UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NOAA Marine and Aviation Operations
NOAA Ship FAIRWEATHER S-220
1010 Stedman Street
Ketchikan, AK 99901

November 11th, 2013

MEMORANDUM FOR: LCDR David J. Zezula, NOAA
Chief, Pacific Hydrographic Branch

FROM: CDR James M. Crocker, NOAA
Commanding Officer

TITLE: 2013 Data Acquisition and Processing Report Approval

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

This report is respectfully submitted to N/CS34, Pacific Hydrographic Branch.

In addition, the following individuals were responsible for oversight and compilation of this report:

Tami Beduhn
2013.11.15
16:49:54 -08'00'

Tami M. Beduhn
Chief Survey Technician

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LT Timothy M. Smith, NOAA
Field Operations Officer

Attachment

APPENDICES

A. INTRODUCTION

This Data Acquisition and Processing Report outlines the acquisition and processing procedures used for the Hydrographic survey of Central Puget Sound (OPR-N395-FA-13) by NOAA Ship *Fairweather*.
Survey specific details will be listed in Descriptive Reports as needed. Unless otherwise noted, the acquisition and processing procedures used and deliverables produced are in accordance with the NOAA *Hydrographic Survey Specifications and Deliverables Manual (HSSD) April 2013*, the *Field Procedures Manual (FPM), April 2013*, and all active Hydrographic Surveys Technical Directives (HTD).

Any additions and changes to the following will be included with the individual Descriptive Reports or by submission of an addendum.

B. EQUIPMENT

Detailed descriptions of the equipment and systems, including hardware and software, used for bathymetric data acquisition and processing are listed below.

1.0 Hardware

1.1 Hardware Systems Inventory

Detailed hardware information, including models and serial numbers, is included in Appendix I of this report. All launch hardware was installed during April 2013. Manufacturer's product specifications are maintained with reference documentation on board *Fairweather*.

1.2 Echo Sounding Equipment

1.2.1 Reson 7125 SV Multibeam Echosounder (MBES)

Survey launches 2805 and 2808 are each equipped with a dual frequency Reson 7125 SV MBES. The Reson 7125 SV has both a low frequency (200kHz) and high frequency (400kHz) transmit array with a swath coverage of 128°. The swath is made up of 256 discrete beams for 200 kHz and both 256 or 512 discrete beams for 400 kHz. The typical operational depth ranges for the Reson 7125 SV operating at 200kHz is 3 to 400 meters and 3 to 100 meters operating with the 400kHz system. Each system is hull mounted along the centerline and includes a single topside unit (see Figure 5 & Figure 6). No calibration information was provided by the manufacturer for the systems; however, the unit installed on 2805 was tank calibrated for backscatter at the University of New Hampshire (UNH) during the winter of 2011. Preliminary calibration reports are forthcoming. Research is ongoing for 7125 SV backscatter calibration.

Figure 1: Reson 7125 SV topside processor

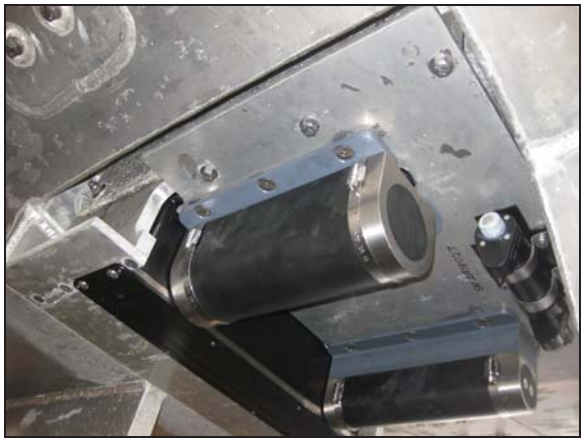


Figure 6: Reson 7125 SV transducer arrays

1.3 Positioning, Heading, and Attitude Equipment

1.3.1 Applanix Positioning and Orientation System for Marine Vehicles (POS MV)

Fairweather and her launches are each equipped with a POS MV 320 V4, configured with TrueHeave™. The POS MV calculates position, heading, attitude, and vertical displacement (heave) of a vessel. It consists of a rack mounted POS Computer System (PCS), a strap down IMU-200 Inertial Measurement Unit (IMU), and two GNSS antennas corresponding to GNSS receivers in the PCS. Launches 2805 and 2808 are equipped with Zephyr II GNSS antennas with BD960 (Launch 2805) and BD950 (Launch 2808) PCS receiver cards. Both launch PCS units for 2805 and 2808 have internal logging capabilities to eliminate packet drops across the acquisition network. The port side antenna is designated as the primary receiver, and the starboard side antenna is the secondary receiver for all vessels (see Figure 9). The POS MV firmware versions and the controller software versions that are currently installed are listed in the Hardware Inventory in Appendix I.

For all multibeam systems aboard *Fairweather's* launches, timing between the sonar swath, position, heading and attitude information was synchronized by utilizing the proprietary UTC string from POS MV. A timing string is sent from the POS MV to the Reson topside unit via serial connection and to the Hypack acquisition computer via Ethernet.

For the launch PCS units with internal logging capabilities, data is logged as small 12 MB files which can be concatenated into a single .000 file. When files are concatenated, it occurs through the NOAA in-house tool "POSConcatenator" created by Grant Froelich of the Pacific Hydrographic Branch.

POS MV controller software was used to monitor position accuracy and quality during data acquisition. This ensured that positioning accuracy requirements are met, as outlined in section 3 of the *HSSD*. The POS MV controller software provides clear visual indications whenever accuracy thresholds are exceeded.

1.3.2 POS MV GAMS Calibration

In the spring of 2013, GNSS Azimuth Measurement System (GAMS) calibrations were performed on each of *Fairweather's* POS MV units mounted to launches 2805, 2808 (Figure 10). The GAMS calibration procedure was conducted in accordance with instructions in chapter 4 of the *POS MV V4 User Guide,* 2009. Results and calibration reports are maintained with reference documentation aboard *Fairweather*. Actual calibration dates are listed in the Hardware Inventory included in Appendix I.

Figure 10: POS GNSS Antennas

1.3.3 DGPS Receivers

Launches 2805 and 2808 are equipped with Hemisphere GPS MBX-4 DGPS receivers to correct the POS MV GPS positions used during real-time MBES and SSS data acquisition. The DGPS receivers are configured in manual mode to allow reception of only one U.S. Coast Guard (USCG) differential GPS beacon station at a time.

Differential GPS (DGPS) is the primary method of real-time positioning. The individual descriptive reports for each survey list the U.S. Coast Guard beacon sites and frequencies used for differential corrections utilized during hydrographic surveying.

All individual vessel POSMV files from all platforms are post processed unless otherwise noted in respective survey Descriptive Reports and project Horizontal and Vertical Control Reports.

1.4 Sound Speed Equipment

1.4.1 Sound Speed Profiles

1.4.1.1 SBE 19plus SEACAT Profiler

Fairweather launches in use are equipped with two SBE 19*plusV2* SEACAT sound speed profilers used to acquire conductivity, temperature, and depth (CTD) data in the water column to determine the speed of sound through water. The SBE 19*plusV2* profilers have pressure sensors and units rated to 600 meters.

The SBE 19*plusV2* SEACAT sound speed profilers were calibrated by the manufacturer during the 2012-2013 winter repair period. The current calibration files can be found in Appendix I.

Periodic quality assurance checks include comparison casts between CTD instruments. Data quality assurance (DQA) checks are conducted during each survey leg include comparison casts between two instruments as per section 1.5.2.2.2 of the *FPM* for each survey. Records of the DQA tests performed are kept aboard the ship and are included with the digital Separates II – Sound Speed Data for each survey. To ensure that the CTDs continue to function properly a stringent maintenance schedule is followed using guidelines from the manufacturer's recommendations.

1.4.2 Surface Sound Speed

1.4.2.1 Reson Sound Velocity Probe (SVP 71)

Survey launches 2805 and 2808 are each equipped with a Reson SVP 71. The SVP 71 measures the speed of sound near the transducer to provide real time surface sound speed values to the Reson 7125's processing unit. The 7125 SV requires surface sound speed information for beam forming due to the flat faced transducer. The units are hull-mounted adjacent to the Reson 7125's transducers as shown in Figure 16.

All of the sensors were initially calibrated by the manufacturer and current calibration files were supplied with the units upon receipt in 2010. The delivery calibration files can be found in Appendix I.

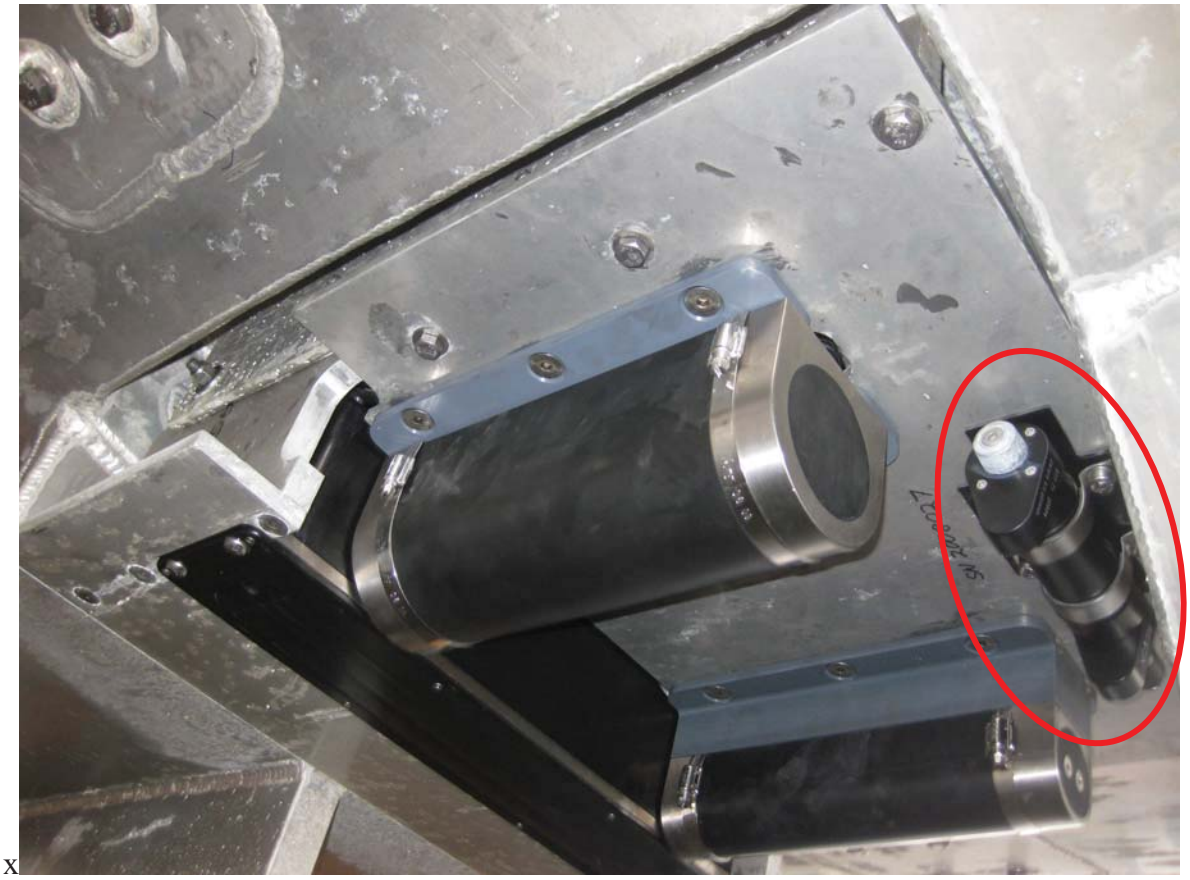
x 

Figure 16: SVP 71 sound speed unit (right) and a Reson 7125

2.0 Software

2.1 Software Systems Inventory

An extensive software inventory with documentation of the software systems used by *Fairweather* is maintained as a survey *Software Inventory* spreadsheet on board *Fairweather*. This spreadsheet includes specifics such as software applications, versions, and hotfixes that are loaded on specific survey processing computers. Snapshot .pdf files are produced approximately bi-monthly or whenever a major software update occurs. The snapshot inventories are included within Appendix I of the DAPR.

2.2 Data Acquisition Software

2.2.1 Hypack® Hysweep

Fairweather uses the Hypack® Hysweep acquisition software package to log all Reson MBES data. Hysweep displays real-time MBES coverage geo-referenced against supporting background files such as charts and vector shoreline files for launch coxswain to follow to acquire adequate MBES coverage. The Hypack Devices (Hysweep Interface and Applanix POS MV Network) and Hysweep Hardware (Hypack Navigation, Applanix POS MV Network,

and Reson) *.ini files are created with the support of HSTP field support liaison and are in accordance with HSTP's configuration management documentation.

Three types of files are recorded per logged line of Reson MBES data: .raw, .hsx, and .7k. The .raw file contains the raw navigation files recorded directly from the POS MV (as device 0) and from Hysweep (as device 1). The .hsx files contain data from Hypack Navigation (as device 0), POS MV (as device 1), and the Reson MBES (as device 2). The .7k file contains all raw data that Hysweep can read from the Reson, including the Reson 7008 snippets message.

The .hsx and .raw files are converted into HDCS data in CARIS HIPS by *Fairweather* personnel. The .7k file is not post-processed by *Fairweather* personnel but is recorded for and submitted with the other raw data for outside backscatter research, processing and product development. All three raw files are submitted directly to NGDC for archival.

2.2.2 Applanix POSView

Applanix POSView is the controller software for the POS MV. POSView is used to configure the serial and network input and output ports on the POS MV PCS. POSView is also used to monitor real-time position, attitude data, and their associated accuracies and to log POSPac .000 files. The POSPac .000 file contains the TrueHeave information that is applied to the MBES HDCS data in CARIS HIPS immediately after conversion. The POSPac .000 file is also post-processed into a PPK SBET file using Applanix's POSPac processing software.

2.3 Data Processing Software

2.3.1 CARIS

CARIS HIPS™ (Hydrographic Information Processing System) is used to process all multibeam data including data conversion, filtering, sound speed corrections, tide correction, merging and cleaning. CARIS HIPS also calculates the Total Propagated Uncertainty (TPU) used to produce Bathymetry Associated with Statistical Error (BASE) surfaces which assist the Hydrographer in data cleaning and analysis, and to produce BASE surfaces.

CARIS SIPS™ (Sonar Information Processing System) is used to process all side scan imagery data including data conversion, altitude adjustment, slant-range correction, and beam pattern correction. CARIS SIPS is also used to inspect the imagery for contacts and to produce side-scan imagery mosaics.

CARIS Notebook™ and CARIS Bathy DataBASE™ BASE Editor (BDB) are used to compile, display, and edit source shoreline, shoreline updates and S-57 features that are collected directly in the field. The .hob files created in Notebook and BDB are exported to S-57 file format as the current shoreline deliverables.

CARIS Bathy DataBASE™ BASE Editor is also used for data quality assurance checks on the BASE surface and for surface differencing.

CARIS Plot Composer is used to create final field plots and special constituent products.

2.3.2 Fledermaus™ and FMGT

Fledermaus ™, an Interactive Visualization Systems 3D™ (IVS 3D) program, is used for data visualizations and creation of data quality control products, public relations material and reference surface comparisons. *Fairweather* personnel process one line of multibeam backscatter per sonar, per day to check Reson Snippet backscatter data in following with the best practices established by NOAA personnel to date. If warranted, specifics of its use or findings for a given survey will be documented in the individual descriptive report.

2.3.3 Applanix POSPac MMS and POSGNSS

Applanix POSPac MMS and POSGNSS are used to post process POS MV data files logged during MBES acquisition. The Single Base PPK processing method is typically used when a single *Fairweather* or third party GPS base station is operating within approximately 20 kilometers of MBES acquisition. The SmartBase™ PPK processing method is used when a stable network of approximately 5-10 available third party GPS base stations such as those in the Continuously Operating Reference Station (CORS) system or Plate Boundary Observatory (PBO) suite of stations exists within approximately 200 kilometers of MBES acquisition. On occasion Precise Point Positioning (PPP) is used when sufficient base stations are not available for Single Base or SmartBase™ PPK. In general, *Fairweather* processing procedures follow the methods outlined in the *POSPac MMS GNSS-Intertial Tools User Guide* for each method. Processing methods specific to each project are documented in the Project Horizontal and Vertical Control Report. Processing methods specific to each survey are documented in the Descriptive Report

2.3.4 Velocipy

Velocipy is a NOAA in-house software supported by the Hydrographic Systems and Technology Program (HSTP) that is used to process raw sound velocity cast files taken with the SEACAT CTDs on the launches and the MVP from the ship. Velocipy creates CARIS format .SVP files that are applied during post processing in HIPS to MBES HDCS data to correct for sound speed. The individual CTD and MVP files are concatenated into a single vessel file by survey. Each vessel file contains the survey registry number and the time and location of each sound speed profile measured.

2.3.5 Pydro

Pydro, another NOAA program produced and maintained by HSTP, is used to produce Final Water Level Requests along with DTON Reports and Survey Feature Reports. The xml Descriptive Report (DR) is produced using the xmlDR component of Pydro, the DR pdf file is then produced via a stylesheet. In addition, Pydro is used for Tidal Constituent and Residual Interpolation (TCARI) tide application in conjunction with CARIS HIPS and various other macros.

Pydro is utilized to assist with sidescan and multibeam contact correlation. Information about each contact is easily entered, images can be added and a final feature report can be produced.

3.0 Vessels

3.1 Vessel Inventory

Fairweather's survey launches 2805 and 2808 are equipped to acquire multibeam echosounder (MBES) and sound speed profile (.svp) data. See Appendix I for the complete vessel inventory.

4.0 Data Acquisition

4.1 Horizontal Control

A complete description of horizontal control will be included in the project's *Horizontal and Vertical Control Report (HVCR)*, submitted for each project under separate cover when necessary as outlined in section 8.1.5.2 of the *HSSD* and section 5.2.3.2.3 of the *FPM*.

The horizontal datum for all projects is the North American Datum of 1983 (NAD83) unless otherwise noted in the individual descriptive reports.

Multibeam and shoreline data are differentially corrected in real time using correctors provided by Coast Guard beacons. The specific beacons used for a given survey will be included in the Horizontal Control section of the survey's descriptive report. If loss of the differential beacon resulted in any data being recorded with C/A GPS positions it will be noted in the Descriptive Report for the specific survey.

When possible, real time DGPS positioning may later be replaced with a post processed kinematic (PPK) single best estimate of trajectory (SBET). The PPK solution is usually dependent on a local base station supported by the ship and processed in Applanix POSPac MMS software using Single Base mode. However, in areas with an adequate network of Continuously Operating Reference Stations (CORS) or public third-party base stations, Applanix POSPac SmartBase™ mode may be used. With either Single Base or SmartBase processing, the resulting navigation from PPK is an improvement over C/A and DGPS navigation. The details of PPK use and application for a given survey will be included in the Horizontal Control section of the project's *HVCR* or the survey's descriptive report.

4.2 Multibeam Echosounder Acquisition and Monitoring Procedures

Acquisition methods and platforms used are determined based on consideration of sonar system specifications, seafloor topography, water depth, and the capability of the acquisition platforms.

All multibeam data are acquired in Hypack's Hysweep® SURVEY extension (.hsx) format and monitored in real-time using the 2-D and 3-D data display windows and the on-screen displays for the Reson 7125 SV. Adjustable parameters that are used to control the Reson include range scale, power, gain, pulse width, absorption, and spreading. These parameters are adjusted as necessary to acquire the highest quality of bathymetry and backscatter. Vessel speed is predominantly between 6-8 knots for acquisition with launch 7125 SV systems. Speeds are reduced as needed to eliminate noise from the data and to ensure the required along-track coverage for object detection in accordance with the *HSSD*.

Survey personnel follow standard operating procedures documented aboard *Fairweather* while setting and utilizing the Reson systems and Hypack for data acquisition. The sensor offsets and mounting biases are entered into the Hysweep® Hardware Reson device. This information is recorded in the Hypack hsx file header for corrected backscatter mosaics created with Hypack Geocoder. These offsets do not have any effect on CARIS HIPS HDCS sounding corrections.

Navigation and motion data are acquired and monitored in POSView and logged into a POS MV file with a .000 extension. Various position and heading accuracies, as well as satellite constellations, are monitored real-time both in POSView and Hypack Hysweep®.

Main scheme MBES acquisition lines using the Reson 7125 SV are generally run parallel to the contours with appropriate overlap to ensure data density requirements for finalized BASE surface resolutions are met. For discrete item developments, 200 percent coverage is acquired to ensure least-depth determination by multibeam near-nadir beams. Hypack Hysweep® real-time coverage display is used in lieu of pre-planned line files. Hysweep® displays the acquired multibeam swath during acquisition and is monitored to ensure overlap and full bottom coverage. If coverage is not adequate, additional lines are run while still in the area.

For areas where shoreline verification is not conducted before multibeam, extra caution is taken by "half stepping" shoreward when operating near shore. Half stepping is done by driving along the edge of real time coverage to prevent the survey vessel from ever being in un-surveyed waters. Survey launch crews in the field survey to the Navigable Area Limit Line (NALL) line as defined by section 1.1.2 of the *HSSD*.

4.3 Shoreline/Feature Verification

The composite source file (CSF) in S-57/.000 format provided with the Project Instructions is the primary source for shoreline features to be verified. The original project file is imported into CARIS BASE Editor, converted to a .hob file, clipped to the sheet limits for the specific survey, and named H#####_Original_Composite_Source.hob to be included with the deliverables. This file is then copied and named H#####_Feature_File.hob to be utilized during field verification. Additionally, AWOIS items and other features to be investigated are provided to the field in the project reference file (PRF). All hob files are re-exported to S-57/.000 format for data submission.
Fairweather personnel conduct limited shoreline verification and reconnaissance at times near predicted negative tides within the survey limits when possible, as directed by section 3.5.5.3 of the *FPM*. Detached positions (DPs) are acquired and edits to the daily field feature files are recorded in CARIS Notebook and on paper DP forms and boat sheets.

An inshore limit buffer line, offset 0.8 mm from the Mean High Water (MHW) line at the scale of the largest chart in the area, is provided with the Project Instructions. This inshore limit buffer line is used in the shoreline acquisition software and on the boat sheet as a reference, and utilized as described in section 1.1.2 of the *HSSD*. The NALL is determined in the field as the farthest off-shore of one of the following; the MHW inshore limit buffer specified above, the 4-meter depth contour, or the inshore limit of safe navigation as defined by the *HSSD*. All shoreline features from the CSF seaward of the NALL are verified (including an update to

depth and/or position as necessary) or disproved during operations. Features off-shore of the NALL and not addressed or features of an ambiguous nature include remarks for further clarification. Specifically assigned features may be investigated that are inshore of the NALL in accordance with the associated instruction for a given project area.

Detached positions (DPs) acquired during shoreline verification indicate new features, revisions to source features, or source features not found in the field. They are recorded in the shoreline acquisition software and on DP forms.

4.4 Bottom Samples

Bottom samples are acquired according to section 7.1 of the *HSSD,* any deviations from this protocol will be outlined in the individual Descriptive Report for the survey. Samples are acquired using CARIS Notebook, Hypack target files (.tgt), or by logging the latitude, longitude, and bottom characteristics manually. All samples are processed similarly to other shoreline features as outlined below in section C - 2.2 of this report. Bottom sample results are included in the Notebook .hob deliverable layer, HXXXXX_Final_Feature_File and are descriptively attributed as New.

4.5 Sound Speed

Sound speed casts are taken at least once every 1–4 hours during multibeam survey operations in accordance with section 3.5.1 of the FPM. *Fairweather's* launches collect sound speed casts approximately every 3 hrs utilizing the SBE 19*plus* SEACAT sound speed profilers. Deviations from this procedure will be outlined in the individual Descriptive Report for the survey.

C. QUALITY CONTROL

Fairweather has numerous standard operating procedures (SOPs) that are followed by personnel throughout the survey to ensure consistent high quality data and products.

1.0 Uncertainty Modeling

Uncertainty values for the multibeam and positioning systems on *Fairweather* and her survey launches were compiled from manufacturer specification sheets for each sensor (Heave, Pitch, Roll, Position, and Heading) and from values set forth in section 4.2.3.8 and Appendix 4 – CARIS HVF Uncertainty Values of the 2013 *FPM*.

The manufacturer specification for POSMV heading accuracy is contingent on a 2 meter baseline between primary and secondary GPS antennas. While the *Fairweather* has a 2 meter baseline her launches have on average a 1.4 meter baseline which has been seen to increase accuracy estimates in the field. Based on observations in the field, the heading error value for all launches has been increased from the manufacturer specification and FPM guidance to 0.04 degrees.

Estimates for the Motion Reference Unit (MRU) alignment errors are taken from the standard deviation of the values determined by multiple personnel processing the patch test data (see

section D 4.0). In some instances, outlier patch test values are excluded to allow more reasonable MRU uncertainty values.

The *Fairweather* TPU Values spreadsheet located in Appendix III, lists the final uncertainty values for *Fairweather* and her launches, including the default tides and sound velocity values. Uncertainty values relating to vessels and survey systems are entered into the HIPS Vessel File (HVF) for each platform. The tidal errors for the gauge and for zoning are determined on a project by project basis. Sound speed uncertainties for a given survey are based upon either the defaults listed in the TPU value spreadsheet or based on utilization of NOAA sound speed uncertainty estimation software. Survey specific uncertainty values for tides and sound speed that are entered during the Compute TPU step in CARIS HIPS and how they were determined will be included in the individual Descriptive Report. After SBET application, TPU values are recalculated using the Error Data option for Uncertainty Source in the CARIS Compute TPU window. This loads more precise residual mean square (RMS) values to selected HDCS lines for position, roll, pitch and gyro.

2.0 Data Processing

2.1 Multibeam Echosounder Data Processing

Bathymetry is processed following section 4.2 of the *FPM* unless otherwise noted.

Raw multibeam data is recorded as .HSX files in Hypack, and then converted to CARIS HIPS HDCS format using established and internally documented settings. After TrueHeave™, sound speed, and water level correctors are applied to all lines, the lines are merged. Once lines are merged, Total Propagated Uncertainty (TPU) is computed.

