaces and mosaics include pipelines, piers, and rocky seabed areas. In general, it is not accepted practice to digitized features from orthophotos, but in select circumstances, the hydrographer will do so. This practice is done only in situations when doing so (1) results in positional and/or semantic accuracy much greater than what is currently charted and (2) helps clarify the treatment of regular Pydro and Non-Pydro features. For example, the extents of a mischarted barrier island would be digitized from an orthophoto if bathymetry data were acquired over the charted land area. Additional criteria are that the orthophoto has reliable metadata (including source, resolution, and acquisition date) and, in the case for shoreline, that the desired information cannot be obtained from a contemporary National Geodetic Survey (NGS) shoreline survey.

B.3.2.2. Non-Pydro Feature Processing

Non-Pydro features are processed in either Caris Bathy Database or Hypack ENC Editor. Both programs allow a user to create and edit S-57 features. Once the S-57 features are topologically correct and appropriately attributed, the resulting .000 file is inserted into Pydro as a reference.

C. CORRECTIONS TO ECHO SOUNDINGS

The following section describes the determination and evaluation of the three main categories of corrections to echosoundings: vessel, sound speed, and water level correctors.

C.1. Vessel Correctors

Vessel correctors include static offsets, dynamic offsets, and patch test biases. The various correctors are applied to echo soundings at different points throughout the data pipeline.

C.1.1. Static Offsets

C.1.1.1. Vessel Lever-Arms

The National Geodetic Survey conducted a full vessel survey on 6/24/09, in Alpena, MI (see Appendix 10 for the NGS report); however, the relatively small RP-to-EM3002 lever arm was not included in the survey. The RP-to-EM3002 lever arm was measured using a tape measure on 2/16/11, in Gloucester Point, VA, while the boat was on the trailer in a parking lot (see Fig. 19). The height of the static draft reference plane above the parking lot was determined by taking the average of the heights of the port and starboard static draft reference points. The height of the EM3002 above the parking lot was determined by taking the average of the heights of the port and starboard sides of the transducer.

The primary-GPS-to-RP lever arm is accounted for in the POS/MV controller, and the RP-to-EM3002 lever arm is accounted for in SIS.

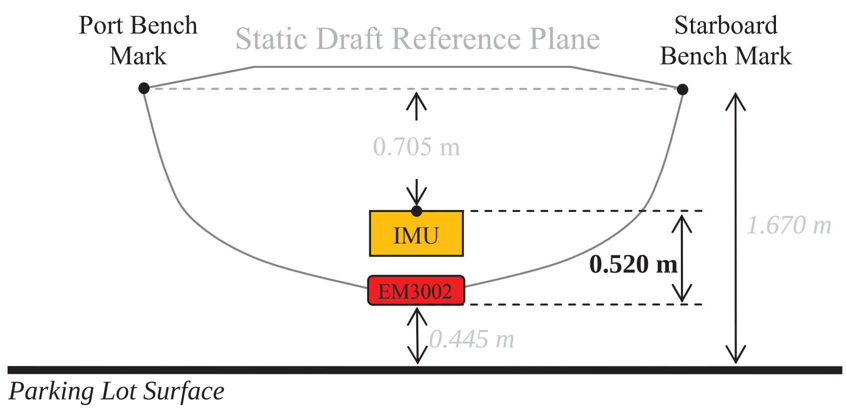


Figure 21: RP-to-Transducer Lever Arm Measurement

C.1.1.2. Static Draft

A static draft measurement was performed on 2/15/11, in Gloucester Point, VA. To determine the static draft (i.e., the height of the waterline above/below the reference point), two new reference marks and an easily repeatable method were established. A reference mark was established on the port and starboard gunwales, closely aligned with the RP (the middle of the top surface of the IMU), in the along-ship dimension (see Fig. 19).

First, the vertical positions of the newly established reference marks were tied into the vessel coordinate frame by running a staff athwartship over the RP (top mark on IMU). This athwartship bar, orthogonal to the z-axis of the vessel coordinate frame, provided a convenient point, over the IMU, at which to measure the RP-to-gunwale vertical distance (see Fig. 20).

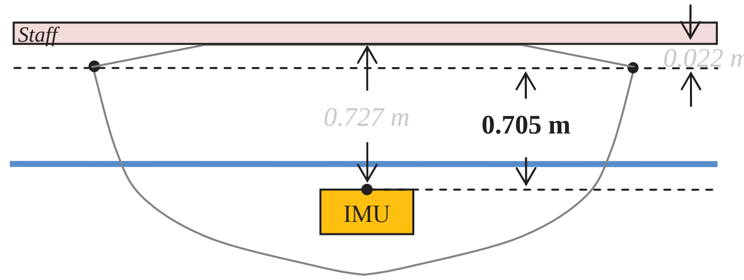


Figure 22: Static Draft Reference Points

Second, the static draft was calculated by subtracting the waterline-to-gunwale vertical distance (0.658 m) from the RP-to-gunwale vertical distance (0.680 m) for each benchmark and then taking the average (see Fig. 21).

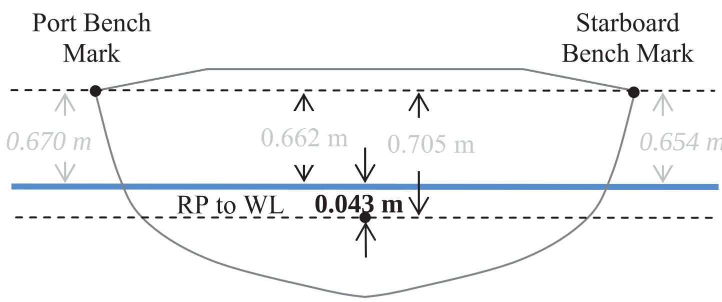


Figure 23: Static Draft Measurements

Third, an induced heave value of 0.07m was subtracted from the measured "static draft" to account for a 2° pitch during the static draft measurements (see Fig. 22).

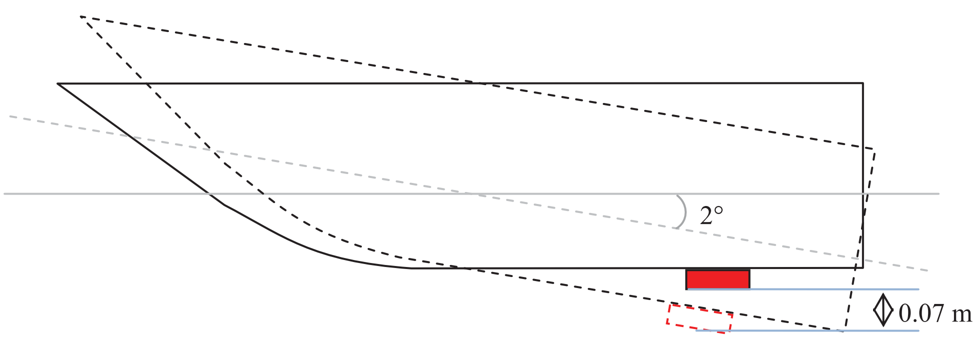


Figure 24: Static Draft Induced Heave

C.1.2. Dynamic Offsets

Dynamic draft was measured using the optical method, on the York River, in Virginia, in water depths of approximately 30 ft. The level was setup at the end of a short pier at Gloucester Point (see Figs. 23 and 24). A collimation check was carried out prior to the dynamic draft tests using the 10-40 method. The collimation error of the level was determined to be 0.1mm/m. While this error is high, it was decided that the accuracy was sufficient for performing the dynamic draft measurements. An attempt was made to make measurements at a similar range to keep errors to a minimum.

Figure 25: Dynamic Draft Level Setup Location

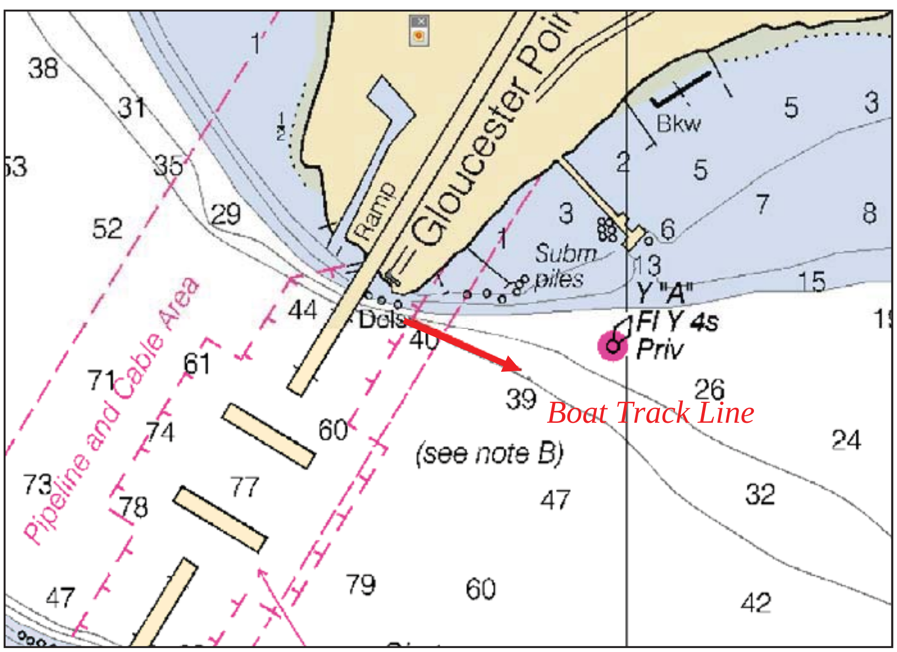


Figure 26: Dynamic Draft Heading (red line)

The wind was blowing ~10 kts out of the southwest, and waves were minimal. Although the test was performed at slack high tide, a current was detected by a change in speed over ground while running lines in opposite directions. To compensate, the speed over ground was recorded for each RPM in opposite directions, and averaged.

Once securely mounted and leveled, the level was focused on a fixed object on land to verify that the dock was sufficiently stable. No movement was detected. On the vessel, the level rod was positioned and leveled on the head of a bolt near the vessel's center of motion. Before and after each speed run, a measurement was made with the vessel at rest to detect any changes in water level. Each run was performed with the engines running at a predetermined RPM, in the same direction along the same line moving away from the level and observer. The speed over ground along with the staff reading was recorded on each run. Once the rod measurement was made, the vessel was turned 180 degrees back towards the observer, and the speed over ground was recorded again. It was not possible to read the staff while the vessel was moving towards the observer because the cabin obstructed the staff. Once one measurement was made for each RPM, the entire test was repeated with a different observer.

The results of the dynamic draft tests are shown in Table 3 below:

Table 3: 2011 Dynamic Draft Values

Speed (kts)	Draft Correction (m)
2.07	-0.05
3.40	-0.04
6.50	-0.04
6.55	-0.03

The agreement between first and second tests was excellent, with a maximum difference of 1 cm. It is believed that the reduction in draft at the highest speed is due to the boat beginning to plane. The results were compared to values from previous years (see Fig. 25). In general, there is poor correlation of the delta draft values among years; however, the 2011 values agree well with the values from 2007.

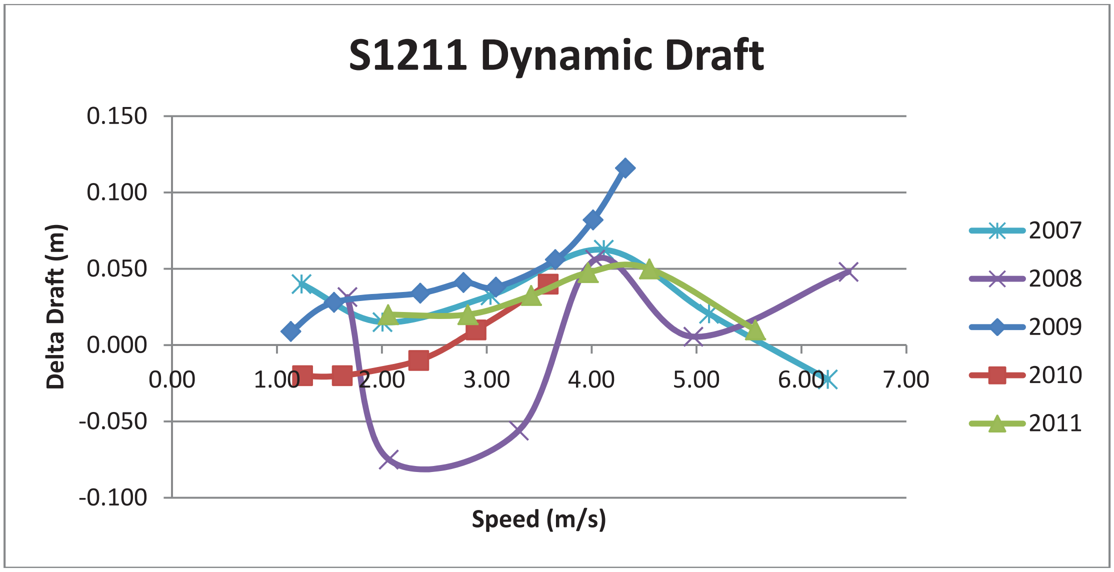


Figure 27: NRT-4 Dynamic Draft

C.1.3. <u>Patch Test Biases</u>

An initial patch test was performed on 2/10/11, on the York River, near Gloucester Point and Yorktown, VA (see Fig. 26). A second patch test was performed on 5/9/11, near the same location, after EM3002 sonar head s/n 753 was replaced with EM3002 sonar head s/n 796. See Table 4 for the patch test results, which were entered into the Swath1 sensor of the HVF.

