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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

Data Acquisition & Processing Report

Type of Survey **Hydrographic**

Project No. **2011 Field Season**

Registry No.

LOCALITY

State **Washington and Alaska**

General Locality

CAPT David O. Neander, NOAA

CHIEF OF PARTY

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DATE

A. INTRODUCTION

This Data Acquisition and Processing Report outlines the acquisition and processing procedures used for Hydrographic projects surveyed in 2011 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 2011*, the *Field Procedures Manual (FPM), May 2011*, 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, horizontal and vertical control operations, shoreline acquisition, and processing are listed below.

1.0 Hardware

The hardware listed in this section is used throughout the 2011 field season.

1.1 Hardware Systems Inventory

Detailed hardware information, including installation dates and serial numbers, is included in Appendix I of this report. Manufacturer's product specifications are maintained with reference documentation on board *Fairweather*.

1.2 Echo Sounding Equipment

1.2.1 Reson 7111 Multibeam Echosounder (MBES)

Fairweather is equipped with a Reson 7111 MBES. The system was upgraded from a Reson 8111 in October 2009, which involved replacing the dry end transceiver and processor units but leaving the wet end hull-mounted projector and receiver intact. The Reson 7111 is a 100 kHz multibeam system with swath coverage of 150°. The swath is made up of 301 discrete equidistant beams with an along-track and across-track beamwidth of 0.5°. It has a specified depth range of 3 to 1200 meters, though the typical operational depth range of the Reson 7111 on *Fairweather* is 20 to 300 meters. No calibration information was provided by the manufacturer for the system. However, since this is 1 of 3 systems in the world used for hydrography we are working with RESON and INFREMER for an improvement with the sonar algorithms. We still have engineering receiver and transceiver boards and awaiting a complete set of production boards from RESON..
The Reson 7111 is hull-mounted within a reinforced projection that extends 27 inches below the keel. It is located 39.5" starboard of the centerline at approximately frame 29 (see Figure 1 & Figure 2).

1.2.2 Reson 8160 Multibeam Echosounder (MBES)

Fairweather is equipped with a Reson SeaBat 8160 MBES with the snippet option. The Reson 8160 is a 50 kHz multibeam system with a swath coverage of greater than 4x water depth. Each swath is made up of 126 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of 10 to 3000 meters, though the typical operational depth range of the Reson 8160 on *Fairweather* is 300 to 1000 meters. No calibration information was provided by the manufacturer of the system.

The 8160 is hull-mounted within a reinforced projection that extends 13.6 inches below the keel. It is located 54 inches port of the centerline at approximately frame 29 (see
Figure 3 &

Figure 4).

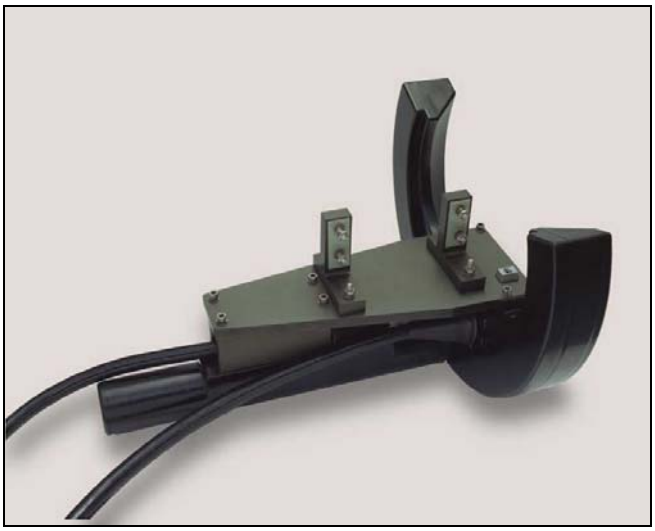


Figure 1: RESON SeaBat 7111 MBES

Figure 2: Installed on *Fairweather*

Figure 3: Reson SeaBat 8160

Figure 4: Installed on *Fairweather*

1.2.3 Reson 7125SV Multibeam Echosounder (MBES)

Survey launches 2805, 2806, 2807 and 2808 are each equipped with a dual frequency Reson 7125SV MBES. The Reson 7125SV has both a low frequency (200kHz) and high frequency (400kHz) head with a swath coverage of 128°. The swath is made up of 256 discrete beams for 200 kHz and 512 discrete beams for 400 kHz. The typical operational depth ranges for the Reson 7125SV operating at 200kHz is 3 to 400 meters and 3 to 100 meters operating with the 400kHz system. No calibration information was provided by the manufacturer for the system. Each system is hull mounted along the centerline (see
Figure 35).

Figure 5: Reson 7125SV on a *Fairweather* Launch

1.2.4 Klein 5000 Side Scan Sonar (SSS)

Fairweather utilizes both a lightweight and heavyweight Klein Series 5000 sonar system in addition to a Klein Series 5410 system operated without the bathymetry option. Each system is comprised of a side scan sonar towfish, Transceiver and Processing Unit (TPU), specialized tow and data cables, and a Windows- based acquisition computer. These systems operate at a nominal frequency of 500 kHz (455 kHz actual). Acquisition is conducted with Klein's SonarPro^{tm} software and files are logged in SDF format. Post processing occurs in CARIS SIPS.

The towfish can be used in one of two configurations, hull-mounted on any one of *Fairweather's* launches (Figure 6) or towed from *Fairweather* (Figure 7). In the hull-mounted configuration, the towfish is bolted to a sled on the bottom of the launch. The sled is situated to port of the keel and is approximately centered fore and aft. In the towed configuration the towfish is fitted with a K-wing depressor and affixed to armored coaxial cable for deployment from *Fairweather's* A-frame. The amount of tow cable being used is automatically entered into SonarPro^{tm} for towfish layback calculation. If in a towed or hull mounted configuration, a side scan position certification check will be conducted and documented prior to data

collection and system utilization. Offsets and values used in the ship Klein K5K hvf will be submitted with t

Figure 6: Hull-Mounted Klein 5000 Side Scan Sonar on *Fairweather* Launch with TPU

Dual acquisition of Klein 5000 SSS and Reson 7125 MBES data is the standard procedure with the hull-mounted configuration. A supplemental wiring diagram for when the launches are outfitted with Klein 5000 SSS is maintained aboard *Fairweather*. Reson 7125 MBES data acquired simultaneously with the SSS data is filtered down to 45-degrees on either side.

Figure 7: Towed Klein 5000 Side Scan Sonar on Fairweather

1.3 Manual Sounding Equipment

1.3.1 Lead Lines

Vessels are equipped with a lead line when appropriate. Lead lines are used for depth measurements near shore over submerged shoals and for echosounder depth comparisons.

Leadlines were created, measured and calibrated according to Section 1.5.3 of the *FPM* with the exception that the lines were calibrated to the meter instead of decimeter. Calibration was performed on February 23, 2011, and documentation is maintained aboard *Fairweather*.

1.4 Positioning, Heading, and Attitude Equipment

1.4.1 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. *Fairweather* (S220) and launches 2805, 2807, and 2808 are equipped with Zephyr II GNSS antennas. Launch 2806 is equipped with Zephyr I GNSS antennas. *Fairweather* (S220) and launch 2805 are equipped with BD960 PCS antenna receiver cards, and launches 2806, 2807, and 2808 are equipped with BD950 PCS antenna receiver cards. The port side antenna is designated as the primary receiver, and the starboard side antenna is the secondary receiver (see Figure 8). 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* and her 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.

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.

1.4.2 POS/MV GAMS Calibration

In the spring of 2011, GNSS Azimuth Measurement System (GAMS) calibrations were performed on each of *Fairweather's* five POS/MV units mounted to launches 2805, 2806, 2807, 2808, and *Fairweather* (S220). 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 8: POS GNSS Antennas

On June 22, 2011 (DN173) and June 23, 2011 (DN174) launch 2806 experienced intermittent GAMS failure as the secondary antenna lost and regained signal. PCS and PCS controller cards were tested along with the antenna-cable assembly. On DN174 personnel aboard the launch determined the problem was attributed to the Trimble Zephyr I antenna. Upon further

investigation a visible crack and discoloration were observed near and around the threaded base of the antenna. The antenna was removed and replaced with another Zephyr I antenna. An additional GAMS calibration was performed on June 24, 2011 (DN175). No further issues have arisen since the replacement antenna was installed.

1.4.3 DGPS Receivers

Fairweather is equipped with a commercial grade CSI Wireless MBX-3S DGPS Receiver on *Fairweather* (S220) and Hemisphere GPS MBX-4 DGPS receivers on launches 2805, 2806, 2807 and 2808 that are used 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.

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.

When *Fairweather* operates in remote areas outside of DGPS range such as during Arctic projects, *Fairweather* is equipped with two POSMV PCS units with integrated DGPS. These units are capabable of receiving the satellite based augmentation systems (SBAS) such as WAAS for real-time decimeter position accuracy. Three of the *Fairweather's* launches are not equipped with these PCS units and run in course acquisition mode (CA) during real-time data acquisition, which typically results in 2-3 meter horizontal position accuracy. All individual vessel POSMV files from all platforms are post processed whenever possible as described in the individual survey Descriptive Reports and project Horizontal and Vertical Control Reports.

1.4.4 Trimble Backpack

Fairweather uses two GPS Pathfinder® Pro XRS receivers in conjunction with a field computer to acquire detached positions during shoreline verification in the field. Data can also be collected with a handheld TSCe data collector. Field computers currently in use are Panasonic Toughbooks; two CF-30's, one CF-29, one CF-19, and two CF-18's. The receivers have integrated beacon/satellite differential antennas which allow access to digital real-time sub-meter accuracy solutions. Data quality assurance testing was conducted by *Fairweather* personnel in May 2011. Trimble units (Figure 9) were tested over a published benchmark. Trimble positions matched the published benchmark position within 0.6m. Test results are maintained with reference documentation on board *Fairweather*.

Figure 9: Trimble Backpack Unit

1.4.5 Hand-held Laser

The Impulse Laser Rangefinder (Figure 10) and TruPulse 200 Laser Rangefinder (Figure 11) are used in conjunction with the Trimble Backpack GPS unit to acquire distances and heights during shoreline verification. These data are entered directly into the shoreline acquisition software and annotated on the detached position forms. The Impulse LR and TruPulse 200 Laser Rangefinders do not function properly in low light or in choppy seas when a feature is not distinguishable from surroundings.

Figure 10: IMPULSE LR Laser Rangefinder

Figure 11: TruPulse 200 Laser Rangefinder

Data quality assurance testing was conducted on June 20, 2011 by *Fairweather* personnel. Vertical and horizontal readings were taken with the laser rangefinders and compared to measurements taken with a steel tape. The laser rangefinder was set up on a tripod and a staff of known height was measured at distances of 10, 20, 50, and 100 meters. Three horizontal and three vertical readings were taken at each interval. The results of the laser rangefinder accuracy testing are maintained with reference documentation on board *Fairweather*.

1.5 Sound Speed Equipment

1.5.1 Sound Speed Profiles

1.5.1.1 SBE 19plus SEACAT Profiler

Fairweather is equipped with three SBE 19*plus* and 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. Two of the SBE 19*plus* profilers have pressure sensors rated to 1000 meters. The third SBE 19*plus* profiler has a pressure sensor rated to 3,500 meters. The two SBE 19*plusV2* profilers have pressure sensors and units rated to 600 meters.

The SBE 19*plus* and SBE 19*plusV2* SEACAT sound speed profilers were calibrated by the manufacturer during the 2010-2011 winter repair period. The current calibration files are maintained with reference documentation aboard *Fairweather*.

Periodic quality assurance checks include comparison casts between CTD instruments. Data quality assurance (DQA) checks 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.

1.5.1.2 Moving Vessel Profiler 200

A Brooke Ocean Technology, Ltd. (BOT) Moving Vessel Profiler 200 (MVP 200) is mounted in the aft starboard corner of the fantail (see Figure 12). The MVP 200 system is a self contained sound speed profiling system capable of sampling water column profiles to 200 meters deep from a vessel moving up to 12 knots. The system is configured with a Single Sensor Free Fall Fish (SSFFF) outfitted with an Applied Microsystems Ltd. Sound Velocity and Pressure Smart Sensor. Deeper profiles can be obtained by reducing the vessel speed. When the vessel is holding station, the system is capable of recording casts over 400m in depth.

The MVP system consists of a winch, cable, fish (the towed unit with the sound velocity sensor), support assembly, and controlling hardware and software. During data acquisition the fish is deployed using the on-deck controller and towed with enough cable out to keep the fish 3-5 m below the water surface. A “messenger” (a short cable-thickening sleeve) is set to allow the system to keep the appropriate amount of cable out and is reset as needed when the ship acquisition speed is altered.

During SVP acquisition, the controlling computer application, BOT MVP with software version 2.401 is used to control the MVP system and to acquire SVP data. The MVP allows for three acquisition modes: 1) automatic continuous multiple cast freefall casting while at speed, 2) single cast freefall casting while at speed, and 3) single cast winch speed casting while stationary. The user limits the depth to which the fish will fall by setting 1) the depth-off-

bottom 2) the maximum depth and 3) maximum cable out. Either single, individually initiated casts can be performed at the discretion of the Hydrographer or the auto deployment function can be enabled and set with varying intervals (every 10 minutes, for example) for deployment.

Fairweather has three Applied Microsystems Ltd. Sound Velocity and Pressure Smart Sensors. All of the sensors were calibrated by the manufacturer during the 2010-2011 winter repair period. The resulting calibration files are maintained with reference documentation aboard *Fairweather*.

Periodic quality assurance checks include comparison casts between the MVP and one of the SBE 19*plus* or SBE 19*plusV2* SEACATs. Data quality assurance (DQA) checks include comparison casts among the 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.

Figure 12: *Fairweather*'s MVP200 sound velocity system

1.5.2 Surface Sound Speed

1.5.2.1 Reson Sound Velocity Probe (SVP 70)

Fairweather is equipped with one Reson SVP 70. The SVP 70 measures the speed of sound near the ship's hull mounted transducers to provide real time surface sound speed values. The unit is mounted adjacent to the Reson 8160 as shown in Figure 13.