Bathymetric surfaces are created and analyzed using the resolution, depth range, and CUBE parameters outlined in 5.2.2.2 of the HSSD. If these depth range values for specific resolutions require adjustment for analysis and submission of individual surveys then a waiver from HSD Operations is required and would be requested. A detailed listing of the resolutions and the actual depth ranges used during the processing of each survey, along with the corresponding fieldsheet(s), will be provided in the Descriptive Report of each survey.

BASE surfaces are created using the Density & Locale function of the CUBE algorithm and parameters contained in the NOAA CUBEParams_NOAA.xml. The CUBEParams_NOAA.xml will be included with the HIPS Vessel Files with the individual survey data. The NOAA parameter configurations for resolutions 1-32 meters are used.

Multibeam data are reviewed and edited in HIPS subset mode and in swath editor as necessary. The finalized BASE surfaces and CUBE hypotheses are used for directed data editing at the appropriate depth range in subset editor. The surfaces and subset editor view are also used to demonstrate coverage and to check for errors due to tides, sound speed, attitude and timing.

Vessel heading, attitude, and navigation data are reviewed in HIPS navigation editor and attitude editor if deemed necessary upon review of surfaces. Where necessary, fliers or gaps in heading, attitude, or navigation data are manually rejected or interpolated for small periods of

time. Any editing of this nature will be outlined in the Descriptive Report for the particular survey.

The Surface Filtering functionality in HIPS may be used in the processing of survey data to reject errant soundings. If utilized, the individual Descriptive Report shall list the confidence level settings for standard deviation used and discuss the particular way the surface filter was applied.

In depths less than 20 meters and deeper and in areas of navigational significance where the BASE surface does not depict the desired depth for the given area, a designated sounding is selected. Designated soundings are selected as outlined in section 5.2.1.2 of the *HSSD*.

Layers determining "IHOness" are added to the CUBE surfaces allowing the Hydrographer to see where and if the surfaces meet IHO Order. The process is easily performed in HIPS and allows the Hydrographer to identify areas of high uncertainty with respect to depth. This is a spatial quality control check rather than just a statistical list of nodes and allows for specific areas with problems to be isolated and addressed. The following logic equation is used to create "IHO_1" child layers in the 1 through 8 meter finalized surfaces:

IHO-1: -Uncertainty/((0.5^2 +((Depth*0.013)^2))^0.5),

and an "IHO_2" child layer is created in the 8, 16 meter, and greater finalized surfaces using

IHO-2: -Uncertainty/((1.0^2 +((Depth*0.023)^2))^0.5).

It should be noted that both IHO order 1 (~80 to 100) and order 2 (100 to 176) child layers are created for the 8 meter surface since it overlaps the order 1 and order 2 boundary (order1<100 meters, order 2>100 meters). IHO surfaces are used during processing to indicate potential problem areas requiring attention or documentation. Observed grid node uncertainty values are compared to IHO order 1 and Order 2 uncertainty standards. The percentage of nodes meeting or exceeding these standards is calculated for each HIPS CUBE surface with a NOAA-supported and distributed script, and then reported in the Descriptive Report. For surveyed areas that do not meet IHO standards, images of affected areas may be included.

The individual finalized or combined surface's IHO layers are exported from CARIS as a text file and examined to allow the Hydrographer to see the full data distribution rather than just the minimum and maximum values in the surface. These data distribution are used to assess the quality of the survey, to ensure ninety-five percent of the data meets the appropriate IHO order as specified in section 5.1.3 of the *HSSD.*

Additionally, a combined surface is reviewed in 3-D mode using one of the following programs, CARIS HIPS, CARIS Base Editor, or IVS Fledermaus, to ensure that the data are sufficiently cleaned for submission.

2.2 Shoreline/Feature Data Processing

During shoreline verification, field detached positions (DP) are acquired with CARIS Notebook or Hypack .tgt files. Tide application for features requiring tide correction is applied in CARIS Notebook when using discrete zoning and with the aid of Pydro when TCARI is used.

New features and any updates to the composite source shoreline, such as ledges or reefs, are acquired or digitized with S-57 attribution and compiled from the field daily files into the H#####_Final_Feature_File.hob. Updates to source shoreline features primarily include a change in depth/height, position, or S-57 classification. If the position of a feature changes, current guidelines are to delete current feature and create a new feature in the new location. Notebook's editing tools are used to modify source feature extents or positions.

The SORIND and SORDAT S-57 attribute fields for new features or modified source features are updated to reflect the information for the associated survey number and date (US,US,graph,H#####). All new or modified features are S-57 attributed as applicable and descriptively attributed as New or Update respectively. All unmodified source features retain their original SORIND and SORDAT values. Assigned features that are addressed but not updated are descriptively attributed as Retain and unaddressed assigned features are attributed as Not Addressed.

Short descriptive comments taken from the boat sheets or DP forms along with investigation or survey methods are listed under the Remarks field. For significant features that deserve additional discussion, the Hydrographer may include a recommendation to the cartographer in the Recommendations field, along with the Hydrographer notes and investigation methods provided in the Remarks field.

Features that are disproved or that do not adequately portray the shoreline are descriptively attributed as Delete in the H#####_Final_Feature_File.hob layer. Features with the attribution of Delete retain their original SORIND and SORDAT values and include a recommendation from the Hydrographer along with an informative remark.

AWOIS investigation items are received in the Project Reference File and investigated as necessary. Features correlated to the AWOIS item are included in the H#####_Final_Feature_File.hob layer and labeled with the appropriate AWOIS number and include a remark detailing the search methods and a recommendation from the Hydrographer. Items will be attributed as AWOIS for reporting purposes. Any features that are submitted as dangers to navigation (DTON) will be attributed accordingly for reporting purposes. The status of Primary or Secondary may be attributed to aid in deconflicting multiple positions or instances of the same feature.

Images are labeled and associated with a DP/userid number or other descriptive/unique name. They are included with the survey data and stored in the CARIS/Multimedia folder with the deliverables. References to the images are listed with file extension and comma delimited in the Images attribute for the specific feature.

The CARIS Notebook files along with CARIS HIPS BASE surface(s) are viewed to compare MBES coverage and features simultaneously. The current NOAA object catalog will be used for CARIS Notebook processing and the version of such will be documented in the individual Descriptive Reports, along with any deviations in shoreline processing from those listed above.

Final shoreline deliverables are two S-57 (*.000) files exported from Notebook, the H##### Original Composite Source and the H##### Final Feature File, included with the processed data.

3.0 Data Review

Specific procedures are used on *Fairweather* to ensure quality control of data throughout acquisition, processing, and submission. These procedures are documented and followed by the Hydrographer. A detailed Quality Control check is performed by the survey manager. A detailed review is conducted by qualified survey personnel (FOO, CST, SST, or PS) other than the survey manager as an outside review of the survey data and deliverables. Submission checklists are used to ensure that all data and deliverables are complete and included upon submission. Documentation of these tasks is completed for every survey but only the final processing log, H##### Data Log, is included in the Separates submitted with the individual survey data.

D. Corrections to Echo Soundings

1.0 Vessel HVFs

CARIS HIPS Vessel Files (HVF) are created by *Fairweather* personnel and used to define a vessel's offsets and measurement uncertainty. The HVF is used for converting and processing raw Hypack .hsx and .raw files to CARIS HIPS HDCS format. The HVFs used for a given project are included with the digital data submitted with the survey.

2.0 Vessel Offsets

Sensor offsets are measured with respect to each vessel's reference point. The reference point for *Fairweather* and her survey launches 2805 and 2808 is the top, center of the POS MV IMU (Figure 17). The offset values from the reference point to the primary GNSS antenna are entered into Applanix's POSView POS MV monitoring software so that all raw position data are centered at the vessel's reference point. The CARIS HVF contains the offset from the vessel's reference point to the multibeam sonar reference point.

Figure 17: Vessel Reference Point (Top of POS MV IMU) & Primary GNSS Antenna (port side).

Additionally, the Reson sonar mounting offsets measured from the center of each projector to the center of the transceiver are entered in the Reson 7125 hardware configuration with the 7K Center for both the 400 kHz and 200 kHz projectors. The measured values are used instead of Reson's default values because *Fairweather's* mounts are slightly different than of Reson's standard sonar mount (Figure 18).

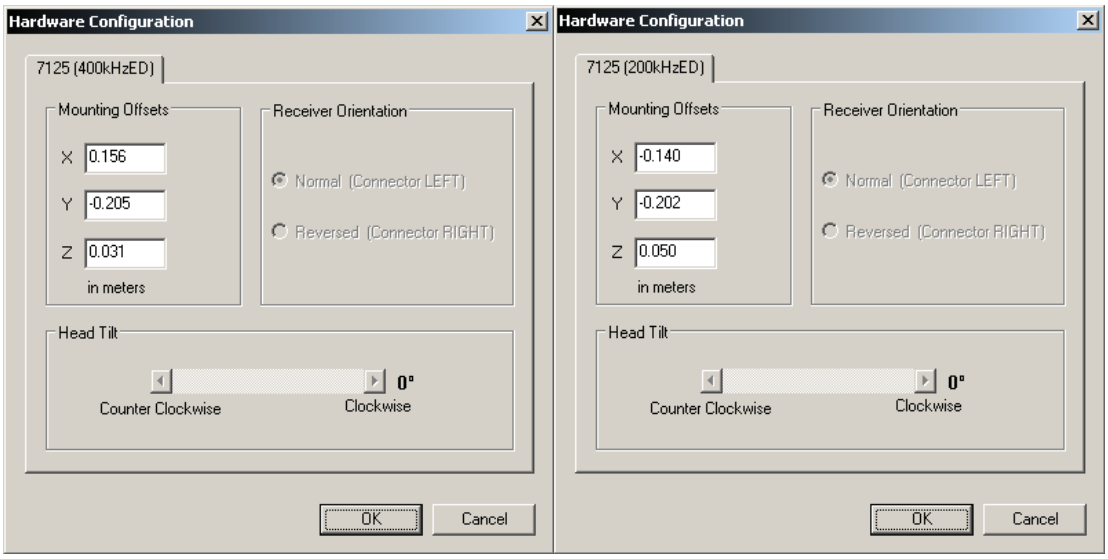


Figure 18: Reson 7125 sonar mounting with 400kHz and 200kHz offsets respectively.

Permanent control points were established on launches 2805 and 2808 during construction at All American Marine in 2009. Sensor offsets were measured by NGS in January 2010 using the methods described in the report on each launch located in Appendix II of this report. The resultant offsets, measurements, derivations, descriptions of methodology used, diagrams, and coordinate system references are included in the respective vessel's Offsets & Measurements spreadsheet also included in Appendix II.

3.0 Static and Dynamic Draft

The static drafts (Waterline Height in the HVF) for launches 2805 and 2808 were calculated based on steel tape and plumb bob measurements of the distance from benchmarks on the port and starboard quarter of the vessel to the waterline. The values and calculations for static draft of the various launches are listed in the respective Waterline Measurement spreadsheets included in Appendix II of this report.

The dynamic draft data were acquired for launches 2805 and 2808 in Seattle, WA in Lake Washington. The measurements were made using the change in ellipsoid height while the vessels were transiting at different speeds in their respective locations. The ellipsoid heights were determined using Post Processed Kinematics (PPK) by recording POSPac data on each vessel and then processing the data with local reference stations in Applanix POSPac MMS software. The resulting Single Best Estimate of Trajectory (SBET) was exported from POSPac and the speed versus ellipsoid height was fit to a third order polynomial curve using a least squares fit method in a Python Script written by NOAA personnel and implemented within Pydro. The polynomial curve was used to derive the table used in the CARIS HVF, and the standard deviation of the residuals was used to determine the associated uncertainty in the measurement. Written reports for each platform including initial measurement notes, graphs, and finalized values are provided in Appendix II of this report. The polynomial best fit curve of the ellipsoidal height differences from launches 2805 and 2808 compare well with each

other and previous years. The dynamic draft offset values and standard deviations were then entered into the CARIS HVFs.

4.0 Patch Tests

Patch tests were conducted in accordance with section 5.2.4.1 of the HSSD on launches 2805 and 2808 for the Reson 7125 SV MBES sonar systems during the month of April 2013 using the Shilshole Bay Reference Surface and Patch Test site near Seattle, WA. The results of all patch tests to date, along with the acquisition and processing logs, are included in the individual MBES Calibration files in Appendix II.

Also included in Appendix II is the sounding system comparison. This comparison includes surface differencing between launch reference surfaces using CARIS Bathy Database. The result of the comparison shows that the differences between each platform and sonar are within NOAA specification for vertical uncertainty.

5.0 Attitude and Kinematic Data

Vessel attitude is measured by the POS MV and recorded in the Hysweep .hsx file. Roll is corrected in real time for Reson 7125 SV data. Attitude correctors not applied in real time (heave, pitch, roll, and heading) are applied during post processing in CARIS HIPS using the raw POS MV attitude data recorded in the Hysweep .hsx file. Post processed kinematic (PPK) data from the POS MV .000 file are applied to MBES data in CARIS HIPS in the form of SBET files once all data acquisition is complete.

5.1 TrueHeave™

The POS MV TrueHeave™ data is logged within the POS MV .000 files and applied in CARIS HIPS during post processing using the "Apply TrueHeave" function during sound speed correction. TrueHeave™ is a forward-backward filtered heave corrector as opposed to the real time heave corrector, and is fully described in Section 6 of the *POS MV V4 User Guide 2009*. To ensure proper application in CARIS HIPS, POS MV files are logged for at least three to five minutes before and after all MBES files are logged.

In cases where TrueHeave™ cannot be applied, real time heave correctors are used. Real time heave data are recorded and stored in the Hypack Hysweep .hsx file and are applied as the heave corrector for MBES data if TrueHeave™ files are unavailable. Data that do not have TrueHeave™ applied will be listed in the individual Descriptive Report for the survey.

5.2 Post Processed Kinematic Data

Post Processed Kinematic (PPK) data in the form of Single Best Estimate of Trajectory (SBET) files are applied to soundings to increase the accuracy of the kinematic vessel corrections and to allow the ability to reference soundings to the ellipsoid.

Standard daily data processing procedures aboard *Fairweather* include post processing of POS MV kinematic .000 files using Applanix POSPac MMS and POSGNSS software using either Single Base batch processing or SmartBase processing. After processing and quality control

analysis of the post-processed SBET files is complete, the SBET and SMRMSG files are applied to the HDCS data in CARIS HIPS using the "Load Attitude/Navigation Data", the "Load error data", and "Compute GPS Tide" processing tools. Ellipsoidal heights are contained within the PPK SBET files. Soundings to which SBETs have been applied can be reduced to the ellipsoid by merging the data in CARIS HIPS with "GPS Tide" applied. Data are frequently referenced to the ellipsoid during data analysis for troubleshooting unexplained vertical offsets, but are reduced back to MLLW for data finalization and submission.

Feature and bottom sample positions are not corrected with post processed GNSS data because at this time as there is not a developed nor streamlined procedure for PPK application to features.

6.0 Sound Speed

Seabird SBE 19*plus* and SBE 19*plusV2* sound speed profilers are used regularly to collect sound speed data for the Reson 7125 SV MBES systems on survey launches 2805 and 2808.

Daily sound speed profiles from the SBE 19*plus* and SBE 19*plusV2* profilers are processed with Velocipy and concatenated into single .svp files for each vessel per survey. Individual .svp files and the concatenated vessel files for the survey are submitted with each survey.

The concatenated sound speed files are applied to multibeam data in CARIS HIPS during data processing. CARIS HIPS uses one of four different methods to automatically apply a sound speed profile stored in a concatenated sound speed file. They are: "previous in time," "nearest in time," "nearest in distance" and "nearest in distance within time." The method of applying sound speed for a specific day of data collection is listed in the daily logs included as Separates submitted with the individual survey data.

7.0 Water Level

Unless otherwise noted in the survey Descriptive Report, the vertical datum for all soundings and heights is Mean Lower Low Water (MLLW). Predicted, preliminary, and/or verified water level correctors from the primary tide station(s) listed in the Project Instructions may be downloaded from the CO-OPS website and used for water level corrections during the course of the project. These tide station files are collated to include the appropriate days of acquisition and then converted to CARIS .tid file format using FetchTides.

Water level data in the .tid files are applied to HDCS data in CARIS HIPS using the zone definition file (.zdf) or a Tidal Constituent and Residual Interpolation (TCARI) model supplied by CO-OPS. Upon receiving final approved water level data, all data are reduced to MLLW using the final approved water levels as noted in the individual survey's Descriptive Report.

If available, a VDATUMN model comparison might be requested by Office of Coast Survey, Operations Branch. If accepted, CARIS HIPS data may be reduced to MLLW per supplied separation model instead of through traditional water level application. See the individual survey's Descriptive Report for further information.

A complete description of vertical control utilized for a given project can be found in the project specific *Horizontal and Vertical Control Report (HVCR)*, submitted for each project under separate cover when necessary as outlined in section 5.2.3.2.3 of the *FPM*.

Appendix I

System Tracking

1. **Vessel Inventory**
2. **Hardware Inventory**
3. **Computer Inventory**

Sound Speed Calibration Documentation

1. **SPE 19+**
2. **SPE 19+ V2**
3. **SVP 71**

Hydrographic Vessel Inventory

Field Unit: FAIRWEATHER
Effective Date: April 3, 2013
Updated Through: August 1, 2013

SURVEY VESSELS				
Vessel Name	**Launch 2805**	**Launch 2808**	**Ambar 700**	**FRB**
Hull Number	2805	2808	2302	2301
Call Letters				
Manufacturer	All American Marine	All American Marine	Marine Silverships, Inc	Zodiak of North America
Year of Construction	2009	2009	1998	2004
Type of Construction	Welded Aluminum	Welded Aluminum	RHIB (Aluminum)	RHIB (Fiberglass)
Length Overall	8.64 m (28' 6")	8.64 m (28' 6")	7.0 m (23')	6.7 m (22')
Beam	3.48 m (11' 5")	3.48 m (11' 5")	2.9 m (9' 4")	2.6 m (8' 6")
Draft	1.12 m (3' 8")	1.12 m (3' 8")	0.4 m (1' 4")	0.6 m (22")
Cruising Speed	24 knots	20 knots	22 knots	18 knots
Max Survey Speed	8 knots	8 knots		
Date of Effective Full Vessel Static Offset Survey	1/26/2010	1/27/2010		
Organization which Conducted the Effective Full Offset Survey	NGS/GSD	NGS/GSD		
Date of Last Partial Survey or Offset Verification & Methods Used	n/a	n/a		
Date of Last Static Draft Determination & Method Used	4/3/2013 Direct Measurement from benchmarks.	4/22/2013 Direct Measurement from benchmarks.		
Date of Last Settlement and Squat/Dynamic Draft Measurements & Method Used	4/16/2013 Post Processed Kinematic (Ellipsoidally referenced)	4/16/2013 Post Processed Kinematic (Ellipsoidally referenced)		

Orange - info needs to be verified

GREY - not applicable

Fairweather Hardware Inventory 2013

Echo Sounders

Manufacturer	Current Location	Equipment Component	Model	Serial Number	CD Number	Firmware	Field Calibration
Reson	FA_2805	Receiver	7125 SV1- EM 7200	3008265	CD0001776106		Patch- 4/25/13
Reson	FA_2808	Receiver	7125 SV1- EM 7200	309014	Unknown		Patch- 4/26/13
Reson	FA_2805	Transducer- 200 kHz	7125 SV1- TC 2163	4408358	Unknown		Patch- 4/25/13
Reson	FA_2808	Transducer- 200 kHz	7125 SV1- TC 2163	1008117	Unknown		Patch- 4/26/13
Reson	FA_2805	Transducer- 400 kHz	7125 SV1- TC 2160	4008071	CD0001776105		Patch- 4/25/13
Reson	FA_2808	Transducer- 400 kHz	7125 SV1- TC 2160	1908209	Unknown		Patch- 4/26/13
Reson	FA_2805	Processor	7125 SV1	1812028	CD0001529714	Feature Pack 1.3.2	Patch- 4/25/13
Reson	FA_2808	Processor	7125 SV1	1812020	CD0001527818	Feature Pack 1.3.2	Patch- 4/26/13

Positioning and Attitude

Manufacturer	Current Location	Equipment Component	Model	Serial Number	CD Number	Firmware	Field Calibration	Notes
Applanix	FA_2805	IMU	LN200	294	CD0001696449		GAMS & ERDDM- 4/16/13	
Applanix	FA_2808	IMU	LN200	324	CD0001722041		GAMS & ERDDM- 4/16/13	
Applanix	FA_2805	PCS	POS MV 320 V4	3627	CD0001527797	HW4.1-7, SW05.01, POS Cntrlr v.5.1.0.2	GAMS & ERDDM- 4/16/13	Upgraded to 4GB Internal Logging.
Applanix	FA_2808	PCS	POS MV 320 V4	2560	CD0001601274	HW4.1-7, SW05.01, POS Cntrlr v.5.1.0.2	GAMS & ERDDM- 4/16/13	Upgraded to 4GB Internal Logging.
Hemisphere	FA_2805	Receiver	MBX-4	0927-9567-0001	CD0001709331			
Hemisphere	FA_2808	Receiver	MBX-4	0923-9416-0007	P004425			
Trimble	FA_2805	Antenna	Zephyr II	311717272	Unknown		GAMS & ERDDM- 4/16/13	Primary Antenna
Trimble	FA_2805	Antenna	Zephyr II	31185275	Unknown		GAMS & ERDDM- 4/16/13	Secondary Antenna
Trimble	FA_2808	Antenna	Zephyr II	1440904832	Unknown		GAMS & ERDDM- 4/16/13	Primary Antenna
Trimble	FA_2808	Antenna	Zephyr II	31177272	Unknown		GAMS & ERDDM- 4/16/13	Secondary Antenna

Sound Speed Sensor

Manufacturer	Current Location	Equipment Component	Model	Serial Number	CD Number		Field Calibration
Sea-Bird Electronics	FA_2805	CTD Sound Speed Profiler	SBE 19plus V2	19P50959-6122	CD0001527778		Daily DQA when in use
Sea-Bird Electronics	FA_2808	CTD Sound Speed Profiler	SBE 19plus V2	19P50959-6121	CD0001527777		Daily DQA when in use
Reson	FA_2805	Surface Sound Speed	SVP-71	2008038	CD0001776104		DQA- 4/13
Reson	FA_2808	Surface Sound Speed	SVP-71	2008016	Unknown		DQA- 4/13

Fairweather Software Inventory

Last Updated:
2/4/2013

#/Type of Licenses	CARIS HIPS/SIPS	CARIS Notebook	CARIS Bathy Database	CARIS Plot Composer	Pydro/Velocipy	Mapinfo	Applanix POSPac*	Ashtech Solutions	Fledermaus	SnagIt	Fetchtides	Hypack	Hypack Geocoder	Hysweep Editor (MB Max)	Applanix POSView	Verification Date	MAC Addresses	Additional Comments	Network Comp
FA P1 Process 1	7.1.2.5	3.1.1.1	4.0.0.0	5.1.1.1	12.9 (r3965)		6.1			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-0A	New 5/2012	FA-Proc1
FA P1 Process 2	8.0 BETA	3.1.1.1	4.0.0.0	5.1.1.1	12.9 (r3965)	11	5.4 SP2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-31	New 5/2012	FA-Proc2
FA P1 Process 3	8.0 BETA	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-28	New 5/2012	FA-Proc3
FA P1 Process 4	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2			10.0.0	2.6					5/30/2012	B8-AC-6F-89-DE-4C	replaced 6/1/11 w/ 64bit machine	FA-Proc4
FA P1 Process 5	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2			10.0.0	2.6					5/30/2012	B8-AC-6F-8D-0D-CE	replaced 6/1/11 w/ 64bit machine	FA-Proc5
FA P1 Process 6	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-EA-CD-D7	New 5/2012	FA-Proc6
FA P1 Process 7	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2		7.3.0 (64bit)	10.0.0	2.6					5/30/2012	B8-AC-6F-89-E0-B4	replaced 6/1/11 w/ 64bit machine	FA-Proc7
FA P1 Process 8	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)		5.4 SP2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-EA-17-BA	New 5/2012	FA-Proc8
FA P1 Process 9	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11	5.4 SP2			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-07	New 5/2012	FA-Proc9
FA CST	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3C-49-14	New Machine 3/2010, Formerly Proc_2 5/2012	FA-CST
FA FOO	7.1.1.1	3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3E-BF-FD	New Machine 3/2010, Formerly Proc_3 5/2012	FA-FOO
FA CO		3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11											00-23-AE-68-4D-37		
FA P2 Process1	7.1.2.1	3.1.1.1	3.2.2.2	5.1.1.1	12.2 (r3724)		5.4 SP2			10.0.0	2.6					5/30/2012	00-1D-09-30-OB-38	Formerly FOO 5/2012	Fa-P2-P1
FA P3 Process1	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.2 (r3724)	10.5	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3C-49-08	New Machine 3/2010	Fa-P3-P1
FA P3 Process2										10.0.0	2.6					5/30/2012	00-24-E8-3E-BF-12	New Machine 3/2010, Formerly Proc_6 5/2012	Fa-P3-P2
FA P3 Process3										10.0.0	2.6					5/30/2012	00-24-E8-3C-7D-DA	New Machine 3/2010, Formerly Pro_8 5/2012	Fa-P3-P3
FA P3 Process4	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.2 (r3724)	10.5	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3C-8A-30	New Machine 3/2010	Fa-P3-P4
FA O-LAB	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.2 (r3724)		5.4 SP2	2.7		10.0.0	2.6					5/30/2012	00-1D-09-30-E1-63	Formerly CST 5/2012	FA-OLAB
S220 Acq					12.1 (r3715)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	8/8/2011	00-1D-09-31-BA-34		
S220 Acq 2					12.2 (r3724)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	8/8/2011	00-24-E8-3E-BF-24	New Machine 3/2010, Formerly Proc_1 5/2012	
2805 Acq		3.1.1.0			11.11 (r3670)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	5/10/2011	00-30-48-CD-32-EF		
2806 Acq		3.1 HF3			10.9 (r3020)					10.0.0		11.0.1.49		11.0.6.0	4.3.4.0	7/2/2011	00-30-48-CA-38-BB		
2807 Acq		3.1 HF2			12.2 (r3724)					10.0.0		11.0.1.49	11.0.6.0	11.0.6.0	4.3.4.0	8/8/2011	00-30-48-CA-38-BD	To *HI* on 7/1/11	
2808 Acq		3.1.1.0			12.2 (r3724)		5.4 SP2			10.0.0		12.0.0.1	11.0.6.0	11.0.6.0	4.3.4.0	2/25/2011	00-30-48-CD-33-E8		
Mobile Station	7.1.0.2	3.1.1.0	3.2 HF2	5.1.1.1	12.2 (r3724)	11		2.7		10.0.0	2.6	2010				12/13/2010	00-24-E8-B5-85-1D		
Toughbook 2		3.1.1.0														11/17/2010	00-0B-97-27-72-92	Tides, Old	
Toughbook 3		3.1.1.0			12.2 (r3724)			2.7				2009				2/25/2011	00-0B-97-33-1C-CD	Some GPS Utilities, Old	
Toughbook 4		3.1.1.0						2.7				2009				2/25/2011	00-21-5C-6C-2B-A3	Bluetooth	
Toughbook 5		3.1.1.0			12.2 (r3724)											11/17/2010	00-1B-D3-38-1B-02	Tides	
Toughbook 6		3.1.1.0						2.7		10.0.0							00-1B-D3-19-EA-4B	Bluetooth	