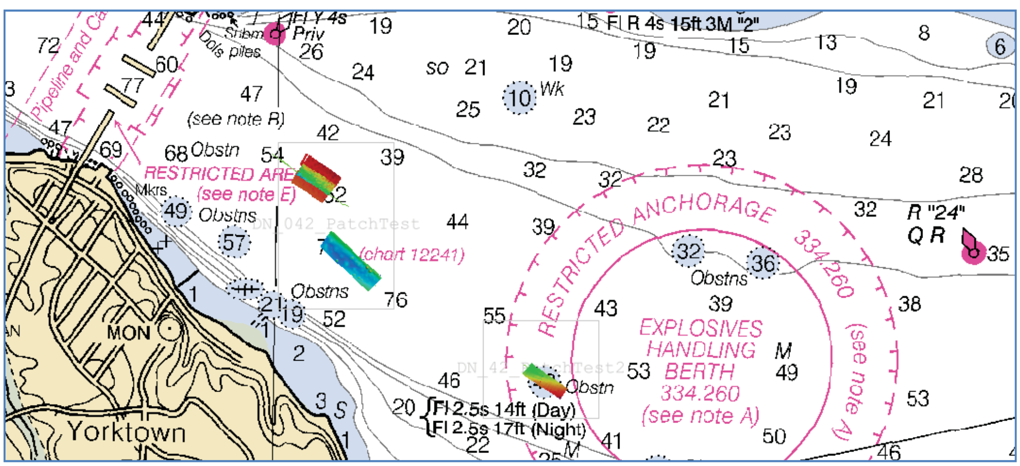


Figure 28: Patch Test Location (Charted depths are in feet)

Table 4: Patch Test Values

Bias	2/10/11	5/9/11
Navigation Timing	0	0
Pitch	-1.67	-0.18
Roll	0.19	0.37
Heading (Yaw)	0.49	0.5

C.2. Sound Speed

As discussed in B.1.1, ray-tracing was performed in real-time in SIS, using a Velocwin-generated .asvp file created from SBE 19+ CTD data.

C.3. Water Level Corrections

NRT4 uses two different water-level-correction paradigms – discrete zoning or TCARI. Refer to a particular Descriptive Report for details regarding a specific survey.

C.3.1. Discrete Zoning

As per procedures described in the Field Procedures Manual, preliminary and final discrete tide zoning files are obtained from CO-OPS. Any desired predicted, preliminary, or verified water level data are downloaded from the internet via the HSTP program Fetch Tides and loaded to the HDCS line folders using the Caris HIPS load-tide function. Any associated zoning-uncertainty is typically included in the final tide note.

C.3.2. TCARI

As with the discrete zoning paradigm, water level data are downloaded using Fetch Tides; however, water level correctors are loaded to the HCDS line folders via Pydro, the software in which the TCARI functionality is embedded.

D. APPROVAL SHEET

Data Acquisition & Processing Report
Navigation Response Team 4

As Chief of Party, I have ensured that surveying and processing procedures were conducted in accordance with the Field Procedures Manual and that the submitted data meet the standards contained in the 2011 Hydrographic Surveys Specifications and Deliverables.

I acknowledge that all of the information contained in this report is complete and accurate to the best of my knowledge.

Respectfully,

Nicholas A. Forfinski
Team Lead, NOAA NRT-4

Appendix 1 – Sound Speed Equipment Calibration Reports

Date:
Feb 14, 2011

Serial #:
98150-021411

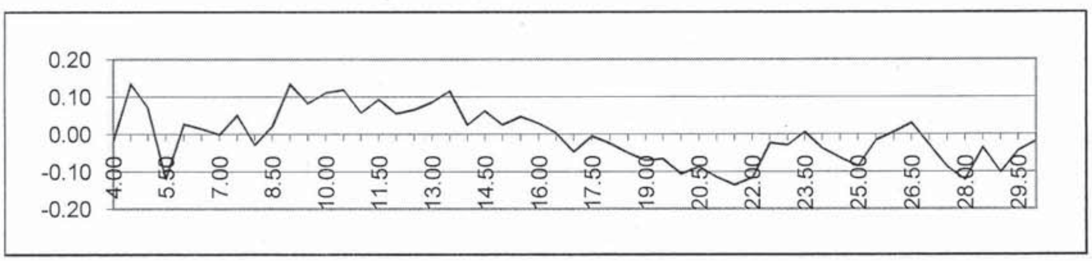
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5561.11	1421.60	-0.02
4.50	1423.90	5570.42	1424.04	0.14
5.00	1426.15	5578.80	1426.22	0.07
5.50	1428.38	5586.59	1428.26	-0.12
6.00	1430.58	5595.57	1430.61	0.03
6.50	1432.75	5603.84	1432.77	0.02
7.00	1434.90	5612.00	1434.90	0.00
7.50	1437.02	5620.32	1437.07	0.05
8.00	1439.12	5628.04	1439.09	-0.03
8.50	1441.19	5636.16	1441.21	0.02
9.00	1443.23	5644.42	1443.37	0.13
9.50	1445.25	5651.96	1445.34	0.08
10.00	1447.25	5659.71	1447.36	0.11
10.50	1449.22	5667.29	1449.34	0.12
11.00	1451.17	5674.51	1451.23	0.06
11.50	1453.09	5682.01	1453.19	0.09
12.00	1454.99	5689.14	1455.05	0.06
12.50	1456.87	5696.36	1456.94	0.07
13.00	1458.72	5703.53	1458.81	0.09
13.50	1460.55	5710.65	1460.67	0.12
14.00	1462.36	5717.22	1462.39	0.03
14.50	1464.14	5724.19	1464.21	0.06
15.00	1465.91	5730.79	1465.93	0.03
15.50	1467.65	5737.53	1467.69	0.05
16.00	1469.36	5744.03	1469.39	0.03
16.50	1471.06	5750.42	1471.06	0.00
17.00	1472.73	5756.63	1472.68	-0.05
17.50	1474.38	5763.11	1474.38	0.00
18.00	1476.01	5769.27	1475.98	-0.02
18.50	1477.62	5775.33	1477.57	-0.05
19.00	1479.21	5781.33	1479.14	-0.07
19.50	1480.77	5787.34	1480.71	-0.07
20.00	1482.32	5793.10	1482.21	-0.11
20.50	1483.84	5799.01	1483.75	-0.09
21.00	1485.35	5804.66	1485.23	-0.11
21.50	1486.83	5810.26	1486.69	-0.14
22.00	1488.29	5815.94	1488.18	-0.12
22.50	1489.74	5821.82	1489.71	-0.02
23.00	1491.16	5827.25	1491.13	-0.03
23.50	1492.56	5832.76	1492.57	0.01
24.00	1493.95	5837.89	1493.91	-0.04
24.50	1495.32	5843.02	1495.25	-0.06
25.00	1496.66	5848.09	1496.58	-0.08
25.50	1497.99	5853.44	1497.97	-0.01
26.00	1499.30	5858.53	1499.30	0.01
26.50	1500.59	5863.56	1500.62	0.03
27.00	1501.86	5868.20	1501.83	-0.03
27.50	1503.11	5872.77	1503.02	-0.09
28.00	1504.35	5877.36	1504.22	-0.12
28.50	1505.56	5882.35	1505.53	-0.03
29.00	1506.76	5886.68	1506.66	-0.10
29.50	1507.94	5891.42	1507.90	-0.04
30.00	1509.10	5895.97	1509.09	-0.02



Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

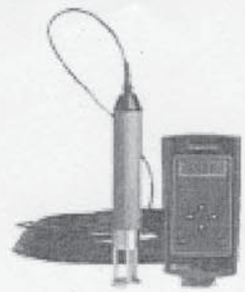
Date:
Feb 14, 2011

Serial #:
98150-021411

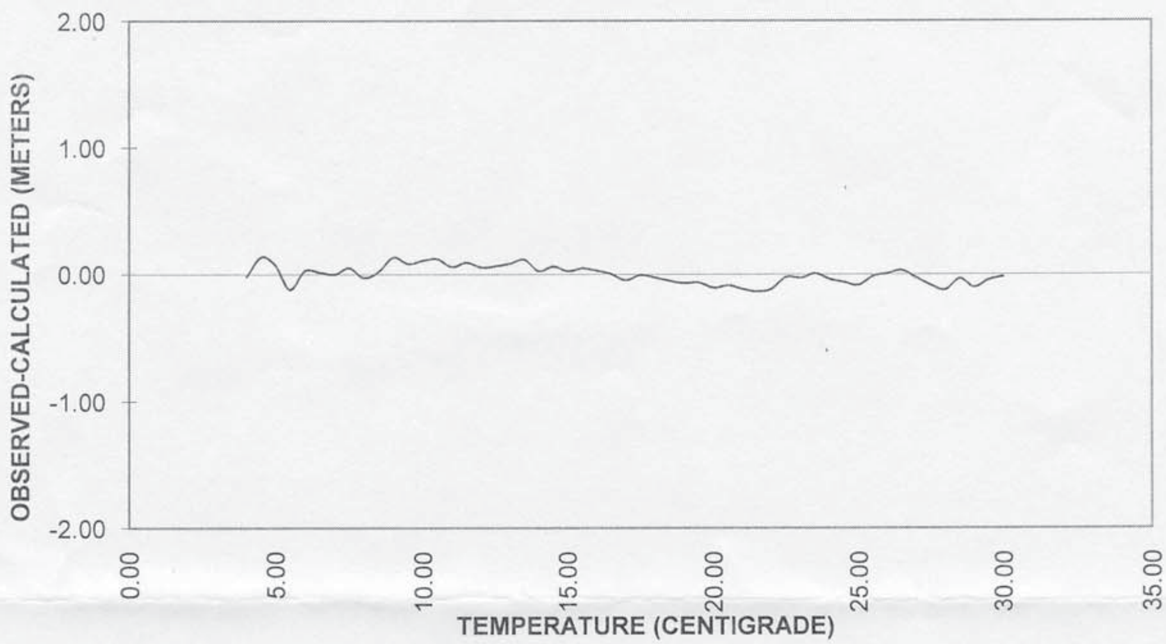
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



Burn these numbers to EPROM: Gradient **3344**
Intercept **313**



The instruments used in this calibration have been calibrated to the published manufacturer specifications using standards traceable to NIST, to consensus standards, to ratio methods, or to acceptable values of natural physical constants that meets the requirements of ANSI/NCSL Z540-1, ISO 9001, ISO 10012 and ISO 17025. Certificate/traceability numbers: 0002-2655.00-23491-001, 0002-2655.00-23491-002. ID#'s:294,295,762,172,56

Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

Digibar

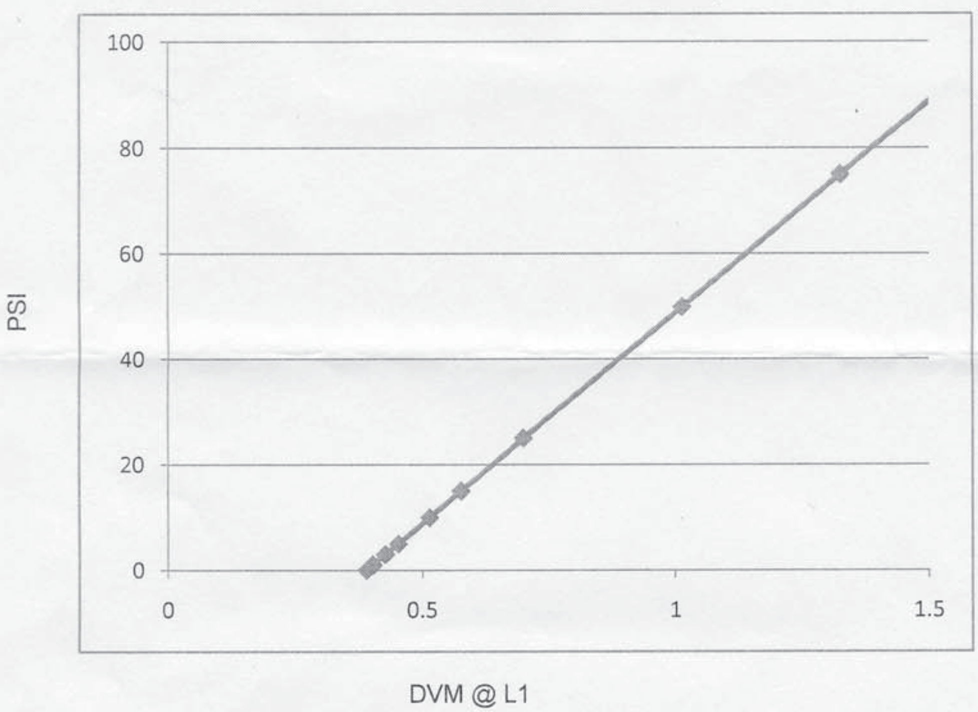
Date	2/22/2011
Serial #	98150
SW Version	1.08
Cable Length	20 meter

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	

Press Transducer	60490
Zero Voltage	.39
Span Volage	2.89
Mid-Scale Voltage	1.64
R5	3.9K
R9	10K
Gradient	3344
Intercept	313

Max psi:	200 psi
Velocity Check:	√
Depth Check:	√
Communications:	√
External Power:	NA

Pressure Transducer Linearity



Transducer Linearity	
PSI	DVM@L1
0	0.39
1	0.402
3	0.427
5	0.452
10	0.514
15	0.577
25	0.701
50	1.014
75	1.327
100	1.64

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 62622

Customer Information:

Company	NOAA/NRT4	Date	1/27/2011
Contact	Lt. Stephen Kuzirian		
PO Number	TBD		

Serial Number	05M0721
Model Number	SBE 05M

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 62622

Customer Information:

Company	NOAA/NRT4	Date	1/27/2011
Contact	Lt. Stephen Kuzirian		
PO Number	TBD		

Serial Number	19P38684-4674
Model Number	SBE 19Plus

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The lithium backup batteries had reached the end of their life expectancy.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Replaced the internal lithium back-up batteries.
3. Calibrated the pressure sensor.
4. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
5. Performed complete system check and full diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	NOAA/NRT4		
Job Number:	62622	**Date of Report:**	1/8/2011
Model Number	SBE 19Plus	**Serial Number:**	19P38684-4674

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 1/7/2011 Drift since last cal: -0.00041 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4674
CALIBRATION DATE: 07-Jan-11

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.144631e-003
a1 = 2.791554e-004
a2 = -1.509676e-006
a3 = 2.030481e-007