Figure 13: *Fairweather*'s SVP 70 sound speed unit (left) and the 8160

The sound speed is output to the Reson 7111 and Reson 8160's processing units. The transducers require sound velocity information for beam forming. The Reson 7111 and Reson 8160 are not used to acquire data without real time sound speed information.

The unit was installed during the 2009 winter drydock period in Seattle, Washington, at Lake Union Drydock Company. The last calibration of the unit was dated January 4, 2009; the calibration report is maintained with reference documentation aboard *Fairweather*.

1.5.2.2 Reson Sound Velocity Probe (SVP 71)

Survey launches 2805, 2806, 2807 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 7125SV 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 14.

All of the sensors were initially calibrated by the manufacturer and current calibration files were supplied with the units upon receipt in 2010. Recommended calibration is every one to two years. Calibration files are maintained with reference documentation aboard *Fairweather*.

Figure 14: SVP 71 sound speed unit (right) and a Reson 7125

1.6 Vertical Control Equipment

1.6.1 Water Level Gauges

Four (4) Sutron 9210B Portable Tide Gauges were provided to *Fairweather* by the Center for Operational Oceanographic Products and Services (CO-OPS) at the start of the 2011 field season. The gauges are equipped with Paros Scientific Sensors for pressure measurements. The tide gauges are annually tested and inspected by CO-OPS Field Operations Division personnel to ensure that their accuracy and standards are being met. CO-OPS provided documentation for the annual throughput testing conducted on each Portable Tide Gauge during February 2011.

Installation and removal of the water level gauges is the responsibility of *Fairweather* personnel. Gauges PTG 1 and PTG 2 were tested for completeness and functionality prior to the 2011 field season. The CO-OPS-issued Portable Tide Gauges are furnished with necessary accessories; however, *Fairweather* maintains an inventory of tools and equipment necessary to support these gauges.

1.6.2 Leveling Equipment

Fairweather is equipped with four universal automatic levels (two Zeiss NI2 333 and two Leica NA2 100) and graduated metric staffs to assist in leveling tide gauges. Calibration was

conducted by Kuker-Ranken Inc. on February 26, 2011 on both Zeiss levels, as the Leica levels are spares that have never been used they are calibrated bi-annually with their last calibration on February 2, 2010. All results are maintained with reference documentation aboard *Fairweather*.

A Kukkamaki procedure is performed prior to leveling in order to verify the collimation error. Procedures used followed those described in the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations*, October 1987. Kukkamaki procedures were performed on March 7, 2011 on all four levels, and the 2011 results are maintained with reference documentation aboard *Fairweather*.

1.7 Horizontal Control Equipment

Fairweather is equipped with two Trimble NetR9, one Trimble NetR5, and one Ashtech Z-Xtreme dual-frequency GPS base stations used for the positioning of horizontal control marks, tidal benchmarks and aids to navigation. These base stations can be configured for use as a portable DGPS or RTK reference station, or as a static receiver to record observations for use in post processing kinematic (PPK) correctors.

Equipment accuracy testing of all four GPS units was performed by *Fairweather* personnel in Seattle, Washington on February 28, March 3, and March 4, 2011. The Online Positioning User Service (OPUS) solutions were obtained using data acquired with all four GPS units over a local benchmark and comparing the solutions to each other and to the published data sheet for the geodetic mark used. Data compared well within the accuracy of the published position of the benchmark. The OPUS solutions are maintained with reference documentation aboard *Fairweather*.
When deployed for PPK the base stations log data locally, either to internal memory or external memory, and the data is downloaded periodically. The data is downloaded either by visiting the site or remotely via Freewave 900 MHz spread spectrum Ethernet radios mounted to *Fairweather* and her launches. Station power needs are supported by batteries and solar panels. The Ashtech antenna can be equipped with an optional ground plane and all receiver antennas are used with a Seco fixed height GPS tripod. Horizontal control equipment serial numbers and version installation dates are located in the hardware section of Appendix I.

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 monthly. The pertinent monthly inventories are included with the Supplemental Survey Records for the individual Descriptive Reports.

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 and ship helmsman to follow to acquire adequate MBES coverage. The Hypack Devices (Hysweep Interface, Applanix POS/MV Network, and MVP) 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. Additionally, the MBES sensor offsets and mounting biases are entered into the respective vessel's Hysweep Hardware device to facilitate later backscatter processing using Hypack GeoCoder. Entry of device offset values in Hysweep Hardware causes the values to be logged in the header of the .hsx only, and does not affect the data pipeline. These values are not tracked or closely monitored aboard *Fairweather* because they are not otherwise integral to meeting the requirements of the 2011 HSSD.

2.2.2 CARIS Notebook

CARIS Notebook™ can be used to directly collect detached shoreline positions and to verify shoreline. The software is run on a field computer and receives the Trimble GPS data output from the GPS Pathfinder® Pro XRS receivers.

GPS settings in CARIS Notebook are as follows:
Maximum Horizontal Dilution of Precision (HDOP) = 3
Maximum Positional Dilution of Precision (PDOP) = 6
Minimum Signal-to-Noise Ratio (SNR) = 12
Minimum Elevation Mask = 8°
Minimum # of Satellites = 4

Real-Time settings in CARIS Notebook are as follows:
Source Type: Integrated Beacon – Manual Mode
Position Mode: Corrected Only
Age Limit: 20 seconds
Differential GPS correction is applied in real-time using the unit's integrated beacon as the primary corrector. The unit can be setup to run without using DGPS with position mode set to "Autonomous Only" or with values different than those listed above. These special circumstances of acquisition with altered parameters are recorded and documented in the individual Descriptive Report as appropriate.

2.2.3 Klein SonarPro

Klein SonarPro is a custom display and acquisition software package for use with Klein Side Scan sonar systems. *Fairweather* uses SonarPro to monitor the quality of real-time imagery and to log raw side scan files in .SDF file format while acquiring Klein 5000 Side Scan data from the sled-mounted systems configurable on any of *Fairweather's* launches. Vessel navigation data from the POS/MV is supplied to SonarPro and logged in the SDF file. The raw SDF files are converted using CARIS SIPS into HDCS files for post processing and analysis.

2.2.4 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 and 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, slant-range correction, beam pattern correction, and despeckling, if appropriate. CARIS SIPS is also used to inspect the imagery for contacts and to produce side-scan imagery mosaics.

CARIS Notebook™ is used to compile, display, and edit source shoreline, shoreline updates and S-57 features that are collected directly in the field, digitized, or imported. The .hob files created in Notebook are the current shoreline deliverables.

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

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

2.3.2 Fledermaus™

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.

2.3.3 Geocoder

The use of any Geocoder software by *Fairweather* personnel to check Reson Snippet backscatter data and/or to create backscatter mosaics will follow 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.

2.3.4 Applanix POSPac MMS and POSGNSS

Applanix POSPac MMS and POSGNSS are used to post process POS/MV data files logged simultaneously 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

2.3.5 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.

2.3.6 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.

3.0 Vessels

3.1 Vessel Inventory

Fairweather (S220) and her survey launches 2805, 2806, 2807, and 2808 are equipped to acquire multibeam echosounder (MBES) and sound speed profile (.svp) data. The AMBAR

(2302) and SeaArk (1905) are used primarily during shoreline verification, bottom sampling, and horizontal and vertical control operations. All vessels may be used in support of dive, tide gauge, and horizontal control operations as well as for feature verification and bottom sampling. 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. 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 7125SV, Reson 7111, and Reson 8160. 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 7125SV systems. For Reson 7111 and Reson 8160 acquisition systems, vessel speeds are 6-7.5 knots. 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 7125SV, Reson 7111, and Reson 8160 are generally run parallel to the contours and spaced no greater than three to four times the water depth and in most cases at a tighter line spacing to ensure the appropriate data density for the required finalized BASE surface resolutions. For discrete item developments, line separation is reduced to two times the water depth 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 Notebook, 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). These items are parsed into separate .hob files and are used for investigations and during shoreline/feature verification.

Fairweather personnel conduct limited shoreline verification and reconnaissance at times near predicted negative tides within the survey limits, 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 at the scale of the largest chart in the area, is provided with the Project Instructions or created by offsetting from the composite source Mean High Water (MHW) line. 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.

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

Error 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 2011 *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 processing followed section 4.2 of the *FPM* unless otherwise noted.

Raw .hsx multibeam data are 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.

The general resolution, depth ranges, and Combined Uncertainty and Bathymetric Estimator (CUBE) parameter settings outlined in section 5.2.2.2 of the *HSSD* and section 4.2.1.1.1.1 of the *FPM* are used for surface creation and analysis. 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 CUBE algorithm and parameters contained in the NOAA CUBEParams_NOAA.xml file as provided in Appendix 4 of the *FPM* 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 swath editor and in subset mode 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 outlined in the Descriptive Report for the particular survey.

Due to the increased sounding densities seen during data collection, the Density method for hypothesis disambiguation is used. This is a deviation from section 4.2.1.1.1 of the *FPM* which lists the default method as Density & Locale, this former method produced surfaces which were less likely to honor distinct features.

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 utilized during data collection and processing as an additional child layer of the finalized surfaces to indicate problem areas that need attention or discussion. Additionally, the percentage of IHO nodes passing from the combined finalized surfaces is included in the Descriptive Report for each survey. For visual depiction of localized areas that do not meet IHO standards, screen grab(s) of the individual finalized IHO child layer(s) may also 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 are 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. 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 Notebook HOB files, the H##### Original Composite Source and the H##### Final Feature File, included with the processed data. A feature report, which includes S-57 and other attribution of items addressed by the survey is included in Appendix II of the individual Descriptive Report.

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

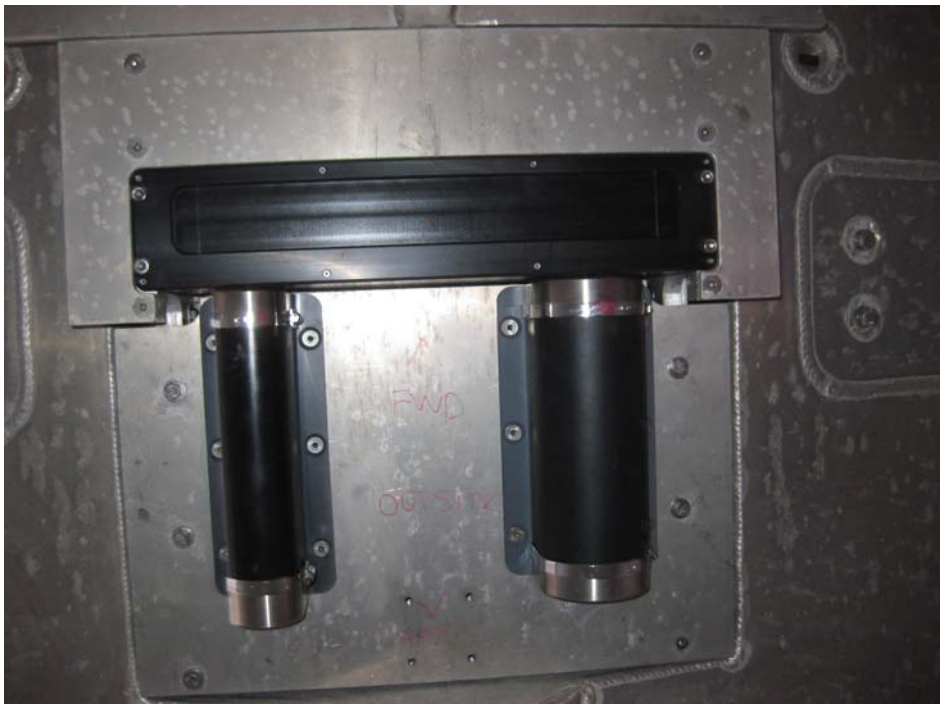
CARIS HIPS Vessel Files (HVF) are created by *Fairweather* personnel and used to define a vessel's offsets and equipment uncertainty. The HVF is used for converting and processing raw Hypack .hsx and .raw files to CARIS HIPS HDCS format. The HVFs used for a given project are included with the digital 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, 2806, 2807, and 2808 is the top, center of the POS/MV IMU (Figure 15). 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 15: 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 16).



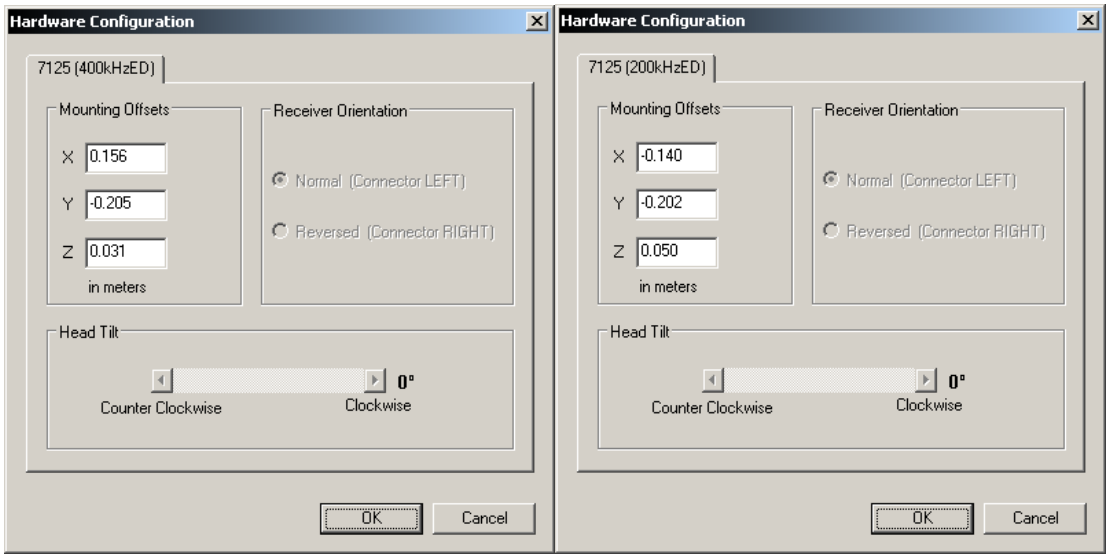


Figure 16: Reson 7125 sonar mounting with 400kHz and 200kHz offsets respectively.