Fairweather Software Inventory

Last Updated:
5/1/2013

#/Type of Licenses	CARIS HIPS/SIPS	CARIS Notebook	CARIS Bathy Database	CARIS Plot Composer	Pydro/Velocipy	Mapinfo	Applanix POSPac*	Ashtech Solutions	Fledermaus	SnagIt	Fetchtides	Hypack	Hypack Geocoder	Hysweep Editor (MB Max)	Applanix POSView	Verification Date	MAC Addresses	Additional Comments	Network Comm
	10-Ntk,1-USB	2-USB	4-Ntk.1-USB	Unlimited	Unlimited	6 St Alone	2 USB Key	?	2-USB	25	Unlimited	5-Keys							
FA P1 Process 1	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-0A	New 5/2012	FA-Proc1
FA P1 Process 2	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)	11	6.2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-31	New 5/2012	FA-Proc2
FA P1 Process 3	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-28	New 5/2012	FA-Proc3
FA P1 Process 4	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	B8-AC-6F-89-DE-4C	replaced 6/1/11 w/ 64bit machine	FA-Proc4
FA P1 Process 5	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	B8-AC-6F-8D-0D-CE	replaced 6/1/11 w/ 64bit machine	FA-Proc5
FA P1 Process 6	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-EA-CD-D7	New 5/2012	FA-Proc6
FA P1 Process 7	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2		7.3.0 (64bit)	10.0.0	2.6					5/30/2012	B8-AC-6F-89-E0-B4	replaced 6/1/11 w/ 64bit machine	FA-Proc7
FA P1 Process 8	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2	2.7		10.0.0	2.6					5/30/2012	BC-30-5B-EA-17-BA	New 5/2012	FA-Proc8
FA P1 Process 9	8.0.2	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)	11	6.2			10.0.0	2.6					5/30/2012	BC-30-5B-E9-FF-07	New 5/2012	FA-Proc9
FA CST	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.9 (r4195)	11	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3C-49-14	New Machine 3/2010, Formerly Proc_2 5/2012	FA-CST
FA FOO	7.1.1.1	3.1.1.1	3.2.2.4	5.1.1.1	12.9 (r4195)	11	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3E-BF-FD	New Machine 3/2010, Formerly Proc_3 5/2012	FA-FOO
FA CO		3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11											00-23-AE-68-4D-37		
FA P2 Process1	7.1.2.1	3.1.1.1	3.2.2.2	5.1.1.1	12.2 (r3724)		5.4 SP2			10.0.0	2.6					5/30/2012	00-1D-09-30-OB-38	Formerly FOO 5/2012	Fa-P2-P1
FA P3 Process1	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	13.8 (r4311)	10.5	5.4 SP2			10.0.0	2.6					5/30/2012	00-24-E8-3C-49-08	New Machine 3/2010	Fa-P3-P1
FA P3 Process2										10.0.0	2.6					5/30/2012	00-24-E8-3E-BF-12	New Machine 3/2010, Formerly Proc_6 5/2012	Fa-P3-P2
FA P3 Process3	8.0.4	3.1.1.1	3.2.2.2	5.1.1.1	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	00-24-E8-3C-7D-DA	New Machine 3/2010, Formerly Pro_8 5/2012	Fa-P3-P3
FA P3 Process4	8.0.4	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	00-24-E8-3C-8A-30	New Machine 3/2010	Fa-P3-P4
FA O-LAB	8.0.4		4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0	2.6					5/30/2012	00-1D-09-30-E1-63	Formerly CST 5/2012	FA-OLAB
S220 Acq					12.1 (r3715)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	8/8/2011	00-1D-09-31-BA-34		
S220 Acq 2					12.2 (r3724)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	8/8/2011	00-24-E8-3E-BF-24	New Machine 3/2010, Formerly Proc_1 5/2012	
2805 Acq		3.1.1.0			11.11 (r3670)					10.0.0		12.0.0.1		11.0.6.0	5.1.0.1	5/10/2011	00-30-48-CD-32-EF		
2806 Acq		3.1 HF3			10.9 (r3020)					10.0.0		11.0.1.49		11.0.6.0	4.3.4.0	7/2/2011	00-30-48-CA-38-BB		
2807 Acq		3.1 HF2			12.2 (r3724)					10.0.0		11.0.1.49	11.0.6.0	11.0.6.0	4.3.4.0	8/8/2011	00-30-48-CA-38-BD	To *HI* on 7/1/11	
2808 Acq		3.1.1.0			12.2 (r3724)		5.4 SP2			10.0.0		12.0.0.1	11.0.6.0	11.0.6.0	4.3.4.0	2/25/2011	00-30-48-CD-33-E8		
Mobile Station	7.1.0.2	3.1.1.0	3.2 HF2	5.1.1.1	12.2 (r3724)	11		2.7		10.0.0	2.6	2010				12/13/2010	00-24-E8-B5-85-1D		
Toughbook 2		3.1.1.0														11/17/2010	00-0B-97-27-72-92	Tides, Old	
Toughbook 3		3.1.1.1			12.2 (r3724)			2.7				2009				2/25/2011	00-0B-97-33-1C-CD	Some GPS Utilities, Old	
Toughbook 4		3.1.1.1						2.7				2009				2/25/2011	00-21-5C-6C-2B-A3	Bluetooth	
Toughbook 5		3.1.1.1			12.2 (r3724)											11/17/2010	00-1B-D3-38-1B-02	Tides	
Toughbook 6		3.1.1.1						2.7		10.0.0							00-1B-D3-19-EA-4B	Bluetooth	

Fairweather Software Inventory

Last Updated:
9/1/2013

#/Type of Licenses	CARIS HIPS/SIPS	CARIS Notebook	CARIS Bathy Database	CARIS Plot Composer	PydroVelocipy	Mapinfo	Applanix POSPac*	Ashtech Solutions	Fledermaus	SnagIt	Hypack	Hypack Geocoder	Hysweep Editor (MB Max)	Applanix POSView	Verification Date	MAC Addresses	Additional Comments	Network Conf
	10-Ntk,1-USB	2-USB	4-Ntk.1-USB	Unlimited	Unlimited	6 St Alone	2 USB Key	?	2-USB	25	5-Keys							
FA P1 Process 1	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	BC-30-5B-E9-FF-0A	New 5/2012	FA-Proc1
FA P1 Process 2	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)	11	6.2	2.7		10.0.0					5/30/2012	BC-30-5B-E9-FF-31	New 5/2012	FA-Proc2
FA P1 Process 3	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	BC-30-5B-E9-FF-28	New 5/2012	FA-Proc3
FA P1 Process 4	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	B8-AC-6F-89-DE-4C	replaced 6/1/11 w/ 64bit machine	FA-Proc4
FA P1 Process 5	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	B8-AC-6F-8D-0D-CE	replaced 6/1/11 w/ 64bit machine	FA-Proc5
FA P1 Process 6	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2	2.7		10.0.0					5/30/2012	BC-30-5B-EA-CD-D7	New 5/2012	FA-Proc6
FA P1 Process 7	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)		6.2		7.3.0 (64bit)	10.0.0					5/30/2012	B8-AC-6F-89-E0-B4	replaced 6/1/11 w/ 64bit machine	FA-Proc7
FA P1 Process 8	8.0.2	3.1.1.1	4.0.0.3	5.2	13.8 (r4311)		6.2	2.7		10.0.0					5/30/2012	BC-30-5B-EA-17-BA	New 5/2012	FA-Proc8
FA P1 Process 9	8.0.4	3.1.1.1	4.0.0.5	5.2	13.8 (r4311)	11	6.2			10.0.0					5/30/2012	BC-30-5B-E9-FF-07	New 5/2012	FA-Proc9
FA CST	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	12.9 (r4195)	11	5.4 SP2			10.0.0	13.0.0.6				5/30/2012	00-24-E8-3C-49-14	New Machine 3/2010, Formerly Proc_2 5/2012	FA-CST
FA FOO	7.1.1.1	3.1.1.1	3.2.2.4	5.1.1.1	12.9 (r4195)	11	5.4 SP2			10.0.0					5/30/2012	00-24-E8-3E-BF-FD	New Machine 3/2010, Formerly Proc_3 5/2012	FA-FOO
FA CO		3.1.1.1	3.2.2.4	5.1.1.1	12.3 (r3834)	11										00-23-AE-68-4D-37		
FA P2 Process1	7.1.2.1	3.1.1.1	3.2.2.2	5.1.1.1	12.2 (r3724)		5.4 SP2			10.0.0					5/30/2012	00-1D-09-30-OB-38	Formerly FOO 5/2012	Fa-P2-P1
FA P3 Process1	7.1.2.1	3.1.1.1	3.2.2.4	5.1.1.1	13.8 (r4311)	10.5	5.4 SP2			10.0.0					5/30/2012	00-24-E8-3C-49-08	New Machine 3/2010	Fa-P3-P1
FA P3 Process2										10.0.0					5/30/2012	00-24-E8-3E-BF-12	New Machine 3/2010, Formerly Proc_6 5/2012	Fa-P3-P2
FA P3 Process3	8.0.4	3.1.1.1	3.2.2.2	5.1.1.1	13.8 (r4311)		6.2			10.0.0					5/30/2012	00-24-E8-3C-7D-DA	New Machine 3/2010, Formerly Pro_8 5/2012	Fa-P3-P3
FA P3 Process4	8.0.4	3.1.1.1	3.2.2.4	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	00-24-E8-3C-8A-30	New Machine 3/2010	Fa-P3-P4
FA O-LAB	8.0.4		4.0.0.5	5.2	13.8 (r4311)		6.2			10.0.0					5/30/2012	00-1D-09-30-E1-63	Formerly CST 5/2012	FA-OLAB
S220 Acq					12.1 (r3715)					10.0.0	13.0.0.6		11.0.6.0	5.1.0.1	8/8/2011	00-1D-09-31-BA-34		
S220 Acq 2					12.2 (r3724)					10.0.0	13.0.0.6		11.0.6.0	5.1.0.1	8/8/2011	00-24-E8-3E-BF-24	New Machine 3/2010, Formerly Proc_1 5/2012	
2805 Acq		3.1.1.0			11.11 (r3670)					10.0.0	13.0.0.6		11.0.6.0	5.1.0.1	5/10/2011	00-30-48-CD-32-EF		
2806 Acq		3.1 HF3			10.9 (r3020)					10.0.0	13.0.0.6		11.0.6.0	4.3.4.0	7/2/2011	00-30-48-CA-38-BB		
2807 Acq		3.1 HF2			12.2 (r3724)					10.0.0	13.0.0.6	11.0.6.0	11.0.6.0	4.3.4.0	8/8/2011	00-30-48-CA-38-BD	To *HI* on 7/1/11	
2808 Acq		3.1.1.0			12.2 (r3724)		5.4 SP2			10.0.0	13.0.0.6	11.0.6.0	11.0.6.0	4.3.4.0	2/25/2011	00-30-48-CD-33-E8		
Mobile Station	7.1.0.2	3.1.1.0	3.2 HF2	5.1.1.1	12.2 (r3724)	11		2.7		10.0.0	2010				12/13/2010	00-24-E8-B5-85-1D		
Toughbook 2		3.1.1.0													11/17/2010	00-0B-97-27-72-92	Tides, Old	
Toughbook 3		3.1.1.1			12.2 (r3724)			2.7			2009				2/25/2011	00-0B-97-33-1C-CD	Some GPS Utilities, Old	
Toughbook 4		3.1.1.1						2.7			2009				2/25/2011	00-21-5C-6C-2B-A3	Bluetooth	
Toughbook 5		3.1.1.1			12.2 (r3724)										11/17/2010	00-1B-D3-38-1B-02	Tides	
Toughbook 6		3.1.1.1						2.7		10.0.0						00-1B-D3-19-EA-4B	Bluetooth	

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Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/16/2013
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4617

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. 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: 1/15/2013 **Drift since last cal:** -0.00020 **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.

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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 15-Jan-13