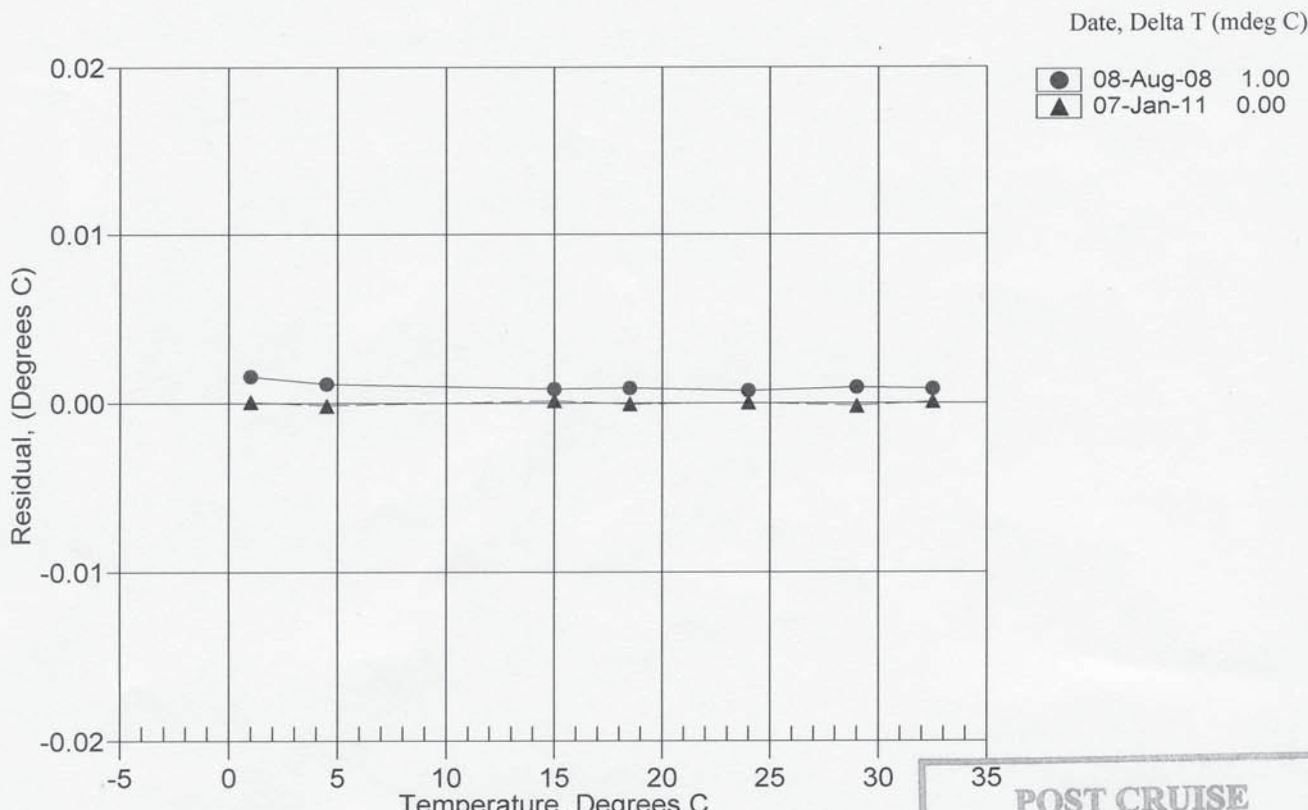
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	691077.333	1.0000	0.0001
4.5000	618143.733	4.4999	-0.0001
15.0000	433779.617	15.0001	0.0001
18.5000	383413.800	18.4999	-0.0001
24.0000	314397.083	24.0000	0.0000
29.0000	261346.850	28.9999	-0.0001
32.4999	229071.483	32.5000	0.0001

MV = (n - 524288) / 1.6e+007

R = (MV * 2.900e+009 + 1.024e+008) / (2.048e+004 - MV * 2.0e+005)

Temperature ITS-90 = $1/\{a0 + a1[ln(R)] + a2[ln^2(R)] + a3[ln^3(R)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	NOAA/NRT4		
Job Number:	62622	**Date of Report:**	1/8/2011
Model Number	SBE 19Plus	**Serial Number:**	19P38684-4674

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 1/7/2011 Drift since last cal: -0.00010 PSU/month

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: PSU/month

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4674
CALIBRATION DATE: 07-Jan-11

SBE19plus CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.052069e+000
h = 1.619550e-001
i = -3.429364e-004
j = 5.126377e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006

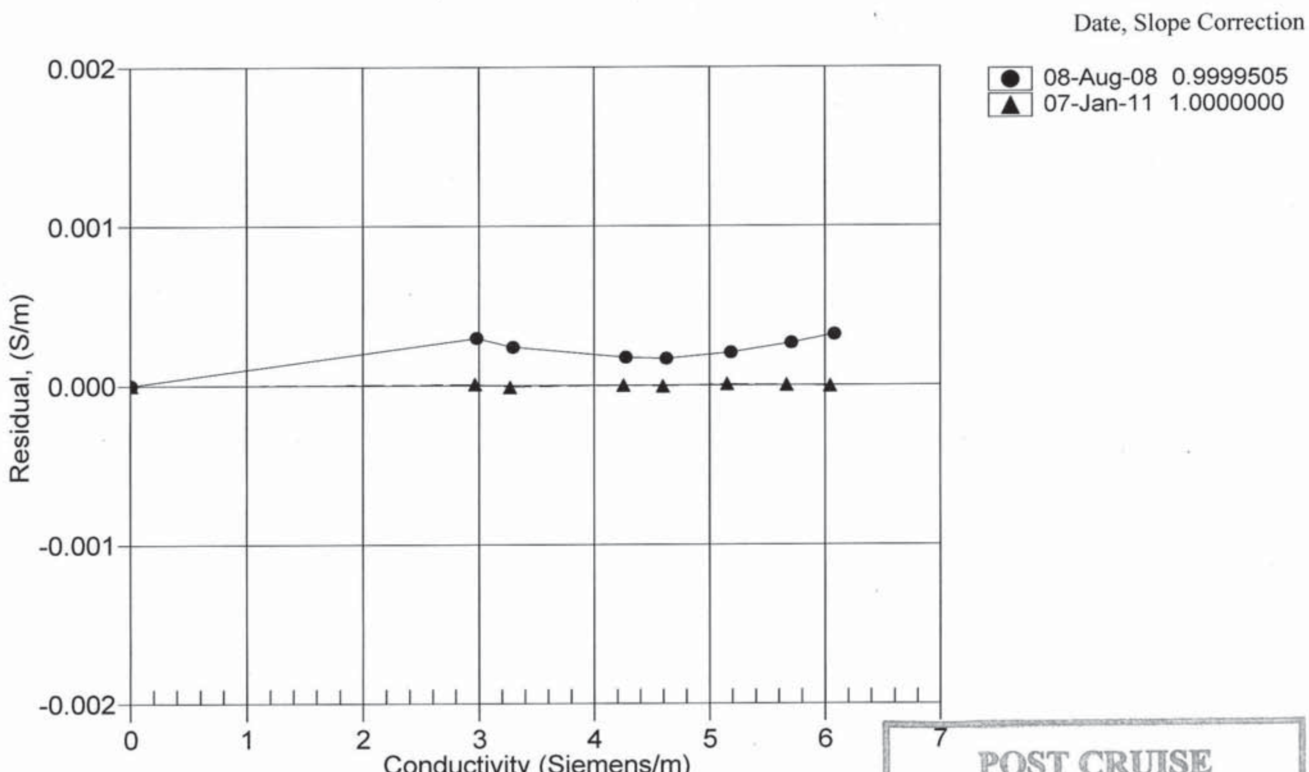
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2553.01	0.0000	0.00000
0.9999	34.6660	2.96433	4986.63	2.9643	0.00001
4.5000	34.6466	3.27029	5172.56	3.2703	-0.00001
15.0000	34.6045	4.24837	5725.94	4.2484	-0.00000
18.5000	34.5956	4.59224	5907.94	4.5922	-0.00000
24.0000	34.5855	5.14808	6190.57	5.1481	0.00001
29.0000	34.5802	5.66798	6443.41	5.6680	0.00000
32.4999	34.5773	6.03900	6617.76	6.0390	-0.00000

f = INST FREQ / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4674
CALIBRATION DATE: 06-Jan-11

SBE19plus PRESSURE CALIBRATION DATA
160 psia S/N 5820

COEFFICIENTS:

PA0 =	1.011210e-001	PTCA0 =	5.252040e+005
PA1 =	4.906488e-004	PTCA1 =	1.663555e+001
PA2 =	-3.597824e-012	PTCA2 =	-3.154669e-001
PTEMPA0 =	-6.702631e+001	PTCB0 =	2.493250e+001
PTEMPA1 =	5.156123e+001	PTCB1 =	1.300000e-003
PTEMPA2 =	-5.390990e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.71	555209.0	1.7	14.70	-0.01
29.89	586190.0	1.7	29.87	-0.01
59.95	647645.0	1.7	59.95	0.00
94.95	719160.0	1.7	94.92	-0.02
124.95	780641.0	1.7	124.96	0.00
159.96	852389.0	1.7	159.97	0.00
124.98	780686.0	1.7	124.98	0.00
94.99	719294.0	1.7	94.99	-0.00
59.98	647766.0	1.7	60.01	0.02
30.00	586510.0	1.7	30.03	0.02
14.72	555227.0	1.7	14.71	-0.01

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.97	555864.70
29.00	1.90	555901.69
24.00	1.80	555893.58
18.50	1.69	555848.01
15.00	1.62	555852.98
4.50	1.41	555743.20
1..00	1.34	555681.71

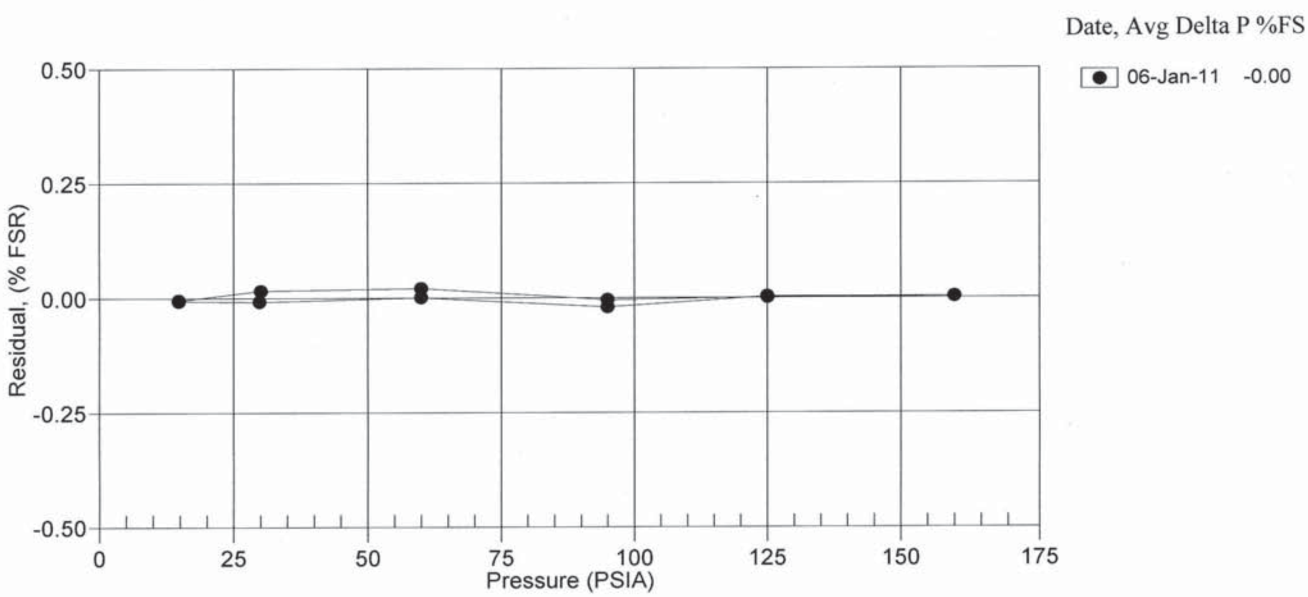
TEMP(ITS90)	SPAN(mV)
-5.00	24.93
35.00	24.98

y = thermistor output; t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2

x = pressure output - PTCA0 - PTCA1 * t - PTCA2 * t^2

n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

pressure (psia) = PA0 + PA1 * n + PA2 * n^2



Date:
Jan 08, 2010

Serial #:
98445-010810

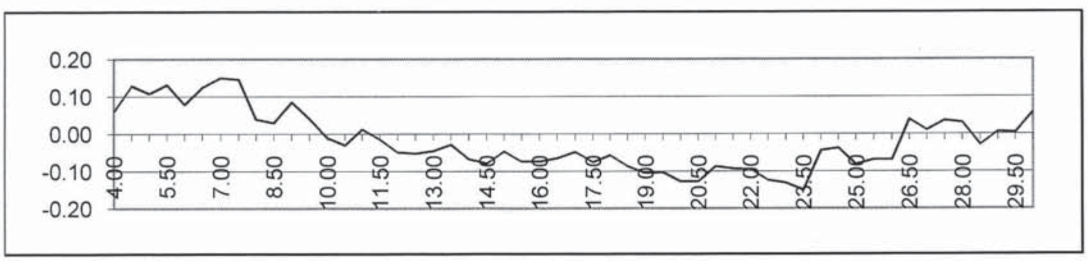
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL	TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5550.02	1421.68	0.06	17.50	1474.38	5748.35	1474.31	-0.07
4.50	1423.90	5558.87	1424.03	0.13	18.00	1476.01	5754.56	1475.95	-0.06
5.00	1426.15	5567.28	1426.26	0.11	18.50	1477.62	5760.51	1477.53	-0.09
5.50	1428.38	5575.76	1428.51	0.13	19.00	1479.21	5766.42	1479.10	-0.11
6.00	1430.58	5583.85	1430.66	0.08	19.50	1480.77	5772.33	1480.67	-0.10
6.50	1432.75	5592.21	1432.88	0.12	20.00	1482.32	5778.06	1482.19	-0.13
7.00	1434.90	5600.40	1435.05	0.15	20.50	1483.84	5783.81	1483.71	-0.13
7.50	1437.02	5608.38	1437.17	0.15	21.00	1485.35	5789.63	1485.26	-0.09
8.00	1439.12	5615.88	1439.16	0.04	21.50	1486.83	5795.20	1486.74	-0.09
8.50	1441.19	5623.65	1441.22	0.03	22.00	1488.29	5800.71	1488.20	-0.09
9.00	1443.23	5631.57	1443.32	0.09	22.50	1489.74	5806.04	1489.61	-0.12
9.50	1445.25	5639.02	1445.30	0.04	23.00	1491.16	5811.38	1491.03	-0.13
10.00	1447.25	5646.35	1447.24	-0.01	23.50	1492.56	5816.60	1492.41	-0.15
10.50	1449.22	5653.71	1449.19	-0.03	24.00	1493.95	5822.22	1493.91	-0.04
11.00	1451.17	5661.21	1451.18	0.01	24.50	1495.32	5827.39	1495.28	-0.04
11.50	1453.09	5668.36	1453.08	-0.01	25.00	1496.66	5832.30	1496.58	-0.08
12.00	1454.99	5675.39	1454.95	-0.05	25.50	1497.99	5837.35	1497.92	-0.07
12.50	1456.87	5682.45	1456.82	-0.05	26.00	1499.30	5842.28	1499.23	-0.07
13.00	1458.72	5689.46	1458.68	-0.04	26.50	1500.59	5847.55	1500.63	0.04
13.50	1460.55	5696.42	1460.53	-0.03	27.00	1501.86	5852.23	1501.87	0.01
14.00	1462.36	5703.08	1462.29	-0.07	27.50	1503.11	5857.05	1503.15	0.04
14.50	1464.14	5709.76	1464.07	-0.08	28.00	1504.35	5861.68	1504.38	0.03
15.00	1465.91	5716.52	1465.86	-0.05	28.50	1505.56	5866.04	1505.53	-0.03
15.50	1467.65	5722.97	1467.57	-0.07	29.00	1506.76	5870.69	1506.77	0.01
16.00	1469.36	5729.44	1469.29	-0.07	29.50	1507.94	5875.13	1507.94	0.00
16.50	1471.06	5735.86	1470.99	-0.07	30.00	1509.10	5879.72	1509.16	0.06
17.00	1472.73	5742.23	1472.68	-0.05					



Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

Date:
Jan 08, 2010

Serial #:
98445-010810

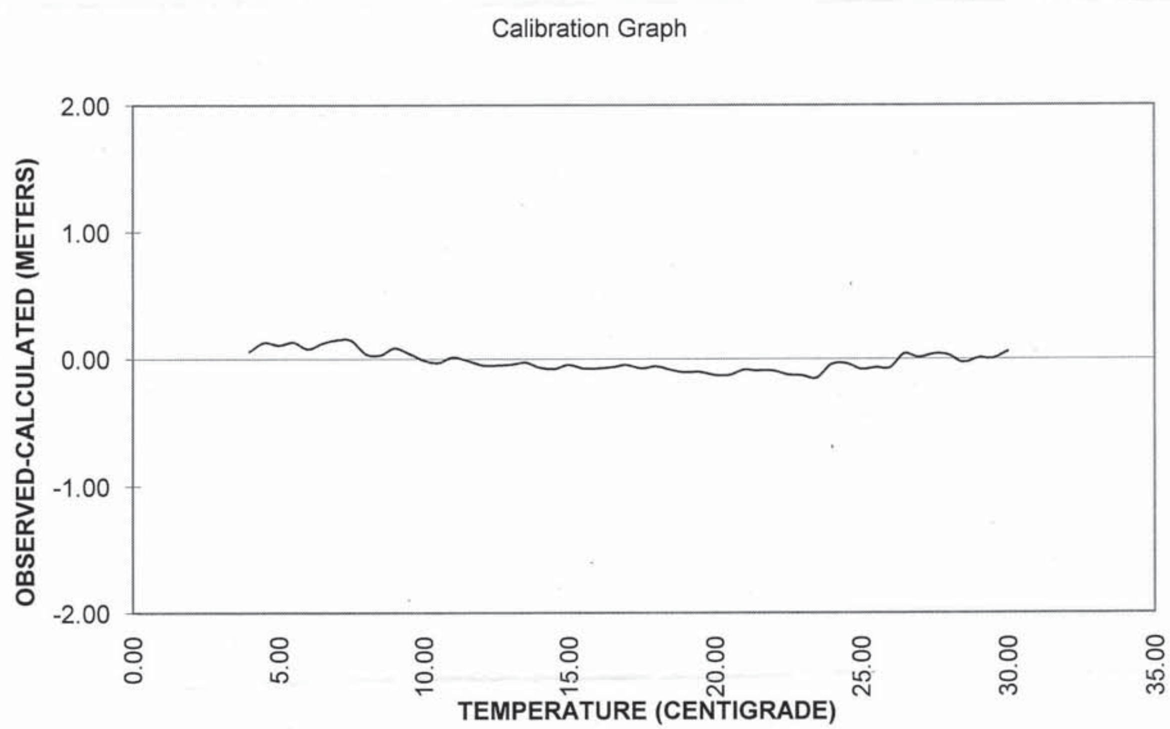
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

Burn these numbers to EPROM:

	Gradient	**3397**
	Intercept	**510**



The instruments used in this calibration have been calibrated to the published manufacturer specifications using standards traceable to NIST, to consensus standards, to ratio methods, or to acceptable values of natural physical constants that meets the requirements of ANSI/NCSL Z540-1, ISO 9001, ISO 10012 and ISO 17025. Certificate/traceability numbers: 0002-2655.00-23491-001, 0002-2655.00-23491-002. ID#'s:294,295,762,172,56

Odom Hydrographic Systems, Inc.
1450 SeaBoard Avenue, Baton Rouge, Louisiana 70810-6261, USA
Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

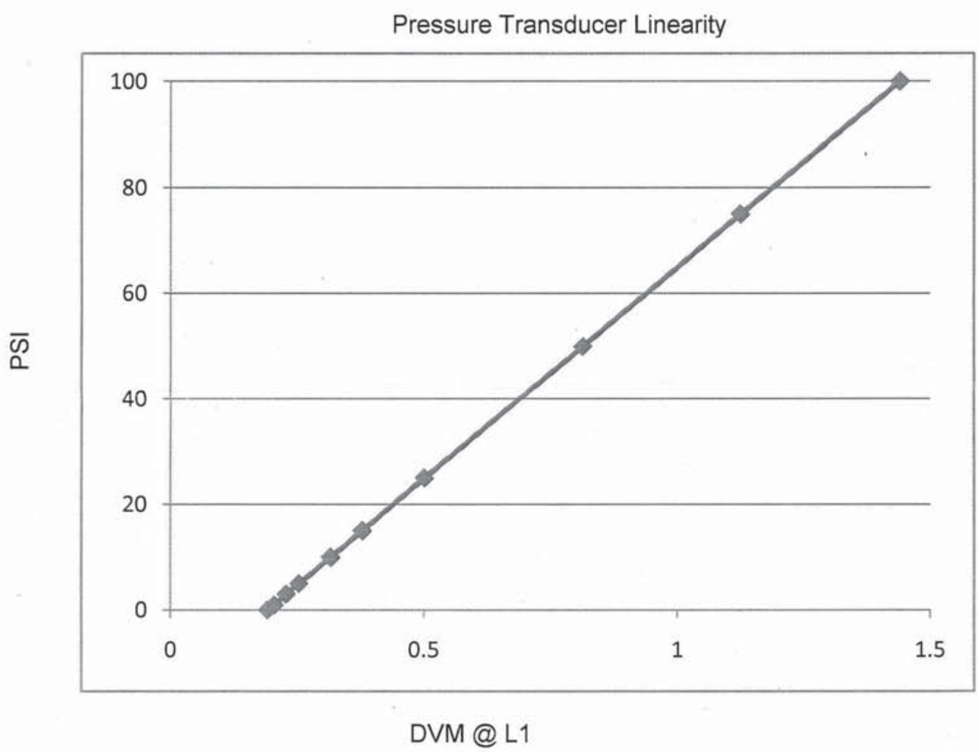
Digibar

Date	1/13/2010
Serial #	98445
SW Version	1.11
Cable Length	30m

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	853902

Press Transducer	82962
Zero Voltage	.19
Span Volage	2.69
Mid-Scale Voltage	1.44
R5	3.9K
R9	10K
Gradient	3397
Intercept	510

Max psi:	200psi
Velocity Check:	√
Depth Check:	√
Communications:	√
External Power:	NA



Transducer Linearity	
PSI	DVM@L1
0	0.19
1	0.203
3	0.227
5	0.252
10	0.315
15	0.377
25	0.501
50	0.814
75	1.127
100	1.44

Appendix 2 – Hydrographic Inventory

Hydrographic Hardware Inventory
Field Unit: NRT4

Equipment Type	*Manufacturer*	*Model*	*Serial Number*	*Firmware*	*Date of Last Calibration*
SONAR AND SOUNDING EQUIPMENT					
Multibeam Echosouner	Kongsberg	EM3002	Head=753 (pre 5/6/11) & 796 (post 5/6/11); PU=668	PU=2.0.23; Head=3.0.3	n/a
Side Scan Sonar	Klein	System 3000	TPU=314; Fish=498 (pre 5/27/11) & ### (post 5/27/11)	vxWorks=5.4.2	n/a
Vertical Beam Echosounder	Odom	Echotrac CV-200	23005	?	n/a
POSITIONING & ATTITUDE EQUIPMENT					
GPS-Aided Inertial Navigation	Applanix	POS/MV 320 V4	PCS-, IMU-3245?	POS=5.03,GPS Rx=4.21	never tumbled
DGPS Reciever	Trimble	DSM212L	220246329	n/a	n/a
GPS Receiver	Trimble	GeoXH 2008	4928419526	v2.11	n/a
SOUND SPEED MEASUREMENT EQUIPMENT					
Sound Speed Profiler	Seabird	SeaBird CTD	4674	n/a	27-Jan-11
Sound Speed Profiler	Odom	DigibarPro	98150	n/a	9-Aug-11
Sound Speed Profiler	Odom	DigibarPro	98351	n/a	7-Aug-11
Sound Speed Profiler	Odom	DigibarPro	98445	n/a	8-Jan-10
TIDES & LEVELING EQUIPMENT					
Optical Level	Sokkisha	B1 Automatic	4968	n/a	9/30/2008
Level Rod	Mound City	903086	7890-2-45	n/a	n/a

Hydrographic Software Inventory
Field Unit: NRT4

COMPUTERS						
CD#	CD0001716680	CD0001613024	CD0001281246	CD0001762483	CD0001044533	CD0001612970
Machine Name	OCS-W-NSD716680	OCS-W-NSD613024	NRT-1 Survey Computer	OCS-L-NSD762483	Hypack	SSS
Operating System	Windows XP	Windows XP	Windows XP	Windows XP	Windows XP	Windows XP
Location	Office	Office	Office	Office	Boat	Boat
Type	Workstation	Workstation	Workstation	Laptop	Workstation	Workstation
Make/Model	Dell Optiplex 960	Dell Precision T3400	Dell Optiplex GX620	Dell Latitude D630	DELL Optiplex GX280	Dell Optiplex 745
Date Purchased	9/2/2009	8/4/2008	2/3/2006	4/21/2008	11/29/2004	7/26/2007
Processor	Core2Quad; Q9550@2.83GHz	Core2Quad; Q6700@2.66GHz	Intel Pentium D 3.Ghz	Core 2 Duo 2.5 GHz	P4 3.20GHz	Core 2 @ 2.66 GHz
RAM	3070MB	3070MB	2046MB	3.5GB	2046MB	2046MB
Video Card	NVIDIA Quadro NVA 420	NVIDIA Quadro NVS 290	NVIDIA Quadro NVS 290	NVIDIA Quadro NVS 135M	Radeon X300	ATI Radeon X1300 Pro
Video RAM	512MB	256MB	256MB	256 MB	128Mb	256 Mb
Service Tag	BX1BVK1	53GM2H1	7X08D91	3HWM3G1	HWHB561	JMZDCD1
Dell Support Expiration	9/2/2010	8/4/2011	2/2/2009	4/21/2011	11/29/2007	7/25/2010
SOFTWARE						
Acquisition						
Hypack	n/a	n/a	n/a	n/a	v10.0.0.34	n/a
Klein Sonar Pro	n/a	n/a	n/a	n/a	n/a	v12.0
Kongsberg SIS	n/a	n/a	n/a	n/a	v3.8.2	n/a
Trimble TSIP	n/a	n/a	n/a	n/a	v2.00	n/a
POS/MV Controller	n/a	n/a	n/a	n/a	v5.1.0.2	n/a
Velocwin	v8.96	n/a	n/a	n/a	v8.96	n/a
Processing						
Caris HIPS & SIPS	v7.1 (CW9604695, CK9606721)				n/a	n/a
Trimble Terrasync	n/a	v5.02	n/a	n/a	n/a	n/a
Trimble Pathfinder	n/a	v5.1.0	n/a	n/a	n/a	n/a
Ancillary						
Caris BASE Editor	v3.2 (license # CK9606721)				n/a	n/a
Pydro	v11.7 (r3548) 6867e3d5cf560882c6	v11.7 (r3548) c59e3da395efc7ce4e	v11.7 (r3548) 7e0a3b45b6f3b33491	v10.11 (r3191) 2feb236caae8128f46	n/a	n/a
MapInfo	v10.0.1; sn# MINWEU1000051174; Access Code 403600	v10.5; sn# MINWEU1000051174 Access Code 403600	v9.0.2; sn# MINWEU0900013987; access code401590	SN# MINWEU1000051174 Access Code 403600	n/a	n/a
Fledermaus	v7.2	n/a	n/a	n/a	n/a	n/a

Appendix 3 – Dynamic Draft

THREE-WIRE LEVELING

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

INST. OP. INT.	1st COMP. INT.	2nd COMP. INT.

PROJECT	LOCATION	ORGANIZATION

OBSERVER	RECORDER	INSTRUMENT	SUN	WIND	WEATHER

FROM	TO	DATE *(YYYYMMDD)*	TIME	LINE OR NET	PAGE NO.	NO. OF PAGES

STATION	BACKSIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	FORESIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	REMARKS
rest	1870	19.90									
900	1890	2030									
rest	1880	2030									
1200	1910	2050									
rest	1900	2040									
1500	1930	2090									
rest	1900	2070									
1800	1950	2120									
rest	1910	2070									
2100	1960	2130									
rest	1910	2090									
2400	1920	2100									

Appendix 4 – Level Collimation Check Log

$$C = \frac{\Delta h_1 + \Delta h_2 - 2(CR_{10} - CR_{40})}{\Delta S_1 + \Delta S_2}$$

THREE-WIRE LEVELING

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

INST. OP. INT.	1st COMP. INT.	2nd COMP. INT.