A ship survey of *Fairweather* was completed by Westlake Consultants, Inc on September 23, 2003. A spatial relationship survey of *Fairweather* POS/MV components was conducted by NOAA's National Geodetic Survey (NGS) in February 2007, and again on February 15, 2009, while the ship was in Lake Union Drydock in Seattle, WA. The results of the Westlake, the 2009 NGS survey, and additional offset values discussed below in section D 4.0 are used to determine the offsets for the ship. The reports from each survey, whose values are used for the offset measurements, are located in Appendix II. The S220 Offsets & Measurements spreadsheet is also included in Appendix II, listing the final values for *Fairweather*'s offsets with explanations of how they were calculated.

Permanent control points were established on launches 2805, 2806, 2807, & 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, 2806, 2807, 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 static draft of *Fairweather* was measured under different loading conditions with different amounts of fuel. The bow and stern draft marks were recorded and then used to perform a linear interpolation of the static draft at *Fairweather*'s IMU. The Ship Draft 2011 spreadsheet

records the static draft values and is included with the ship offset documentation in Appendix II.

Fairweather's dynamic draft measurement was taken June 3, 2011 in Puget Sound while the ship was transiting from Seattle, WA to Kodiak, AK survey grounds. The dynamic draft data were acquired for launches 2805 and 2806 in Shilshole Bay during March and April 2011 respectively. Launches 2807 and 2808 obtained dynamic draft data in Lake Washington in March 2011. 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 polynomial curve using a least squares fit method in a Python Script written by NOAA personnel and implemented within Pydro. When available MLLW verified levels were loaded into Pydro for dynamic draft locations influenced with tides. 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, 2806, and 2807, 2808 compare well with each other. 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, 2806, 2807 and 2808 for the Reson 7125SV MBES sonar systems during the months of March and April 2011 using the Shilshole Bay Reference Surface and Patch Test site near Seattle, WA. Patch tests were conducted for *Fairweather's* -Reson 8160 and Reson 7111 MBES sonar systems during June 2011, near Kodiak, AK. 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 all launch and ship MBES reference surfaces using CARIS Bathy Database. The results of both comparisons show 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 applied real time to Reson 8160 and Reson 7125SV data. Pitch is applied real time to Reson 7111 and Reson 8160 data. Attitude measurements 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. 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.

If the POS/MV files fail to apply in CARIS HIPS during the "Apply TrueHeave" process the files are fixed using a CARIS tool called "fixTrueHeave.exe." In cases where this is necessary a new fixed file is created with the extension ".fixed" (2011-ddd-vssl.000.fixed). The new fixed TrueHeave™ file is then applied to the data in CARIS HIPS. The original corrupted file is retained along with the fixed file with the submitted Global Navigation Satellite System (GNSS) data. Occurrences of this for specific surveys are noted in the individual Descriptive Reports.

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 or SmartBase batch processing methods as described in section B.2.3.4. 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.

Positioning of features and bottom samples is 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 7125SV MBES systems on survey launches 2805, 2806, 2807,

and 2808, and used on an as needed basis for *Fairweather*'s Reson 7111 and Reson 8160 MBES systems. The Brooke Ocean Technology Moving Vessel Profiler (MVP) is primarily used to collect sound speed data for sound speed correction of data acquired with *Fairweather*'s Reson 7111 and Reson 8160 MBES systems.

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.

Sound speed profiles acquired using the Brooke Ocean Technology Moving Vessel Profiler 200 (MVP) are stored in files labeled BOT_XXXX.calc, where X is the incrementally increasing cast number. The .calc file for each cast is opened with Velocipy and converted into CARIS .svp file format. The individual .svp profiles are concatenated into vessel specific .svp files for the entire survey. Individual sound speed profiles taken by the MVP are not submitted separately due to the large number of casts acquired and the way in which they are processed; however, the daily concatenated files are submitted for backup purposes and include all profiles acquired.

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.

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

Vessel Inventory
Hardware Inventory
Computer Inventory

Hydrographic Vessel Inventory

Field Unit: FAIRWEATHER
Effective Date: April 12, 2010
Updated Through: August 9, 2010

SURVEY VESSELS								
Vessel Name	**FAIRWEATHER**	**Launch 2805**	**Launch 2806**	**Launch 2807**	**Launch 2808**	**Ambar 700**	**Skiff**	**FRB**
Hull Number	S 220	2805	2806	2807	2808	2302	1905	2301
Call Letters	WTEB							
Manufacturer	Aerojet-General Shipyards	All American Marine	All American Marine	All American Marine	All American Marine	Marine Silverships, Inc	SeaArk	Zodiak of North America
Year of Construction	1967	2009	2009	2009	2009	1998	2000	2004
Type of Construction	Welded steel hull - ice strengthened	Welded Aluminum	Welded Aluminum	Welded Aluminum	Welded Aluminum	RHIB (Aluminum)	Welded Aluminum	RHIB (Fiberglass)
Length Overall	70.4 m (231')	8.64 m (28' 6")	8.64 m (28' 6")	8.64 m (28' 6")	8.64 m (28' 6")	7.0 m (23')	5.79 m (19')	6.7 m (22')
Beam	12.8 m (42')	3.48 m (11' 5")	3.48 m (11' 5")	3.48 m (11' 5")	3.48 m (11' 5")	2.9 m (9' 4")	2.44 m (8')	2.6 m (8' 6")
Draft	4.7 m (15' 6")	1.12 m (3' 8")	1.12 m (3' 8")	1.12 m (3' 8")	1.12 m (3' 8")	0.4 m (1' 4")	0.66 m (26")	0.6 m (22")
Cruising Speed	12.5 knots	24 knots	24 knots	24 knots	20 knots	22 knots	25 knots	18 knots
Max Survey Speed	8 knots	8 knots	8 knots	8 knots	8 knots			
Date of Effective Full Vessel Static Offset Survey	Origninal Survey 9/23/2003 POS/MV Offsets Surveyed 2/2007 and 2/15/2009	1/26/2010	1/26/2010	1/27/2010	1/27/2010			
Organization which Conducted the Effective Full Offset Survey	Original Survey - Westlake Consultants POS/MV Spatial Surveys - NGS	NGS/GSD	NGS/GSD	NGS/GSD	NGS/GSD			
Date of Last Partial Survey or Offset Verification & Methods Used	n/a	n/a	n/a	n/a	n/a			
Date of Last Static Draft Determination & Method Used	6/3/2011 Draft Marks	3/25/2011 Direct Measurement from benchmarks.	4/5/2011 Direct Measurement from benchmarks.	4/6/2011 Direct Measurement from benchmarks.	3/14/2011 Direct Measurement from benchmarks.			
Date of Last Settlement and Squat/Dynamic Draft Measurements & Method Used	6/3/2011 Post Processed Kinematic (Ellipsoidally referenced)	3/25/2011 Post Processed Kinematic (Ellipsoidally referenced)	4/19/2011 Post Processed Kinematic (Ellipsoidally referenced)	3/3/2011 Post Processed Kinematic (Ellipsoidally referenced)	3/02/2011 Post Processed Kinematic (Ellipsoidally referenced)			

Hydrographic Hardware Inventory

Field Unit: FAIRWEATHER

Effective Date: 3/20/2011

Updated Through: 8/26/2011

Legend

not verified in 2011	LM/TF/CZ-verified		
equipment not in sunflower	bar code not found in sunflower	barcode thought to exist but unknown	Further investigation/info/effort required in future

SONAR & SOUNDING EQUIPMENT

Equipment Type	Manufacturer	Model	Serial Number	Hardware Install date	Firmware and/or Software Version	Version Install Date	Location	Date of last Field Cal/Testing	Date of last Manufacturer Cal/Service	Bar Code	Part Numberbr	in use	Comments
Processor	RESON	81-P (8160)	35385	Apr-2004	Firmware Dry: 8160-2.09-7C6D Wet: 8160-1.00-E9E1	May-2004	S220-Plot 1, Rack	N/A	2004	CD0001065313		x	
Transducer	RESON	8160	unknown	Apr-2004	N/A	N/A	S220-hull	6/13/2011	2004	Ducer tracked with TPU		x	Caryn working with RESON to get s/r
Tranceiver	RESON	81-P (8160)	35028	Apr-2004	N/A	N/A	S220-Conf Rm	N/A	2004	Xcver tracked with TPU	P/N 85108051, RMA# 501210	x	
Processor	RESON	71-P (7111)	2009003	Oct-2009	7k UI: 3.11.1.0 7k Center: 3.4.4.0 7kIO: 3.4.1.11	May-2011	S220-Plot 1, Rack	N/A	July 2010 - Reson visit	CD0001065312	P/N 85101802	x	
Transducer	RESON	7111	unknown	Mar-2009	N/A	N/A	S220-hull	6/13/2011	Jan-2009	Ducer tracked with TPU		x	original 2004-8111 transducer replaced on Mar 2009 as 8111, then later upgraded to 7111 on top-side unit
Tranceiver	RESON	71-P (7111)	3309001		N/A	Oct-2010	S220-Conf Rm	N/A	July 2010 - Reson visit	Xcver tracked with TPU	P/N 85107111	x	Reson visits also on Feb & May 2010
Processor	RESON	7125 SV	1812028	Jan-2010	7k UI:3.12.5.8 7k Center: 3.7.7.9 7kIO: 3.4.1.11	Mar-2011	2805	N/A	2009	CD0001529714	P/N 85101812	x	
Processor	RESON	7125 SV	1812027	Jan-2010	7k UI: 3.12.5.8 7k Center: 3.7.7.9 7kIO: 3.4.1.11	Mar-2011	2807	N/A	2010	CD0001529685	P/N 85101812	x	
Processor	RESON	7125 SV	1812020	Jan-2010	7k UI: 3.12.5.8 7k Center: 3.7.7.9 7kIO: 3.4.1.11	Mar-2011	2806	N/A	2009	CD0001527818	P/N 8572027	x	
Processor	RESON	7125 SV	1812023	Jan-2010	7k UI: 3.12.5.8 7k Center: 3.7.7.9 7kIO: 3.4.1.11	Mar-2011	2808	N/A	2009	CD0001529704	P/N: 85101812	x	
200 khz Projector	RESON	200kHz (2163)	4408358	Jan-2010	N/A	N/A	2805 - hull	3/25/2011	2009	CD0001776107		x	not sure why we have a CD number on this. Investigate
200 khz Projector	RESON	200kHz (2163)	1008117	Jan-2010	N/A	N/A	2806 - hull	4/26/2011	2009	no bar code		x	
200 khz Projector	RESON	200kHz (2163)	2409098	Jan-2010	N/A	N/A	2807* - hull	3/9/2011	2009	no bar code		x	* possibly installed on 2808, obtain S/N#s during winter import 2012
200 khz Projector	RESON	200kHz (2163)	4408351	Jan-2010	N/A	N/A	2808* - hull	3/10/2011	2009	no bar code		x	* possibly installed on 2807, obtain S/N#s during winter import 2012
400 khz Projector	RESON	400kHz (2160)	4008071	Jan-2010	N/A	N/A	2805 - hull	3/25/2011	2009	CD0001776105		x	not sure why we have a CD number on this. Investigate
400 khz Projector	RESON	400kHz (2160)	1908209	Jan-2010	N/A	N/A	2806 - hull	4/26/2011	2009	no bar code		x	
400 khz Projector	RESON	400kHz (2160)	2208007	Jan-2010	N/A	N/A	2807* - hull	3/9/2011	2009	no bar code		x	* possibly installed on 2808, obtain S/N#s during winter import 2012
400 khz Projector	RESON	400kHz (2160)	2308110	Jan-2010	N/A	N/A	2808* - hull	3/10/2011	2009	no bar code		x	* possibly installed on 2807, obtain S/N#s during winter import 2012
Receiver	RESON	EM7200	3008265	Jan-2010	N/A	N/A	2805 - hull	N/A	2009	no bar code		x	
Receiver	RESON	EM7200	0309014	Jan-2010	N/A	N/A	2806 - hull	N/A	2009	no bar code		x	
Receiver	RESON	7200/7216	309012	Jan-2010	N/A	N/A	2807* - hull	N/A	2009	no bar code		x	* possibly installed on 2808, obtain S/N#s during winter import 2012
Receiver	RESON	EM7200	309019	Jan-2010	N/A	N/A	2808* - hull	N/A	2009	no bar code		x	* possibly installed on 2807, obtain S/N#s during winter import 2012
Processor	RESON	81-P (8125)	31562	not installed	Dry: 8125-2.10-A50F Wet: 8125-1.08-9E98	Unknown	stored S220-DP3	N/A	Unknown	CD0000825308			Transferred to Mike Webb's Property (EEB)
Transducer	RESON	8125	4400007	not installed	N/A	Unknown	C02	not installed	Unknown	Ducer tracked with TPU			on loan from RUDE
Towfish	Klein	5000	321	Jul-2011	N/A	N/A	stored S220-boat deck until in use	not installed	Unknown	No CD		x	lightweight towfish for use on 2805
Towfish	Klein	5000	293	Jul-2011	N/A	N/A	stored S220-boat deck until in use	not installed	Unknown	CD0000825404		x	heavyweight towfish for use on S220
Towfish	Klein	5410	260	Jul-2011	N/A	N/A	stored S220-boat deck until in use	not installed	Unknown	No CD		x	on loan from Bay Hydro II for use on 2808
TPU	Klein 5000 TPU	5000	117633	Jul-2011	N/A	N/A	2805	N/A	Unknown	CD0001527021	PN: 12V-0320-TV05J12-P150-KA-1	x	
TPU	Klein 5000 TPU	5000	130144	Jul-2011	N/A	N/A	S220 Dive Lab-Rack	N/A	Unknown	CD0001527022	PN: 12V-0320-TV05J12-P150-KA-1	x	
TPU	Klein 5000 TPU	5000	119307	Jul-2011	N/A	N/A	2808	N/A	Unknown	CD0001722042		x	Vx-Works: 5.4.2
Processor	Odom Hydrographic Systems	Echotrac CVM-A	26034	May-2007	Version 4.01	May-2007	2302 or 1905	N/A	Apr-2007	CD0001703210		x	ChartView Dongle (100.001.001.098)
Transducer	Odom Hydrographic Systems	SMBB200_9	TR5138	May-2007	N/A	N/A	2302 or 1905	N/A	Mar-2007	no bar code		x	9 degree (small)
Transducer	Odom Hydrographic Systems	SMBB200_9	TR5139	May-2007	N/A	N/A	stored S220-CO2	functionally tested, needs in field test	Mar-2007	no bar code			9 degree (small)
Transducer	Odom Hydrographic Systems	SMBB200-4A	TR5162	May-2007	N/A	N/A	stored S220-CO2		Mar-2007	no bar code			4 degree (large)