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

COEFFICIENTS:

```
g = -9.988382e-001
h =  1.277109e-001
i = -2.422985e-004
j =  3.298924e-005

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

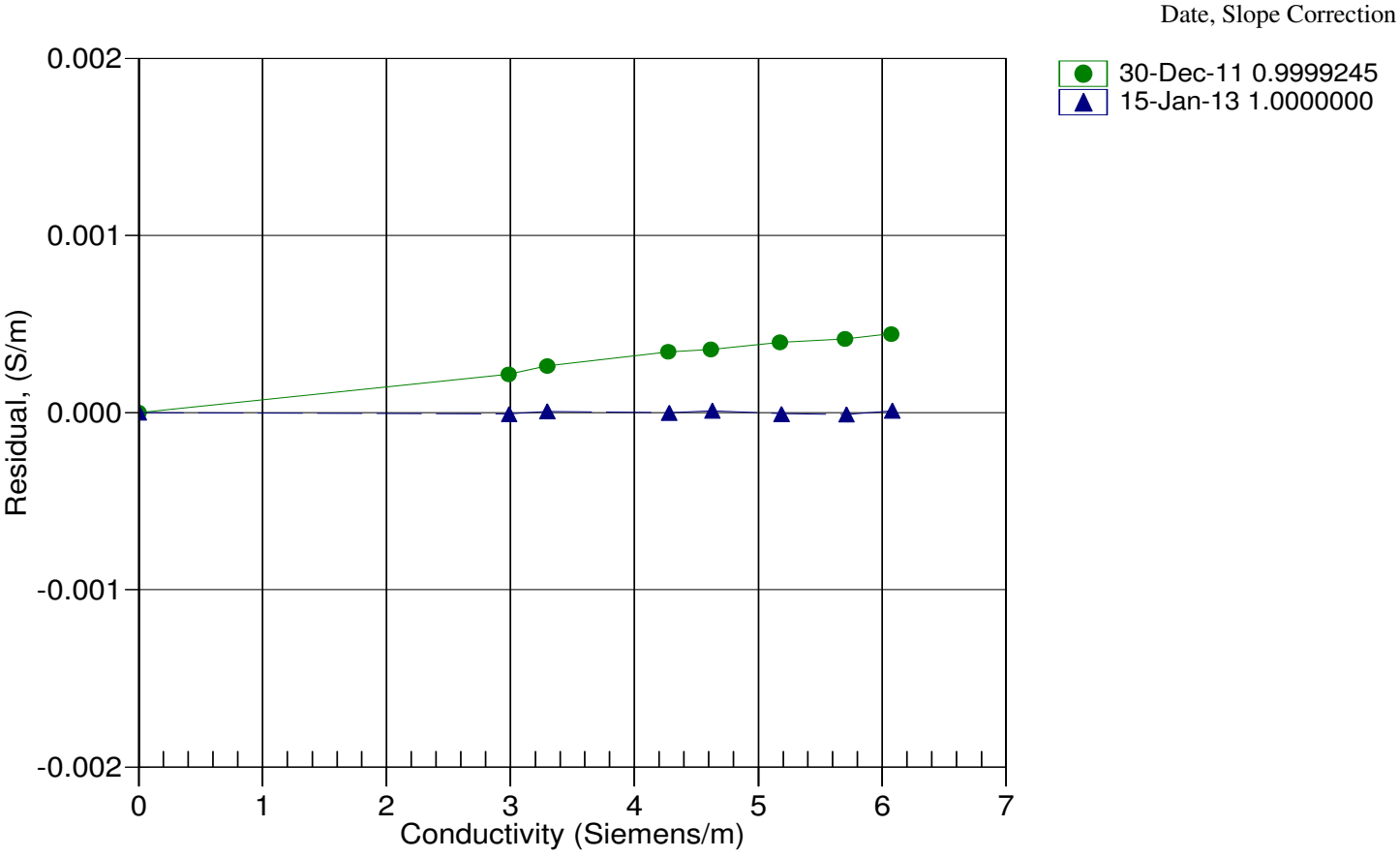
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2801.23	0.0000	0.00000
1.0000	34.9579	2.98691	5593.60	2.9869	-0.00001
4.4999	34.9380	3.29506	5805.19	3.2951	0.00001
14.9999	34.8945	4.28018	6434.28	4.2802	-0.00000
18.4999	34.8842	4.62639	6640.94	4.6264	0.00001
23.9999	34.8718	5.18596	6961.65	5.1860	-0.00001
29.0000	34.8625	5.70903	7248.27	5.7090	-0.00001
32.5000	34.8528	6.08163	7445.52	6.0816	0.00001

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



SEA-BIRD ELECTRONICS, INC.
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Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/16/2013
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4617

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. 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: 1/15/2013 Drift since last cal: +0.00039 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 15-Jan-13

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.267255e-003
a1 = 2.620479e-004
a2 = 2.503373e-007
a3 = 1.427996e-007

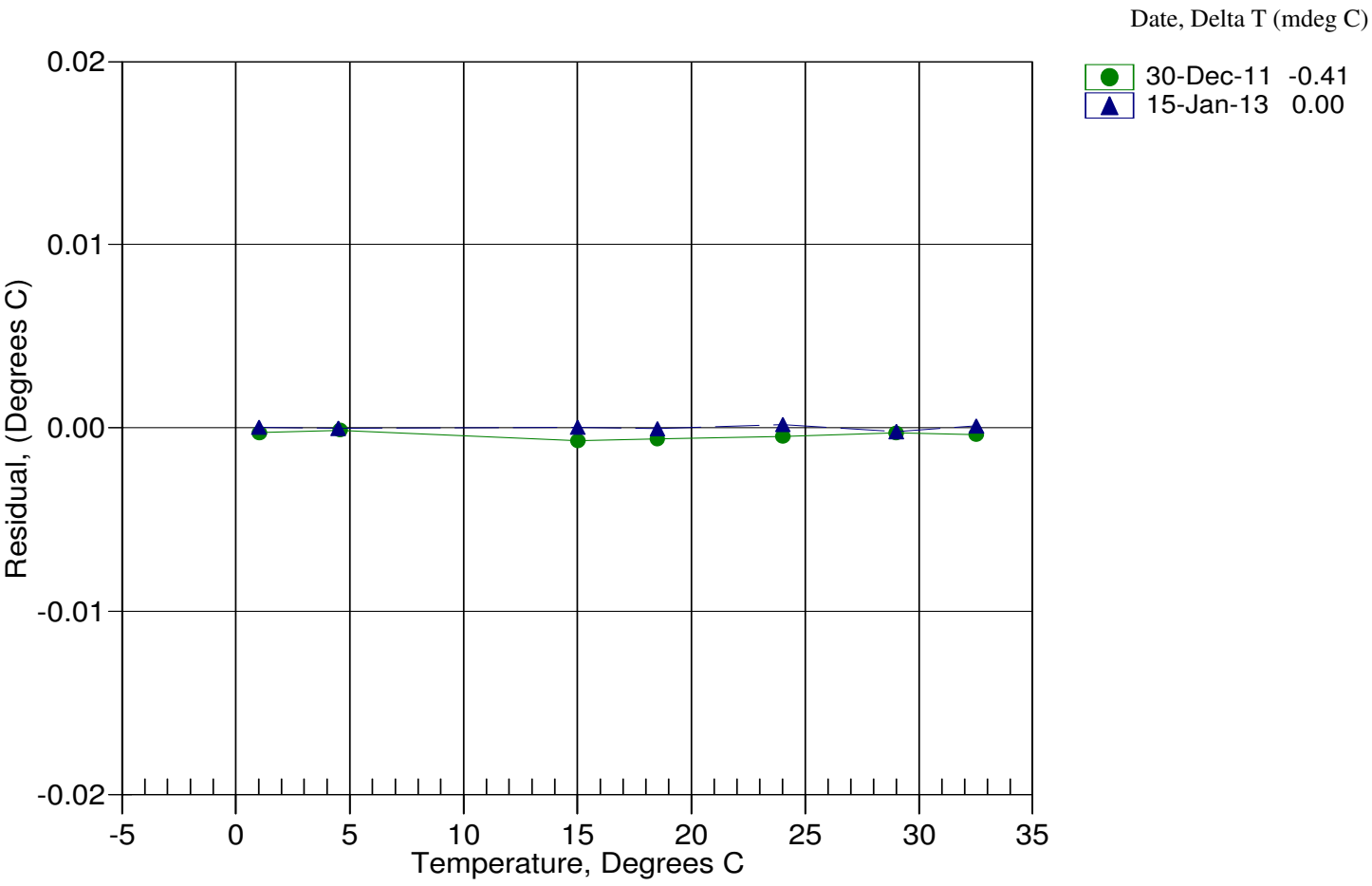
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	585630.288	1.0000	0.0000
4.4999	518796.780	4.4999	-0.0000
14.9999	354147.797	14.9999	0.0000
18.4999	310219.797	18.4999	-0.0000
23.9999	250754.017	24.0001	0.0002
29.0000	205618.712	28.9998	-0.0002
32.5000	178401.119	32.5001	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



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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 11-Jan-13

SBE19plus PRESSURE CALIBRATION DATA
1450 psia S/N 5513

COEFFICIENTS:

PA0 =	-4.701047e-001	PTCA0 =	5.192728e+005
PA1 =	4.447332e-003	PTCA1 =	-1.041390e+001
PA2 =	-1.304121e-011	PTCA2 =	2.558563e-001
PTEMPA0 =	-7.822603e+001	PTCB0 =	2.460838e+001
PTEMPA1 =	4.830428e+001	PTCB1 =	6.750000e-004
PTEMPA2 =	-1.958091e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.76	522594.8	2.1	14.76	0.00
301.47	587124.9	2.1	301.52	0.00
588.36	651711.6	2.1	588.42	0.00
875.32	716329.0	2.1	875.34	0.00
1162.35	780976.5	2.1	1162.29	-0.00
1449.33	845661.7	2.1	1449.30	-0.00
1162.30	781002.2	2.1	1162.41	0.01
875.32	716327.8	2.1	875.34	0.00
588.05	651593.1	2.1	587.89	-0.01
301.46	587111.5	2.1	301.46	0.00
14.76	522593.5	2.1	14.76	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.31	522702.93
29.00	2.24	522693.29
24.00	2.13	522685.00
18.50	2.02	522674.61
15.00	1.95	522671.91
4.50	1.73	522725.79
1.00	1.65	522776.42

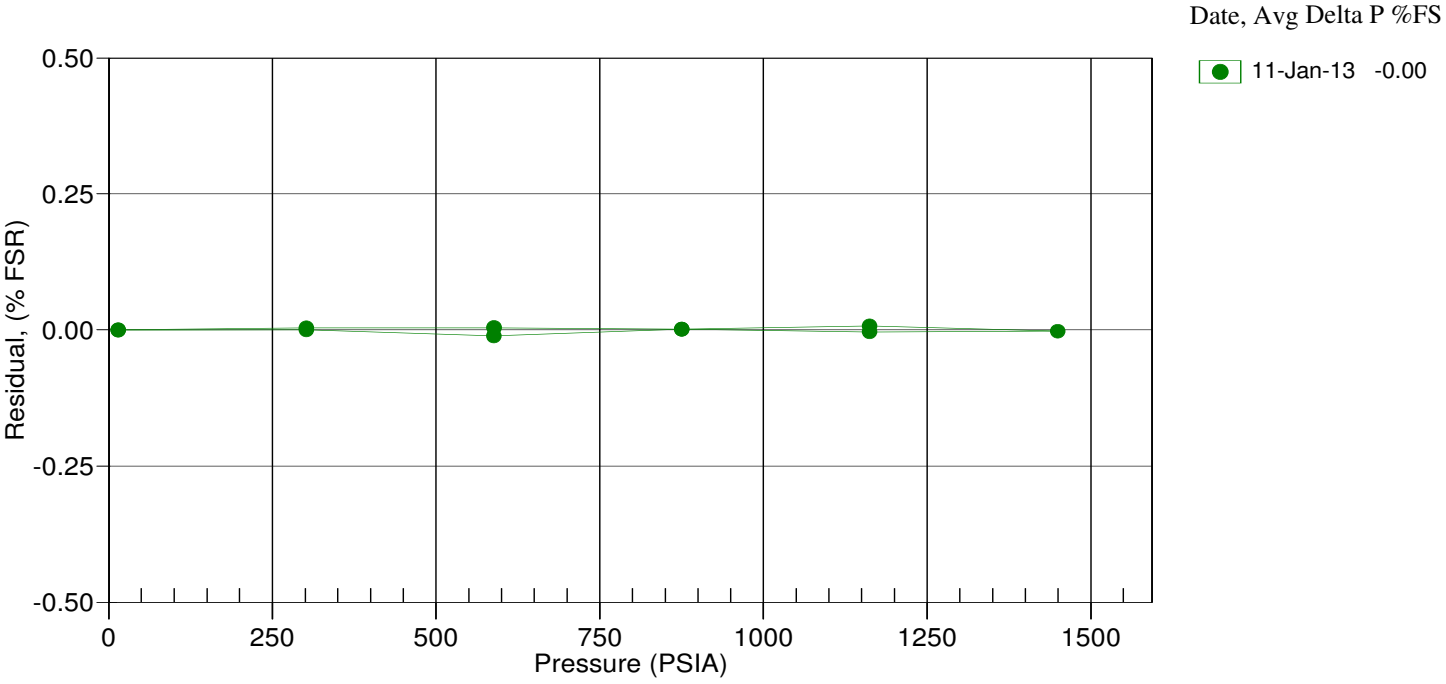
TEMP(ITS90)	SPAN(mV)
-5.00	24.61
35.00	24.63

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) = $PA0 + PA1 * n + PA2 * n^2$



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Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/14/2013
Model Number	SBE 19Plus	**Serial Number:**	19P50959-6122

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. 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: 1/12/2013 **Drift since last cal:** -0.00020 **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.

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SENSOR SERIAL NUMBER: 6122
CALIBRATION DATE: 12-Jan-13

SBE19plusV2 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.952241e-001
h =  1.571720e-001
i = -5.010477e-004
j =  6.360475e-005

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

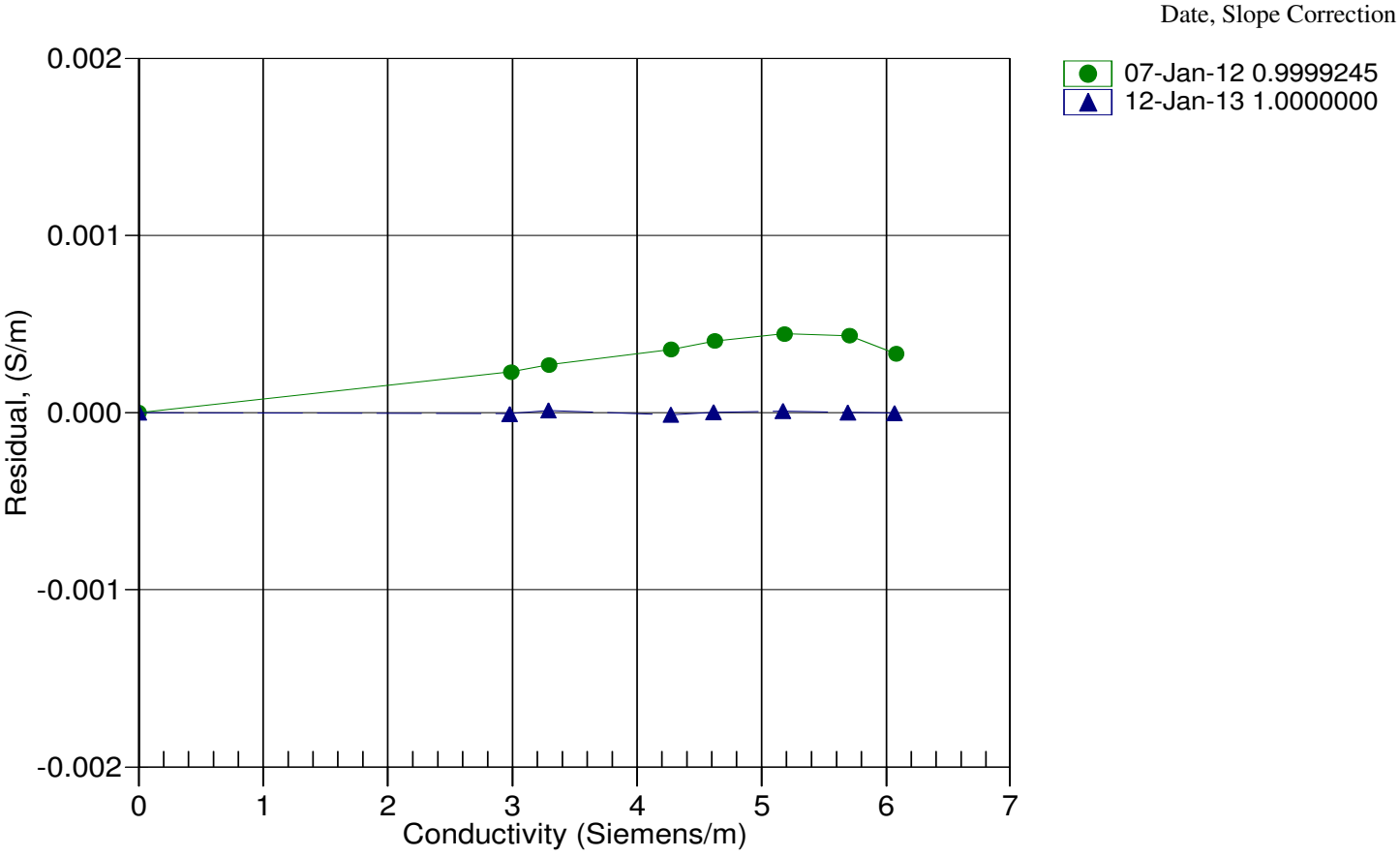
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2523.27	0.0000	0.00000
1.0000	34.8497	2.97855	5042.82	2.9785	-0.00001
4.4999	34.8298	3.28586	5233.74	3.2859	0.00001
14.9999	34.7859	4.26827	5801.21	4.2683	-0.00001
18.5000	34.7749	4.61347	5987.57	4.6135	0.00000
24.0000	34.7616	5.17139	6276.75	5.1714	0.00001
29.0000	34.7500	5.69268	6535.02	5.6927	0.00000
32.5000	34.7379	6.06386	6712.66	6.0639	-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



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Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/14/2013
Model Number	SBE 19Plus	**Serial Number:**	19P50959-6122

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. 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: 1/12/2013 Drift since last cal: -0.00110 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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SENSOR SERIAL NUMBER: 6122
CALIBRATION DATE: 12-Jan-13

SBE19plusV2 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.311436e-003
a1 = 2.512171e-004
a2 = 7.670896e-007
a3 = 1.064799e-007

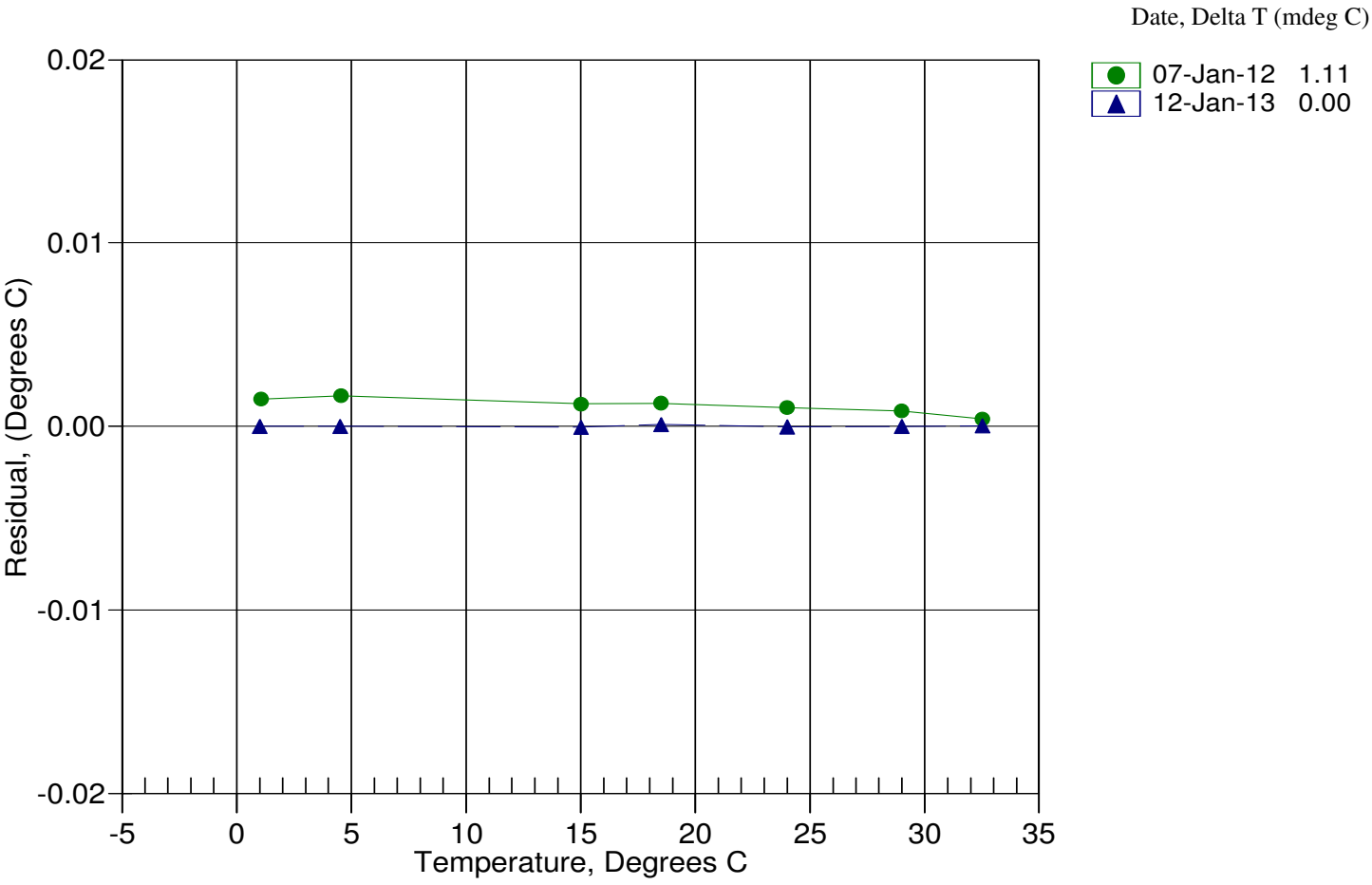
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	640406.164	1.0000	0.0000
4.4999	567830.450	4.4999	-0.0000
14.9999	387717.410	14.9998	-0.0001
18.5000	339443.533	18.5001	0.0001
24.0000	274050.383	24.0000	-0.0000
29.0000	224422.115	29.0000	-0.0000
32.5000	194529.770	32.5000	0.0000

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



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SENSOR SERIAL NUMBER: 6122
CALIBRATION DATE: 11-Jan-13

SBE19plusV2 PRESSURE CALIBRATION DATA
870 psia S/N 2752080

COEFFICIENTS:

PA0 =	-1.625248e-001	PTCA0 =	5.244217e+005
PA1 =	2.635779e-003	PTCA1 =	-1.948462e+000
PA2 =	2.061527e-011	PTCA2 =	-5.889249e-002
PTEMPA0 =	-6.146598e+001	PTCB0 =	2.507825e+001
PTEMPA1 =	5.373745e+001	PTCB1 =	-5.500000e-004
PTEMPA2 =	-2.607578e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.71	530001.0	1.5	14.72	0.00
179.99	592641.0	1.5	179.99	0.00
360.00	660791.0	1.5	359.99	-0.00
540.02	728880.0	1.5	540.02	-0.00
720.05	796899.0	1.5	720.05	0.00
875.06	855399.0	1.5	875.05	-0.00
720.08	796915.0	1.5	720.10	0.00
540.09	728910.0	1.5	540.10	0.00
360.06	660813.0	1.5	360.05	-0.00
180.04	592653.0	1.5	180.03	-0.00
14.72	529999.0	1.5	14.72	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.76	530074.05
29.00	1.70	530095.03
24.00	1.60	530119.00
18.50	1.50	530143.08
15.00	1.43	530159.73
4.50	1.24	530187.25
1.00	1.17	530200.03

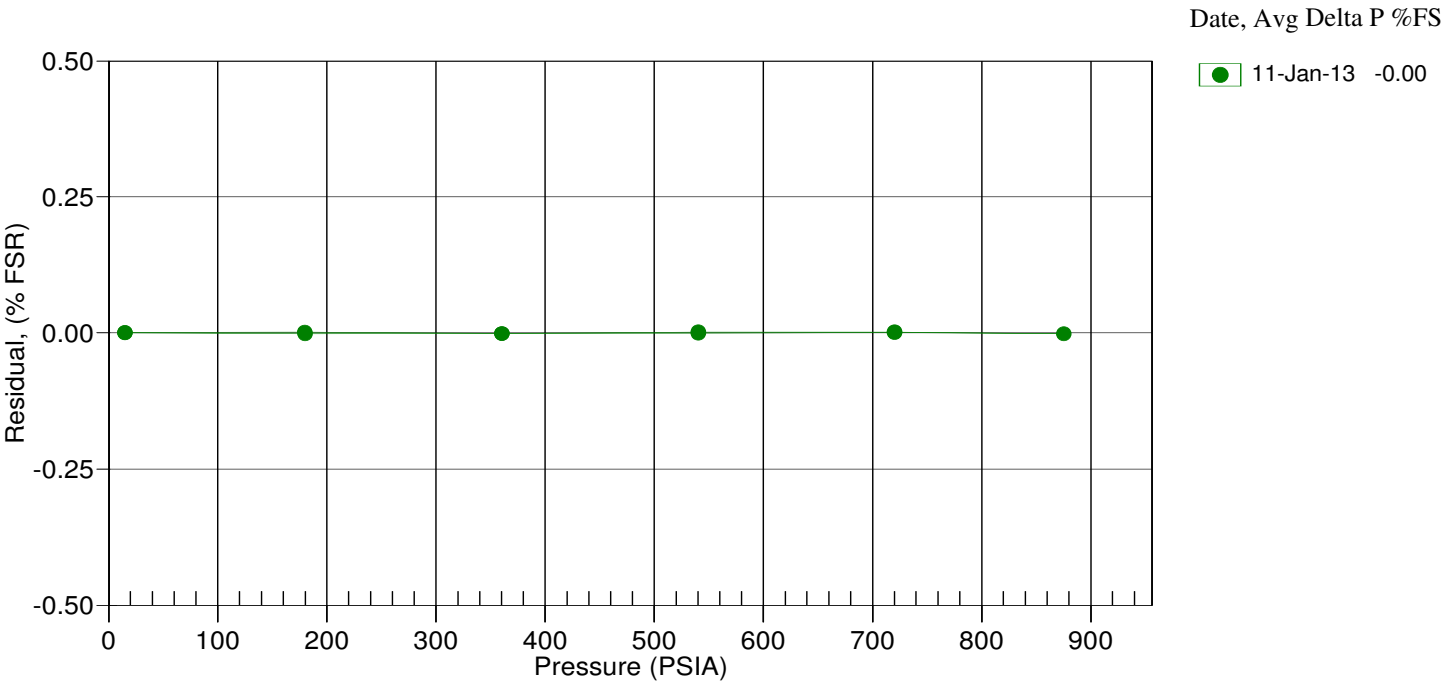
TEMP(ITS90)	SPAN(mV)
-5.00	25.08
35.00	25.06

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) = $PA0 + PA1 * n + PA2 * n^2$



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Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/16/2013
Model Number	SBE 19Plus	**Serial Number:**	19P50959-6121

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. 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: 1/15/2013 **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.

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SENSOR SERIAL NUMBER: 6121
CALIBRATION DATE: 15-Jan-13

SBE19plusV2 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -1.001225e+000
h =  1.548297e-001
i = -3.722102e-004
j =  5.023761e-005

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

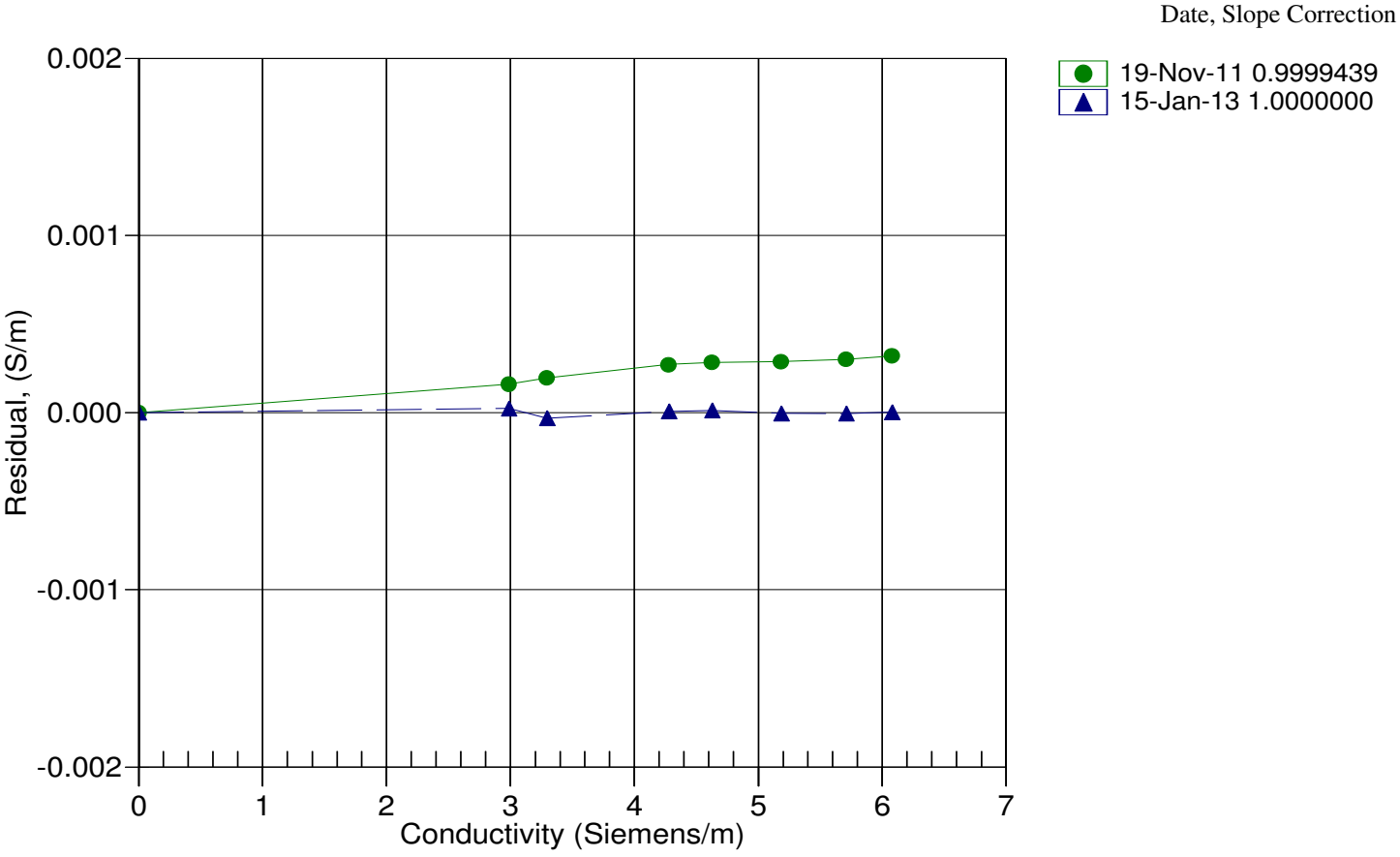
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2548.08	0.0000	0.00000
1.0000	34.9579	2.98691	5085.03	2.9869	0.00002
4.4999	34.9380	3.29506	5277.33	3.2950	-0.00003
14.9999	34.8945	4.28018	5849.25	4.2802	0.00001
18.4999	34.8842	4.62639	6037.13	4.6264	0.00001
23.9999	34.8718	5.18596	6328.72	5.1860	-0.00000
29.0000	34.8625	5.70903	6589.32	5.7090	-0.00001
32.5000	34.8528	6.08163	6768.66	6.0816	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



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Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	72195	**Date of Report:**	1/16/2013
Model Number	SBE 19Plus	**Serial Number:**	19P50959-6121

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. 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: 1/15/2013 Drift since last cal: -0.00058 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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SENSOR SERIAL NUMBER: 6121
CALIBRATION DATE: 15-Jan-13

SBE19plusV2 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.295516e-003
a1 = 2.542861e-004
a2 = 4.335425e-007
a3 = 1.208696e-007

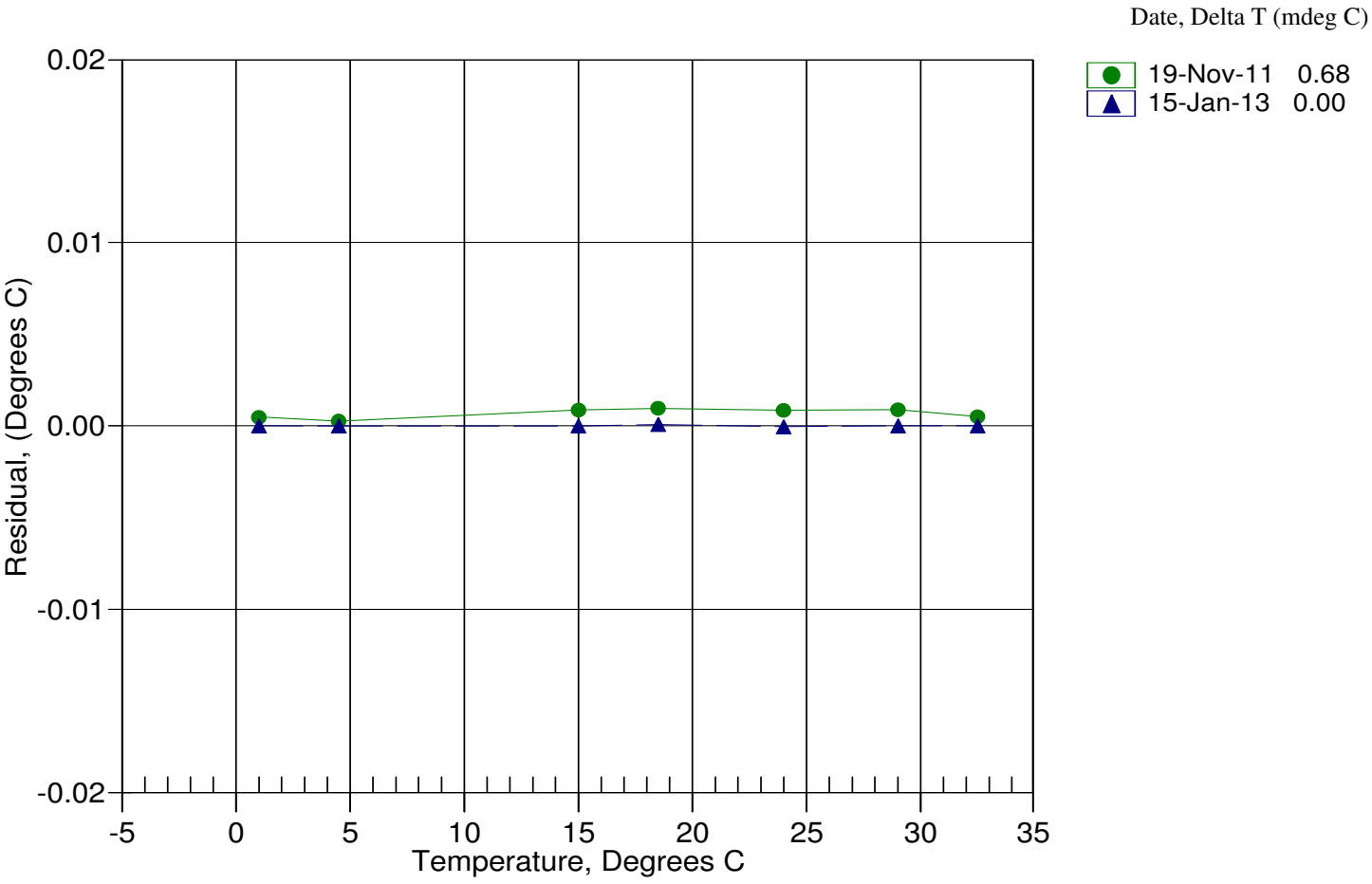
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	648465.131	1.0000	0.0000
4.4999	575538.623	4.4999	-0.0000
14.9999	394119.067	14.9999	-0.0000
18.4999	345384.617	18.5000	0.0001
23.9999	279281.852	23.9999	-0.0000
29.0000	229047.393	29.0000	0.0000
32.5000	198761.600	32.5000	0.0000

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



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SENSOR SERIAL NUMBER: 6121
CALIBRATION DATE: 11-Jan-13

SBE19plusV2 PRESSURE CALIBRATION DATA
870 psia S/N 2752079

COEFFICIENTS:

PA0 =	-2.168329e-001	PTCA0 =	5.247699e+005
PA1 =	2.639989e-003	PTCA1 =	-5.009466e+000
PA2 =	1.757815e-011	PTCA2 =	4.527557e-002
PTEMPA0 =	-5.976510e+001	PTCB0 =	2.511463e+001
PTEMPA1 =	5.349302e+001	PTCB1 =	-1.075000e-003
PTEMPA2 =	-4.374279e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.76	530357.0	1.5	14.77	0.00
180.02	592862.0	1.5	180.01	-0.00
360.04	660899.0	1.5	360.04	0.00
540.06	728872.0	1.5	540.06	0.00
720.08	796790.0	1.5	720.10	0.00
875.07	855198.0	1.5	875.05	-0.00
720.09	796792.0	1.5	720.10	0.00
540.10	728886.0	1.5	540.10	-0.00
360.08	660913.0	1.5	360.08	-0.00
180.07	592875.0	1.5	180.05	-0.00
14.76	530351.0	1.5	14.76	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.75	530473.02
29.00	1.68	530482.08
24.00	1.59	530496.28
18.50	1.48	530512.41
15.00	1.41	530522.78
4.50	1.21	530565.61
1.00	1.15	530585.51

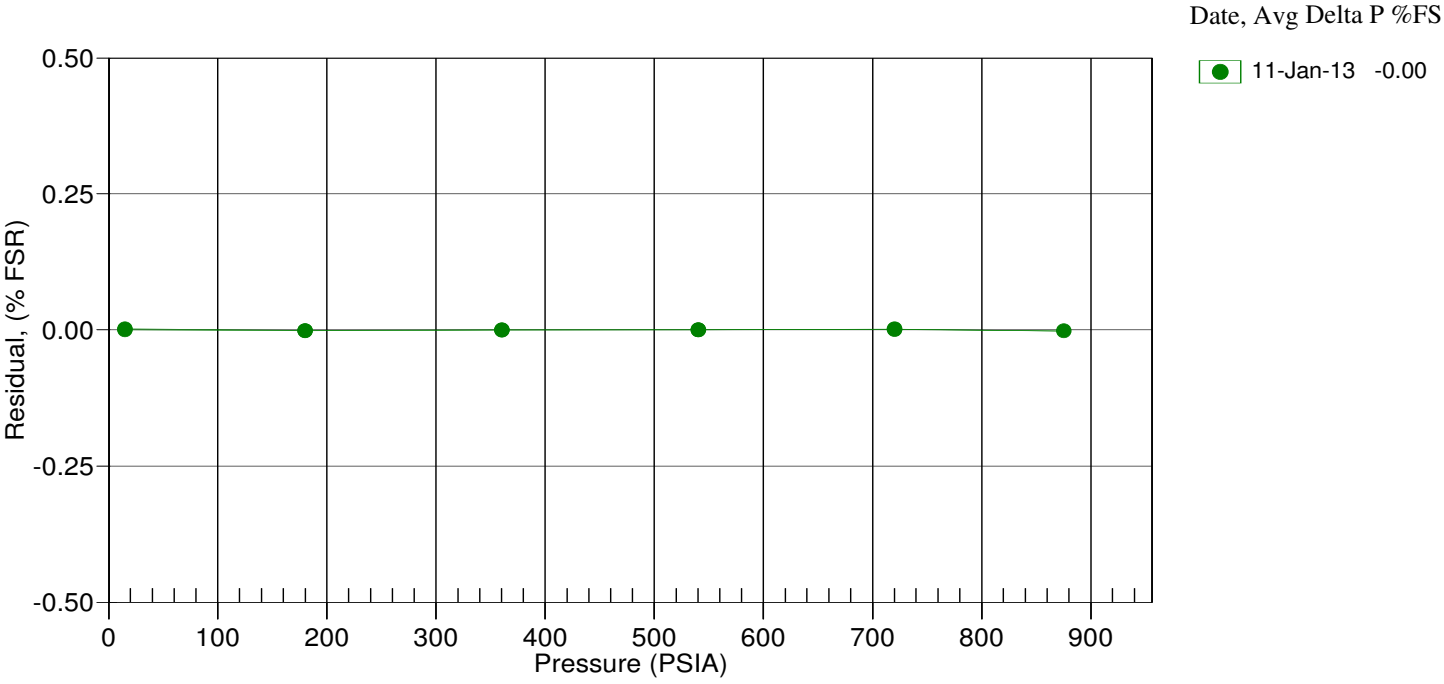
TEMP(ITS90)	SPAN(mV)
-5.00	25.12
35.00	25.08

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) = $PA0 + PA1 * n + PA2 * n^2$



SVP Test and Calibration certificate

SVP Type :	SVP71
SVP Serial No.	2008016

Date of issue :	08-10-2009

Functionality Test : Sign : Michael Hansen

Temperature Calibration :	Hart 1504 s/n A6B554 & Thermistor s/n 3014
Point 1:	4.6 °C
Point 2:	16.6 °C
Point 3:	25.5 °C
Pressure Calibration :	Custom Built Tank (TestUnit ASF150 Ser# 41-10-0007-R03)
Point 1:	0 Bar
Point 2:	100.3 Bar
Point 3:	206.2 Bar

	RMS Speed of Sound Errors
Temperature Validation :	0.0080 m/s
Pressure Validation :	0.1071 m/s

Calibration Completed : Sign : Michael Hansen

Final Function Test : Sign : Michael Hansen

QA Signature : Inits : JCHR

RESON A/S
Jegstrupvej 54
8361 Hasselager
Tel: +45 86 28 82 44

SVP Test and Calibration certificate

SVP Type :	SVP71
SVP Serial No.	2008038

Date of issue :	14-07-2009

Functionality Test : Sign : Michael Hansen

Temperature Calibration :	Hart 1504 s/n A6B554 & Thermistor s/n 3014
Point 1:	4.6 °C
Point 2:	16.6 °C
Point 3:	25.5 °C
Pressure Calibration :	Custom Built Tank (TestUnit ASF150 Ser# 41-10-0007-R03)
Point 1:	0 Bar
Point 2:	100.1 Bar
Point 3:	206.4 Bar

	RMS Speed of Sound Errors
Temperature Validation :	0.0034 m/s
Pressure Validation :	0.1263 m/s

Calibration Completed : Sign : Michael Hansen

Final Function Test : Sign : Michael Hansen

QA Signature : Inits : JHN

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Appendix II

Vessel Reports, Offsets, and Diagrams

Launch 2805

1. Offsets
2. Patch Test
3. POS MV GAMS Calibration
4. Dynamic Draft

Launch 2808

1. Offsets
2. Patch Test
3. POS MV GAMS Calibration
4. Dynamic Draft

Coordinate Systems Utilized in Vessel Offsets

2805 Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to 7125 *SWATH1 x,y,z & MRU to Trans* Caris	Port Ant to 7125 *Nav to Trans x,y,z* Caris	RP* to Waterline Caris	Port Ant to Stbd Ant	IMU to Port Ant Caris	IMU to Port Ant Pos/Mv	IMU to Heave Caris	IMU to Heave Pos/Mv
x	0.000	0.004	0.686	n/a	Scaler Distance 1.447	-0.682	-0.806	0.000	0.000
y	0.000	0.245	1.051	n/a		-0.806	-0.682	0.000	0.000
z	0.000	0.482	3.656	-0.097		-3.174	-3.174	0.000	0.000

*IMU is Reference Point

-0.111 (2010 used for K5K)