PROJECT	LOCATION	ORGANIZATION

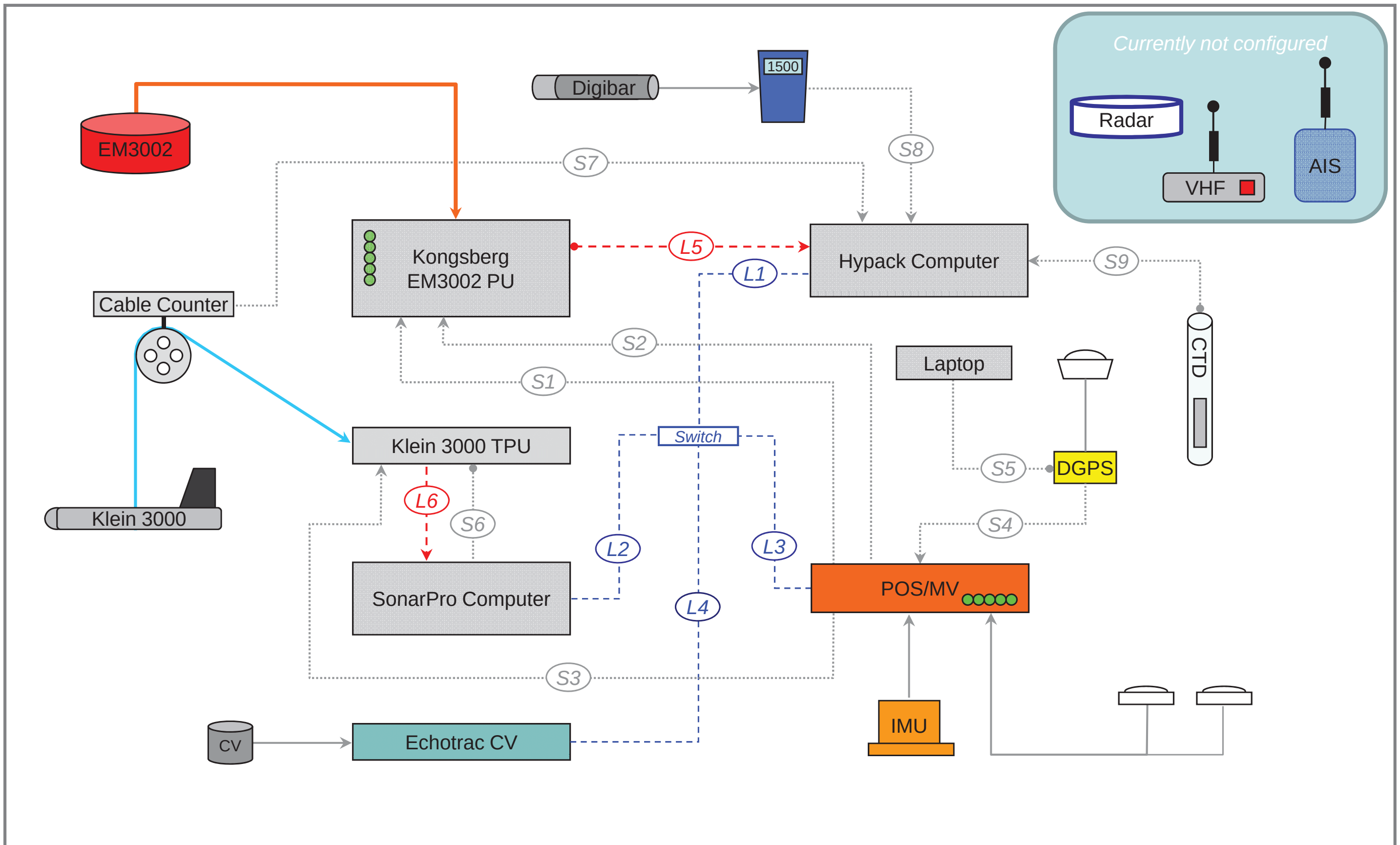
OBSERVER	RECORDER	INSTRUMENT	SUN	WIND	WEATHER

FROM	TO	DATE *(YYYYMMDD)*	TIME	LINE OR NET	PAGE NO.	NO. OF PAGES

STATION	BACKSIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	FORESIGHT FACE OF ROD	MEAN	BACK OF ROD	INTERVAL	SUM OF INTERVALS	REMARKS
	1582			14		1648			60		
	1568	1567.3		16		1588	1588		60		
	1552					1528					
	1547			15		1579			60		
	1532	1532		15		1519	1517		60		
	1517					1459					
				Δh_1	$= 20.7$		20.7	-13.0 -	2(-.02 + .27)		$= \frac{7.2\ mm}{60\ m}$
				Δh_2	$= -13$						
									60		$\frac{.12\ mm}{m}$
	1491			14		1558			60		
	1477	1478.3		16		1498	1498		60		
	1461					1438					
				$\Delta h_1 = -13$							
				$\Delta h_2 = 19.7$			-13 + 19.7	- 2(-.02 + .27)		=	$\frac{6.2}{60} = \frac{.1\ mm}{m}$
								60			

DA FORM 5820, JUL 2001 — EDITION OF AUG 89 IS OBSOLETE. — USAPA V1.00

Appendix 5 – Wiring Diagram



Serial

LAN

LAN (crossover)

Other

Arrow-end indicates data flow

Dot-end indicates cable is for device control/configuration

NOAA NRT4 (S1211)

Survey-System Configuration

June 01, 2011

Cable	End1	End2	Settings	Description
L1	Hypack Computer 129.100.1.230 255.255.0.0	Network Switch	n/a	Connects to SonarPro Computer and POS/MV
L2	SonarPro Computer 129.100.1.240 255.255.0.0	Network Switch	n/a	Network share with Hypack Computer for SSS data download transfer
L3	POS/MV 129.100.1.231 255.255.0.0	Network Switch	Port 5602	UDP broadcast of depth, attitude, & PosPac data to Hypack (3,7,102@2Hz)
L4	Echotrac CV-200 *not configured*	Network Switch	n/a	UDP broadcast to Hypack
L5	EM3002 157.237.2.61 255.255.0.0	Hypack Computer 157.237.2.60 255.255.0.0	Port 16103	UDP broadcast of various EM datagrams (crossover)
L6	Klein 3000 TPU 192.168.0.81 255.255.255.0	SonarPro Computer 192.168.82 255.255.255.0	n/a	SSS data stream (crossover)
S1	POS/MV Com 1	EM3002 PU Com 1	9600,n,8,1	Position data to EM3002 (GGA) @ 1 Hz
S2	POS/MV Com 2	EM3002 PU Com 2	19200, n,8,1	Attitude data to EM3002 (Simrad 3000 TSS) @ 100 Hz
S3	POS/MV *not configured*	Klein 3000 TPU *not configured*	4800, n,8,1	Position and Speed to Klein TPU (RMC & VTG)
S4	Trimble DGPS Port B	POS/MV Com 3	9600, n,8,1	RTCM DGPS correctors to POS/MV
S5	Trimble DGPS Port A	Laptop Com 1	9600, n,8,1	Trimble DGPS configuration via TSIP talker
S6	SonarPro Computer Com 1	Klein 3000 TPU Com 1	9600,8,n,1 null modem	HyperTerminal connection to view Klein TPU bootup sequence
S7	Cable Counter	SonarPro Computer Com 2	2400,7,n,1	Cable out from Dynapar unit to SonarPro
S8	Digibar	Hypack Computer Com 14 (P1)	9600,8,n,1	Surface sound speed to SIS for EM3002 beam forming/steering
S9	Seabird SBE 19+	Hypack Computer Com 1	9600,8,n,1	Download CTD cast data
S#	POS/MV Com 5	VHF radio	4800,8,n,1	Position (GGA) sent to non-NOAA VHF radio for DSC (digital selective calling) capability
S#	POS/MV Com 4	Radar		
S#	AIS Transceiver	Hypack Computer Com 6	38400,8,n,1	AIS (automatic identification system) broadcast and receive