Transducer	Odom Hydrographic Systems	SMBB200-4A	TR5159	May-2007	N/A	N/A	stored S220-CO2		Mar-2007	no bar code			4 degree (large)
Divers Least Depth Gauge	PTC	MODIII	68337	Mar-2006	N/A	N/A	S220-ET shop	N/A	4/2/2008	CD0001698256			not holding a charge, being fixed
Divers Least Depth Gauge	RJE International Inc	TAC-DDGC-III	DT16313	June-2009	N/A	N/A	S220-Dive Lab	8/20/2011	May-2009	DOC: P004372		x	new unit to test to replace DLDG
Divers Least Depth Gauge	RJE International Inc	TAC-DDGC-III	DT15894	June-2009	N/A	N/A	S220-Dive Lab	N./A	May-2009	DOC: P004373			new unit to test to replace DLDG, needs rubber gasket for switch
Lead Line	FA Personnel	Traditional	10_01_05	Mar-2005	N/A	N/A		2/23/2011	N/A	no bar code			missing
Lead Line	FA Personnel	Traditional	10_02_05	Mar-2005	N/A	N/A	S220-O-Lab	2/23/2011	N/A	no bar code		x	
Lead Line	FA Personnel	Traditional	20_01_05	Mar-2005	N/A	N/A			N/A	no bar code			missing
Lead Line	FA Personnel	Traditional	20_02_05	Mar-2005	N/A	N/A	S220-O-Lab	2/23/2011	N/A	no bar code		x	
Lead Line	FA Personnel	Traditional	20_03_05	Mar-2005	N/A	N/A	S220-O-Lab	2/23/2011	N/A	no bar code		x	
Lead Line	FA Personnel	Traditional	30_01_05	Mar-2005	N/A	N/A	S220-O-Lab	2/23/2011	N/A	no bar code		x	
Lead Line	FA Personnel	V-100/Non-Traditional	10_05_09	Mar-2009	N/A	N/A	S220-O-Lab	2/23/2011	N/A	no bar code		x	
Lead Line	FA Personnel	V-100/Non-Traditional	10_06_XX	not yet	N/A	N/A	unknown	N/A	N/A	no bar code			work in progress
POSITIONING & ATTITUDE EQUIPMENT													
Equipment Type	**Manufacturer**	**Model**	**Serial Number**	**Hardware Install date**	**Firmware and/or Software Version**	**Version Install Date**	**Location**	**Date of last Field Cal/Testing**	**Date of last Manufacturer Cal/Service**	**Bar Code**			**Comments**
POS/MV PCS	Applanix	POS MV 320 V4	3628	Nov-2010	HW4.1-7, SW05.01, POS Cntrlr v. 5.1.0.2	Jul-2011	S220	6/2/11		CD0001527796	P/N: PCS-29	x	Previously-2010 on 2805. Spring 2011-HW4.1-7, SW04.22, POS Cntrlr v. 4.3.4.0
POS/MV IMU	Applanix	LN200	292	Apr-2004	N/A	N/A	S220	N/A	TT 2010	CD0001696450		x	
POS MV Port Antenna	Trimble	Zephyr II	1440904133	5/2/2010	N/A	N/A	S220	N/A			P/N: 57970-00 DC 4911	x	On permanent loan from Rainer
POS MV Stbd Antenna	Trimble	Zephyr II	31180200	5/2/2010	N/A	N/A	S220	N/A			P/N: 57970-00 DC 4845	x	On permanent loan from Rainer
POS/MV PCS	Applanix	POS MV 320 V4	3627	Nov-2010	HW4.1-7, SW05.01, POS Cntrlr v. 5.1.0.2	Feb-2009	2805	3/25/11		CD0001527797		x	Auth. No. 811025-00534537. Previously-2010 on S220. Spring 2011-HW4.1-7, SW04.22, POS Cntrlr v. 4.3.4.0
POS/MV IMU	Applanix	LN200	294	Mar-2010	N/A	N/A	2805	N/A	2/2/2010	CD0001696449	P/N: 10001506-4	x	Cal date is Tumble Test, July-2003 date??? Manftr cal date?
POS MV Port Antenna	Trimble	Zephyr II	31171727	Jan-2010	N/A	N/A	2805	N/A		no bar code	P/N: 57970-00 DC4905	x	
POS MV Stbd Antenna	Trimble	Zephyr II	31185275	Jan-2010	N/A	N/A	2805	N/A		no bar code	P/N: 57970-00 DC4905	x	
POS/MV PCS	Applanix	POS MV 320 V4	2564	Jan-2010	HW2.6-7, SW04.22 POS Cntrlr v. 4.3.4.0	Feb-2009	2806	4/26/11		CD0001601275	no p/n	x	
POS/MV IMU	Applanix	LN200	324	Jan-2010	N/A	N/A	2806	N/A	2/2/2010	CD0001722041	P/N: 10001506-4	x	Feb-2007 date??? Manftr cal date?
POS MV Port Antenna	Trimble	Zephyr I	60078644	Jan-2010	N/A	N/A	2806	N/A	Unknown	no bar code	P/N: 39105-00 DC4521	x	
POS/MV Stbd Antenna	Trimble	Zephyr I	60125191	6/22/2011	HW1	Feb-2007	2806	N/A	Unknown	no bar code	P/N 39105-00 DC 4602		spare moved onto 2806 on 6/22/2011
POS MV Stbd Antenna	Trimble	Zephyr I	60130644	Jan-2010	N/A	N/A	2806	N/A		no bar code	P/N: 39105-00 DC4604	x	previously 2806 stbd antenna, removed 6/22/2011 due to failure
POS/MV PCS	Applanix	POS MV 320 V4	2560	Jan-2010	HW2.6-7, SW04.22 POS Cntrlr v. 4.3.4.0	Feb-2009	SPARE (C-02 STORES)	3/3/11		CD0001601274	P/N: PCS-29	x	previous GAMS on 3/3/11
POS/MV IMU	Applanix	LN200	37	Jan-2010	N/A		2807	N/A	TT 2007	CD0000832907	P/N: 10000978	x	
POS MV Port Antenna	Trimble	Zephyr II	1440925095	Jan-2010	N/A	N/A	SPARE (C-02 STORES)	N/A		no bar code	P/N: 57970-00 DC4928	x	
POS MV Stbd Antenna	Trimble	Zephyr II	1440912566	Jan-2010	N/A	N/A	SPARE (C-02 STORES)	N/A		no bar code	P/N: 57970-00 DC4920	x	
POS/MV PCS	Applanix	POS MV 320 V4	2411	Jan-2010	HW2.9-7, SW04.22 POS Cntrlr v.4.3.4.0	Feb-2009	2808	3/2/11		CD0001697462	no p/n	x	
POS/MV IMU	Applanix	LN200	991	Jan-2011	N/A	N/A	2808	N/A	4/2010	CD0001722214	P/N: 10,000,978	x	Brand New - 2010
POS MV Port Antenna	Trimble	Zephyr II	1440904832		N/A	N/A	2808	N/A		no bar code	P/N: 57970-00 DC4911	x	
POS MV Stbd Antenna	Trimble	Zephyr II	1440941041	Jan-2010	N/A	N/A	2808	N/A		no bar code	P/N: 57970-00 DC4947	x	
POS/MV IMU	Applanix	LN200	995	not installed	N/A	N/A	FOO stores		4/2010	CD0001530026			Brand New - 2010
POS/MV IMU	Applanix	LN200	007	not installed			ET stores D02		Unknown	CD00001709318			
POS/MV Antenna	Trimble	OEM2 3151R	60145158		N/A	Feb-2007	Matrix			no bar code	P/N 39105-00 DC 4618		spare
POS/MV Antenna	Trimble	OEM2 3151R	60268090		N/A	Aug-2009	Matrix			no bar code	P/N 39105-00 DC 4916		spare
DGPS Receiver	CSI Wireless	MBX-3S	0324-11969-0002	Apr-2004	P012-0.1-Bx S/N 00019001 P021-0.001 SBX-2 S/N 00019001 C1000-1.002 BxTAB CRC: 8227	Jul-2004	S220	N/A		CD0001065375		x	
DGPS Antenna	CSI Wireless	MGL3	9824-1779-0002	Apr-2004	N/A	N/A	S220	N/A		no bar code		x	
DGPS Receiver	Hemisphere	MBX-4	0927-9567-0001	Jan-2010	P012-0.010-Bx S/N 00019001	Fall 2009	2805	N/A		CD0001709331	P/N: 801-3012-000#	x	CDP004433
DGPS Antenna	Hemisphere	MA40	0924-9488-0046	Jan-2010	N/A	N/A	2805	N/A		no bar code	P/N: 804-3029-000#	x	
DGPS Receiver	Hemisphere	MBX-4	0923-9416-0005	Jan-2010	P012-0.010-Bx S/N 00019001	Fall 2009	2806	N/A		CD0001709329	P/N: 801-3012-000#	x	CDP004432
DGPS Antenna	Hemisphere	MA40	0919-9231-0193	Jan-2010	N/A	N/A	2806	N/A		no bar code	P/N: 804-3029-000#	x	
DGPS Receiver	Hemisphere	MBX-4	0923-9416-0007	Jan-2010	P012-0.010-Bx S/N 00019001	Fall 2009	SPARE (C-02 STORES)	N/A		no bar code	P/N: 801-3012-000#	x	