Vessel Offsets for 2805 7125 are derived from the NGS Survey, January 2010, Trimble Equipment Specs, and 2011 and 2010 Measured Values.

Calculations

Coord. Sys./ Source	IMU to 7125			Port Ant to 7125			RP to Waterline			Port Ant to Stbd Ant			IMU to Port Ant			IMU to Heave		
NGS	IMU (m)	x	0.00000	IMU to Port Ant (m) (calculated)	x	-0.68217	RP to Waterline (m) (waterline worksheet)	z	0.097	IMU to Port Ant (m) (calculated)	x	-0.68217	IMU (m)	x	0.00000	IMU (m)	x	0.00000
		y	0.00000		y	-0.80598					y	-0.80598		y	0.00000		y	0.00000
		z	0.00000		z	3.17407					z	3.17407		z	0.00000		z	0.00000
	MBES RP Rcvr - Phase Center (m)	x	0.00401	IMU to 7125 Phase Ctr (calculated)	x	0.00401	2010 RP to Waterline (m) (waterline worksheet)	z	0.111	IMU (m)	x, y, z	0.00000	Top of Port Ant (m)	x	-0.68217	Heave Pt (by design) (m)	x	0.00000
		y	0.24503		y	0.24503								y	-0.80598		y	0.00000
		z	-0.48191		z	-0.48191				Top of Stbd Ant (m)	x	0.76454		z	3.16277		z	0.00000
											y	-0.80778	Base to top of Port Ant (measured) (m)	z	0.073			
											z	3.14528						
										Base to top of Stbd Ant (measured) (m)	z	0.073	Bottom of Port Ant (calculated) (m)	z	3.08977			
										Bottom of Stbd Ant (calculated) (m)	z	3.07228	Base to Phase Cntr of Port Ant (eqp spc) (m)	z	0.0843			
										Base to Phase Cntr of Stbd Ant (eqp spc) (m)	z	0.0843						

Coord. Sys.	IMU to 7125			Port Ant to 7125			RP to Waterline			Port Ant to Stbd Ant			IMU to Port Ant			IMU to Heave		
NGS	IMU to 7125 Phase Ctr	x	0.00401		x	0.68618		x	n/a					x	-0.68217		x	0.00000
		y	0.24503		y	1.05101		y	n/a	Scalar Distance		1.4468		y	-0.80598		y	0.00000
		z	-0.48191		z	-3.65598		z	0.097					z	3.17407		z	0.00000
	Coord. Sys. CARIS	x	0.00401	Coord. Sys. CARIS	x	0.68618	Coord. Sys. CARIS	x	n/a				Coord. Sys. Pos/Mv	x	-0.80598	Coord. Sys. Pos/Mv	x	0.00000
		y	0.24503		y	1.05101		y	n/a					y	-0.68217		y	0.00000
		z	0.48191		z	3.65598		z	-0.097					z	-3.17407		z	0.00000

2012 2011 Measured Values

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to K5K Caris	IMU to Tow PT K5K Caris
x	0.000	0.534	0.609
y	0.000	0.845	-5.525
z	0.000	0.772	-2.186

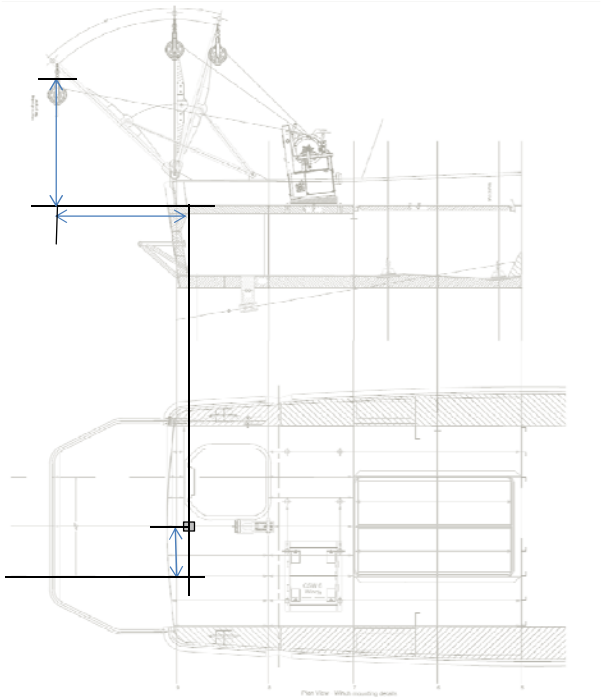
*IMU is Reference Point

Vessel Offsets for 2805 K5K are derived from the NGS Survey, January 2010, Trimble Equipment Specs, and

Calculations

Coord. Sys./ Source		IMU to K5K			IMU to Tow PT K5K		
NGS	IMU (m)		x	0.00000	IMU (m)	x	0.00000
			y	0.00000		y	0.00000
			z	0.00000		z	0.00000
	KEEL FORE BM		x	-0.00202	Centerline Stern BM	x	-0.01735
			y	0.44007		y	-4.04803
			z	-0.6141		z	0.67574
	KEEL FORE BM to K5K				CSBM to Tow PT		
	Rcvr - Phase		x	0.536		x	0.626
	Center		y	0.405		y	-1.477
	(measured)		z	-0.158	(measured)	z	1.510

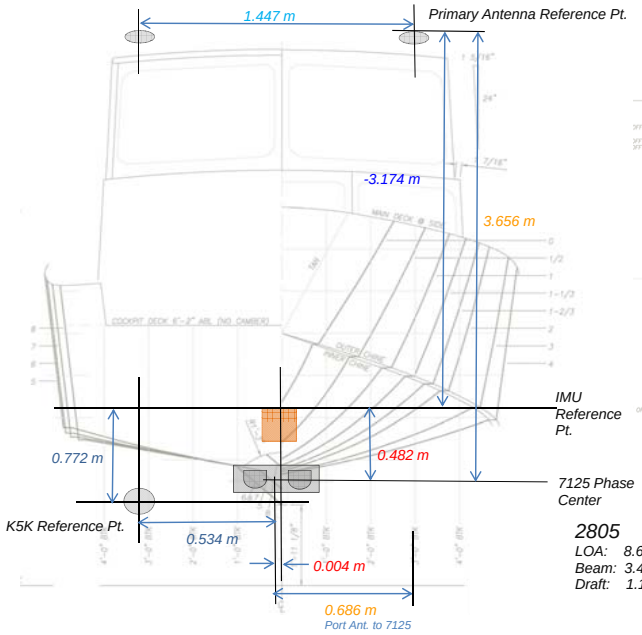
Coord. Sys.		IMU to K5K			IMU to Tow PT K5K		
NGS	IMU to K5K		x	0.53398	IMU to Tow PT K5K	x	0.60865
	Phase Ctr		y	0.84507		y	-5.52503
			z	-0.77210		z	2.18574
	Coord. Sys.		x	0.53398	Coord. Sys.	x	0.60865
	CARIS		y	0.84507	CARIS	y	-5.52503
			z	0.77210		z	-2.18574

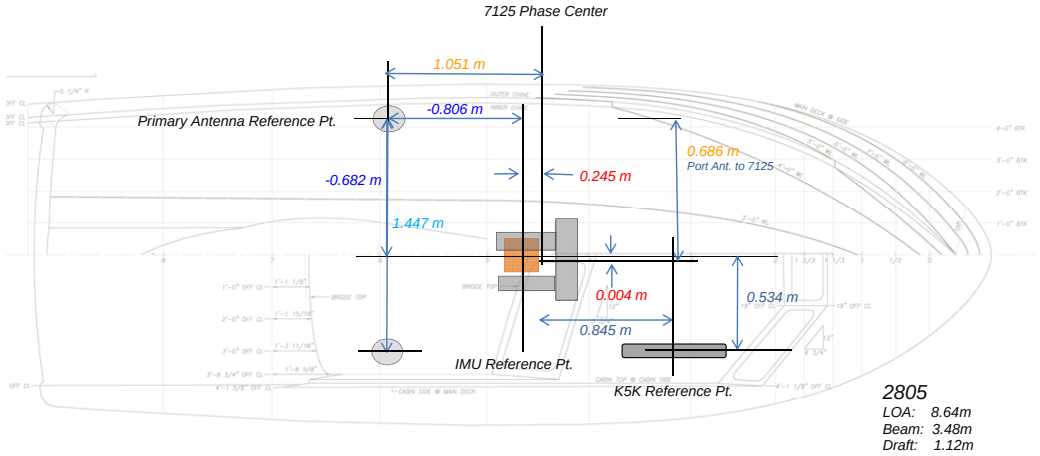


Description of Offsets for Launch 2805

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 2805 was based from the IMU reference point as the 0,0,0 point. Physical locations were measured with x,y,z offsets from this point. These locations were used to calculate offsets of items with respect to each other, as described for each offset.





IMU to 7125		
x	y	z
0.004	0.245	0.482

The physical positions of the IMU and the receiver phase center of the 7125 were measured during the NGS survey. These physical measurements were taken while the launch was secured on the pier and thought to be as level as possible. The measured values for the IMU and MB were taken directly for the report. The difference is the offset from the IMU to the phase center of the 7125 which was then transposed from the NGS to the CARIS coordinate system.

Port Ant to 7125		
x	y	z
0.686	1.051	3.656

The values were calculated by subtracting the physical height of the Port Antenna to the IMU x, y, z values from the respective values of the IMU to the 7125. The calculated values were then transposed from the NGS to the CARIS coordinate system.

RP to Waterline		
x	y	z
N/A	N/A	-0.097

The average vertical distance from Port Benchmark to waterline and the Starboard Benchmark to the waterline were measured by FAIRWEATHER personnel using a steel tape and bubble level. These values were combined with the Z value of the Benchmarks to the RP/IMU to get an average for the waterline to RP. The Waterline Measurement value is in NGS coordinates initially and is converted to CARIS coordinates.

Port Ant to Stbd Ant
Scalar Distance
1.447

The location of the phase center of the port and starboard POS/MV antennas were surveyed by NGS. The z-values were adjusted to the phase center. Then the scalar distance between the phase centers was calculated.

IMU to Port Antenna		
x	y	z
-0.682	-0.806	-3.174

The location of the IMU and the location of the top of port antenna were surveyed by NGS. The z-value of the antenna was calculated by subtracting the height of the antenna and then adding the value from the base of the antenna to the phase center of the antenna. The calculation results were then transposed from the NGS to the CARIS coordinate system.

IMU to Heave		
x	y	z
0.000	0.000	0.000

The Heave Point is assumed to coincide with the IMU location.

IMU to K5K		
x	y	z
0.534	0.845	0.772

The location of the IMU and the location of the forward keel benchmark were surveyed by NGS. BM to K5K were measured by FAIRWEATHER personnel using a steel tape and bubble level.

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

NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
January, 2010

NOAA SURVEY VESSEL 2805
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, launch bench marks and the components of a POS MV navigation system aboard the NOAA survey vessel 2805.

PROJECT DETAILS

This survey was conducted in Seattle, WA at the NOAA Western Center on the 26th of January, 2010. The weather was sunny early then cloudy with temperatures in the 40s to 50s. For this survey, the vessel was on blocks, supported by boat jacks. The vessel was reported to have been leveled relative to the IMU.

INSTRUMENTATION

A Leica TDA5005 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

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

PERSONNEL

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NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

DEFINITION OF THE REFERENCE FRAME

For this survey, data was collected in a 3-D right handed Cartesian coordinate system. The origin of this coordinate system is defined as the center of the IMU target. The Y (Northing) axis is parallel to the centerline of the launch and is positive towards the bow of the launch. The X (Easting) axis is perpendicular to the Y axis and is positive towards the starboard side of the launch. The Z (Elevation) axis is perpendicular to the XY plane and is positive towards the top of the launch. The coordinates of the points established this survey are reported in this coordinate system and are provided in Appendix A.

SURVEY METHODOLOGY

Four temporary control points, (1, 2, 3, and 4), were established around the vessel such that every point 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 temporary control point 1. A distance and height difference were measured between control points 1 and 2. Temporary control point 2 was assumed to have an Easting of 100.000. The measured distance between these two points was used to determine the Northing for temporary control point 2. The height difference between the two points was used to determine the Up component for control point 2.

Control point 1 was occupied and control point 2 was observed to initialize the instrument. After initialization, control point 4 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

Control point 2 was occupied and control point 1 was observed to initialize the instrument. After initialization, control point 3 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 1.

Control point 3 was occupied and control point 2 was observed to initialize the instrument. After initialization, control point 4 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

Control point 4 was occupied and control point 3 was observed to initialize the instrument. After initialization, all visible points to be observed on the launch were observed in both direct and reverse. Control point 1 was also observed in order to evaluate the accuracy of the traverse. Inverse computations between the original and observed control point yielded a horizontal accuracy, or traverse closure of of 0.000m and a vertical accuracy of 0.000m. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

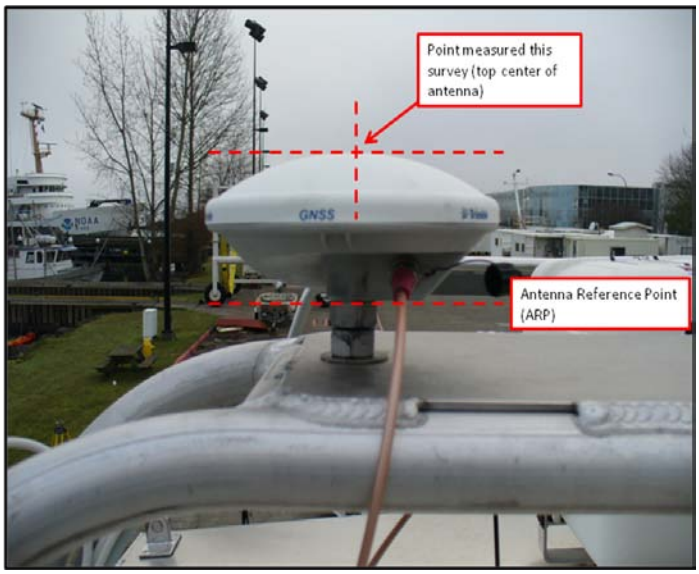
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

The reference frame was rotated using CENTERLINE STERN BM (CLS) as the point of rotation. A zero degree azimuth was used during the rotation from CLS to CENTERLINE BOW BM (BMB). The reference frame was then translated to relocate the origin of the reference frame to the IMU.

DISCUSSION

The positions given for the POS GPS antennas (Zephyr Model II 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;

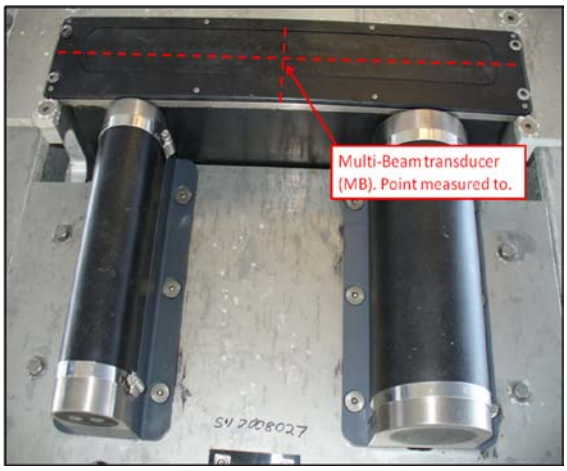
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This 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.



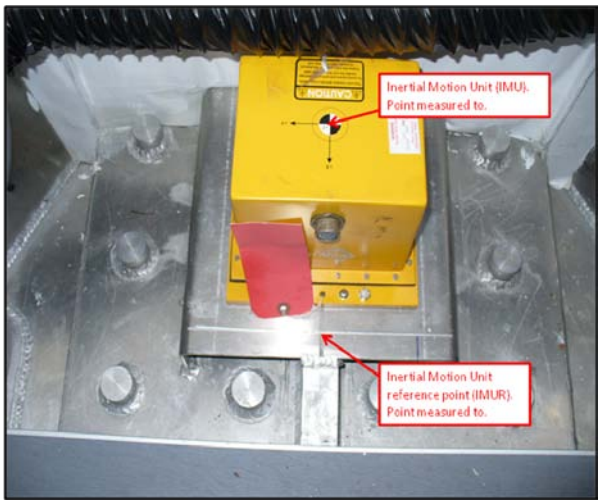
NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

Two reference points (MBF and MBA) were positioned in order to facilitate future measurements to the Multi-Beam sensor by launch personnel. These reference points are punch marks set along the center of the keel, at the locations described in the image at right.

A point on the Multi-Beam transducer (MB) was measured directly this survey. The measured point was at the center of the bottom of the transducer. No mark was left to indicate the measured point.



The point positioned for the Inertial Motion Unit (IMU) this survey was the center of the target affixed to the top of the unit. Additionally, a reference mark (IMUR) was established on the plate the IMU is attached to at a point where two scribed lines intersect, forward of the IMU.



NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

STATION LISTING

BMB- CENTERLINE BOW BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the deck, along the centerline and near the bow of the launch.

CLS- CENTERLINE STERN BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the deck, along the centerline and near the stern of the launch.

BMC- CENTERLINE CAB BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the top of the cab, along the centerline of the launch.

BMP- PORT SIDE BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the top of the deck, near the middle of and along the port side of the launch.

BMS- STARBOARD SIDE BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the top of the deck, near the middle of and along the starboard side of the launch.

MBF- KEEL BM
A punch mark set along the bottom center of the keel, fore of the multi-beam transducer, 0.030 m from a point where the keel makes a 90 degree angle upwards.

MBA- KEEL BM
A punch mark set along the bottom center of the keel, aft of the multi-beam transducer, 0.030 m from a point where the keel makes a 90 degree angle upwards.

IMU- IMU TARGET
Center of a target affixed to the top of the IMU housing.

IMUR- IMU REFERENCE BM
The intersection of two scribed lines atop a metal support plate for the IMU and forward of the IMU.

GPSP- PORT SIDE GPS ANTENNA REFERENCE POINT
The top center of the port side GPS antenna for the POS system.