Orange: not currently set up on NRT-4

Appendix 6 – SIS PU Settings

```
#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved:  2011.02.15 19:07:56

#// Build info:
#* SIS:                 [Version: 3.8.2, Build: 78, DBVersion 19.0 CD
generated: Mon Jan 17 14:47:42 2011]
[Fox ver = 1.6.37]
[db ver = 19, proc = 19.0]
[OTL = 4.0.-95]
[ACE ver = 5.7.6]
[Coin ver = 2.5.0]
[Simage ver = 1.6.2a]
[Dime ver = DIME v0.9]
[STLPort ver = 8.0]
[FreeType ver = 2.3.7]
[TIFF ver = 3.9.2]
[GeoTIFF ver = 1250]
[GridEngine ver = ???]

#* Language             [3] #// Current language, 1-Norwegian, 2-
German,3-English, 4-Spanish

#* Type                 [3020]
#* Serial no.           [753]
#* Number of heads      [1]
#* System descriptor    [33554441] #// 02000009

#//
*********************************************************************
#{ User comment #//


#} User comment

#//
*********************************************************************

#//
*********************************************************************
#// Installation parameters


#{ Input Setup #// All Input setup parameters

   #{ COM1 #// Link settings.

      #{ Com. settings #// Serial line parameter settings.
         #* Baud rate:           [9600]
         #* Data bits            [8]
         #* Stop bits:           [1]
         #* Parity:              [NONE]
      #} Com. settings

      #{ Position #// Position input settings.
         #* None                 [1] [0]
         #* GGK                  [1] [0]
         #* GGA                  [1] [1]
```

```
      #* GGA_RTK                [1] [0]
      #* SIMRAD90               [1] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude               [0] [0]
      #* MK39 Mod2 Attitude,    [0] [0]
      #* ZDA Clock              [1] [1]
      #* HDT Heading            [1] [0]
      #* SKR82 Heading          [0] [0]
      #* DBS Depth              [1] [0]
      #* DPT Depth              [1] [0]
      #* EA500 Depth            [0] [0]
      #* ROV. depth             [1] [0]
      #* Height, special purp   [1] [0]
      #* Ethernet AttVel        [0] [0]
   #} Input Formats

#} COM1

#{ COM2 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #* Baud rate:             [19200]
      #* Data bits              [8]
      #* Stop bits:             [1]
      #* Parity:                [NONE]
   #} Com. settings

   #{ Position #// Position input settings.
      #* None                   [0] [1]
      #* GGK                    [0] [0]
      #* GGA                    [0] [0]
      #* GGA_RTK                [0] [0]
      #* SIMRAD90               [0] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude               [1] [1]
      #* MK39 Mod2 Attitude,    [0] [0]
      #* ZDA Clock              [0] [0]
      #* HDT Heading            [0] [0]
      #* SKR82 Heading          [0] [0]
      #* DBS Depth              [0] [0]
      #* DPT Depth              [0] [0]
      #* EA500 Depth            [0] [0]
      #* ROV. depth             [0] [0]
      #* Height, special purp   [0] [0]
      #* Ethernet AttVel        [0] [0]
   #} Input Formats

#} COM2

#{ COM3 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #* Baud rate:             [9600]
      #* Data bits              [8]
      #* Stop bits:             [1]
      #* Parity:                [NONE]
```

```
    #} Com. settings

    #{ Position #// Position input settings.
       #* None                 [1] [1]
       #* GGK                  [1] [0]
       #* GGA                  [1] [0]
       #* GGA_RTK              [1] [0]
       #* SIMRAD90             [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
       #* Attitude             [1] [0]
       #* MK39 Mod2 Attitude,  [1] [0]
       #* ZDA Clock            [0] [0]
       #* HDT Heading          [1] [0]
       #* SKR82 Heading        [1] [0]
       #* DBS Depth            [1] [0]
       #* DPT Depth            [1] [0]
       #* EA500 Depth          [0] [0]
       #* ROV. depth           [1] [0]
       #* Height, special purp [1] [0]
       #* Ethernet AttVel      [0] [0]
    #} Input Formats

 #} COM3

 #{ COM4 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
       #* Baud rate:           [9600]
       #* Data bits            [8]
       #* Stop bits:           [1]
       #* Parity:              [NONE]
    #} Com. settings

    #{ Position #// Position input settings.
       #* None                 [1] [1]
       #* GGK                  [1] [0]
       #* GGA                  [1] [0]
       #* GGA_RTK              [1] [0]
       #* SIMRAD90             [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
       #* Attitude             [0] [0]
       #* MK39 Mod2 Attitude,  [0] [0]
       #* ZDA Clock            [0] [0]
       #* HDT Heading          [1] [0]
       #* SKR82 Heading        [1] [0]
       #* DBS Depth            [1] [0]
       #* DPT Depth            [1] [0]
       #* EA500 Depth          [0] [0]
       #* ROV. depth           [1] [0]
       #* Height, special purp [1] [0]
       #* Ethernet AttVel      [0] [0]
    #} Input Formats

 #} COM4

 #{ UDP2 #// Link settings.
```

```
    #{ Com. settings #// Serial line parameter settings.
       #// N/A
    #} Com. settings

    #{ Position #// Position input settings.
       #* None                 [1] [1]
       #* GGK                  [1] [0]
       #* GGA                  [1] [0]
       #* GGA_RTK              [1] [0]
       #* SIMRAD90             [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
       #* Attitude             [0] [0]
       #* MK39 Mod2 Attitude,  [0] [0]
       #* ZDA Clock            [0] [0]
       #* HDT Heading          [0] [0]
       #* SKR82 Heading        [0] [0]
       #* DBS Depth            [0] [0]
       #* DPT Depth            [0] [0]
       #* EA500 Depth          [1] [0]
       #* ROV. depth           [0] [0]
       #* Height, special purp [0] [0]
       #* Ethernet AttVel      [0] [0]
    #} Input Formats

 #} UDP2

 #{ UDP3 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
       #// N/A
    #} Com. settings

    #{ Position #// Position input settings.
       #* None                 [0] [1]
       #* GGK                  [0] [0]
       #* GGA                  [0] [0]
       #* GGA_RTK              [0] [0]
       #* SIMRAD90             [0] [0]
    #} Position

    #{ Input Formats #// Format input settings.
       #* Attitude             [0] [0]
       #* MK39 Mod2 Attitude,  [0] [0]
       #* ZDA Clock            [0] [0]
       #* HDT Heading          [1] [0]
       #* SKR82 Heading        [0] [0]
       #* DBS Depth            [1] [0]
       #* DPT Depth            [1] [0]
       #* EA500 Depth          [0] [0]
       #* ROV. depth           [1] [0]
       #* Height, special purp [1] [0]
       #* Ethernet AttVel      [0] [0]
    #} Input Formats

 #} UDP3

 #{ UDP4 #// Link settings.
```

```
      #{ Com. settings #// Serial line parameter settings.
         #// N/A
      #} Com. settings

      #{ Position #// Position input settings.
         #* None                 [0] [1]
         #* GGK                  [0] [0]
         #* GGA                  [0] [0]
         #* GGA_RTK              [0] [0]
         #* SIMRAD90             [0] [0]
      #} Position

      #{ Input Formats #// Format input settings.
         #* Attitude             [1] [0]
         #* MK39 Mod2 Attitude,  [0] [0]
         #* ZDA Clock            [0] [0]
         #* HDT Heading          [1] [0]
         #* SKR82 Heading        [0] [0]
         #* DBS Depth            [1] [0]
         #* DPT Depth            [1] [0]
         #* EA500 Depth          [0] [0]
         #* ROV. depth           [1] [0]
         #* Height, special purp [1] [0]
         #* Ethernet AttVel      [0] [0]
      #} Input Formats

   #} UDP4

   #{ UDP5 #// Link settings.

      #{ Com. settings #// Serial line parameter settings.
         #// N/A
      #} Com. settings

      #{ Position #// Position input settings.
         #* None                 [0] [0]
         #* GGK                  [0] [0]
         #* GGA                  [0] [0]
         #* GGA_RTK              [0] [0]
         #* SIMRAD90             [0] [0]
      #} Position

      #{ Input Formats #// Format input settings.
         #* Attitude             [0] [0]
         #* MK39 Mod2 Attitude,  [0] [0]
         #* ZDA Clock            [0] [0]
         #* HDT Heading          [0] [0]
         #* SKR82 Heading        [0] [0]
         #* DBS Depth            [0] [0]
         #* DPT Depth            [0] [0]
         #* EA500 Depth          [0] [0]
         #* ROV. depth           [0] [0]
         #* Height, special purp [0] [0]
         #* Ethernet AttVel      [0] [0]
      #} Input Formats

      #{ Attitude Velocity settings #// Only relevant for UDP5 on EM122,
EM302, EM710, EM2040 currently
         #* Attitude 1           [1] [1]
```

```
      #* Attitude 2           [1] [0]
      #* Use Ethernet 2       [1] [0]
      #* Port:                [3001]
      #* IP addr.:            [192.168.1.1]
      #* Net mask:            [255.255.0.0]
   #} Attitude Velocity settings

#} UDP5

#{ MCAST1 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #// N/A
   #} Com. settings

   #{ Position #// Position input settings.
      #* None                 [1] [1]
      #* GGK                  [0] [0]
      #* GGA                  [0] [0]
      #* GGA_RTK              [0] [0]
      #* SIMRAD90             [0] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude             [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock            [0] [0]
      #* HDT Heading          [0] [0]
      #* SKR82 Heading        [0] [0]
      #* DBS Depth            [0] [0]
      #* DPT Depth            [0] [0]
      #* EA500 Depth          [0] [0]
      #* ROV. depth           [0] [0]
      #* Height, special purp [0] [0]
      #* Ethernet AttVel      [1] [0]
   #} Input Formats

#} MCAST1

#{ MCAST2 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #// N/A
   #} Com. settings

   #{ Position #// Position input settings.
      #* None                 [1] [1]
      #* GGK                  [1] [0]
      #* GGA                  [1] [0]
      #* GGA_RTK              [1] [0]
      #* SIMRAD90             [1] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude             [0] [0]
      #* MK39 Mod2 Attitude,  [0] [0]
      #* ZDA Clock            [0] [0]
      #* HDT Heading          [0] [0]
      #* SKR82 Heading        [0] [0]
      #* DBS Depth            [0] [0]
```

```
      #* DPT Depth             [0] [0]
      #* EA500 Depth           [0] [0]
      #* ROV. depth            [0] [0]
      #* Height, special purp  [0] [0]
      #* Ethernet AttVel       [1] [0]
   #} Input Formats

#} MCAST2

#{ MCAST3 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #// N/A
   #} Com. settings

   #{ Position #// Position input settings.
      #* None                  [1] [1]
      #* GGK                   [1] [0]
      #* GGA                   [1] [0]
      #* GGA_RTK               [1] [0]
      #* SIMRAD90              [1] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude              [0] [0]
      #* MK39 Mod2 Attitude,   [0] [0]
      #* ZDA Clock             [0] [0]
      #* HDT Heading           [0] [0]
      #* SKR82 Heading         [0] [0]
      #* DBS Depth             [0] [0]
      #* DPT Depth             [0] [0]
      #* EA500 Depth           [0] [0]
      #* ROV. depth            [0] [0]
      #* Height, special purp  [0] [0]
      #* Ethernet AttVel       [1] [0]
   #} Input Formats

#} MCAST3

#{ MCAST4 #// Link settings.

   #{ Com. settings #// Serial line parameter settings.
      #// N/A
   #} Com. settings

   #{ Position #// Position input settings.
      #* None                  [0] [1]
      #* GGK                   [0] [0]
      #* GGA                   [0] [0]
      #* GGA_RTK               [0] [0]
      #* SIMRAD90              [0] [0]
   #} Position

   #{ Input Formats #// Format input settings.
      #* Attitude              [0] [0]
      #* MK39 Mod2 Attitude,   [0] [0]
      #* ZDA Clock             [0] [0]
      #* HDT Heading           [0] [0]
      #* SKR82 Heading         [0] [0]
      #* DBS Depth             [0] [0]
```

```
         #* DPT Depth            [0] [0]
         #* EA500 Depth          [0] [0]
         #* ROV. depth           [0] [0]
         #* Height, special purp [0] [0]
         #* Ethernet AttVel      [1] [0]
      #} Input Formats

   #} MCAST4


   #{ Misc. #// Misc. input settings.
      #* External Trigger     [1] [0]
   #} Misc.

#} Input Setup

#{ Output Setup #// All Output setup parameters

   #* PU broadcast enable  [1] [1]
   #* Log watercolumn to s [1] [0]

   #{ Host UDP1 #// Host UDP1 Port: 16100

      #{ Datagram subscription #//
         #* Depth                [0] [0]
         #* Raw range and beam a [0] [0]
         #* Seabed Image         [0] [0]
         #* Central Beams        [0] [0]
         #* Position             [0] [0]
         #* Attitude             [0] [0]
         #* Heading              [0] [0]
         #* Height               [0] [0]
         #* Clock                [0] [0]
         #* Single beam echosoun [0] [0]
         #* Sound Speed Profile  [0] [1]
         #* Runtime Parameters   [0] [1]
         #* Installation Paramet [0] [1]
         #* BIST Reply           [0] [1]
         #* Status parameters    [0] [1]
         #* PU Broadcast         [0] [0]
         #* Stave Display        [0] [0]
         #* Water Column         [0] [0]
         #* Internal, Range Data [0] [0]
         #* Internal, Scope Data [0] [0]
      #} Datagram subscription

   #} Host UDP1


   #{ Host UDP2 #// Host UDP2 Port: 16101

      #{ Datagram subscription #//
         #* Depth                [1] [1]
         #* Raw range and beam a [1] [1]
         #* Seabed Image         [1] [1]
         #* Central Beams        [0] [0]
         #* Position             [1] [1]
         #* Attitude             [1] [1]
         #* Heading              [1] [1]
         #* Height               [1] [1]
```

```
      #* Clock                    [1] [1]
      #* Single beam echosoun [1] [1]
      #* Sound Speed Profile  [0] [1]
      #* Runtime Parameters   [0] [1]
      #* Installation Paramet [0] [1]
      #* BIST Reply           [1] [1]
      #* Status parameters    [0] [1]
      #* PU Broadcast         [1] [0]
      #* Stave Display        [0] [1]
      #* Water Column         [0] [1]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
   #} Datagram subscription

#} Host UDP2


#{ Host UDP3 #// Host UDP3 Port: 16102

   #{ Datagram subscription #//
      #* Depth                [0] [1]
      #* Raw range and beam a [0] [0]
      #* Seabed Image         [0] [0]
      #* Central Beams        [0] [0]
      #* Position             [0] [0]
      #* Attitude             [0] [1]
      #* Heading              [0] [0]
      #* Height               [0] [1]
      #* Clock                [0] [0]
      #* Single beam echosoun [0] [1]
      #* Sound Speed Profile  [0] [1]
      #* Runtime Parameters   [0] [0]
      #* Installation Paramet [0] [1]
      #* BIST Reply           [0] [0]
      #* Status parameters    [0] [0]
      #* PU Broadcast         [0] [0]
      #* Stave Display        [0] [0]
      #* Water Column         [0] [0]
      #* Internal, Range Data [0] [0]
      #* Internal, Scope Data [0] [1]
   #} Datagram subscription

#} Host UDP3


#{ Host UDP4 #// Host UDP4 Port 16103

   #{ Datagram subscription #//
      #* Depth                [1] [1]
      #* Raw range and beam a [1] [0]
      #* Seabed Image         [1] [1]
      #* Central Beams        [0] [0]
      #* Position             [1] [0]
      #* Attitude             [1] [1]
      #* Heading              [1] [1]
      #* Height               [1] [0]
      #* Clock                [1] [0]
      #* Single beam echosoun [1] [0]
      #* Sound Speed Profile  [1] [0]
      #* Runtime Parameters   [1] [0]
```

```
      #* Installation Paramet [1] [0]
      #* BIST Reply           [1] [0]
      #* Status parameters    [1] [0]
      #* PU Broadcast         [1] [0]
      #* Stave Display        [1] [0]
      #* Water Column         [1] [0]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
   #} Datagram subscription

  #} Host UDP4


  #{ Watercolumn #// Host UDP4 Port 16103

   #{ Datagram subscription #//
      #* Depth                [1] [0]
      #* Raw range and beam a [1] [0]
      #* Seabed Image         [1] [0]
      #* Central Beams        [1] [0]
      #* Position             [1] [0]
      #* Attitude             [1] [0]
      #* Heading              [1] [0]
      #* Height               [1] [0]
      #* Clock                [1] [0]
      #* Single beam echosoun [1] [0]
      #* Sound Speed Profile  [1] [0]
      #* Runtime Parameters   [1] [0]
      #* Installation Paramet [1] [0]
      #* BIST Reply           [1] [0]
      #* Status parameters    [1] [0]
      #* PU Broadcast         [1] [0]
      #* Stave Display        [1] [0]
      #* Water Column         [1] [1]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
   #} Datagram subscription

  #} Watercolumn

#} Output Setup

#{ Clock Setup #// All Clock setup parameters

  #{ Clock #// All clock settings.
   #* Source:              [1] #// External ZDA Clock
   #* 1PPS Clock Synch.    [1] [1]
   #* Offset (sec.):       [0]
  #} Clock

#} Clock Setup

#{ Settings #// Sensor setup parameters

  #{ Positioning System Settings #// Position related settings.

   #{ COM1 #// Positioning System Ports:
      #* P1S                  [1] #// Serial
      #* P1T                  [1] #// Datagram
      #* P1M                  [0] #// Enable position motion
```

```
correction
         #* P1D                  [0] #// Position delay (sec.):
         #* P1G                  [GRS80] #// Datum:
         #* P1Q                  [1] #// Enable
         #* Pos. qual. indicator [] #//
      #} COM1

   #} Positioning System Settings

   #{ Motion Sensor Settings #// Motion related settings.

      #{ COM2 #// Motion Sensor Ports:
         #* MRP                  [RP] #// Rotation (POSMV/MRU)
         #* MSD                  [0] #// Motion Delay (msec.):
         #* MAS                  [1.00] #// Motion Sensor Roll Scaling:
      #} COM2

   #} Motion Sensor Settings

   #{ Active Sensors #//
      #* APS                  [0] [COM1] #// Position:
      #* ARO                  [2] [COM2] #// Motion:
      #* AHE                  [2] [COM2] #// Motion:
      #* AHS                  [2] [COM2] #// Heading:
   #} Active Sensors

#} Settings

#{ Locations #// All location parameters

   #{ Location offset (m) #//

      #{ Pos, COM1: #//
         #* P1X                  [0.00] #// Forward (X)
         #* P1Y                  [0.00] #// Starboard (Y)
         #* P1Z                  [0.00] #// Downward (Z)
      #} Pos, COM1:

      #{ Pos, COM3: #//
         #* P2X                  [0.00] #// Forward (X)
         #* P2Y                  [0.00] #// Starboard (Y)
         #* P2Z                  [0.00] #// Downward (Z)
      #} Pos, COM3:

      #{ Pos, COM4/UDP2: #//
         #* P3X                  [0.00] #// Forward (X)
         #* P3Y                  [0.00] #// Starboard (Y)
         #* P3Z                  [0.00] #// Downward (Z)
      #} Pos, COM4/UDP2:

      #{ Sonar head 1: #//
         #* S1X                  [0.00] #// Forward (X)
         #* S1Y                  [0.00] #// Starboard (Y)
         #* S1Z                  [0.00] #// Downward (Z)
      #} Sonar head 1:

      #{ Attitude 1, COM2: #//
         #* MSX                  [0.00] #// Forward (X)
         #* MSY                  [0.00] #// Starboard (Y)
         #* MSZ                  [0.00] #// Downward (Z)
```

```
      #} Attitude 1, COM2:

      #{ Attitude 2, COM3: #//
         #* NSX                    [0.00] #// Forward (X)
         #* NSY                    [0.00] #// Starboard (Y)
         #* NSZ                    [0.00] #// Downward (Z)
      #} Attitude 2, COM3:

      #{ Waterline: #//
         #* WLZ                    [0.00] #// Downward (Z)
      #} Waterline:

      #{ Depth Sensor: #//
         #* DSX                    [0.00] #// Forward (X)
         #* DSY                    [0.00] #// Starboard (Y)
         #* DSZ                    [0.00] #// Downward (Z)
      #} Depth Sensor:

   #} Location offset (m)

#} Locations

#{ Angular Offsets #// All angular offset parameters

   #{ Offset angles (deg.) #//

      #{ Sonar head 1: #//
         #* S1R                    [0.00] #// Roll
         #* S1P                    [0.00] #// Pitch
         #* S1H                    [0.00] #// Heading
      #} Sonar head 1:

      #{ Attitude 1, COM2: #//
         #* MSR                    [0.00] #// Roll
         #* MSP                    [0.00] #// Pitch
         #* MSG                    [0.00] #// Heading
      #} Attitude 1, COM2:

      #{ Attitude 2, COM3: #//
         #* NSR                    [0.00] #// Roll
         #* NSP                    [0.00] #// Pitch
         #* NSG                    [0.00] #// Heading
      #} Attitude 2, COM3:

      #{ Stand-alone Heading: #//
         #* GCG                    [0.00] #// Heading
      #} Stand-alone Heading:

   #} Offset angles (deg.)

#} Angular Offsets

#{ ROV. Specific #// All ROV specific parameters

   #{ Depth/Pressure Sensor #//
      #* DSF                    [1.00] #// Scaling:
      #* DSO                    [0.00] #// Offset:
      #* DSD                    [0] #// Delay (msec.):
      #* DSH                    [NI] #// Disable Heave Sensor
   #} Depth/Pressure Sensor
```

```
#} ROV. Specific

#{ System Parameters #// All system parameters

   #{ BS Offset and TX Freq. #//

      #{ Sonar head 1: #//
         #* GO1                    [0.0] #// BS Offset (dB)
         #* FX1                    [2] #// TX Freq. (kHz) 300
      #} Sonar head 1:

   #} BS Offset and TX Freq.

#} System Parameters

#//
*********************************************************************
#// Runtime parameters


#{ Sounder Main #//

   #{ Sector Coverage #//

      #{ Sonar Head 1 (deg.): #//
         #* MPA                    [65] #// Port
         #* MSA                    [65] #// Starboard
      #} Sonar Head 1 (deg.):
      #{ Coverage (m): #//
         #* MPC                    [300] #// Port
         #* MSC                    [300] #// Starboard
      #} Coverage (m):

      #* ACM                    [1] #// Angular Coverage mode: AUTO
      #* BSP                    [2] #// Beam Spacing: HIDENS EQDIST

   #} Sector Coverage

   #{ Depth Settings #//
      #* FDE                    [2] #// Force Depth (m):
      #* MID                    [1.00] #// Min. Depth (m):
      #* MAD                    [3.00] #// Max. Depth (m):
   #} Depth Settings

   #{ Transmit Control #//
      #* YPS                    [0] #// Pitch stabilization
      #* BMW                    [0] #// Beam Width: NORMAL
      #* TXA                    [0.0] #// Along Direction (deg.):
      #* PRF                    [40.00] #// Max. Ping Freq. (Hz):
   #} Transmit Control

#} Sounder Main

#{ Sound Speed #//

   #{ Sound Speed at Transducer #//
      #* SHS                    [0] #// Source SENSOR
      #* SST                    [15000] #// Sound Speed (dm/sec.):
      #* Sensor Offset (m/sec [0.0] #//
```

```
      #* Filter (sec.):       [60] #//
   #} Sound Speed at Transducer


#// The ROV Specific parameters Offset and Scale are located in the
Installation Parameters part of this listing.
#} Sound Speed

#{ Filter and Gains #//

   #{ Filtering #//
      #* SFS                  [0] #// Spike Filter Strength: OFF
      #* RGS                  [1] #// Range Gate: NORMAL
      #* SLF                  [1] #// Slope
   #} Filtering

   #{ Absorption Coefficient #//
      #* Source:              [0] #// Salinity. Note: This is not a PU
parameter.
      #* ABC                  [65.108] #// 300.0 kHz
   #} Absorption Coefficient

   #{ Normal incidence sector #//
      #* TCA                  [10] #// Angle from nadir (deg.):
   #} Normal incidence sector

#} Filter and Gains

#{ Data Cleaning #//
   #* Active rule:         [AUTOMATIC1] #//
   #{ AUTOMATIC1 #//
      #* PingProc.maxPingCountRadius                          [10]
      #* PingProc.radiusFactor                                [0.050000]
      #* PingProc.medianFactor                                [1.500000]
      #* PingProc.beamNumberRadius                            [3]
      #* PingProc.sufficientPointCount                        [40]
      #* PingProc.neighborhoodType                            [Elliptical]
      #* PingProc.timeRule.use                                [false]
      #* PingProc.overhangRule.use                            [false]
      #* PingProc.medianRule.use                              [false]
      #* PingProc.medianRule.depthFactor                      [0.050000]
      #* PingProc.medianRule.minPointCount                    [6]
      #* PingProc.quantileRule.use                            [false]
      #* PingProc.quantileRule.quantile                       [0.100000]
      #* PingProc.quantileRule.scaleFactor                    [6.000000]
      #* PingProc.quantileRule.minPointCount                  [40]
      #* GridProc.minPoints                                   [8]
      #* GridProc.depthFactor                                 [0.200000]
      #* GridProc.removeTooFewPoints                          [false]
      #* GridProc.surfaceFitting.surfaceDegree                [1]
      #* GridProc.surfaceFitting.tukeyConstant                [6.000000]
      #* GridProc.surfaceFitting.maxIteration                 [10]
      #* GridProc.surfaceFitting.convCriterion                [0.010000]
      #* GridProc.surfaceDistanceDepthRule.use                [false]
      #* GridProc.surfaceDistanceDepthRule.depthFactor        [0.050000]
      #* GridProc.surfaceDistancePointRule.use                [false]
      #* GridProc.surfaceDistancePointRule.scaleFactor        [1.000000]
      #* GridProc.surfaceDistanceUnitRule.use                 [false]
      #* GridProc.surfaceDistanceUnitRule.scaleFactor         [1.000000]
      #* GridProc.surfaceDistanceStDevRule.use                [false]
```

```
    #* GridProc.surfaceDistanceStDevRule.scaleFactor      [2.000000]
    #* GridProc.surfaceAngleRule.use                      [false]
    #* GridProc.surfaceAngleRule.minAngle                 [20.000000]
    #* SonarProc.use                                      [false]
    #* SonarProc.gridSizeFactor                           [4]
    #* SonarProc.mergerType                               [Average]
    #* SonarProc.interpolatorType                         [TopHat]
    #* SonarProc.interpolatorRadius                       [1]
    #* SonarProc.fillInOnly                               [true]
  #} AUTOMATIC1

  #{ Seabed Image Processing #//
    #* Seabed Image Process [1] [0]
  #} Seabed Image Processing
#} Data Cleaning

#{ Advanced param. #//

  #{ Manual control #//
    #* TPL                  [0] #// Pulse length (us): AUTO
    #* RVF                  [0] #// Special TVG
    #* MPS                  [0] #// Multi Path Suppression
    #* SOF                  [0] #// Soft Sediments
    #* RV1                  [0.0] #// RX gain offset (dB):
    #* RV2                  [0.0] #// TVG ramp level (dB):
    #* DEM                  [0] #// Detector Mode: NORMAL
    #* PHR                  [1] #// Phase ramp: NORMAL
  #} Manual control

#} Advanced param.
```