DGPS Antenna	Hemisphere	MA40	0919-9231-0191	Jan-2010	N/A	N/A	SPARE (C-02 STORES)	N/A		no bar code	P/N: 804-3029-000#	x	
DGPS Receiver	Hemisphere	MBX-4	0924-9498-0007	Jan-2010	P012-0.010-Bx S/N 00019001	Fall 2009	2808	N/A		no bar code	P/N: 801-3012-000#	x	CDP004425
DGPS Antenna	Hemisphere	MA40	0924-9488-0040	Jan-2010	N/A	N/A	2808	N/A		no bar code	P/N: 804-3029-000#	x	
DGPS Receiver	CSI Wireless	MBX-3S	0328-12362-0001	not installed		Jul-2004	ET Stores - D02	N/A	Jul-2004	10652291			
DGPS Antenna	CSI Wireless	MGL3	0328-12352-0002	not installed	N/A	Jul-2004	Matrix	N/A	Jul-2004	no bar code			CSI Wireless in ET stores w/o SN, thought to be this one
StarFire GPS Receiver	NavCom	SF-2050R	5012	Jul-2008		Jul-2008	S220-Plot 1, Rack		Sept-2008	CD0001697402	P/N: 92-310059	x	Net 1&2 capable only
StarFire GPS Receiver	NavCom	SF-2050G	5086	not installed			C02			CD0001699203	P/N 92-310059-3001		thought to be Net 1 capable only
StarFire GPS Antenna	NavCom	AN-2004T	7020	not installed			C02			no bar code	P/N 82-001000-3004		
Trimble Backpack 1	Trimble	Pathfinder Pro XRS	0224078543	May-2004	Firmware v1.96 RevA	Mar-2008	field or O-lab	5/17/2011	Jan-2004	CD0001269835		x	
Trimble Backpack 1: Antenna	Trimble	33580-50	0220341062	May-2004	N/A	N/A	field or O-lab	N/A	Jan-2004	no bar code		x	
Trimble Backpack 2	Trimble	Pathfinder Pro XRS	0224090101	May-2004	Firmware v1.96 RevA	Mar-2008	field or O-lab	5/17/2011	Jan-2004	CD0001269836		x	
Trimble Backpack 2: Antenna	Trimble	33580-50	0220321059	May-2004	N/A	N/A	field or O-lab	N/A	Jan-2004	no bar code		x	
Laser	Laser Tech Inc.	Impulse Laser Rangefinder	i09290	Oct-2004	N/A	N/A	field or O-lab	6/20/2011	Jul-2004	CD0001269812	P/N 7002700	x	
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	001481	Sept-2006	N/A	N/A	field or O-lab	6/20/2011	Apr-2006	no bar code		x	Not in good shape, used for tide description/balance measurements
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	000676	Mar-2006	N/A	N/A	field or O-lab	6/20/2011	Dec-2005	no bar code		x	
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	041169	May-2011	N/A	N/A	field or O-lab	6/20/2011	Feb-2011	no bar code		x	Survey 4, 0.3m accuracy
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	041156	May-2011	N/A	N/A	field or O-lab	6/20/2011	Feb-2011	no bar code		x	Survey 5, 0.3m accuracy
SOUND SPEED MEASUREMENT EQUIPMENT													
Equipment Type	**Brooke Ocean Technology Inc.**	**Model**	**Serial Number**	**Hardware Install date**	**Firmware and/or Software Version**	**Version Install Date**	**Location**	**Date of last Field Cal/Testing**	**Date of last Manufacturer Cal/Service**	**Bar Code**			**Comments**
Moving Vessel Profiler winch	Brooke Ocean Technology Inc.	MVP-200-5	10328	Apr-2004	N/A	N/A	S220	N/A	May-2011	no bar code		x	Visit by BOT tech Darrell Groom; serviced atleast bi-annually
Moving Vessel Profiler fish	Brooke Ocean Technology Inc.	MVP-FFF-SS-32-1	10478	May-2011	N/A	N/A	S220 - Fish	N/A	May-2011	no bar code		x	on deck attached to MVP
Moving Vessel Profiler fish	Brooke Ocean Technology Inc.	MVP-FFF-SS-32-1	10329	not installed	N/A	N/A	S220 - Spare fish	N/A	May-2011	no bar code			
Moving Vessel Profiler sensor	Applied Micro Systems Ltd.	AML Smart SV +P	4986	May-2011	N/A	N/A	installed on Fish	DQAs weekly	12/21/2010	no bar code		x	calibrated annually
Moving Vessel Profiler sensor	Applied Micro Systems	AML Smart SV +P	5229	not installed	N/A	N/A	S220-ET stores, spare	DQAs weekly if in service	12/14/2010	no bar code		x	calibrated annually
Moving Vessel Profiler sensor	Applied Micro Systems Ltd.	AML Smart SV +P	5466	not installed	N/A	N/A	S220-ET stores, spare	DQAs weekly if in service	12/22/2010	no bar code		x	calibrated annually
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4585	May-2004	1.6b	12/3/2010	Ship	DQAs weekly	12/3/2010	CD0001697254	90385.01	x	CON file: 4585.con, calbrtd annually, Titanium to 3500m
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4616	May-2004	1.6b	12/3/2010	Launch	DQAs weekly	12/3/2010	CD0001697264	90385.009	x	CON file: 4616.con, calbrtd annually
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4617	May-2004	1.6b	1/26/2011	Launch	DQAs weekly	1/26/2011	CD0001697251		x	CON file: 4617.con, calbrtd annually
SEACAT Profiler	Sea-Bird	SBE 19plus V2	19P50959-6121	Jul-2009	2.3	12/16/2010	Launch	DQAs weekly	12/16/2010	CD0001527777		x	CON file: 6121.con, calbrtd annually
SEACAT Profiler	Sea-Bird	SBE 19plus V2	19P50959-6122	Jul-2009	2.2c	12/16/2010	Launch	DQAs weekly	12/16/2010	CD0001527778	90635.006	x	CON file: 6122.con, calbrtd annually
Sound Velocity Probe	RESON	SVP-71	2008024	Nov-2009	NA	NA	2805	DQAs weekly	11/4/2009	no bar code		x	calibrated atleast bi-annually
Sound Velocity Probe	RESON	SVP-71	2008016	Jan-2010	NA	NA	2806	DQAs weekly	10/8/2009	no bar code		x	calibrated atleast bi-annually
Sound Velocity Probe	RESON	SVP-71	2008038	Jan-2010	NA	NA	2807	DQAs weekly	7/14/2009	no bar code		x	calibrated atleast bi-annually
Sound Velocity Probe	RESON	SVP-71	2008017	Oct-2009	NA	NA	2808	DQAs weekly	6/11/2009	no bar code		x	calibrated atleast bi-annually
Real Time Sound Speed Profiler	RESON	SVP 70	4008077	Mar-2009	NA	NA	S220	DQAs weekly	1/4/2009	no bar code		x	calibrated atleast bi-annually
Real Time Sound Speed Profiler	Odom Hydrographic Systems	Digibar Pro/ DB 1200	98207	not installed	SW 1.11	Unknown	Goes with 8125 stored in C02	DQAs weekly, when in use	4/16/2009	(Atlantic Marine Center A009511)			Previous S/N listed: 98013-041609
TIDES & LEVELING EQUIPMENT													
Equipment Type	**Manufacturer**	**Model**	**Serial Number**	**Hardware Install date**	**Firmware and/or Software Version**	**Version Install Date**	**Location**	**Date of last Field Cal/Testing**	**Date of last Manufacturer Cal/Service**	**Bar Code**			**Comments**
Level	Carl Zeiss	N12 333	100056	May-2004	N/A	N/A	O-lab	3/7/2011	2/26/2011	no bar code		x	from W-COOPS, calibrated yearly
Level	Carl Zeiss	N12 333	103267	May-2004	N/A	N/A	O-lab	3/7/2011	2/26/2011	no bar code		x	from W-COOPS, calibrated yearly
Level	Leica	NA2 100	5332747	2003	N/A	N/A	stored in O-lab	3/7/2011	2/3/2010	no bar code			Spare, calibrated bi-annually
Level	Leica	NA2 100	5332739	2003	N/A	N/A	stored in O-lab	3/7/2011	2/3/2010	no bar code			Spare, calibrated bi-annually
HORIZONTAL AND VERTICAL CONTROL EQUIPMENT													

Equipment Type	Manufacturer	Model	Serial Number		Firmware and/or Software Version	Version Install Date	Location	Date of last Field Cal/Testing	Date of last Manufacturer Cal/Service	Bar Code			Comments
GPS Antenna	Ashtech	Geodetic 4	8365	Apr-2004	N/A	N/A	field or O-lab	N/A	Jan-2004	no bar code	P/N 701975-01	x	used in field, for static positioning of benchmarks, ATONs
GPS Antenna	Trimble	Zephyr Geodetic 2	30767996	Apr-2009	N/A	N/A	field or O-lab	N/A	Jan-2009	no bar code	P/N 5791-00	x	PPK - Oscar - Black box
GPS Antenna	Trimble	Zephyr Geodetic 2	1441027807	Feb-2011	N/A	N/A	field or O-lab	N/A	Jan-2011	no bar code		x	PPK - Bert - Yellow box
GPS Antenna	Trimble	Zephyr Geodetic 2	1441031361	Feb-2011	N/A	N/A	field or O-lab	N/A	Jan-2011	no bar code		x	PPK - Ernie - Orange box
GPS Antenna	NovAtel	531	18250.531	N/A	N/A	N/A	ET Stores D2	N/A	N/A	no bar code			Ye ol' L1 antenna, just throw it away
GPS Antenna	NovAtel	531	18284.531	N/A	N/A	N/A	ET Stores D2	N/A	N/A	no bar code			Ye ol' L1 antenna, just throw it away
GPS Antenna	NovAtel	531	13843.531	N/A	N/A	N/A	ET Stores D2	N/A	N/A	no bar code			Ye ol' L1 antenna, just throw it away
GPS Reciever	Trimble	NetR5	4910K61054	Apr-2009	4.03	Apr-2009	field or O-lab		Jan-2009	CD0001526973		x	used in field, Oscar - Black box
GPS Reciever	Trimble	NetR9	5034K69698	Feb-2011	4.15	4/7/2010	field or O-lab		Jan-2011	CD0001709319		x	used in field, Bert - Yellow box
GPS Reciever	Trimble	NetR9	5034K69677	Feb-2011	4.15	4/7/2010	field or O-lab		Jan-2011	CD0001709320		x	used in field, Ernie - Orange box
GPS Receiver	Ashtech	Z-Xtreme	ZE1200339016	Apr-2004	ZE21	Mar-2008	field or O-lab		Jan-2004	CD0001062363		x	used in field, for static positioning of benchmarks, ATONs
UHF Radio	FreeWave	HTP-900RE	884-9190	Mar-2009	2.15	Mar-2009	S220	N/A	Jan-2009	CD0001526971		x	Ship Radio
UHF Radio	FreeWave	HTP-900RE	884-9301	Mar-2009	2.15	2/12/2009	2808	N/A	Jan-2009	(P004369)		x	2808 Radio
UHF Radio	FreeWave	HTP-900RE	885-8740	May-2010	2.18	7/24/2009	2805	N/A	Jan-2010	CD0001709330		x	2805 Radio
UHF Radio	FreeWave	HTP-900RE	885-8156	May-2009	2.18	7/24/2009	2806	N/A	Jan-2009	CD0001709328		x	2806 Radio
UHF Radio	FreeWave	HTP-900RE	885-8689	May-2010	2.18	7/24/2009	SPARE (C-02 STORES)	N/A	Jan-2010	no Bar Code		x	2807 Radio
UHF Radio	FreeWave	HTP-900RE	884-9511	May-2009	2.15	2/12/2009	field or O-lab	N/A	Jan-2009	(P004370)		x	Oscar - Black Box
UHF Radio	FreeWave	HTP-900RE	886-0745	May-2010	2.18	7/24/2009	field or O-lab	N/A	Jan-2010	CD0001526975		x	Ernie - Orange Box
UHF Radio	FreeWave	HTP-900RE	886-0744	May-2010	2.18	7/24/2009	field or O-lab	N/A	Jan-2010	CD0001526976		x	Bert - Yellow Box
UHF Antenna	PCTEL	MAX9053	N/A	May-2008	N/A	N/A	S220	N/A	Jan-2008	no Bar Code		x	used in field
UHF Antenna	PCTEL	MAX9053	N/A	May-2009	N/A	N/A	Launches	N/A	Jan-2009	no Bar Code		x	used in field, Qty 4, 1/launch
UHF Antenna	PCTEL	MAX9053	N/A	May-2009 or 2010	N/A	N/A	field or O-lab	N/A	Jan-2009 or 2010	no Bar Code		x	used in field, Qty 3
Solar Charger	PWM	EPRC5	0702EPRC5-026	May-2009	N/A	N/A	stored O-lab	N/A	Jan-2009	no Bar Code			spare
Solar Charger	PWM	EPRC5			N/A	N/A	stored O-lab	N/A	obtained May-2009	no Bar Code			spare or used in field?
Solar Charger	PWM	EPRC5			N/A	N/A	stored O-lab	N/A	obtained May-2009	no Bar Code			spare?
Solar Charger	Morningstar	SS-10-L. 12v	10190177	Aug-2010	N/A	N/A	field or O-lab	N/A	Apr-2010	no Bar Code	2003	x	Spare - Tan Box
Solar Charger	Morningstar	SS-10-L. 12v	10190178	Aug-2010	N/A	N/A	field or O-lab	N/A	Apr-2010	no Bar Code		x	Oscar - Black Box
Solar Charger	Morningstar	SS-10-L. 12v	10190179	Aug-2010	N/A	N/A	field or O-lab	N/A	Apr-2010	no Bar Code	2003	x	Bert - Yellow Box
Solar Charger	Morningstar	SS-10-L. 12v	10331024	Feb-2011	N/A	N/A	field or O-lab	N/A	Dec-2010	no Bar Code		x	Ernie - Orange Box
Solar Panel	Uni-Solar	FLX-32	USF-32-14639	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	FLX-32	USF-32-14634	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	FLX-32	USF-32-14633	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	FLX-32	USF-32-14529	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	FLX-32	USF-32-14631	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	FLX-32	USF-32-14625	Jul-2004	N/A	N/A	field or O-lab	N/A	Aug-2003	no Bar Code		x	used in field
Solar Panel	Uni-Solar	MBC-525	525-011093	Mar-2006	N/A	N/A	field or O-lab	N/A		CD000684507		x	used in field
Solar Panel	Uni-Solar	MBC-525	525-011589	Mar-2006	N/A	N/A	field or O-lab	N/A		CD000684510		x	used in field
Solar Panel	Uni-Solar	MBC-525	525-011607	Mar-2006	N/A	N/A	field or O-lab	N/A		CD000684512		x	used in field
Solar Panel	Sunlinq	P3-12V-60	146636	Oct-2010	N/A	N/A	field or O-lab	N/A	Jun-2010	no Bar Code		x	used in field
Solar Panel	Sunlinq	P3-12V-60	146624	Oct-2010	N/A	N/A	field or O-lab	N/A	Jun-2010	no Bar Code		x	used in field. In field on 6/10/2011
Solar Panel	GE Energy	GEPV-030-MNA-001	C30G200506210063	Mar-2010	N/A	N/A	stored O-lab	N/A	Unknown	no Bar Code			old tide one, testing only

Additional Equipment

Equipment Type	Manufacturer	Model	Serial Number	Hardware Install date	Firmware and/or Software Version	Version Install Date	Location	Date of last Field Cal/Testing	Date of last Manufacturer Cal/Service	Bar Code			Comments
Solutions Dongles	Ashtech	600586 (A)	KEB2083		N/A	N/A	CST desk			no Bar Code			
Solutions Dongles	Ashtech	600586 (A)	KEB2077		N/A	N/A	missing			no Bar Code			
GPS RTK Receiver	Trimble	DSM-232	225111661		3.57	Mar-2008	C02			CD0001697439	PN/ 60232-00		RTK capable
GPS RTK Reciver	Trimble	MS 750	220339262				C02			CD0001478898	P/N 36487-02		RTK capable
GPS Receiver	Trimble	DSM-232RS	225111655		3.57	Mar-2008	C02			CD0001697422	P/N 60232-80		Not upgradable
GPS Antenna	Trimble	Zephyr Geodetic 2	30325441		N/A	N/A	C02			no Bar Code	P/N 55971-00DC4703		
GPS Antenna	Trimble	SPS MSK	5876		N/A	N/A	C02			no Bar Code	P/N 44530-00REV.A		