GPSS- STARBOARD GPS ANTENNA REFERENCE POINT
The top center of the starboard side GPS antenna for the POS system.

MB- MULTI-BEAM REFERENCE POINT
The physical bottom center of the Multi-Beam transducer.

Appendix A

Coordinate Report Launch 2805

Pt Name	*North(Y)*	*East(X)*	*Elev.(Z)*	*ID*
IMU Target	0.00000	0.00000	0.00000	IMU
IMU Reference BM	0.13270	-0.00348	-0.16937	IMUR
Centerline Stern BM	-4.04803	0.01735	0.67574	CLS
Centerline Bow BM	3.46914	0.01735	1.39751	BMB
Portside GPS Ant. Ref. Point	-0.80598	-0.68217	3.16277	GPSP
Starboard GPS Ant. Ref. Point	-0.80778	0.76454	3.14528	GPSS
Multi-Beam Ref.Point	0.24503	0.00401	-0.48191	MB
Keel BM	0.44007	-0.00202	-0.61410	MBF
Keel BM	-0.22895	-0.00227	-0.53363	MBA
Port Side BM	0.10603	-1.42637	1.07535	BMP
Starboard Side BM	0.10926	1.45859	1.04250	BMS
Centerline Cab BM	-0.19024	0.03192	2.65903	BMC

Units = meters

Appendix B

Point to Point Inverse Launch 2805

Pt. 1	*Pt. 2*	*Dist.*	*Northing*	*Easting*	*Elevation*	*ID*
18	31	0.004	-0.003	0.003	-0.00141	BMC
9	29	0.001	0.001	- 0.001	0.00051	BMP
39	49	0.003	-0.003	0.001	-0.00063	BMS
8	48	0.001	-0.001	-0.001	0.00016	CLS
10	30	0.002	-0.001	0.002	0.00033	GPSP
11	41	0.000	0.000	0.000	0.00034	GPSS
16	53	0.001	0.000	0.001	0.00024	IMU
17	54	0.002	0.000	0.002	0.00029	IMUR
4	46	0.006	0.005	0.002	-0.00018	MB
5	47	0.001	0.000	0.001	0.00016	MBA
3	45	0.002	0.001	0.001	-0.00017	MBF

Units = meters

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2805 200kHz
Vessel

3/4/2014	063	Newport,OR
Date	Dn	Local Area

Bravo,Bradley
Calibrating Hydrographer(s)

7125	2805	
MBES System	MBES System Location	Date of most recent EED/Factory Check

Sonar Serial Number	Processing Unit Serial Number
Sonar Mounting Configuration	Date of current offset measurement/verification
Applanix POS/MV S/N:3627 IMU S/N:294	03/03/2014
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

3/4/2014	063	Newport,OR	partly cloudy
Date	Dn	Local Area	Wx

sand	7.5m
Bottom Type	Approximate Water Depth

Bravo,Bradley,Brooks
Personnel on board

Comments

2014_063_2805.554-.566
POSMV Filename(s)

2014_063_214813	2148	44/37/31.07	124/02/12.860	9.38	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2014_063_225323	2253	44/37/35.87	124/02/25.00	8.9	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0632158	292	4.0	
2	2014M_0632203	290	4.0	
3	2014M_0632208	291	8.0	
4	2014M_0632211	290	8.0	
5				
6				
7				
8				

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0632212	110	4.0	
2	2014M_0632203	292	4.0	
3				
4				
5	2014M_0632216	287	4.0	
6	2014M_0632218	115	4.0	
7				
8				

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0632221	288	4.0	
2	2014M_0632224	112	4.0	
3	2014M_0632227	288	4.0	
4	2014M_0632230	115	4.0	
5				
6				
7				
8				

ROLL view across track, same line [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_063_2235	295	4.0	
2	2014M_063_2239	125	4.0	
3	2014M_063_2242	293	4.0	
4	2014M_063_2246	122	4.0	
5	2014M_063_2249	299	4.0	
6				
7				
8				

Processing Log

3/3/2014	063	GDC
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** GDC

☑ **SVP applied** GDC

☑ **Tide applied** GDC

9435380.tid

Zone file

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing **2. Pitch bias** **3. Heading bias** **4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency Lines Used	Latency (sec)	Pitch Lines Used	Pitch (deg)	Roll Lines Used	Roll (deg)	Yaw Lines Used	Yaw (deg)
Wartick	2203/2208	0.00	2216/2212	-1.44	2235/2239	-0.13	2230/2224	0.07
Argento	2158/2208	0.00	2203/2212	-1.32	2246/2249	-0.11	2230/2224	0.00
Beduhn	2158/2208	0.00	2203/2212	-1.47	2246/2242	-0.08	2227/2230	0.08

Averages	0.00	-1.41	-0.11	0.05
Standard Deviation	0.00	0.08	0.03	0.04
FINAL VALUES	0.00	-1.41	-0.11	0.05

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.04	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.05	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: Ryan Wratick **Date:** 3/27/2014

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2805 400kHz
Vessel

3/4/2014	063	Newport,OR
Date	Dn	Local Area

Bradley, Bravo
Calibrating Hydrographer(s)

7125	2805	
MBES System	MBES System Location	Date of most recent EED/Factory Check
Sonar Serial Number		Processing Unit Serial Number
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:3627 IMU S/N:294		03/03/2014
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/4/2014	063	Newport,OR	Partly cloudy
Date	Dn	Local Area	Wx
sand			7.5m
Bottom Type			Approximate Water Depth

Bravo, Bradley
Personnel on board

sonar crashed at 1753
Comments

2014_031_2805.537
POSMV Filename(s)

2014_063_164421.HEX		44/37/33.88N	124/02/18.65	7.13	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2014	1810	44/37/29.72	124/02/25.07	7.63	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0631703	289	4.0	
2	2014M_0631708	289	4.0	
3	2014M_0631714	288	8.0	
4	2014M_0631718	289	8.0	
5				
6				
7				
8				

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0631711_PITCH	109	4.0	
2	2014M_0631723.PITCH	290	4.0	
3				
4				
5				
6				
7				
8				

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0631731	109	4.0	
2	2014M_0631734	290	4.0	
3	2014M_0631737	110	4.0	
4	2014M_0631740	291	4.0	
5				
6				
7				
8				

ROLL view across track, same line [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0631746_Roll.HSX	113	4.0	
2	2014M_0631750_Roll.HSX	309	4.0	
3	2014M_0631759.HSX	303	4.0	
4	2014M_0631803.HSX	123	4.0	
5				
6				
7				
8				

Processing Log

3/4/2014	063	GDC
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** GDC

☑ **SVP applied** GDC

☑ **Tide applied** GDC

9435380.tid

Zone file

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing **2. Pitch bias** **3. Heading bias** **4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency Lines Used	Latency (sec)	Pitch Lines Used	Pitch (deg)	Roll Lines Used	Roll (deg)	Yaw Lines Used	Yaw (deg)
Wartick	1708/1714	0.00	1711/1723	-1.40	1746/1750	-0.13	1737/1740	-0.12
Argento	1708/1714	0.00	1711/1723	-1.50	1759/1803	-0.16	1731/1734	0.00
Beduhn	1708/1714	0.00	1711/1723	-1.28	1759/1803	-0.10	1731/1734	0.00

Averages	0.00	-1.39	-0.13	-0.04
Standard Deviation	0.00	0.11	0.03	0.07
FINAL VALUES	0.00	-1.39	-0.13	-0.04

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro 0.07 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.07 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: Ryan Wartick **Date:** 3/27/2014

NOAA POS/MV Calibration Report

Fill out all fields! See previous years as an example.

Yellow areas require screen grabs!

Ship: FAIRWEATHER **Vessel:** 2805

Date: 4/16/2013 **Dn:** 106

Personnel: SS Brooks, ENS Broo, ENS Chensue, ENS Marwine

PCS Serial # 3627 **IMU Serial #** 294

IP Address: 129.100.1.231

POS controller Version (Use Menu Help > About) 5.1.0.2

POS Version (Use Menu View > Statistics) MV-320, VER4 (BD960)

GPS Receivers

Primary Receiver Serial #: 4851K33806

Secondary Receiver Serial #: 4851K33772

2013_106_2805.040

POSMV filename(s)

Calibration area

Location: Lake Washington

Approximate Position:

Lat	47	41	24
Lon	122	15	36

DGPS Beacon Station: Point Robinson **DGPS Receiver Serial#:** 0927-9567-0001

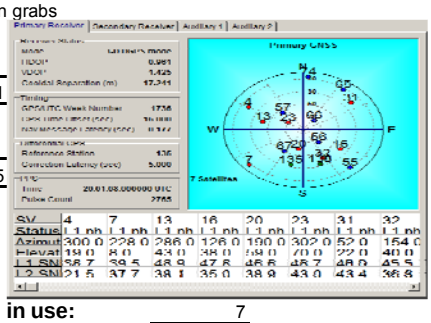
Frequency(kHz): 323

Satellite Constellation

(Use View> GPS Data)

Primary GPS

Insert screen grabs



HDOP 0.961

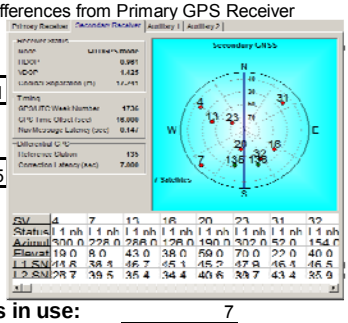
VDOP 1.425

Sattelites in use: 7

L1 SNR > 30 35 40

Secondary GPS

Note any differences from Primary GPS Receiver



HDOP 0.961

VDOP 1.425

Sattelites in use: 7

L1 SNR > 30 35 40

PDOP (Use View> GAMS Solution)

POS/MV Configuration
Settings

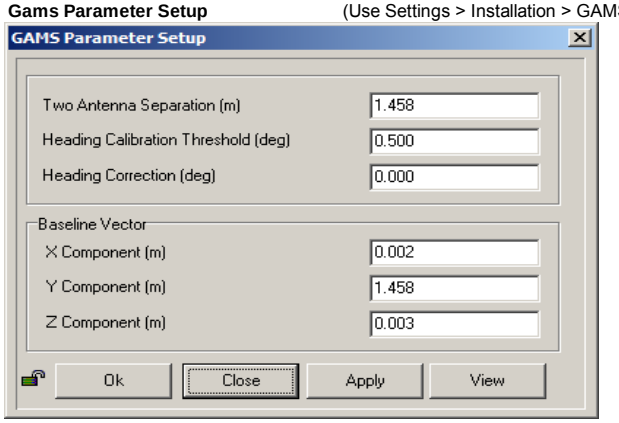
POS/MV Calibration

Calibration Procedure: (Refer to POS MV V4 Installation and Operation Guide, 4-25)

Start time: 19:40:00
End time: 20:09:05
Heading accuracy achieved for calibration: 0.469

Calibration Results:

Gams Parameter Setup (Use Settings > Installation > GAMS Intallation)



Save POS Settings on PC (Use File > Store POS Settings on PC)

File Name: 2013_04_16_POSCONFIG_GAMS.nvm
D:\HYPACK 2012\Projects\HSRR2012\Raw\Positioning

General Notes:

The POS/MV uses a Right-Hand Orthogonal Reference System

The right-hand orthogonal system defines the following:

- The x-axis is in the fore-aft direction in the appropriate reference frame.
- The y-axis is perpendicular to the x-axis and points towards the right (starboard) side in the appropriate reference frame.
- The z-axis points downwards in the appropriate reference frame.

The POS/MV uses a Tate-Bryant Rotation Sequence

Apply the rotation in the following order to bring the two frames of reference into complete alignment:

a) Heading rotation - apply a right-hand screw rotation θz about the z-axis to align one frame with the other.

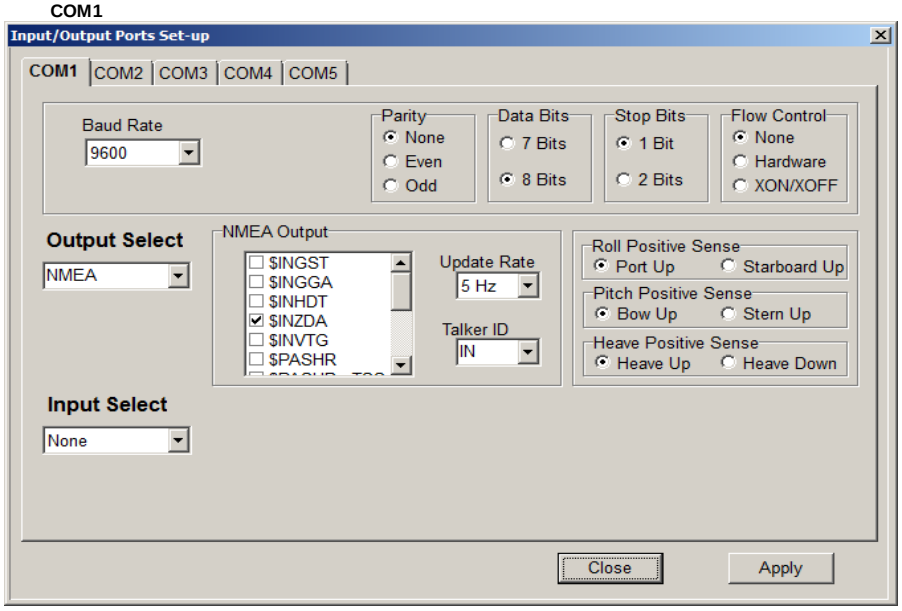
b) Pitch rotation - apply a right-hand screw rotation θy about the once-rotated y-axis to align one frame with the other.

c) Roll rotation - apply a right-hand screw rotation θx about the twice-rotated x-axis to align one frame with the other.

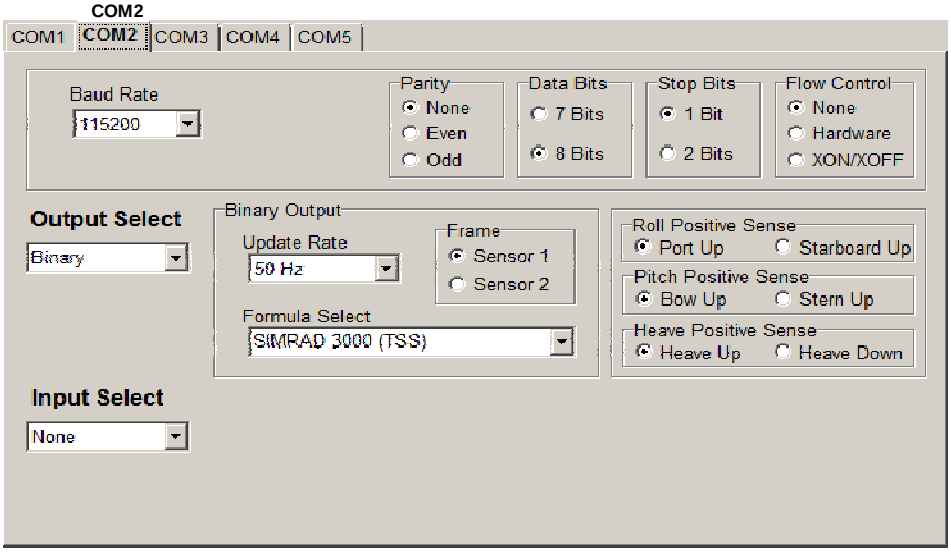
SETTINGS

Input/Output Ports (Use Settings > Input/Output Ports)

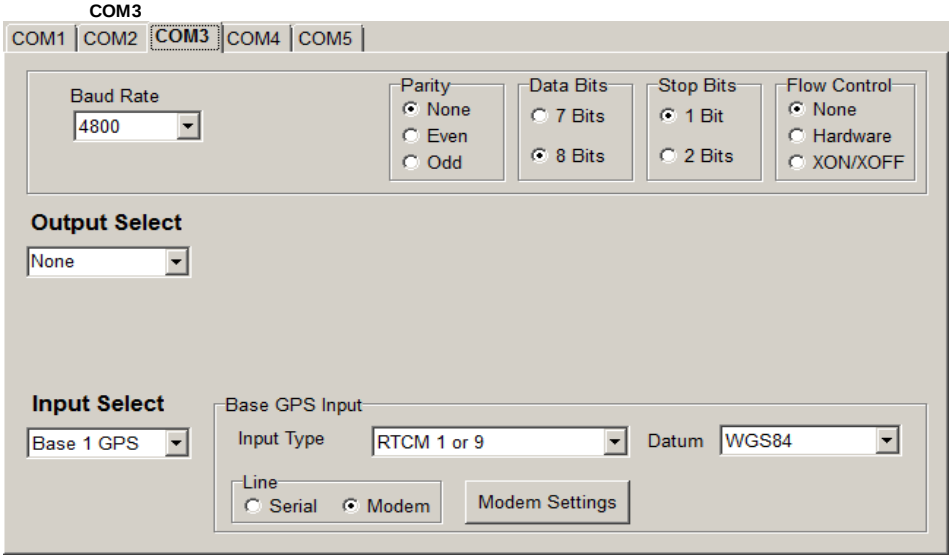
COM1



COM2

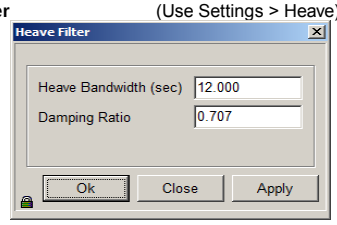


COM3

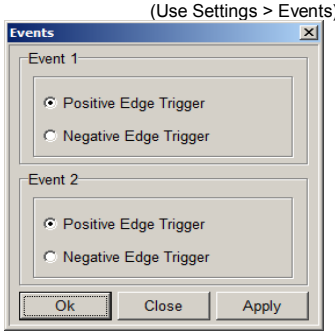


SETTINGS Continued

Heave Filter (Use Settings > Heave)

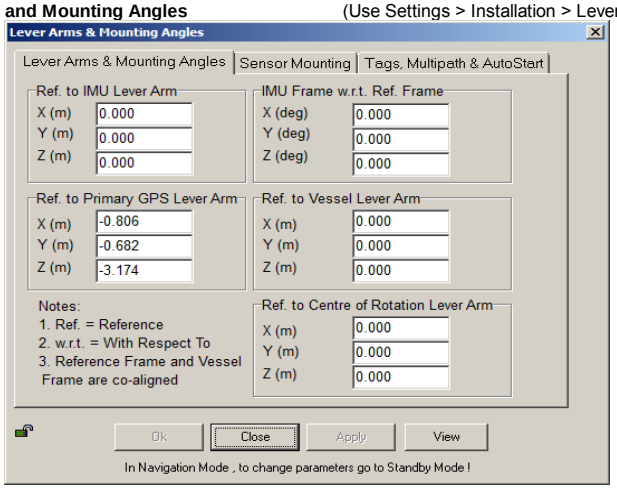


Events (Use Settings > Events)

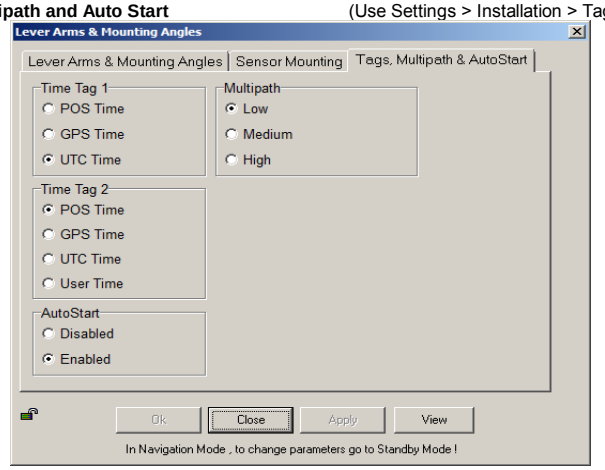


INSTALLATION (Use Settings > Installation)

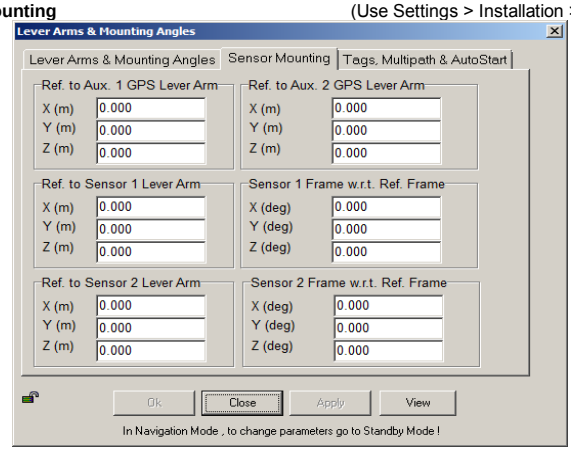
Lever Arms and Mounting Angles (Use Settings > Installation > Lever Arms and Offsets)



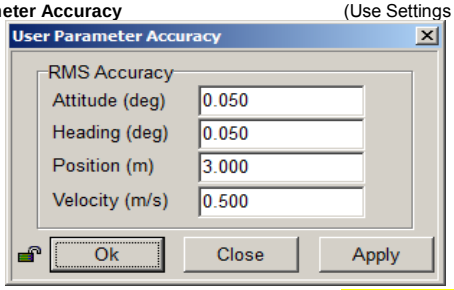
Tags, Multipath and Auto Start (Use Settings > Installation > Tags, Multipath and Auto Start)



Sensor Mounting (Use Settings > Installation > Sensor Mounting)



User Parameter Accuracy (Use Settings > Installation > User Accuracy)



Frame Control (Use Tools > Config) Diagnostics

☐ User Frame ☐ IMU Frame

Primary GPS Measurement

Auxiliary GPS Measurement

☐ **Use GAMS enabled**

ERDDM Acquisition Log

Launch 2805 200kHz
Vessel

4/16/2013	106	Lake Washington	Partly Cloudy, Calm
Date	Dn	Local Area	Wx

SS Brooks, ENS Broo, ENS Chensue, ENS Marwine
Personnel

Comments

N/A	Please select DGPS Beacon
Tidal Cycle Notes	USCG DGPS Beacon Used

2013_106_2805.056 - .076
POSMV filename(s)

POS File	Azmuth	Vessel Speed	RPM	Start and End Time
2013_106_2805.056 – 059	350	04	600	20:18:30 – 20:23:40
2013_106_2805.061 – 063	350	06	840	20:29:32 – 20:34:32
2013_106_2805.063 – 066	350	08	1310	20:38:30 – 20:43:30
2013_106_2805.066 – 069	170	010	1770	20:47:25 – 20:52:25
2013_106_2805.070 - 073	350	012	1900	20:56:45 – 21:01:45
2013_106_2805.073 – 076	170	014	2050	21:06:10 – 21:11:10

Processing Log

4/17/2013	107	Bravo and Witmer
Date	Dn	Personnel

☑ **POS Files Processed in POS Pac** — Smartbase
Smartbase or Singlebase? Station used.

☑ **SBET Processed in Pydro Using the ERDDM Tool**

☑ **Graph and Table Values compared with previous year**

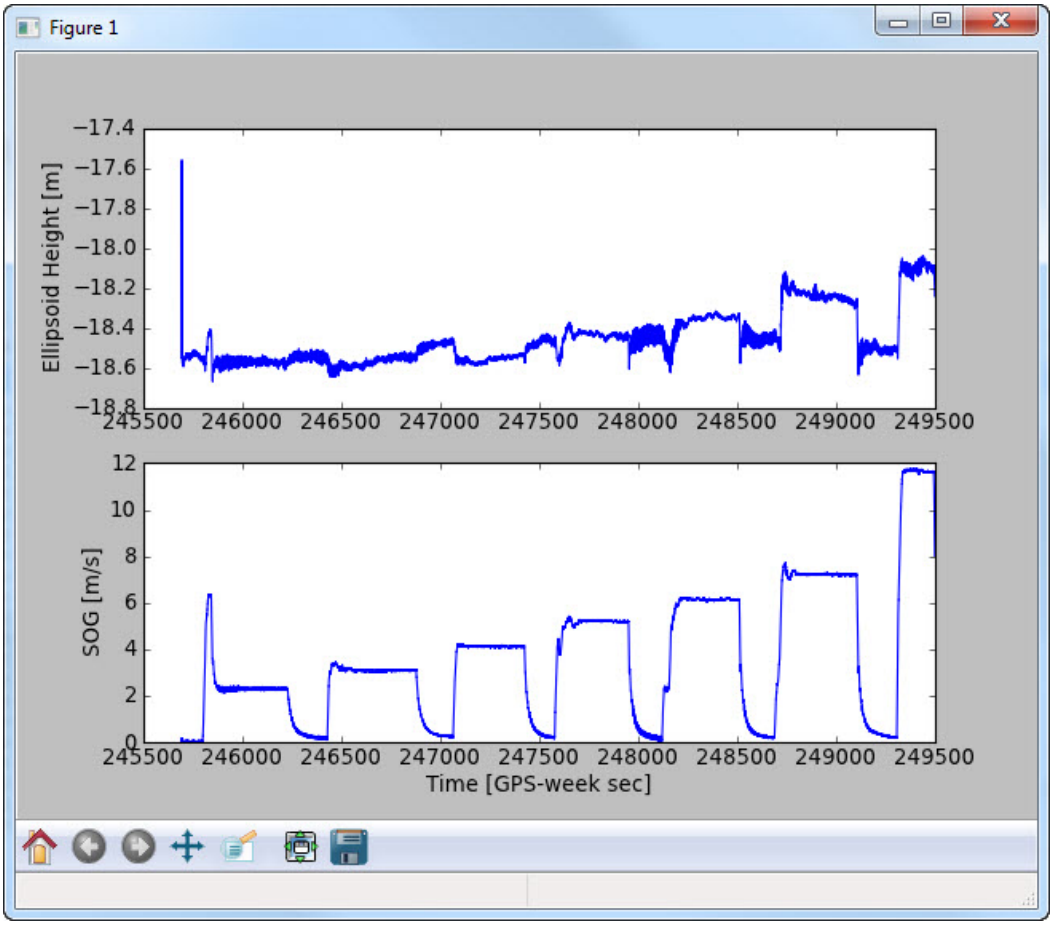
☑ **Documentaion Complete in DAPR Appendix**

☑ **See OPS/CST for updating HVF with new values**

FA – 2805

2013- DN106

4th Order Ellipsoidally Referenced ERDDM



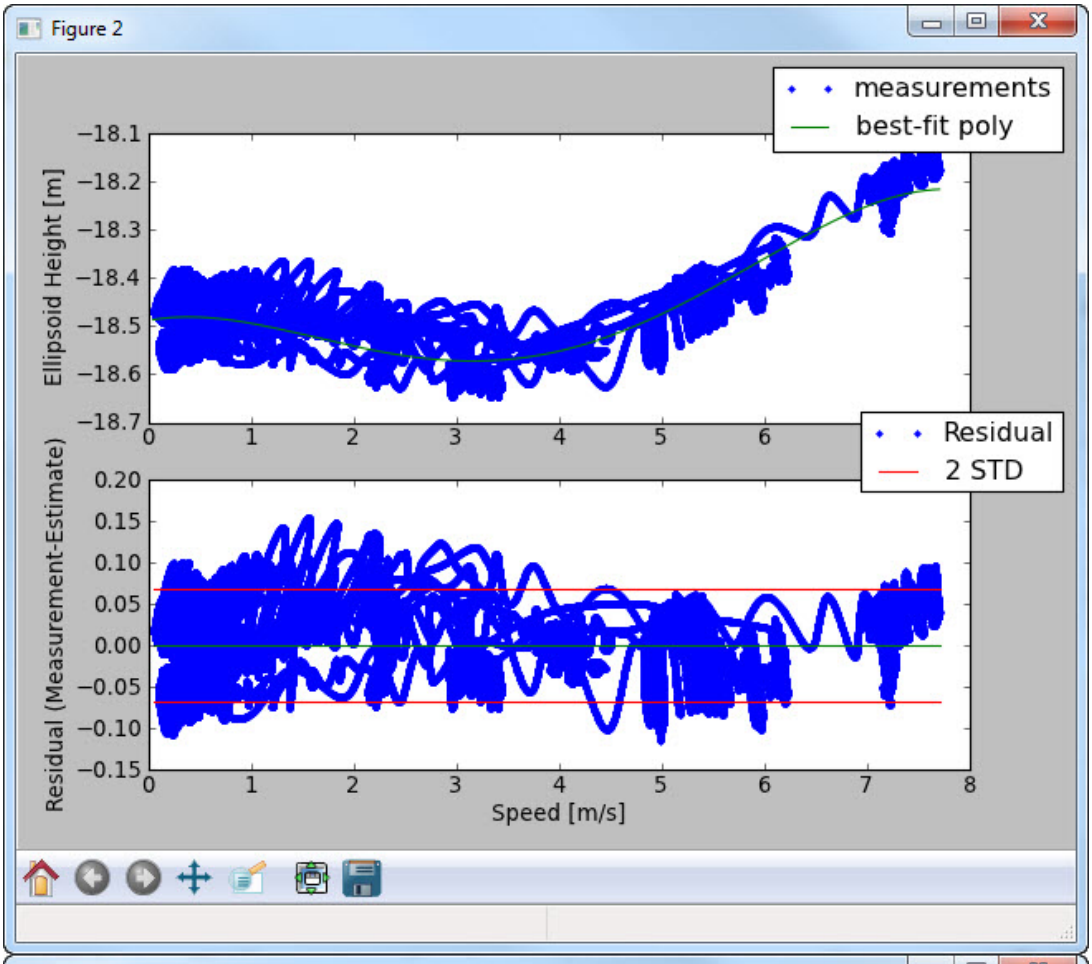


Figure 2
measurements
best-fit poly
Ellipsoid Height [m]
−18.1
−18.2
−18.3
−18.4
−18.5
−18.6
−18.7
0
1
2
3
4
5
6
Residual
2 STD
Residual (Measurement-Estimate)
0.20
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
0
1
2
3
4
5
6
7
8
Speed [m/s]

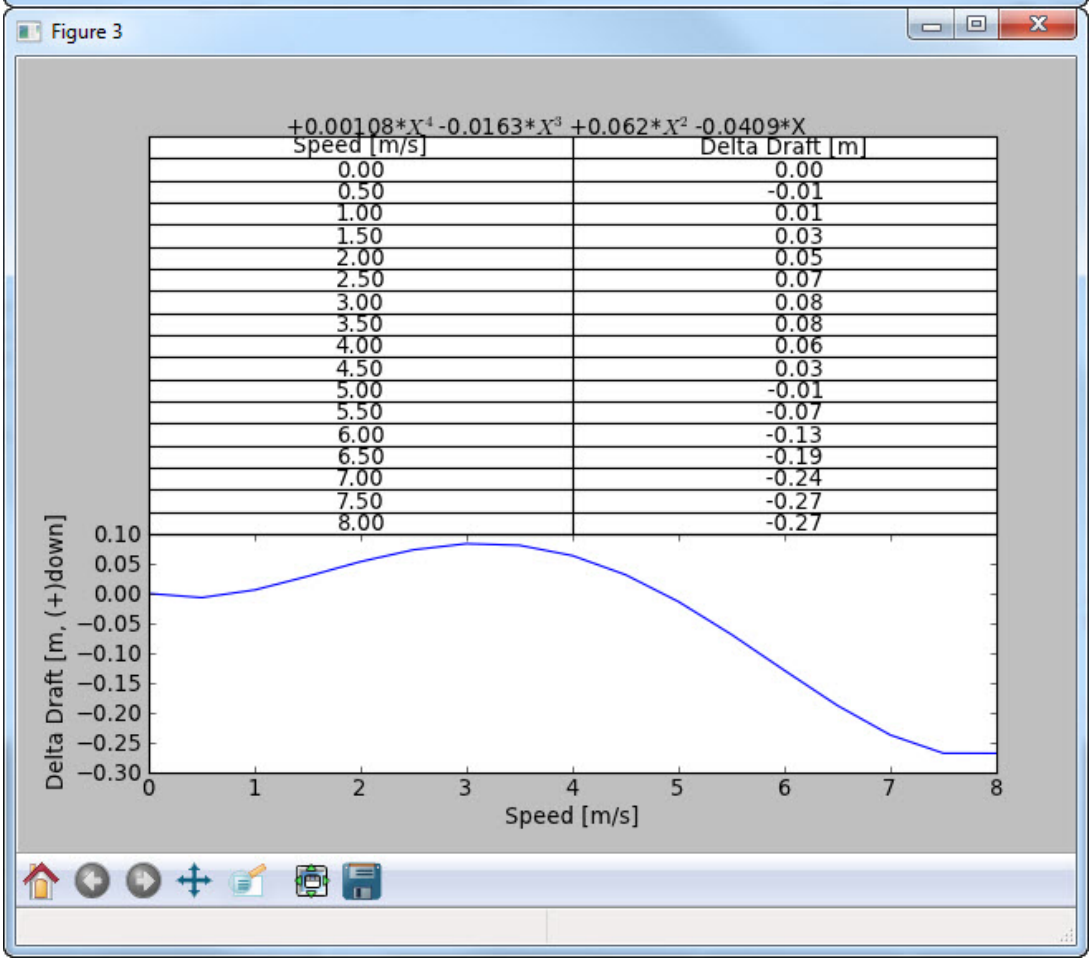


Figure 3
+0.00108*X⁴ -0.0163*X³ +0.062*X² -0.0409*X
Speed [m/s]
Delta Draft [m]
0.00
0.00
0.50
-0.01
1.00
0.01
1.50
0.03
2.00
0.05
2.50
0.07
3.00
0.08
3.50
0.08
4.00
0.06
4.50
0.03
5.00
-0.01
5.50
-0.07