Appendix 7 – SonarPro Device Settings

```
[Cable Out]
CONumDevices=10
CODeviceName_0000=SD41 from 3PS, Inc.
COMsgDel_0000=<CR><LF>
COMsgNumSpec_0000=0
COCmdPrefix_0000=1
COPrefix_0000=<CR><LF>
COPreNumSpec_0000=0
COFixedPos_0000=1
COCharStart_0000=16
COCharEnd_0000=22
COFieldNum_0000=4
COFieldDel_0000=,
COScaleFactor_0000=0.304800
COOffset_0000=0.000000
COPollRate_0000=500
COBaudRate_0000=9600
COByteSize_0000=8
COParity_0000=0
COStopBits_0000=0
CODeviceName_0001=Tcount Counter System from BJ Design
COMsgDel_0001=<CR><LF>
COMsgNumSpec_0001=0
COCmdPrefix_0001=0
COPrefix_0001=
COPreNumSpec_0001=0
COFixedPos_0001=0
COCharStart_0001=0
COCharEnd_0001=0
COFieldNum_0001=2
COFieldDel_0001=:
COScaleFactor_0001=1.479690
COOffset_0001=0.000000
COPollRate_0001=500
COBaudRate_0001=9600
COByteSize_0001=8
COParity_0001=0
COStopBits_0001=0
CODeviceName_0002=Brooke Ocean Technology Metering Sheave
COMsgDel_0002=<CR>
COMsgNumSpec_0002=0
COCmdPrefix_0002=1
COPrefix_0002=CABLEOUT
COPreNumSpec_0002=0
COFixedPos_0002=0
COCharStart_0002=0
COCharEnd_0002=0
COFieldNum_0002=1
COFieldDel_0002=<SP>
COScaleFactor_0002=1.000000
COOffset_0002=0.000000
COPollRate_0002=500
COBaudRate_0002=9600
COByteSize_0002=8
COParity_0002=0
COStopBits_0002=0
CODeviceName_0003=Delph format from CoastalO
COMsgDel_0003=<CR><LF>
COMsgNumSpec_0003=0
```

```
COCmdPrefix_0003=0
COPrefix_0003=
COPreNumSpec_0003=0
COFixedPos_0003=0
COCharStart_0003=0
COCharEnd_0003=0
COFieldNum_0003=11
COFieldDel_0003=<SP>
COScaleFactor_0003=1.000000
COOffset_0003=0.000000
COPollRate_0003=500
COBaudRate_0003=9600
COByteSize_0003=8
COParity_0003=0
COStopBits_0003=0
CODeviceName_0004=TOTCO Cable Counter
COMsgDel_0004=<CR><LF>
COMsgNumSpec_0004=0
COCmdPrefix_0004=0
COPrefix_0004=
COPreNumSpec_0004=0
COFixedPos_0004=0
COCharStart_0004=0
COCharEnd_0004=0
COFieldNum_0004=4
COFieldDel_0004=,
COScaleFactor_0004=1.000000
COOffset_0004=0.000000
COPollRate_0004=500
COBaudRate_0004=9600
COByteSize_0004=8
COParity_0004=0
COStopBits_0004=0
CODeviceName_0005=Dynapar Cable Counter
COMsgDel_0005=<CR>
COMsgNumSpec_0005=0
COCmdPrefix_0005=1
COPrefix_0005=<CR>R:<SP>Co.
COPreNumSpec_0005=0
COFixedPos_0005=1
COCharStart_0005=8
COCharEnd_0005=14
COFieldNum_0005=0
COFieldDel_0005=
COScaleFactor_0005=0.100000
COOffset_0005=0.000000
COPollRate_0005=500
COBaudRate_0005=2400
COByteSize_0005=7
COParity_0005=0
COStopBits_0005=0
CODeviceName_0006=NMEA 0183 format template
COMsgDel_0006=*<#><#><CR><LF>
COMsgNumSpec_0006=2
COCmdPrefix_0006=1
COPrefix_0006=$--CCO
COPreNumSpec_0006=0
COFixedPos_0006=0
COCharStart_0006=0
COCharEnd_0006=0
```

```
COFieldNum_0006=1
COFieldDel_0006=,
COScaleFactor_0006=1.000000
COOffset_0006=0.000000
COPollRate_0006=500
COBaudRate_0006=4800
COByteSize_0006=8
COParity_0006=0
COStopBits_0006=0
CODeviceName_0007=Delph
COMsgDel_0007=<LF><LF>
COMsgNumSpec_0007=0
COCmdPrefix_0007=0
COPrefix_0007=
COPreNumSpec_0007=0
COFixedPos_0007=0
COCharStart_0007=10
COCharEnd_0007=11
COFieldNum_0007=10
COFieldDel_0007=<SP>
COScaleFactor_0007=1.000000
COOffset_0007=0.000000
COPollRate_0007=500
COBaudRate_0007=9600
COByteSize_0007=8
COParity_0007=0
COStopBits_0007=0
CODeviceName_0008=Dynapar Cable Counter_2
COMsgDel_0008=<CR>
COMsgNumSpec_0008=0
COCmdPrefix_0008=1
COPrefix_0008=<CR>R:<SP>Co.
COPreNumSpec_0008=0
COFixedPos_0008=1
COCharStart_0008=8
COCharEnd_0008=14
COFieldNum_0008=0
COFieldDel_0008=
COScaleFactor_0008=0.100000
COOffset_0008=0.000000
COPollRate_0008=500
COBaudRate_0008=9600
COByteSize_0008=8
COParity_0008=0
COStopBits_0008=0
CODeviceName_0009=Delph format from Coastal1
COMsgDel_0009=CableLength
COMsgNumSpec_0009=0
COCmdPrefix_0009=1
COPrefix_0009=CableLength
COPreNumSpec_0009=0
COFixedPos_0009=1
COCharStart_0009=102
COCharEnd_0009=106
COFieldNum_0009=11
COFieldDel_0009=<SP>
COScaleFactor_0009=1.000000
COOffset_0009=0.000000
COPollRate_0009=500
COBaudRate_0009=9600
```

```
COByteSize_0009=8
COParity_0009=0
COStopBits_0009=0
[Depth Output]
DepthNumDevices=3
DepthDeviceName_0000=ORE Trackpoint
DepthPrefix_0000=<^D> 1
DepthSuffix_0000=<CR><LF>
DepthScaleFactor_0000=1.000000
DepthOffset_0000=0.000000
DepthNumDecPlaces_0000=1
DepthSendRate_0000=1000
DepthBaudRate_0000=4800
DepthByteSize_0000=8
DepthParity_0000=0
DepthStopBits_0000=0
DepthDeviceName_0001=NMEA 0183 DPT (Depth)
DepthPrefix_0001=$SNDPT,
DepthSuffix_0001=,0.0,<MAX>*<CHK><CR><LF>
DepthScaleFactor_0001=1.000000
DepthOffset_0001=0.000000
DepthNumDecPlaces_0001=1
DepthSendRate_0001=1000
DepthBaudRate_0001=4800
DepthByteSize_0001=8
DepthParity_0001=0
DepthStopBits_0001=0
DepthDeviceName_0002=ORE Trackpoint
DepthPrefix_0002=
DepthSuffix_0002=<CR><LF>
DepthScaleFactor_0002=1.000000
DepthOffset_0002=0.000000
DepthNumDecPlaces_0002=1
DepthSendRate_0002=1000
DepthBaudRate_0002=9600
DepthByteSize_0002=8
DepthParity_0002=0
DepthStopBits_0002=0
```