GPS Antenna	Trimble	Trimble Micro Centered L1/L2	220298707		N/A	N/A	C02			(NOAA Launch Barcode A2008)	P/N 33429-00		
GPS Antenna	Trimble	Zephyr Geodetic	12297641		N/A	N/A	C02	N/A		no bar code	P/N 41249-00 DC 4218		Zezula brought antenna from AK Nav
DGPS Antenna	Trimble	33580-00 ?	220395038		N/A	N/A	C02			no Bar Code	P/N 33580-00		
UHF Radio	PCTEL	MAX9053					C02		obtained May-2009	no Bar Code			RTK stuff
Position Data Link High Powered Base Unit	Pacific Crest	PDL 4135	0424 0171		2.40	Apr-2004	C02	5/3/2007	obtained Apr-2004	CD0001269910	P/N A01334		
Position Data Link Rover	Pacific Crest	PDL 4100	04240154		2.4	Apr-2004	C02	5/3/2007	obtained Apr-2004	CD0001269896	P/N A01337		
Position Data Link Rover	Pacific Crest	PDL 4100	03473047		2.32	Apr-2004	C02	5/3/2007	obtained Apr-2004	CD0001269912	P/N A01337		
Position Data Link Rover	Pacific Crest	PDL 4100	04240155		2.4	Apr-2004	C02	5/3/2007	obtained Apr-2004	CD0001269911	P/N A01337		
Position Data Link Rover	Pacific Crest	PDL 4101	07095939				C02			no Bar Code	P/N A01337		
Penetrometer	Brooke Ocean Technology Inc.	FFCPT-35-2	10416				Not found on FA						
Penetrometer sensor	Brooke Ocean Technology Inc.	AML SV +P	191-3				Not found on FA						
Micro Thermosalinograph	Sea-Bird	SBE 45 (TSG)	4536628-0117		N/A	N/A	Lodar room	Jul-2009	1/8/2008		P/N 4536628		not used for surveying at this time
Handheld data collector	Trimble	TSCe	37318		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 45268-50
Antenna cable	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 22628
Camcorder Batteries	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 17466
NMEA/RTCM cable	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 30232-00
data/power cable	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 30231-00
dual battery cable	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 24333
GPS Pathfinder field device cable	Trimble	N/A	N/A		N/A	N/A	S220 O-lab, Backpack	N/A	N/A	no bar code			P/N: 45052
8-Port Gigabit Switch	Lynksys	SRW2008	RMQ00J700285				2805			(P004422)			
8-Port Gigabit Switch	Lynksys	SRW2008	RMQ00J700115				2806			(P004421)			
8-Port Gigabit Switch	Lynksys	SRW2008	RMQOOJ70016				SPARE (C-02 STORES)			no bar code			
8-Port Gigabit Switch	Lynksys	SRW2008	RMQ00J700119				2808			(P004424)			
Hard Drive Dock	Nexstar						2805			no bar code			
Hard Drive Dock	Nexstar						2806			no bar code			
Hard Drive Dock	Nexstar						SPARE (C-02 STORES)			no bar code			
Hard Drive Dock	Nexstar						2808			no bar code			
POS/MV IMU	Applanix	LN200	047				FOO stores			CD0000825306			removed from 2807 in April 2010 - bad, faulty data out, need to excess
POS/MV IMU	Applanix	LN200	323				FOO stores						bad, faulty or no data out, need to excess

FAIRWEATHER Computers

Machine Name	Location	Make/Model	Operationg System	Date Purchased	Date of Last Rebuild	Processor Speed	RAM (original)	RAM (checked on date)	Number of Video Outputs	Video RAM	Service Tag	Barcode	Comments
FA_Proc_1	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	HG7LWK1	CD0001766763	New Dell desktop installed March 2010
FA_Proc_2	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	DJKBZK1	CD0001766913	New Dell desktop installed March 2010
FA_Proc_3	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	7G7CWK1	CD0001766754	New Dell desktop installed March 2010
P1_p4_64bit	Plot Room	Dell Precision T3500	Win 7 Pro	Winter 2011		3.33 GHz	12 GB		2		3MD5KN1	CD0001684477	New Dell desktop installed February 2011
P1_p5_64bit	Plot Room	Dell Precision T3500	Win 7 Pro	Winter 2011		3.33 GHz	12 GB		2		5N55KN1	CD0001684476	New Dell desktop installed February 2011
FA_Proc_6	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	JG7CWK1	CD0001766764	New Dell desktop installed March 2010
Ops64bit-pc	Plot Room	Dell Precision T3500	Win 7 Pro	Winter 2011		3.33 GHz	12 GB		2		3MD4KN1	CD0001684478	New Dell desktop, not currently connected.
FA_Proc_8	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	GZ55K1	CD0001766791	Moved 6/11, Dell desktop installed 3/10
FA_Proc_9	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Apr-08		3.0 GHz	3 GB		2	512 MB	3JKCZF1	CD0001615472	Dell desktop installed week of 04/06/08
FA_Proc_10	Plot Room	Dell Precision T3400	XP Pro 2002 SP3	Apr-08		3.0 GHz	3 GB		2	512 MB	TJKCZF1	CD0001615471	Dell desktop installed week of 04/06/08, Not installed as of 6/3/10
FA_CST	Field Office	Dell Precision T3400	XP Pro 2002 SP3	Apr-08		3.0 GHz	3 GB		2	512 MB	4JKCZF1	CD0001615469	Dell desktop installed week of 04/06/08
FA_FOO	Field Office	Dell Precision T3400	XP Pro 2002 SP3	Apr-08		3.0 GHz	3 GB		2	512 MB	DHKCZF1	CD0001615470	Dell desktop installed week of 04/06/08
FA_O-Lab	O-Lab	Dell Precision 490	XP Pro 2002 SP3	Nov-07		2.66 GHz	3 GB		2	256 MB	2NP1PD1	CD0001615380	Dell desktop installed week of 12/4/07, Moved 03/2010
FA_P2_Proc_1	Plot Room 2	Dell Precision T3400	XP Pro 2002 SP3	Apr-08		3.0 GHz	3 GB		2	512 MB	JHKCZF1	CD0001615468	Dell desktop installed week of 04/06/08
FA_P3_Proc_1	Plot Room 3	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	FJKBZK1	CD0001766914	New Dell desktop installed March 2010
FA_P3_Proc_2	Plot Room 3	Dell Precision 490	XP Pro 2002 SP3	Nov-07		2.66 GHz	3 GB		2	256 MB	8MP1PD1	CD0001615384	Dell desktop installed week of 12/4/07, Moved 03/2010
FA_P3_Proc_3	Plot Room 3	Dell Precision 490	XP Pro 2002 SP3	Nov-07		2.66 GHz	3 GB		2	256 MB	9MP1PD1	CD0001615385	Refreshed 02/2010, 12/4/07, Moved 03/2010
FA_P3_Proc_4	Plot Room 3	Dell Precision T3400	XP Pro 2002 SP3	Summer-09		3.33 GHz	3 GB		2	512 MB	HZ55ZK1	CD0001766792	New Dell desktop installed March 2010
Toughbook 1	ET Office	Panasonic CF-18	XP Pro 2002 SP2	~ March 2004	~ July 2006	1.1 GHz	2.5 GB		1	64 MB	4HKSA59499	CD0001269860	ET Office
Toughbook 2	Laptop	Panasonic CF-18	XP Pro 2002 SP2	~ March 2004	~ September 2005	1.1 GHz	2.5 GB		1	64 MB	4HKSA59560	CD0001269858	
Toughbook 3	Laptop	Panasonic CF-29	XP Pro 2002 SP2	March 2006		1.6 GHz	2.5 GB		1	128 MB	6AKSB06863	CD0001698251	
Toughbook 4	Laptop	Panasonic CF-30	XP Pro 2002 SP3	March 2009		1.7 GHz	1 Gb		0	384 MB	8HKSB80630	CD0001447100	
Toughbook 6	Laptop	Panasonic CF-30	XP Pro 2002 SP3	March 2009		1.7 GHz	1 Gb		0	384 MB	8HKSB80631	CD0001447101	
Toughbook 5	Laptop	Panasonic CF-19	XP Pro 2002 SP3	March 2009		1.1 GHz	1 Gb		1	384 MB	9AKSB43281	CD0001696424	
Survey Mobile Workstation	Laptop	Dell Precision M4400	XP Pro 2002 SP3			3.0 GHz	3.5 Gb		1	512 MB	8L56ZK1	CD0001766841	
2805_ACQ	Launch 2805	Cybertron PC ACP-4000	XP Pro 2002 SP3			2.0 GHz	3 GB		2	1024 MB	40001000160709	CD0001703148	P/N ACP-4000MB-00XE
2806_ACQ	Launch 2806	Cybertron PC ACP-4000	XP Pro 2002 SP3			2.0 GHz	3 GB		2	1024 MB	40001000160707	CD0001703147	P/N ACP-4000MB-00XE
2807_ACQ	Hi'ialakai	Cybertron PC ACP-4000	XP Pro 2002 SP3			2.0 GHz	3 GB		2	1024 MB	40001000160711	CD0001703146	P/N ACP-4000MB-00XE
2808_ACQ	Launch 2808	Cybertron PC ACP-4000	XP Pro 2002 SP3			2.0 GHz	3 GB		2	1024 MB	4000100016078	CD0001703149	P/N ACP-4000MB-00XE
S220_ACQ	Plot Room	Dell Precision T3400	XP Pro 2002 SP2	Mar-08		3.0 GHz	3 GB		3	512 MB	CSH8NF1	CD0001615444	
FA_MVP200	Plot Room	MVP-C1-2001	2000 SP4	~ March 2004	~ September 2005	2.4 GHz	230 MB		1	64 MB	SN: 10330	CD0001269854	

Appendix II

Vessel Reports, Offsets, and Diagrams

Launch 2805

1. Offsets
2. Patch Test
3. Dynamic Draft

Launch 2806

1. Offsets
2. Patch Test
3. Dynamic Draft

Launch 2807

1. Offsets
2. Patch Test
3. Dynamic Draft

Launch 2808

1. Offsets
2. Patch Test
3. Dynamic Draft

S220

1. Offsets
2. Static Draft
3. Vessel Report
    a. Survey Report 3/2009
    b. Stability Report 7/2004
    c. Survey Report 9/2003
4. Patch Test
5. Dynamic Draft

Coordinate Systems Utilized in Vessel Offsets

Reference Surface Comparison

Multibeam-Leadline Sounding Comparison

2805 Offsets and Measurements - Summary

2805 7125 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 (m) Center	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 (m) (by design)	x	0.00000
		y	0.24503		y	0.24503				Top of Stbd Ant (m)	x	0.76454		y	-0.80598		y	0.00000
		z	-0.48191		z	-0.48191					y	-0.80778		z	3.16277		z	0.00000
											z	3.14528	Base to top of Port Ant (measured) (m)	z	0.073			
										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

2805 K5K Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to K5K Caris
x	0.000	0.534
y	0.000	0.845
z	0.000	0.772

*IMU is Reference Point

Vessel Offsets for 2805 K5K are derived from the NGS Survey, January 2010, Trimble Equipment Specs, and 2011 Measured Values.

Calculations

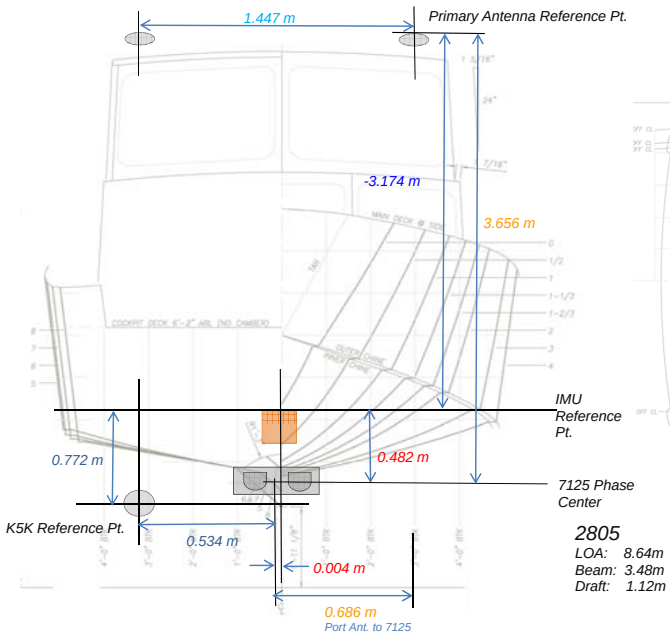
Coord. Sys./ Source		IMU to K5K	
NGS	IMU (m)	x	0.00000
		y	0.00000
		z	0.00000
	KEEL FORE BM	x	-0.00202
		y	0.44007
		z	-0.6141
	KEEL FORE BM to K5K Rcvr - Phase Center (measured)	x	0.536
		y	0.405
		z	-0.158

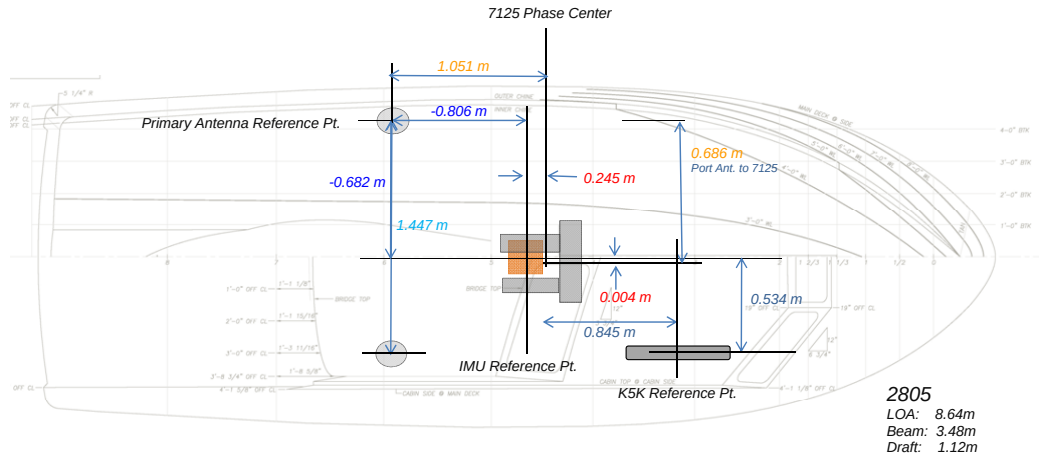
Coord. Sys.		IMU to K5K	
NGS	IMU to K5K Phase Ctr	x	0.53398
		y	0.84507
		z	-0.77210
	Coord. Sys. CARIS	x	0.53398
		y	0.84507
		z	0.77210

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.

Waterline Measurements

Fill in Yellow squares only!

Measuring Party: ENS Wilson, ST Francksen, ENS Flowers

2805

Waterline measurements should be negative and cm!