6.00
-0.13
6.50
-0.19
7.00
-0.24
7.50
-0.27
8.00
-0.27
Delta Draft [m, (+)down]
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.20
−0.25
−0.30
0
1
2
3
4
5
6
7
8
Speed [m/s]

Waterline Measurements

Fill in Yellow squares only!

Measuring Party: Beduhn, Golmon, Gluntz

2805

Waterline measurements should be negative and cm!

	2805	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-97.800	-95.200
Measure 2	-95.900	-95.100
Measure 3	-97.600	-96.000
Avg (cm)	-97.10	-95.43
Avg (m)	-0.9710	-0.9543
Stdev	0.01044	0.00493
BM Z-value (m)*	1.07535	1.04250
BM to WL (m)	0.104	0.088
Individual measurement	0.09735	0.09050
	0.11635	0.09150
StDev for TPU xls (of 6 #'s)	0.011	0.09935	0.08250

Date: 4/3/2013
Fuel Level: 32.3
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0329	0.0167	-0.0162

RP to WL Average (m)
0.096

Measuring Party: Beduhn, Golmon, Gluntz

Waterline measurements should be negative and cm!

	2805	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-92.200	-91.400
Measure 2	-91.900	-91.100
Measure 3	-93.000	-90.600
Avg (cm)	-92.37	-91.03
Avg (m)	-0.9237	-0.9103
Stdev	0.00569	0.00404
BM Z-value (m)	1.07535	1.04250
BM to WL (m)	0.151683333	0.132
Individual measurement	0.15335	0.12850
	0.15635	0.13150
StDev for TPU xls (of 6 #'s)	0.012	0.14535	0.13650

Date: 4/3/2013
Fuel Level: 101
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0329	0.0133	-0.0195

RP to WL Average (m)
0.142
(Add this value to VSSL_Offsets & Measurements_20XX.xls)

utilized in Offsets and Measurements and TPU spreadsheet

2808 Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to 7125 (Receiver) *SWATH1 x,y,z & MRU to Trans* Caris	Port Ant to 7125 *Nav to Trans x,y,z* Caris	RP* to Waterline Caris	Port Ant to Stbd Ant	IMU to Port Ant Caris	IMU to Port Ant Pos/Mv	IMU to Heave Caris	IMU to Heave Pos/Mv
x	0.000	0.004	0.685	n/a	Scaler Distance 1.453	-0.682	-0.837	0.000	0.000
y	0.000	0.250	1.086	n/a		-0.837	-0.682	0.000	0.000
z	0.000	0.477	3.637	-0.093		-3.160	-3.160	0.000	0.000

*IMU is Reference Point

-0.123 (2010 used for K5K)

Vessel Offsets for 2808 7125 are derived from the NGS Survey, January 2010, Trimble Equipment Specs, and 2011 and 2010 Measured Values.

Calculations

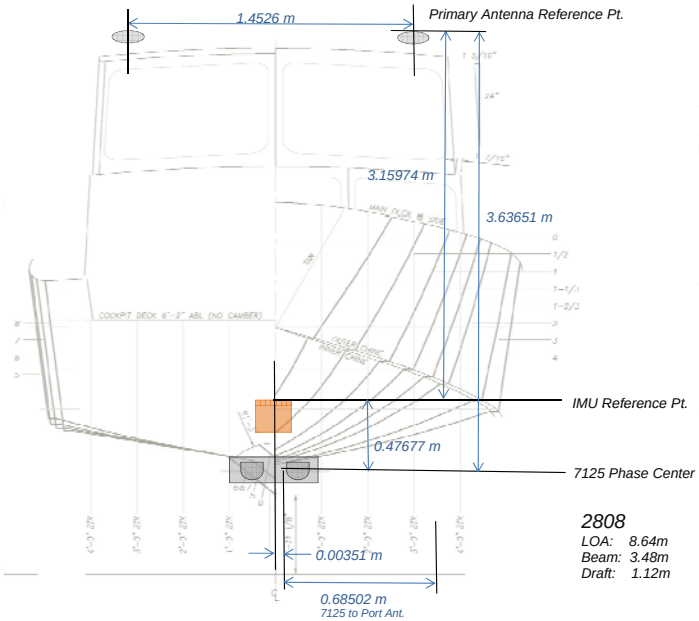
Coord. Sys./ Source	IMU to 7125	Port Ant to 7125	RP to Waterline	Port Ant to Stbd Ant	IMU to Port Ant	IMU to Heave
NGS	IMU (m) x 0.00000 y 0.00000 z 0.00000	IMU to Port Ant (m) (calculated) x -0.68151 y -0.83666 z 3.15974	RP to Waterline (m) (waterline worksheet) z 0.093	IMU to Port Ant (m) (calculated) x -0.68151 y -0.83666 z 3.15974	IMU (m) x 0.00000 y 0.00000 z 0.00000	IMU (m) x 0.00000 y 0.00000 z 0.00000
	MBES RP Rcvr - Phase Center (m) x 0.00351 y 0.24969 z -0.47677	IMU to Phase Ctr (calculated) x 0.00351 y 0.24969 z -0.47677	2010 RP to Waterline (m) (waterline worksheet) z 0.123	IMU (m) x, y, z 0.00000 Top of Stbd Ant (m) x 0.77098 y -0.83402 z 3.13235 Base to top of Stbd Ant (measured) (m) z 0.073 Bottom of Stbd Ant (calculated) (m) z 3.05935 Base to Phase Cntr of Stbd Ant (eqp spc) (m) z 0.0843	Top of Port Ant (m) x -0.68151 y -0.83666 z 3.14844 Base to top of Port Ant (measured) (m) z 0.073 Bottom of Port Ant (calculated) (m) z 3.07544 Base to Phase Cntr of Port Ant (eqp spc) (m) z 0.0843	Heave Pt (by design) m) x 0.00000 y 0.00000 z 0.00000

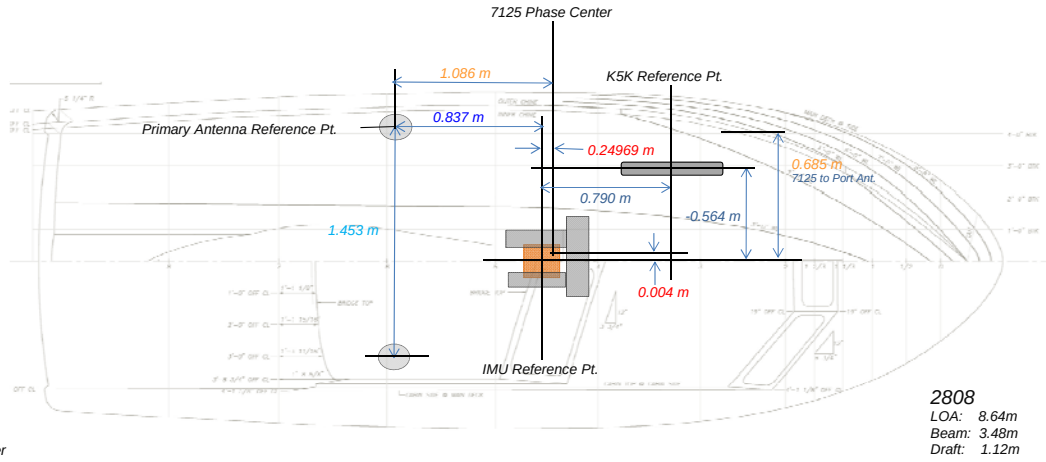
Coord. Sys.	IMU to 7125	Port Ant to 7125	RP to Waterline	Port Ant to Stbd Ant	IMU to Port Ant	IMU to Heave
NGS	IMU to Phase Ctr x 0.00351 y 0.24969 z -0.47677	x 0.68502 y 1.08635 z -3.63651	x n/a y n/a z 0.093	Scalar Distance 1.4526	x -0.68151 y -0.83666 z 3.15974	x 0.00000 y 0.00000 z 0.00000
	Coord. Sys. CARIS x 0.00351 y 0.24969 z 0.47677	Coord. Sys. CARIS x 0.68502 y 1.08635 z 3.63651	Coord. Sys. CARIS x n/a y n/a z -0.093		Coord. Sys. Pos/Mv x -0.83666 y -0.68151 z -3.15974	Coord. Sys. Pos/Mv x 0.00000 y 0.00000 z 0.00000

Description of Offsets for Launch 2808

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 2808 was based from the IMU reference point as the 0,0,0 point. Physical locations were measured with x,y,z offsets from this point. These locations were used to calculate offsets of items with respect to each other, as described for each offset.





IMU to 7125		
x	y	z
0.004	0.250	0.477

The physical positions of the IMU and the receiver phase center of the 7125 were measured during the NGS survey. These physical measurements were taken while the launch was secured on the pier and thought to be as level as possible. The measured values for the IMU and MB were taken directly for the report. The difference is the offset from the IMU to the phase center of the 7125 which was then transposed from the NGS to the CARIS coordinate system.

Port Ant to 7125		
x	y	z
0.685	1.086	3.637

The values were calculated by subtracting the physical height of the of the Port Antenna to the IMU x, y, z values from the respective values of the IMU to the 7125. The calculated values were then transposed from the NGS to the CARIS coordinate system.

RP to Waterline		
x	y	z
n/a	n/a	-0.093

The average vertical distance from Port Benchmark to waterline and the Starboard Benchmark to the waterline were measured by FAIRWEATHER personnel using a steel tape and bubble level. These values were combined with the Z value of the Benchmarks to the RP/IMU to get an average for the waterline to RP. The Waterline Measurement value is in NGS coordinates initially and is converted to CARIS coordinates.

Port Ant to Stbd Ant
Scalar Distance
1.453

The location of the phase center of the port and starboard POS/MV antennas were surveyed by NGS. The z-values were adjusted to the phase center. Then the scalar distance between the phase centers was calculated.

IMU to Port Antenna		
x	y	z
-0.682	-0.837	-3.160

The location of the IMU and the location of the top of port antenna were surveyed by NGS. The z-value of the antenna was calculated by subtracting the height of the antenna and then adding the value from the base of the antenna to the phase center of the antenna. The calculation results were then transposed from the NGS to the CARIS coordinate system.

IMU to Heave		
x	y	z
0.000	0.000	0.000

The Heave Point is assumed to coincide with the IMU location.

IMU to K5K		
x	y	z
-0.564	0.790	0.777

The location of the IMU and the location of the forward keel benchmark were surveyed by NGS. BM to K5K were measured by FAIRWEATHER personnel using a steel tape and bubble level.

Waterline Measurements

Fill in Yellow squares only!

Measuring Party: Francksen, Stuart, Pfundt, Smith

2808

Waterline measurements should be negative and cm!

	2808	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-94.3	-98.3
Measure 2	-95.8	-97.1
Measure 3	-96.5	-98.4
Avg (cm)	-95.53	-97.93
Avg (m)	-0.9553	-0.9793
Stdev	0.01124	0.00723
BM Z-value (m)*	1.07600	1.04444
BM to WL (m)	0.121	0.065
Individual measurement	0.13300	0.06144
	0.11800	0.07344
StDev for TPU xls (of 6 #'s)	0.032	0.11100 0.06044

Date: 3/14/2011

Fuel Level: 62.6 GAL (about 1/2 full)

Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0316	-0.0240	-0.0556

RP to WL Average (m)

0.093 NGS Coordinate System (do not enter into CARIS directly)

(Add this value to VSSL_Offsets & Measurements_20XX.xls)

utilized in Offsets and Measurements and TPU spreadsheet

Measuring Party: Francksen, Pfundt, Abraham

Waterline measurements should be negative and cm!

	2808	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-96.2	-97.1
Measure 2	-92.1	-96.1
Measure 3	-94.0	-96.8
Avg (cm)	-94.10	-96.67
Avg (m)	-0.9410	-0.9667
Stdev	0.02052	0.00513
BM Z-value (m)	1.07600	1.04444
BM to WL (m)	0.135	0.078
Individual measurement	0.11400	0.07344
	0.15500	0.08344
StDev for TPU xls (of 6 #'s)	0.034079	0.13600 0.07644

Date: 3/21/2011

Fuel Level: 100gal

Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0316	-0.0257	-0.0572

RP to WL Average (m)

0.106 NGS Coordinate System (do not enter into CARIS directly)

(or add this value to VSSL_Offsets & Measurements_20XX)

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

NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
January, 2010

NOAA SURVEY VESSEL 2808
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, launch bench marks and the components of a POS MV navigation system aboard the NOAA survey vessel 2808.

PROJECT DETAILS

This survey was conducted in Seattle, WA at the NOAA Western Center on the 27th of January, 2010. The weather was foggy then sunny with temperatures in the 40s to 50s. For this survey, the vessel was on blocks, supported by boat jacks. The vessel was reported to have been leveled relative to the IMU.

INSTRUMENTATION

A Leica TDA5005 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

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

PERSONNEL

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NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

DEFINITION OF THE REFERENCE FRAME

For this survey, data was collected in a 3-D right handed Cartesian coordinate system. The origin of this coordinate system is defined as the center of the IMU target. The Y (Northing) axis is parallel to the centerline of the launch and is positive towards the bow of the launch. The X (Easting) axis is perpendicular to the Y axis and is positive towards the starboard side of the launch. The Z (Elevation) axis is perpendicular to the XY plane and is positive towards the top of the launch. The coordinates of the points established this survey are reported in this coordinate system and are provided in Appendix A.

SURVEY METHODOLOGY

Four temporary control points, (1, 2, 3, and 4), were established around the vessel such that every point 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 temporary control point 1. A distance and height difference were measured between control points 1 and 2. Temporary control point 2 was assumed to have an Easting of 100.000. The measured distance between these two points was used to determine the Northing for temporary control point 2. The height difference between the two points was used to determine the Up component for control point 2.

Control point 1 was occupied and control point 2 was observed to initialize the instrument. After initialization, control point 4 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

Control point 2 was occupied and control point 1 was observed to initialize the instrument. After initialization, control point 3 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 1.

Control point 3 was occupied and control point 2 was observed to initialize the instrument. After initialization, control point 4 and all visible points to be observed on the launch were observed in both direct and reverse. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

Control point 4 was occupied and control point 3 was observed to initialize the instrument. After initialization, all visible points to be observed on the launch were observed in both direct and reverse. Control point 1 was also observed in order to evaluate the accuracy of the traverse. Inverse computations between the original and observed control point yielded a horizontal accuracy, or traverse closure of of 0.001m and a vertical accuracy of 0.000m. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

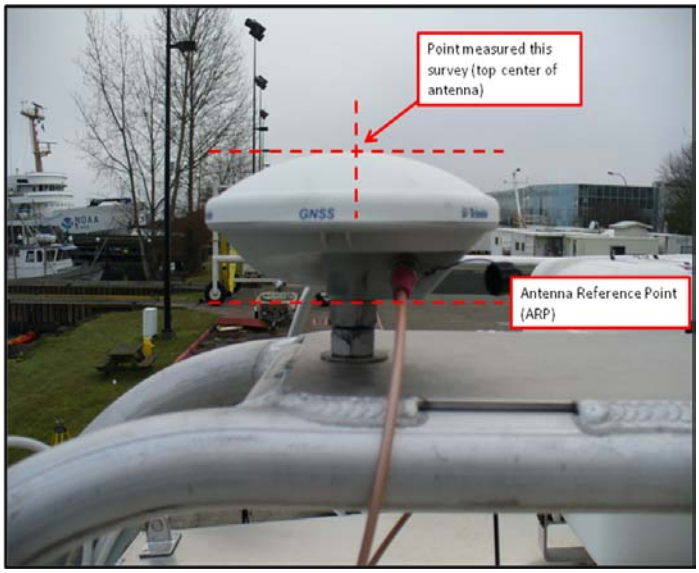
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

The reference frame was rotated using CENTERLINE STERN BM (CLS) as the point of rotation. A zero degree azimuth was used during the rotation from CLS to CENTERLINE BOW BM (BMB). The reference frame was then translated to relocate the origin of the reference frame to the IMU. The resulting coordinates are reported in appendix A.

DISCUSSION