Appendix 8 – Hypack & Hysweep Hardware Settings

```
[Ranges]
Count=0
[Printer]
Port=NUL:
[System]
SortOrder=Off
NormalView=Off
AutoSave=Off
EnableTidePerMobile=Off
Devices=3
Boats=1
HardwareAdvanced=On
HardwareVersion=3
[autostart]
logging=Off
[Files]
XYZ=Off
RAW=Off
[Device0]
Library=OdomCV_3.dll
Name=Odom CV2
Type=32784
Flags=16777728
RecInterval=0.00
Offset=0.00,0.00,0.00,0.00,0.00,0.00
OffsetM=0.000,0.000,0.000,0.00,0.00,0.00
Latency=0.00
Port=NET:129.100.200.200:1600,UDP,1601
QAParams=0.00,0.00,0.00,0.00,0.00,0.00
Message=FM
Boat=0
Channel1=1
Channel2=0
Channel3=0
HdgStr=CV3
MainLeft=0
MainWidth=244
MainTop=0
MainHeight=148
MainOpen=On
Ch1Left=25
Ch1Top=680
Ch1Width=278
Ch1Height=221
Ch1Open=Off
Disabled=On
[Device1]
Library=posmv.dll
Name=Applanix POS MV Network
Type=196
Flags=49152
RecInterval=0.00
Offset=0.00,0.00,0.00,0.00,0.00,0.00
OffsetM=0.000,0.000,0.000,0.00,0.00,0.00
Latency=0.00
Port=NET:129.100.1.231:5602,UDP,5602
QAParams=0.00,0.00,0.00,0.00,0.00,0.00
Message=FRQ
Boat=0
UseT0=Off
```

```
TrueHeave=Off
Heave111=Off
Sensor1=On
SerialPort=0
MaxRTKCode=4
Version3=Off
UTCAlways=On
TideAlways=Off
[Device2]
Library=hysweep.dll
Name=HySweep Interface
Type=560
Flags=16777216
RecInterval=0.00
Offset=0.00,0.00,0.00,0.00,0.00,0.00
OffsetM=0.000,0.000,0.000,0.00,0.00,0.00
Latency=0.00
Port=NUL:
QAParams=0.00,0.00,0.00,0.00,0.00,0.00
Message=FM
Boat=0
Initial=1.20
[Boat]
TrackX=0.00
TrackY=0.00
Length=0.00
Width=0.00
Function=0
InfoSource=1,2,-1,1,-1,2,-1,-1,-1,2,2,2
Shape=C:\HYPACK 2009\Boat Shapes\Birdofprey.shp
[Windows]
Kernel=-8,-8,1288,110,1
ToolBox=On
Map=-1,-1,745,638,1
Helm Map=1017,2,742,596,1
Data Display=747,3,267,419,1
Helm Data Display=1761,3,258,572,1
Left/Right Indicator=1017,565,1016,107,1
Helm Left/Right Indicator=-15,515,1003,105,2
Device0=2050,498,252,182,1
Device1=1006,357,268,224,1
Device2=-30,624,426,113,1
[Data Display]
Maxitems=1000
Visible=7,16,8,29,45,5,2,6,33,34,14,12,40,28
[Helm Data Display]
Maxitems=1000
Visible=7,9,6,3,8,29,45,5,0,1,50,51,12,13,40,23,18,17,28,16
```

```
[Settings]
NDevices=2
HighQualityLimit=1
LowQualityLimit=1
SonarId=37
[Device0]
Name=Hypack Navigation
MfrId=7
ModelId=2
Enabled=1
IgnoreChecksum=1
RawMessages=0
Timeout=15.0
PosOffsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
HdgOffsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
RtkTideOffsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
OnTowfish=0
[Device1]
Name=Simrad EM3002
MfrId=3
ModelId=3
InternetAddress=157.237.2.61
NetPort=16103
Enabled=1
IgnoreChecksum=1
RawMessages=0
Timeout=15.0
HdgOffsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
HprOffsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
Head1Offsets=0.00 0.00 0.00 0.00 0.00 0.00 0.000
OnTowfish=0
RecordRaw=0
UseCombinedHeaveDraft=0
UseImage=1
UseRawEM3000Data=1
```

Appendix 9 – POS/MV Configuration Settings

Extract POS COnfig Version 1.0

September 8 2011 11:20 am

Source Name: pos_new_config.nvm
Output File: Z:\SystemsCert\2011\HSRR\WiringDiagram\pos_new_config

```
Message 37 - Base GPS 1 Setup

   Input Data Type Port 1 - Accept RTCM 1/9

Message 38 - Base GPS 2 Setup

   Input Data Type Port 2 - Accept RTCM 1/9

Message 34 - COM Port Setup

   Number of COM ports = 5
   COM1 - Protocol: 9600,No Parity,8 data,1 stop,None
          Input Selection: No Input
          Output Selection: NMEA Message

   COM2 - Protocol: 19200,No Parity,8 data,1 stop,None
          Input Selection: No Input
          Output Selection: Real-time Binary

   COM3 - Protocol: 9600,No Parity,8 data,1 stop,None
          Input Selection: Base GPS 1
          Output Selection: No Output

   COM4 - Protocol: 9600,No Parity,8 data,1 stop,None
          Input Selection: No Input
          Output Selection: NMEA Message

   COM5 - Protocol: 4800,No Parity,8 data,1 stop,None
          Input Selection: No Input
          Output Selection: NMEA Message

Message 51 - Display Port Control

   Number of groups selected for Display Port = 26
   1  2  3  4  5  6  7  8  9  10  11  12
   13  14  17  20  21  25  26  99  102  103  104  105
   110  20000

Message 53 - Logging Port Control

   Number of groups selected for Logging Port = 0
   Logging Port Output Rate 1 Hz
   AutoLog Select Disabled

Message 135 - NMEA Message Select

   Number of Port 3
      Assigned port number COM1
         Update Rate Selection 1 Hz
         Output Selection  GGA HDT ZDA VTG
         talker ID $IN
         Roll Sense Port Up
```

```
         Pitch Sense Bow Up
         Heave Sense Heave Up
      Assigned port number COM4
         Update Rate Selection 1 Hz
         Output Selection  GGA HDT ZDA VTG
         talker ID $IN
         Roll Sense Port Up
         Pitch Sense Bow Up
         Heave Sense Heave Up
      Assigned port number COM5
         Update Rate Selection 1 Hz
         Output Selection  GGA HDT ZDA VTG UTC
         talker ID $IN
         Roll Sense Port Up
         Pitch Sense Bow Up
         Heave Sense Heave Up

Message 136 - Binary Message Select

   Number of Port 1
      Assigned port number COM2
         Update Rate Selection 50 Hz
         Output Selection  SIMRAD-1000(TB)
         Selected frame Sensor1
         Roll Sense Port Up
         Pitch Sense Bow Up
         Heave Sense Heave Up

Message 33 - Event Discrete Setup

   Event 1 Trigger Positive edge
   Event 2 Trigger Positive edge

Message 30 - Primary GPS Setup

   GPS AutoConfig True

Message 31 - Secondary GPS Setup

   GPS AutoConfig True

Message 24 - User Accuracy Specifications

   User Attitude Accuracy 0.05
   User Heading Accuracy 0.05
   User Position Accuracy 2
   User Velocity Accuracy 0.5

Message 52 - Real-time Data Port Control

   Number of groups selected for Real-time Data Port = 4
   3  7  20  102
Data Port Output Rate 2 Hz

Message 61 - Data Port Control

   Number of groups selected for Data Port = 16
   1  2  4  5  9  10  99  110  111  113  10001  10007
   10008  10009  10011  10012
   Data Port Output Rate 25 Hz

Message 20 - General Installation Parameters
```

```
   Ref to IMU Lever Arm   -0.000  -0.000   0.000          [ Wavemaster User =>
-0.008  -0.022   0.073 ]
   Ref to Pri GPS Lever Arm    3.851  -0.972  -2.497
   Ref to Aux1 GPS Lever Arm    0.000   0.000   0.000
   Ref to Aux2 GPS Lever Arm    0.000   0.000   0.000
   IMU to Ref Mounting Angle    0.000   0.000   0.000
   AutoStart Enabled
   Multipath  Low

Message 120 - Sensor Parameter Set-up

   Sensor1 Ref Mount Angle    0.000   0.000   0.000
   Sensor2 Ref Mount Angle    0.000   0.000   0.000
   Ref Sensor1 Lever Arm    0.000   0.000   0.000
   Ref Sensor1 Lever Arm    0.000   0.000   0.000
   Ref to CoR Lever Arm    2.000   0.000   0.000

Message 121 - Vessel Installation Parameter Set-up

   Ref to Vessel Lever Arm    0.000   0.000   0.000

Message 106 - Heave Filter Set-up

   Heave Bandwidth 10.000
   Heave Damping Ratio 0.707

Message 105 - Analog Port Set-up

   Roll Scale 1.00
   Pitch Scale 1.00
   Heave Scale 1.00
   Roll Sense Port Up
   Pitch Sense Bow Up
   Heave Sense Clockwise
   Formula Select - TSS Trig
   Analog Port Enabled  True
   Output Frame Sensor 1

Message 21 - GAMS Installation Parameters

   Two Antenna Separation 1.985
   Baseline Vector    0.010   1.985   0.007
   Heading Calibration Threshold    0.500
   Heading Correction    0.000
```

Appendix 10 – NGS Static-Offset Survey

US DEPARTMENT OF COMMERCE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
NATIONAL GEODETIC SURVEY
GEODETIC SERVICES DIVISION
INSTRUMENTATION & METHODOLOGIES BRANCH

NOAA SURVEY VESSEL S1211
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
June 25, 2009

NOAA SURVEY VESSEL S1211
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

PURPOSE

The primary purpose of the survey was to precisely determine the spatial relationship between various hydrographic surveying sensors, and the components of a POS MV navigation system aboard the NOAA survey vessel S1211.

PROJECT DETAILS

This survey was conducted in Alpena, MI on the 24th of June, 2009. The weather was warm and clear in the morning, turning hot and clear by mid-day. For this survey, the vessel was on a trailer stabilized by the trailer tongue jack and one hydraulic bottle jacks. The vessel was leveled relative to the IMU.

INSTRUMENTATION

A Leica (Wild) TC300 precision total station was used to make all measurements.
Technical Data:

Standard Deviation

Horizontal angle	0.5 seconds
Vertical angle	0.5 seconds
Distance measurement	1mm + 1ppm

Standard precision prisms were used as sighting targets. Prisms were configured to have a zero mm offset.

PERSONNEL

Kendall Fancher NOAA/NOS/NGS/GSD/I&M BRANCH
(540) 373-1243
Kendall.fancher@noaa.gov

Dave Rigney NOAA/NOS/NGS/GSD/STATE ADVISOR BRANCH
(517) 335-1916
Dave.Rigney@noaa.gov

NOAA SURVEY VESSEL S1211
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

DEFINITION OF THE REFERENCE FRAME

To conduct this survey a right handed 3-D coordinate system was used where the Northing (Y) axis runs along the centerline of the boat and is positive from the primary reference point towards the bow of the boat. The Easting (X) axis is perpendicular to the centerline of the boat and is positive from the primary reference point towards the right, when looking at the boat from the stern. The Up (Z) axis is positive in an upward direction from the primary reference point.

SURVEY METHODOLOGY

Three temporary control points, (1, 2, 3), were established around the vessel such that all points, to be positioned on the launch, could be observed from at least two separate locations.

Coordinates of 100.000N, 100.000E, and 100.000U were assumed for control point 1. A distance and height difference were measured between control points 1 and 2. These values were used to determine the Northing and Up coordinates for control point 2 of 121.094N and 99.796U. An Easting value of 100.000E was assumed for control point 2 providing for a zero azimuth between the two control points.

Control point 1 was occupied and control point 2 was observed as a backsight. After initialization, control point 3 and all points to be observed on the launch were measured in both direct and reverse.

Control point 2 was occupied and control point 1 was observed as a backsight. After initialization, control point 3 and all points to be observed on the launch were measured in both direct and reverse.

Control point 3 was occupied and control point 2 was observed as a backsight. After initialization, control point 1 was measured in both direct and reverse. An inverse was computed between the measured and beginning coordinates for control point 1 to assess the closure of the traverse. The traverse closure was 0.6mm horizontally and 0.5mm vertically.

The reference system was rotated using the center of the target atop the IMU housing as the point of rotation. A zero degree azimuth was used during the rotation from IMU to Centerline Bow (CLB). The reference system was then translated to relocate the origin of the reference frame to the target atop the IMU housing, which was reported to have been set on the centerline of the launch. Analysis of points GPSP, GPSS, PBM, and SBM indicated that the IMU was not located along the centerline of the vessel and should not have been held as a point of rotation for the vessel reference frame.

Control point 1 was re-occupied and control point 2 was observed as a backsight. After initialization, control point 3, CLS, and the IMU were observed on the launch in both direct and reverse. An azimuth check to control point 3 yielded a closure of 2.8 mm horizontally and 0.6mm vertically. Analysis of the data indicated that the launch had moved, relative to the temporary control points, sufficiently to require that all remaining points on the launch would have to be re-observed.

Control point 1 was re-occupied and control point 2 was observed as a backsight. After initialization, control point 3, and all remaining points on the launch were observed in both direct and reverse. An azimuth check to control point 3 yielded a closure of 2.9mm horizontally and 1.0 mm vertically.

The reference system was rotated using CLS as the point of rotation. A zero degree azimuth was used during the rotation from CLS to CLB. The reference system was then translated to relocate the origin of the reference frame to the target atop the IMU housing (IMU).

DISCUSSION

The positions given for the POS GPS antennas (Zephyr Model 2 p/n 57970-00) are to the top center of the antenna. To correct the Z value provided in this report for each antenna to the electronic phase center, I recommend the following steps be taken;

1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This value may also be available at the NGS website for antenna modeling.
3) Subtract the total height of the antenna from the Z value for each antenna. This will give you a Z value for the antenna ARP (antenna reference point)
4) Then add to this value the electronic phase center offset value appropriate for the antenna model.

The coordinates provided in this report for the single beam are to the center of the bottom of the sensor transducer. No correction has been applied to translate the Z value to the electronic phase center.

The reference point for the side scan sonar (J-arm) was measured with the J-arm configured in the deployed position.

Station Listing

CLB-	CENTERLINE REFERENCE POINT BOW A punch mark set in top center of a ballard located near the bow of the vessel.
CLS-	CENTERLINE REFERENCE POINT STERN A punch mark set in top center of the center keel at a point just aft of the generator, located in the generator hold.
SB-	SINGLE BEAM TRANSDUCER REFERENCE POINT The center of the bottom of the Single Beam Transducer.
SSS-	SIDE SCAN SONAR REFERENCE POINT A punch mark set this survey located at the center of the bottom of the J-arm at a point directly below a drill hole which is used to suspend the Side Scan Sonar cable tackle.
IMU-	IMU REFERENCE TARGET Center of a target affixed to the top of the IMU housing.
GPSP-	POS GPS ANTENNA REFERENCE POINT The top center of the port side GPS antenna for the POS system.
GPSS-	POS GPS ANTENNA REFERENCE POINT The top center of the starboard side GPS antenna for the POS system.
PBM	A punch mark set in the top center of a ballard located near the stern of the launch and along the port side.
SBM	A punch mark set in the top center of a ballard located near the stern of the launch and along the starboard side.

__**Coordinate Listing using the IMU as the Reference System Origin**__

ID	***Y(m)***	***X(m)***	***Z(m)***
IMU	0.000	0.000	0.000
CLB	6.540	0.011	1.013
CLS	-0.913	0.011	-0.333
PBM	-1.066	-1.129	0.868
SBM	-1.083	1.135	0.865
GPSP	3.851	-0.972	2.497
GPSS	3.873	1.006	2.511
SB	2.237	-0.178	-0.438
SSS	-0.683	1.992	2.686