	2805	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-98.1	-100.3
Measure 2	-95.2	-98.1
Measure 3	-96.8	-96.8
Avg (cm)	-96.70	-98.40
Avg (m)	-0.9670	-0.9840
Stdev	0.01453	0.01769
BM Z-value (m)*	1.07535	1.04250
BM to WL (m)	0.108	0.059
Individual measurement	0.09435	0.03950
	0.12335	0.06150
StDev for TPU xls (of 6 #'s)	0.031 0.10735	0.07450

Date: 3/17/2011
Fuel Level: 101 Gallon
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0329	-0.0170	-0.0498

RP to WL Average (m)
0.083

Measuring Party: ENS Wilson, ST Francksen, LT Jaskoski, SS Abraham

Waterline measurements should be negative and cm!

	2805	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-96.5	-95.9
Measure 2	-96.5	-95.7
Measure 3	-95.7	-96.8
Avg (cm)	-96.23	-96.13
Avg (m)	-0.9623	-0.9613
Stdev	0.00462	0.00586
BM Z-value (m)	1.07535	1.04250
BM to WL (m)	0.113016667	0.081
Individual measurement	0.11035	0.08350
	0.11035	0.08550
StDev for TPU xls (of 6 #'s)	0.018 0.11835	0.07450

Date: 3/25/2011
Fuel Level: 68.9 Gallon
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0329	0.0010	-0.0319

RP to WL Average (m)
0.097
(Add this value to VSSL_Offsets & Measurements_20XX.xls)

utilized in Offsets and Measurements and TPU spread

Measuring Party: Morgan, Loy, Pfundt

Waterline measurements should be negative and cm!

	2805	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-94.2	-100.7
Measure 2	-94.6	-98.1
Measure 3	-94.5	-98.5
Avg (cm)	-94.43	-99.10
Avg (m)	-0.9443	-0.9910
Stdev	0.00208	0.01400
BM Z-value (m)	1.07535	1.04250
BM to WL (m)	0.131	0.051
Individual measurement	0.13335	0.03550
	0.12935	0.06150
StDev for TPU xls (of 6 #'s)	0.044464 0.13035	0.05750

Date: 4/6/2011
Fuel Level: 30 gallons
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0329	-0.0467	-0.0795

RP to WL Average (m)
0.091

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.

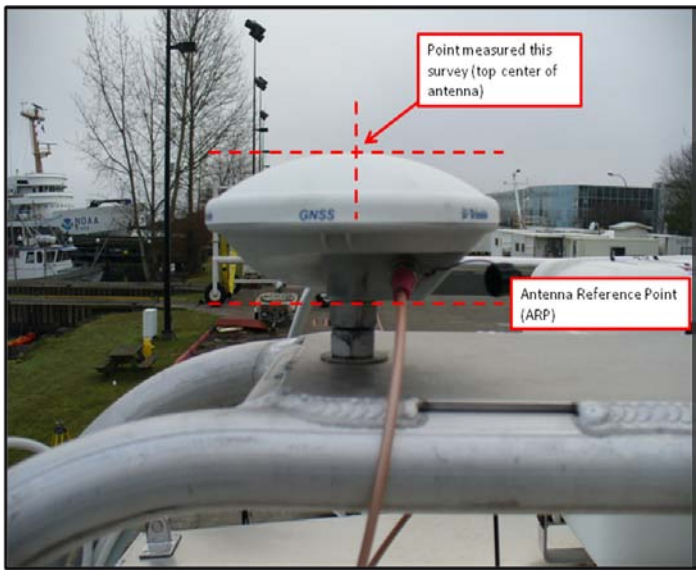
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

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;

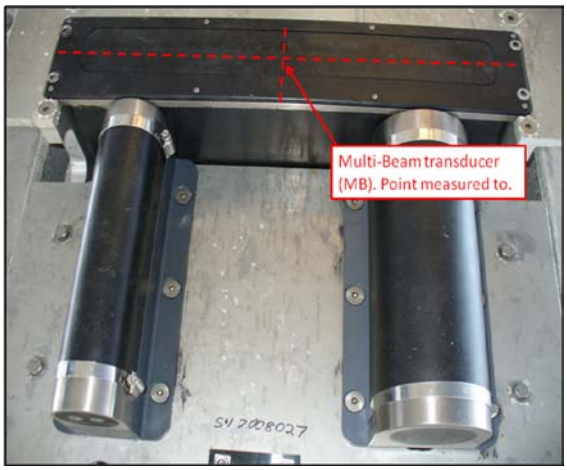
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This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



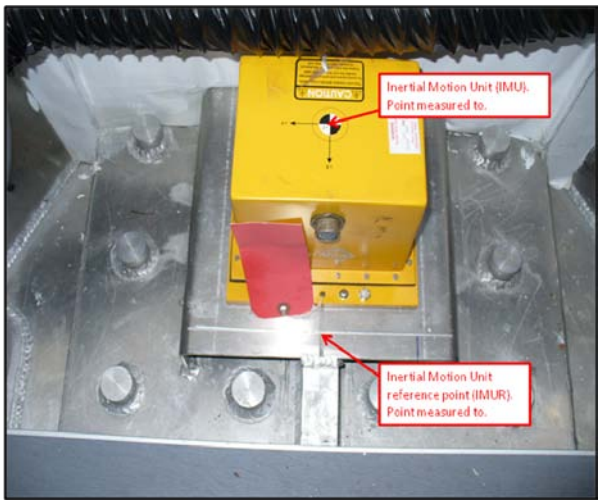
NOAA SURVEY VESSEL 2805
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

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

3/25/2011	084	Shilshole
Date	Dn	Local Area

Abraham, Zacharias, Francksen, Wilson
Calibrating Hydrographer(s)

7125 200kHz ED	Hull Mount	2009
MBES System	MBES System Location	Date of most recent EED/Factory Check

4408358	1812028
Sonar Serial Number	Processing Unit Serial Number
Fixed Hull Mount	1/26/2010
Sonar Mounting Configuration	Date of current offset measurement/verification

Applanix POS/MV S/N:3627	IMU S/N:294	3/25/2011
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/25/2011	084	Shilshole	Partly Cloudy, S Winds
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Abraham, Zacharias, Francksen, Wilson
Personnel on board

Comments

2011_2805_084_Patch+Ref.000
TrueHeave filename

2011_084_170215	1706	47/40/32.89	-122/25/30.27	42.75		
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth	
2011_084_191839	1918	47/40/20.58	-0.161215725	42.75		
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth	
2011_084_192830	1929	47/40/31.05	-122/25/32.24	38.01		1468.5
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth	

view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir)

NAV TIME LATENCY

[same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2011R_0841827	284	4.7	
1	2011R_0841831	108	4.5	
1	2011R_0841834	287	4.4	
1	2011R_0841836	108	4.6	
1	2011R_0841840	112	7.5	
1	2011R_0841842	275	7.4	
	2011R_0841838			Deleted due to Sailboat

PITCH

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2011R_0841845	135	4.6	
1	2011R_0841847	308	5.6	
1	2011R_0841849	135	5.8	
1	2011R_0841850	306	5.8	

HEADING/YAW

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011R_0841851	135	6.4	
	2011R_0841853	310	6.0	
	2011R_0841854	146	6.7	
	2011R_0841855	306	5.8	

ROLL

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	2011R_0841827	284	4.7	
1	2011R_0841831	108	4.5	
1	2011R_0841834	287	4.4	
1	2011R_0841836	108	4.6	
1	2011R_0841840	112	7.5	
1	2011R_0841842	275	7.4	

Processing Log

3/27/2011	086	Wilson

Date Dn Personnel

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

Tr ☑ **Heave applied** JPRW

SV ☑ **applied** JPRW

Tid ☑ **applied** JPRW 9447130.tid

Zone file N/A

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Morgan	0.00	-0.91	-0.44	0.86
Francksen	0.00	-0.71	-0.44	0.87
Jaskoski	0.00	-1.03	-0.47	0.91
Mallory	0.00	-0.93	-0.46	0.74
Averages	0.00	-0.90	-0.45	0.85
Standard Deviation	0.00	0.13	0.02	0.07
FINAL VALUES	0.00	-0.90	-0.45	0.85

Final Values based on averages

esulting HVF File Name FA_2805_200kHz_Rsn7125_256bms.hvf

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: CST Morgan, checked/finalized on **Date:** 6/10/2011

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2805 400kHz
Vessel

3/25/2011	084	Shilshole
Date	Dn	Local Area

Abraham, Zacharias, Francksen, Wilson
Calibrating Hydrographer(s)

7125 400kHz ED	2805 - Hull	2009
MBES System	MBES System Location	Date of most recent EED/Factory Check

4008017	1812028
Sonar Serial Number	Processing Unit Serial Number

Fixed Hull Mount	1/26/2010
Sonar Mounting Configuration	Date of current offset measurement/verification

Applanix POS/MV S/N:3627 IMU S/N:294	3/25/2011
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

3/25/2011	084	Shilshole	1 ft swell, partly cloudy
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Francksen, Zacharias, Abraham, Wilson
Personnel on board

DGPS- 302, ED. Times need to be reset on the CTDs
Comments

2011_2805_084_Patch+Ref.000
TrueHeave filename

2011_084_170215	1706	47/40/32.89	-122/25/30.27	42.75	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2011_084_191839	1918	47/40/20.58	-0.161215725	42.75	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2011_084_192830	1929	47/40/31.05	-122/25/32.24	38.01	
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]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	016_1716	106	4.0	
1	016_1718	286	5.2	
1	016_1721	115	4.0	
1	016_1725	286	5.1	
1	016_1728	110	7.5	
1	016_1730	280	7.5	Cut short and off course due to vssl
1	016_1733	106	7.0	

PITCH

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	016_1735	316	4.0	
1	016_1737	130	4.0	
1	016_1739	310	4.6	
1	016_1741	128	4.3	

HEADING/YAW

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	013_1743	309	4.8	
1	012_1744	135	4.3	V close to buoy
1	002_1746	310	4.5	
1	001_1748	153	4.5	DELETE
1	001_1750	123	4.3	

ROLL

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	016_1716	106	4.0	
1	016_1718	285	5.0	
1	016_1725	280	5.0	
1	016_1728	110	7.5	

Processing Log

Date	Dn	Personnel
3/27/2011	086	Wilson

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

☑ **TrueHeave applied** JPRW

☑ **SVP applied** JPRW

☑ **Tide applied** JPRW 9447130.tid

Zone file N/A

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Morgan	0.00	-0.90	-0.38	0.70 **
Wilson	0.00	-1.00	-0.37	1.58
Francksen	0.00	1.74 *	-0.35	1.28
Jaskoski	0.00	-0.84	-0.38	1.18
Moehl	0.00	-1.13	-0.34	1.13
Mallory	0.00	-1.07	-0.33	1.11
Averages	0.00	-0.99	-0.36	1.16
Standard Deviation	0.00	0.12	0.02	0.19
FINAL VALUES	0.00	-0.99	-0.36	1.16

Final Values based on averages

Resulting HVF File Name FA_2805_400kHz_512bms_2011.hvf

MRU Align StdDev gyro 0.19 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

* Not used in the average for pitch or in the standard deviation calculation.

** Used in the average for yaw but not in the standard deviation calculation as it unnecessarily inflates the value.

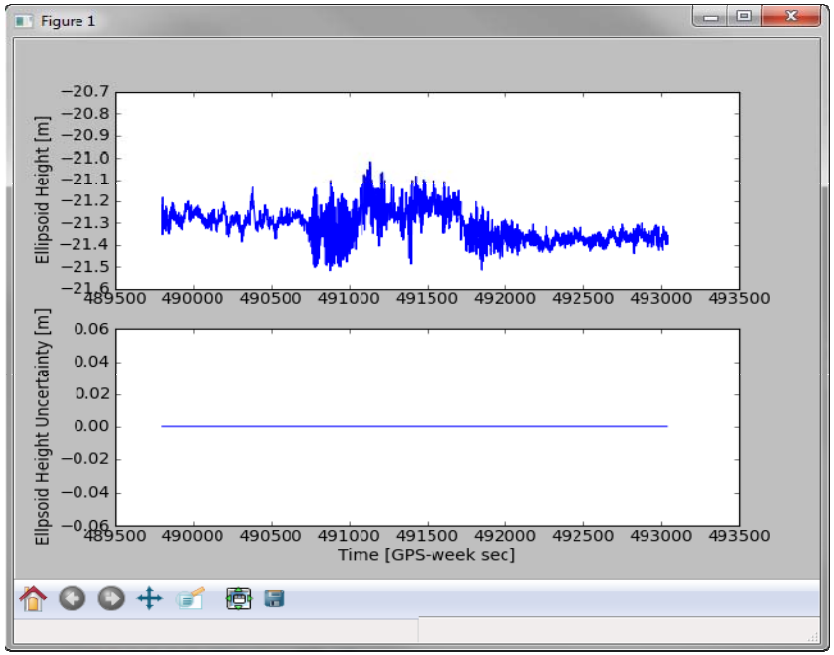
☑ **HVF Hydrographic Vessel File created or updated with current offsets**

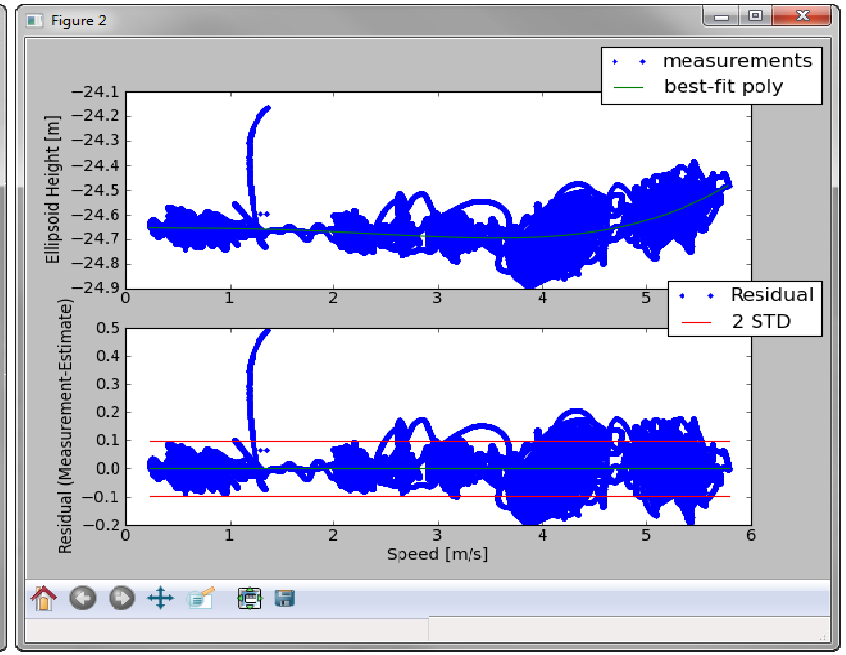
Name: CST Morgan, checked/finalized on **Date:** 6/10/2011