The positions given for the POS GPS antennas (Zephyr Model II 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;

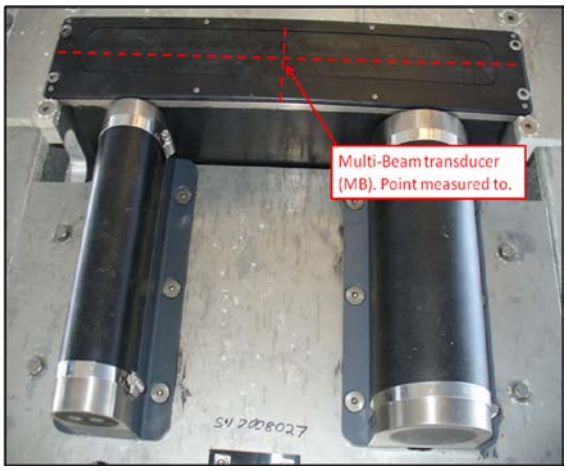
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This 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.



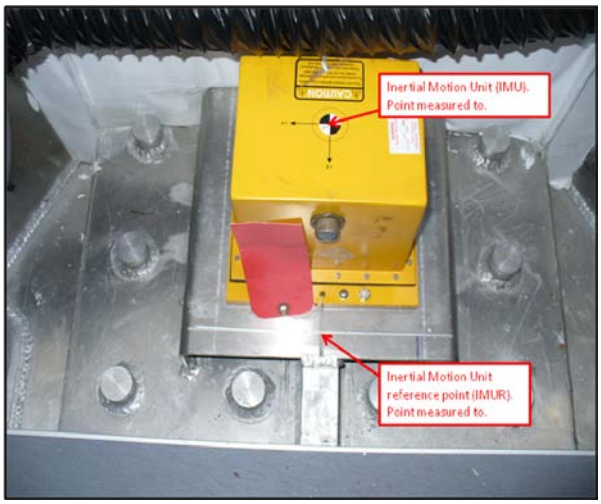
NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

Two reference points (MBF and MBA) were positioned in order to facilitate future measurements to the Multi-Beam sensor by launch personnel. These reference points are punch marks set along the center of the keel, at the locations described in the image at right.

A point on the Multi-Beam transducer (MB) was measured directly this survey. The measured point was at the center of the bottom of the transducer. No mark was left to indicate the measured point.



The point positioned for the Inertial Motion Unit (IMU) this survey was the center of the target affixed to the top of the unit. Additionally, a reference mark (IMUR) was established on the plate the IMU is attached to at a point where two scribed lines intersect, forward of the IMU.



NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

STATION LISTING

BMB- CENTERLINE BOW BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the deck, along the centerline and near the bow of the launch.

CLS- CENTERLINE STERN BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the deck, along the centerline and near the stern of the launch.

BMP- PORT SIDE BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the top of the deck, near the middle of and along the port side of the launch.

BMS- STARBOARD SIDE BM
The center of a cross mark inscribed into the top of a square metal flange, welded to the top of the deck, near the middle of and along the starboard side of the launch.

MBF- KEEL BM
A punch mark set along the bottom center of the keel, fore of the multi-beam transducer, 0.030 m from a point where the keel makes a 90 degree angle upwards.

MBA- KEEL BM
A punch mark set along the bottom center of the keel, aft of the multi-beam transducer, 0.030 m from a point where the keel makes a 90 degree angle upwards.

IMU- IMU TARGET
Center of a target affixed to the top of the IMU housing.

IMUR- IMU REFERENCE BM
The intersection of two scribed lines atop a metal support plate for the IMU and forward of the IMU.

GPSP- PORT SIDE GPS ANTENNA REFERENCE POINT
The top center of the port side GPS antenna for the POS system.

GPSS- STARBOARD GPS ANTENNA REFERENCE POINT
The top center of the starboard side GPS antenna for the POS system.

MB- MULTI-BEAM REFERENCE POINT
The physical bottom center of the Multi-Beam transducer.

Appendix A

Coordinate Report Launch 2808

Pt Name	*North(Y)*	*East(X)*	*UP(Z)*	*ID*
IMU Target	0.00000	0.00000	0.00000	IMU
IMU Reference BM	0.13282	-0.00186	-0.16518	IMUR
Centerline Stern BM	-4.07730	0.01391	0.61506	CLS
Centerline Bow BM	3.44544	0.01391	1.44047	BMB
Portside GPS Ant. Ref. Point	-0.83666	-0.68151	3.14844	GPSP
Starboard GPS Ant. Ref. Point	-0.83402	0.77098	3.13235	GPSS
Multi-Beam Ref.Point	0.24969	0.00351	-0.47677	MB
Keel BM	0.44021	-0.00126	-0.60545	MBF
Keel BM	-0.22600	0.00192	-0.53583	MBA
Port Side BM	0.08204	-1.42963	1.07600	BMP
Starboard Side BM	0.08324	1.46250	1.04444	BMS

Units = meters

Appendix B

Point to Point Inverse Launch 2808

Pt. 1	*Pt. 2*	*Dist.*	*Northing*	*Easting*	*Elevation*	*ID*
3	40	0.001	-0.001	0.000	0.00026	MBF
5	42	0.003	-0.002	-0.001	0.00013	MBA
4	41	0.002	-0.001	-0.002	0.00062	MB
14	55	0.006	-0.005	0.004	0.00049	IMUR
13	56	0.006	-0.004	0.004	0.00055	IMU
43	6	0.001	0.000	0.001	0.00048	CLS
33	44	0.000	0.000	0.000	0.00006	BMS
8	22	0.001	-0.001	0.000	0.00039	BMP
17	25	0.005	0.000	0.005	0.00011	BMB
24	34	0.001	0.000	0.000	0.00049	GPSS
23	7	0.000	0.000	0.000	0.00022	GPSP

Units = meters

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2808 200kHz
Vessel

3/11/2014	070	Newport,OR
Date	Dn	Local Area

Marcus, Ramsay
Calibrating Hydrographer(s)

Reson 200 kHz	FA 2808	
MBES System	MBES System Location	Date of most recent EED/Factory Check
		1812020
Sonar Serial Number		Processing Unit Serial Number
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2560 IMU S/N:324		
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/11/2014	070	Newport, OR	clear
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Marcus, Ramsay, Davis
Personnel on board

Comments

2014_070_2808.394-.406
POSMV Filename(s)

	1615	44/37/32.35N	124/02/15.8W	9	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2014_070_172753.HEX	1727	44/37/26.24N	124/02/18.7W	9.4	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0701623	287	4.8	multiple SSV spikes
2	2014M_0701627	285	4.7	multiple SSV spikes
3	2014M_0701631	287	8.1	multiple SSV spikes
4	2014M_0701634	287	8.0	multiple SSV spikes
5				
6				
7				
8				

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0701637	110	4.0	multiple SSV spikes (smiles)
2	2014M_0701640	290	4.9	multiple SSV spikes (smiles)
3	2014M_0701643	110	4.2	multiple SSV spikes (smiles)
4	2014M_0701646	290	4.8	multiple SSV spikes (smiles)
5				
6				
7				
8				

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0701653	110	4.0	multiple SSV spikes
2	2014M_0701658	110	4.0	multiple SSV spikes
3	2014M_0701703	110	4.0	multiple SSV spikes
4	2014M_0701707	110	4.0	multiple SSV spikes
5				
6				
7				
8				

ROLL view across track, same line [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0701713	300	5.0	
2	2014M_0701716	120	4.0	
3	2014M_0701720	300	5.0	fish-finder interference
4	2014M_0701723	120	4.0	
5				
6				
7				
8				

Processing Log

3/11/2014	070	Marcus/Ramsay
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** crm

☑ **SVP applied** crm NID

☑ **Tide applied** crm

Zone file M320RA2011CORP_Rev.zdf

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing **2. Pitch bias** **3. Heading bias** **4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency Lines Used	Latency (sec)	Pitch Lines Used	Pitch (deg)	Roll Lines Used	Roll (deg)	Yaw Lines Used	Yaw (deg)
Argento	1623/1627	0.00	1637/1640	-2.60	1720/1723	0.38	1653/1703	0.70
Wartick	1623/1631	0.00	1643/1646	-2.66	1713/1723	0.44	1658/1707	0.60
Beduhn	1623/1627	0.00	1643/1646	-2.64	1720/1723	0.45	1653/1703	0.70

Averages	0.00	-2.63	0.42	0.67
Standard Deviation	0.00	0.03	0.04	0.06
FINAL VALUES	0.00	-2.63	0.42	0.67

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro 0.06 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.03 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: Ryan Wartick and Tami Beduhn **Date:** 3/27/2014

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2808 400kHz
Vessel

3/14/2014	073	Yaquina Bay
Date	Dn	Local Area

Chensue, Friel, Fergusen
Calibrating Hydrographer(s)

400 kHz	Hull Mount	
MBES System	MBES System Location	Date of most recent EED/Factory Check
Sonar Serial Number		Processing Unit Serial Number
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2560 IMU S/N:324		
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/14/2014	073	Newport	Clear, Calm, Slack Tide
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Chensue, Friel, Fergusen
Personnel on board

Comments

2014_073_2808.414-434
POSMV Filename(s)

2014_073_190743	1907	44/37/36.346N	124/02/29.529W	8m	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2014_073_200213	2002	44 37 29.3282N	124/02/17.5216W	10m	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0731916	114	4.0	
2	2014M_0731922	114	8.0	
3	2014M_0731926	110	4.0	
4	2014M_0731931	110	8.0	
5				
6				
7				
8				

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0731916	114	4.0	
2	2014M_0731919	292	4.0	
3	2014M_0731924	290	4.0	
4	2014M_0731926	110	4.0	
5				
6				
7				
8				

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0731933	294	6.0	
2	2014M_0731937	290	6.0	
3	2014M_0731941	290	6.0	
4	2014M_0731944	290	6.0	
5				
6				
7				
8				

ROLL view across track, same line [opposite direction, same speed]

Line Number	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2014M_0731949	117	6.3	
2	2014M_0731951	292	6.1	
3	2014M_0731953	115	6.3	
4	2014M_0731956	290	6.1	
5				
6				
7				
8				

Processing Log

3/14/2014	073	Berube
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** 2014_073_2808.414-..434

☑ **SVP applied** 2014_073.svp

☑ **Tide applied** 9435380.tid

Zone file

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing **2. Pitch bias** **3. Heading bias** **4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency Lines Used	Latency (sec)	Pitch Lines Used	Pitch (deg)	Roll Lines Used	Roll (deg)	Yaw Lines Used	Yaw (deg)
Wartick	1916/1922	0.00	1916/1919	-1.71	1949/1951	0.40	1933/1937	0.30
Marcus	1926/1931	0.00	1924/1926	-1.83	1953/1956	0.42	1941/1944	
Beduhn	1916/1922	0.00	1919/1926	-1.60	1949/1951	0.40	1941/1944	0.42

Averages	0.00	-1.71	0.41	0.36
Standard Deviation	0.00	0.12	0.01	0.08
FINAL VALUES	0.00	-1.71	0.41	0.36

Final Values based on

Resulting HVF File Name

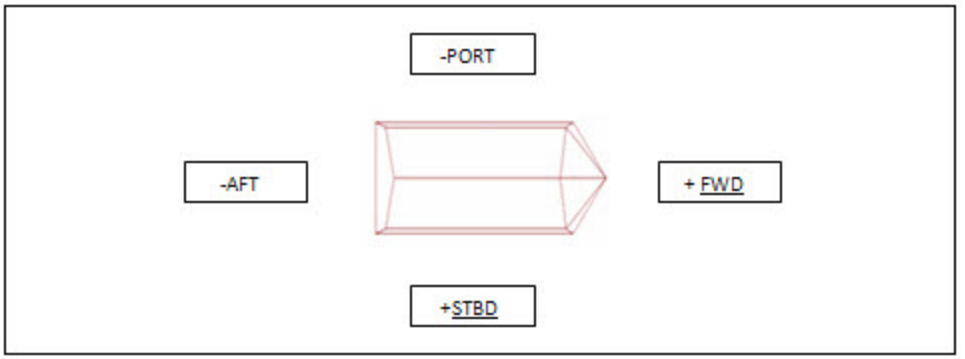
MRU Align StdDev gyro	0.08	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.06	Value from averaged standard deviations of pitch and roll offset values

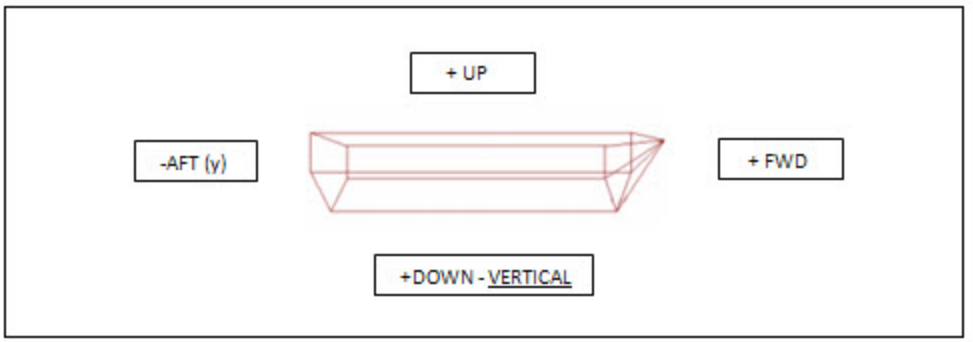
NARRATIVE

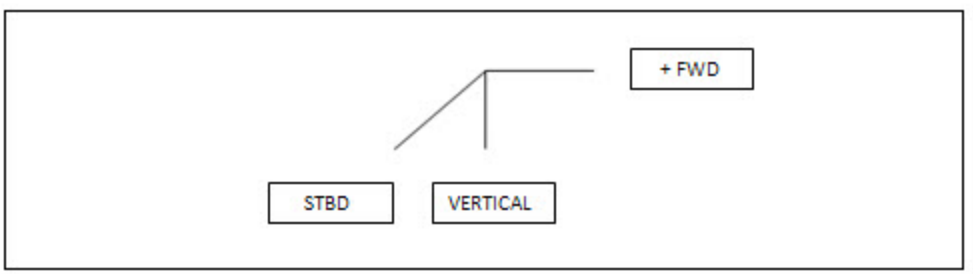
☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: Ryan Wartick and Tami Beduhn **Date:** 3/27/2014

Hypack Coordinate System

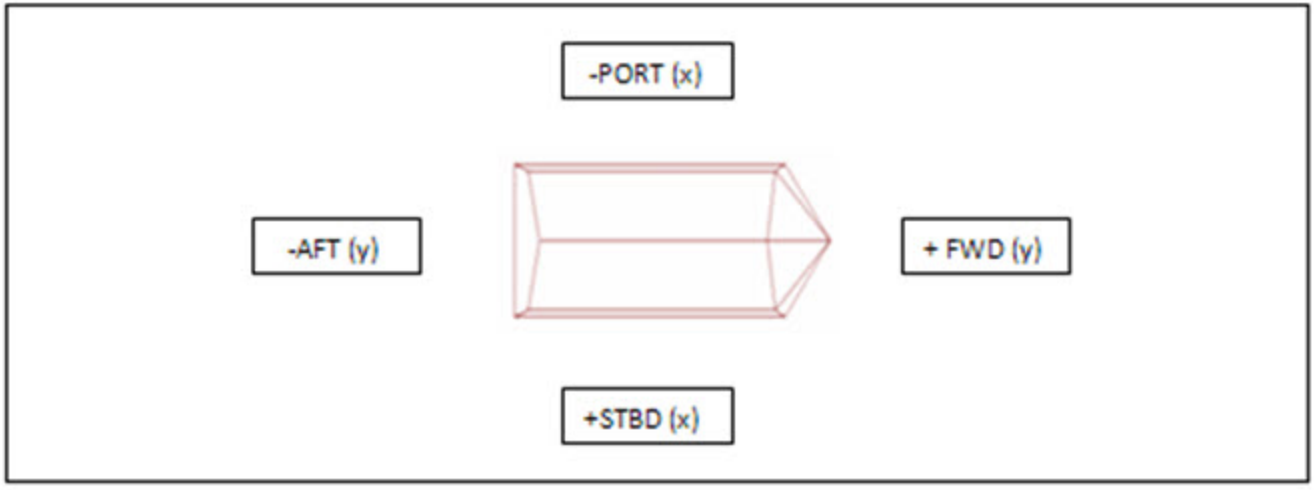


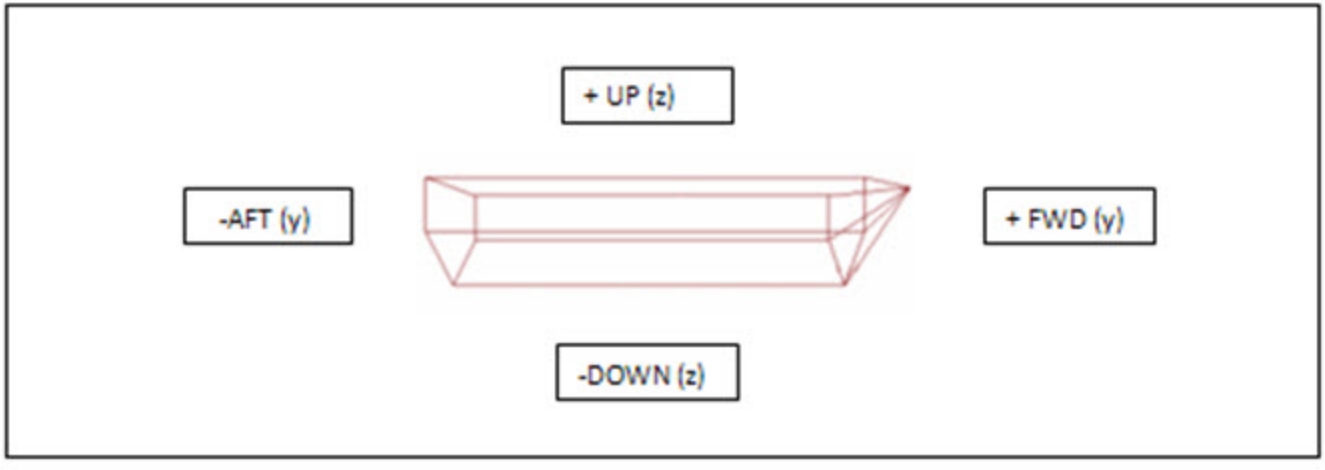


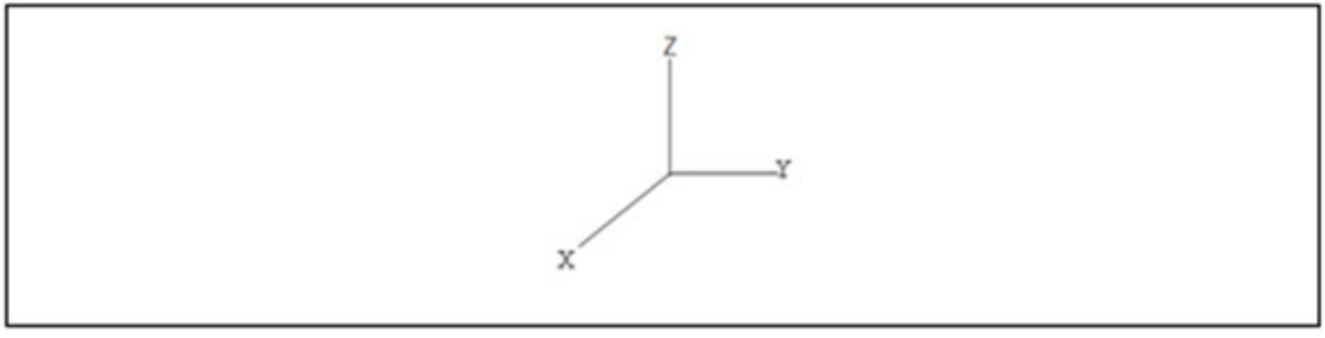


Top Center of IMU is origin of Hypack Coordinate System

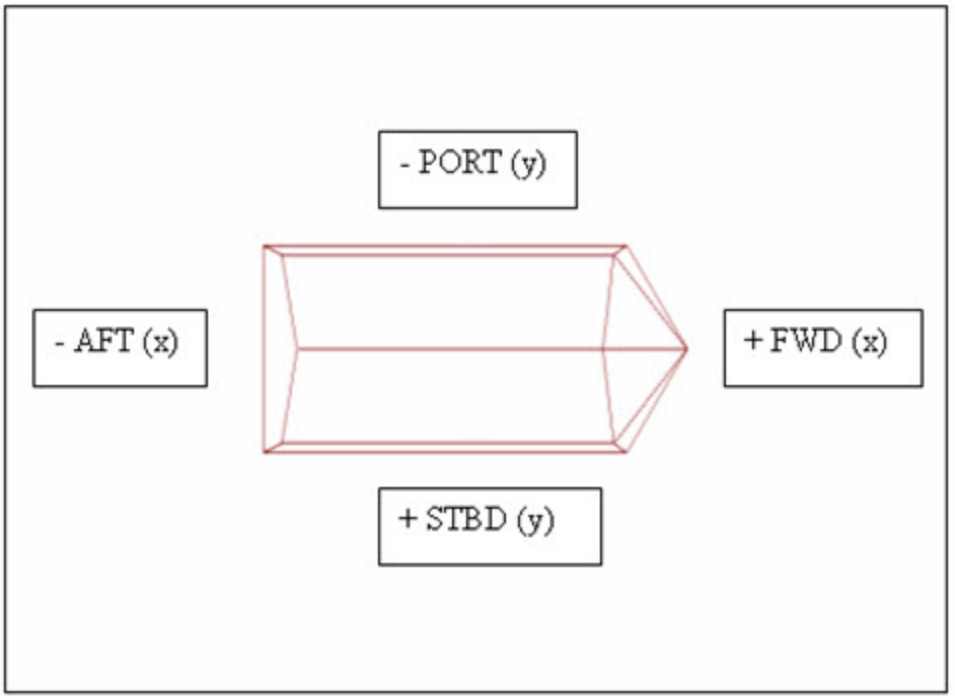
NGS/ RESON Coordinate System

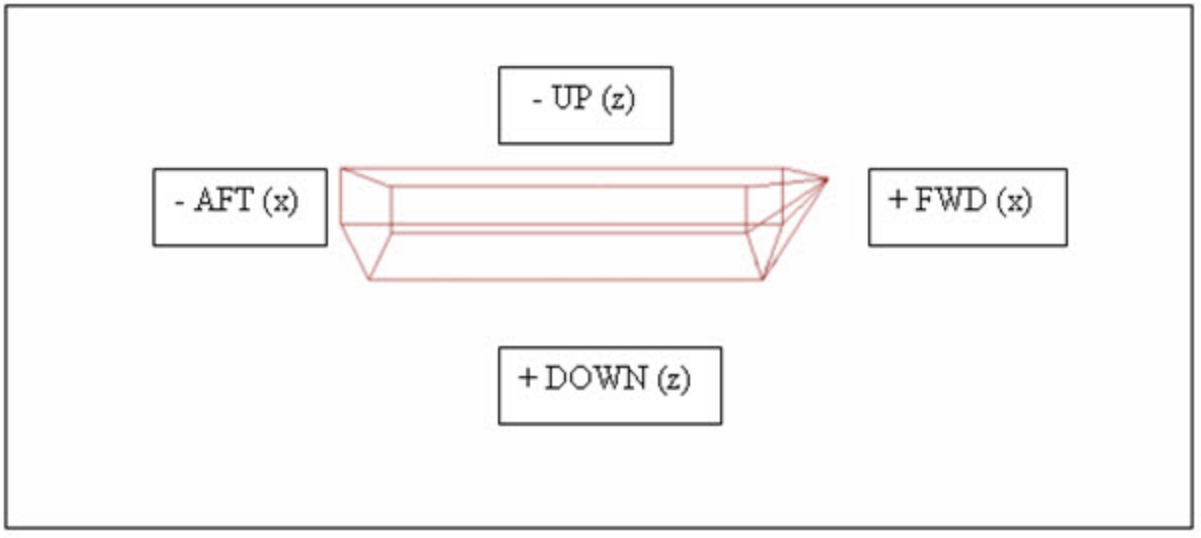


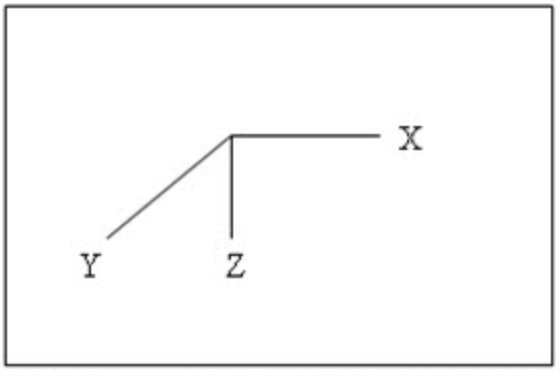




POS/MV Coordinate System

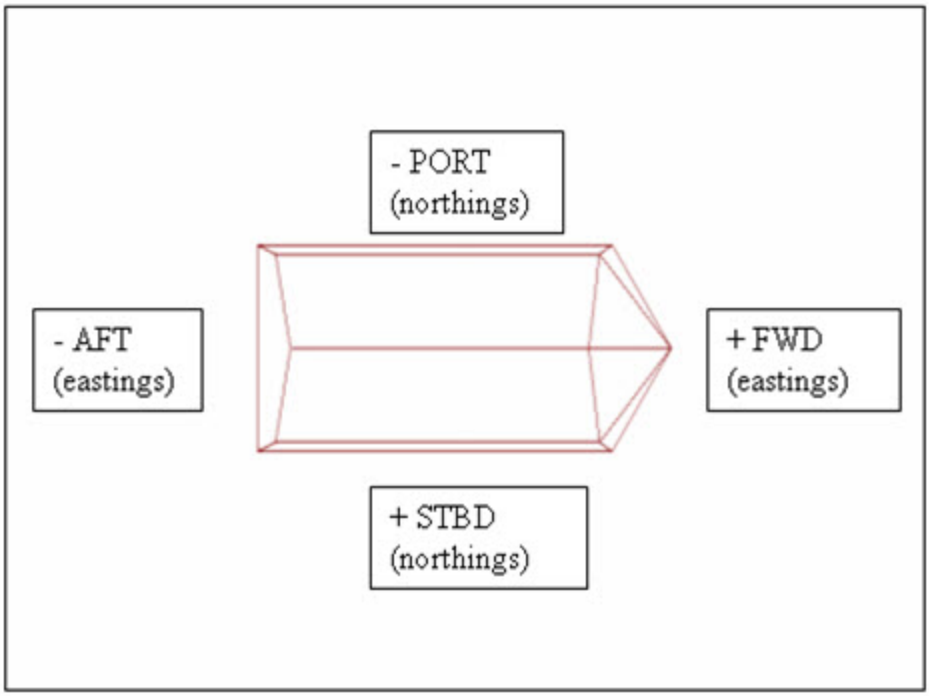


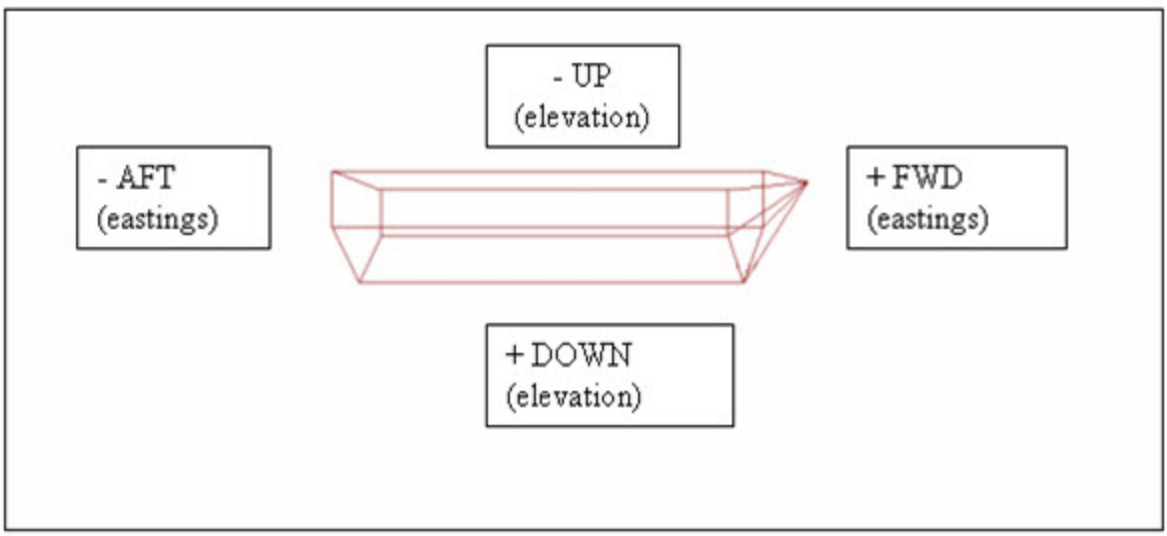


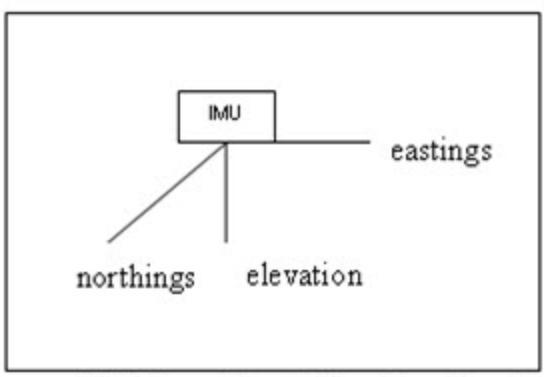


Top Center of IMU is origin of POS/MV Coordinate System

WESTLAKE Coordinate System







Bottom Center of IMU is origin of Westlake Coordinate System

Appendix III

Total Propagated Uncertainty (TPU)

Fairweather TPU Values

TIDE and SOUND SPEED - COMPUTE TPE VALUES

PROJECT	Tide Measurement (m) (Use in CARIS)	Tide Zoning 95% Provided by CO-OPS)	Tide Zoning (m) - 1 sigma (Use in CARIS)	SYSTEM	SV Measured (m/s) (Use in CARIS)	SV Surface (m/s) (Use in CARIS)
DEFAULT	0.01	0.2	0.10	7125	2	0.5
non-TCARI				7111/8160	1	0.5
DEFAULT	0	0	0.00	7125	2	0.5
TCARI				7111/8160	1	0.5
OPR-N395-FA-13	0	0	0.097	7125	2	0.5
Central Puget Sound			VDATUM	7111/8160	1	0.5
OPR-L318-FA-13	0.01	0.15	0.08		2	0.5
Approaches LA Long Beach CA					2	0.5

Tide zoning uncertainty values at the 95% confidence level for discrete zoning are provided by CO-OPS in the tide requirements document on the project CD. All error value components entered in CARIS for TPE calculation are assumed to be 1 sigma; therefore, the value provided by CO-OPS should be divided by 1.96.

Tides	
Measured:	Range (0.01m - 0.05m) dependent on gauge accuracy and duration of deployment
Zoning (discrete):	Range (0.01m - 0.40m) dependent on distance from gauge, range of tide, rate of tide change, and meteorological factors. Value provided by CO-OPS in the tide document in the project instructions package.
Zoning (TCARI):	*TCARI automatically calculates the error associated with water level interpolation. This error is incorporated into the residual/harmonic solutions and included in the Total Propagated Error(TPE) for the survey.*
Sound Speed	
Measured:	Range (0.5m/s to 4 m/s) dependent on spatial and temporal variability Use 1 m/s for casts every 15 min or less Use 4 m/s for casts every 4 hours
Surface:	Range (0.2 m/s to 2 m/s): dependent on surface sound speed gradient

Appendix IV

Additional Correspondence

None