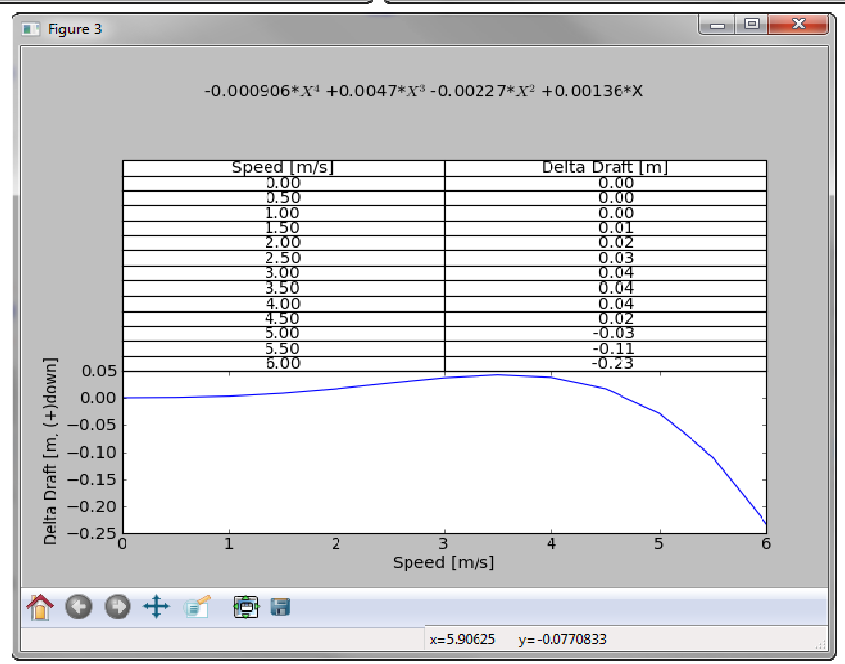
2805 ERDDM Shilshole Bay Area, WA

DN 084 Friday, March 25th, 2011
Personnel: Abraham, Zacharias, Wilson

HDG	Time	Speed (m/s)	Speed (kts)
010	1609	2.1 - 2.7	4.1 - 5.2
010	1614	3.1	6.0
010	1619	4.1	8.0
010	1624	5.3	10.3
190	1630	5.3	10.3
190	1635	4.2	8.2
190	1640	3.1	6.0
190	1645	2.2	4.3







Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	0.00
1.00	0.00
1.50	0.01
2.00	0.02
2.50	0.03
3.00	0.04
3.50	0.04
4.00	0.04
4.50	0.02
5.00	-0.03
5.50	-0.11
6.00	-0.23

2806 Offsets and Measurements - Summary

2806 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	-0.013	0.624	n/a	Scaler Distance 1.448	-0.637	-0.832	0.000	0.000
y	0.000	0.254	1.087	n/a		-0.832	-0.637	0.000	0.000
z	0.000	0.481	3.617	-0.086		-3.136	-3.136	0.000	0.000

*IMU is Reference Point

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

Calculations

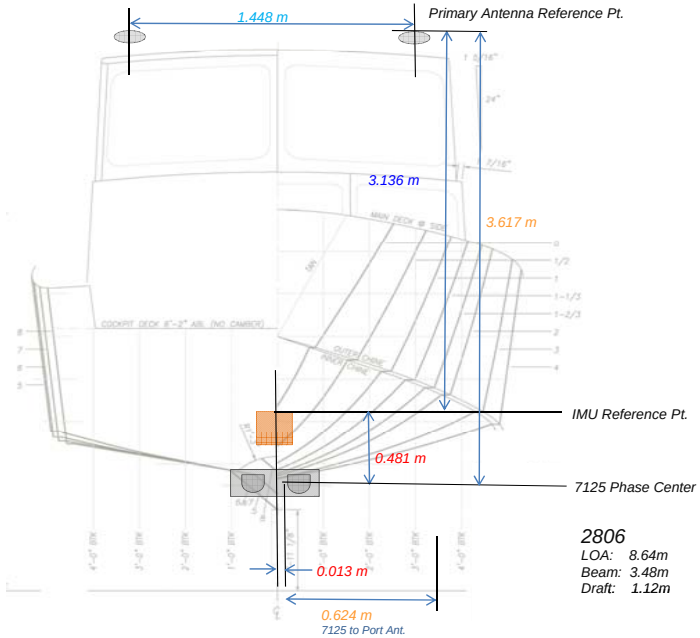
Coord. Sys./ Source	IMU to 7125	Port Ant to 7125	RP to Waterline	Port Ant to Stbd Ant	IMU to Port Ant	IMU to Heave
NGS	IMU (m) x 0.00000	IMU to x -0.63695	RP to Waterline (m)	IMU to x -0.63695	IMU (m) x 0.00000	IMU (m) x 0.00000
	y 0.00000	Port Ant (m) y -0.83249	(waterline z 0.086	Port Ant (m) y -0.83249	y 0.00000	y 0.00000
	z 0.00000	(calculated) z 3.13638	worksheet)	(calculated) z 3.13638	z 0.00000	z 0.00000
	MBES RP x -0.01284	IMU to x -0.01284		IMU (m) x, y, z 0.00000	Top of x -0.63695	Heave Pt m) x 0.00000
	Rcvr - Phase (m) y 0.25447	Phase Ctr y 0.25447			Port Ant (m) y -0.83249	(by design) y 0.00000
	Center z -0.48083	(calculated) z -0.48083		Top of x 0.81062	z 3.14938	z 0.00000
				Stbd Ant (m) y -0.82526		
				z 3.10821	Base to top of Port Ant	
					(measured) (m) z 0.059	
				Base to top of Stbd Ant		
				(measured) (m) z 0.059	Bottom of Port Ant	
					(calculated) (m) z 3.09038	
				Bottom of Stbd Ant		
				(calculated) (m) z 3.04921	Base to Phase Cntr of Port Ant	
					(eqp spc) (m) z 0.046	
				Base to Phase Cntr of Stbd Ant		
				(eqp spc) (m) z 0.046		

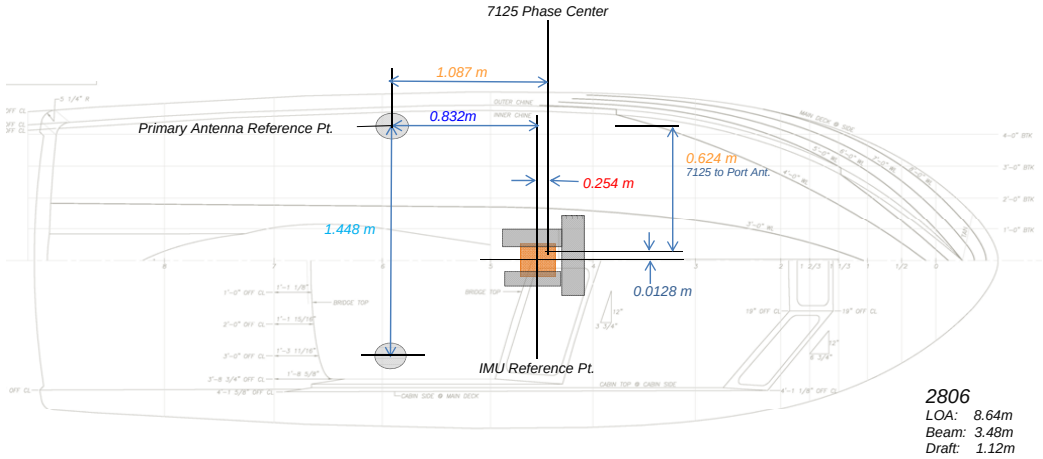
Coord. Sys.	IMU to 7125	Port Ant to 7125	RP to Waterline	Port Ant to Stbd Ant	IMU to Port Ant	IMU to Heave
NGS	IMU to x -0.01284	x 0.62411	x n/a		x -0.63695	x 0.00000
	Phase Ctr y 0.25447	y 1.08696	y n/a	Scalar Distance 1.4482	y -0.83249	y 0.00000
	z -0.48083	z -3.61721	z 0.086		z 3.13638	z 0.00000
	Coord. Sys. x -0.01284	Coord. Sys. x 0.62411	Coord. Sys. x n/a		Coord. Sys. x -0.83249	Coord. Sys. x 0.00000
	CARIS y 0.25447	CARIS y 1.08696	CARIS y n/a		Pos/Mv y -0.63695	Pos/Mv y 0.00000
	z 0.48083	z 3.61721	z -0.086		z -3.13638	z 0.00000

Description of Offsets for Launch 2806

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 2806 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
-0.013	0.254	0.481

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
0.624	1.087	3.617

The values were calculated by subtracting the top of the Port Antenna to the IMU x, y, z values then 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	-0.086

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
1.448

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

IMU to Port Antenna		
x	y	z
-0.637	-0.832	-3.136

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.

Waterline Measurements

Fill in Yellow squares only!

Measuring Party: ST Francksen, AST Mallory, ENS Smith

2806

Waterline measurements should be negative and cm!

	2806	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-97.2	-98.5
Measure 2	-96.2	-98.0
Measure 3	-95.8	-97.1
Avg (cm)	-96.40	-97.87
Avg (m)	-0.9640	-0.9787
Stdev	0.00721	0.00709
BM Z-value (m)*	1.09615	1.01777
BM to WL (m)	0.132	0.039
Individual measurement	0.12415	0.03277
	0.13415	0.03777
StDev for TPU xls (of 6 #'s)	0.051364	0.13815	0.04677

Date: 4/5/2011
Fuel Level: 41.3 gallons
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0784	-0.0147	-0.0930

RP to WL Average (m)
0.086 NGS Coordinate System (do not enter in CARIS directly)
(Add this value to VSSL_Offsets & Measurements_20XX.xls)

utilized in Offsets and Measurements and TPU spreadsheet

Measuring Party: ENS Pfundt, AST Mallory, ENS Smith

Waterline measurements should be negative and cm!

	2806	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-93.1	-98.4
Measure 2	-95.0	-97.6
Measure 3	-93.7	-95.8
Avg (cm)	-93.93	-97.27
Avg (m)	-0.9393	-0.9727
Stdev	0.00971	0.01332
BM Z-value (m)	1.09615	1.01777
BM to WL (m)	0.156816667	0.045
Individual measurement	0.16515	0.03377
	0.14615	0.04177
StDev for TPU xls (of 6 #'s)	0.06207	0.15915	0.05977

Date: 4/26/2011
Fuel Level: 110 gallons
Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0784	-0.0333	-0.1117

RP to WL Average (m)
0.101 NGS Coordinate System (do not enter in CARIS directly)

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

NOAA SURVEY VESSEL 2806
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
January, 2010

NOAA SURVEY VESSEL 2806
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 2806.

PROJECT DETAILS

This survey was conducted in Seattle, WA at the NOAA Western Center on the 26th of January, 2010. The weather was sunny 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 2806
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 2806
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.

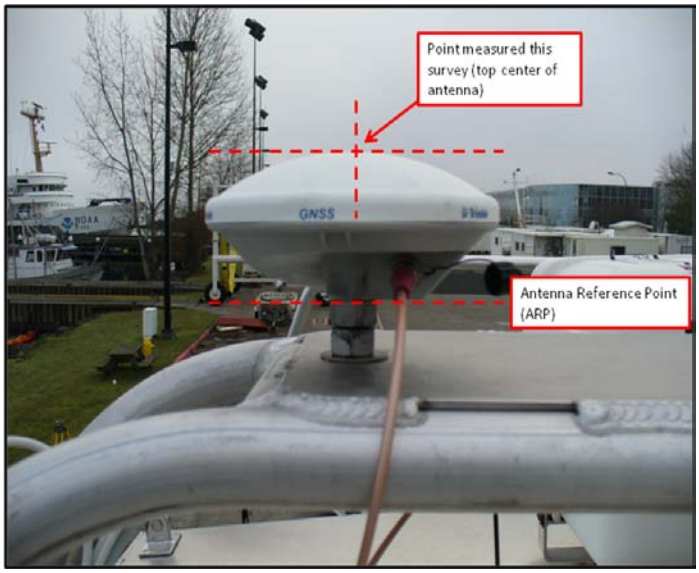
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

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. The resulting coordinates are reported in appendix A.

DISCUSSION

The positions given for the POS GPS antennas (Zephyr p/n 39105-00) 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;

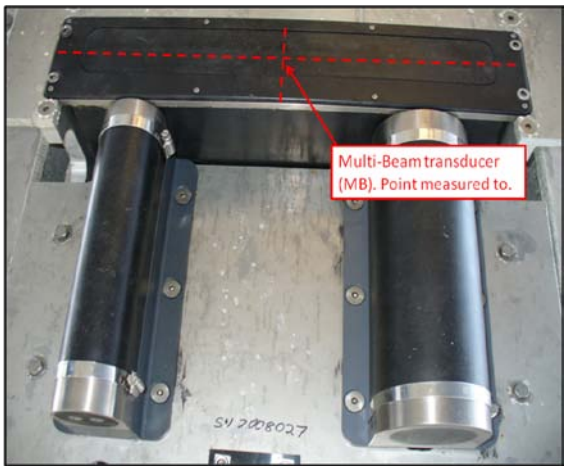
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This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



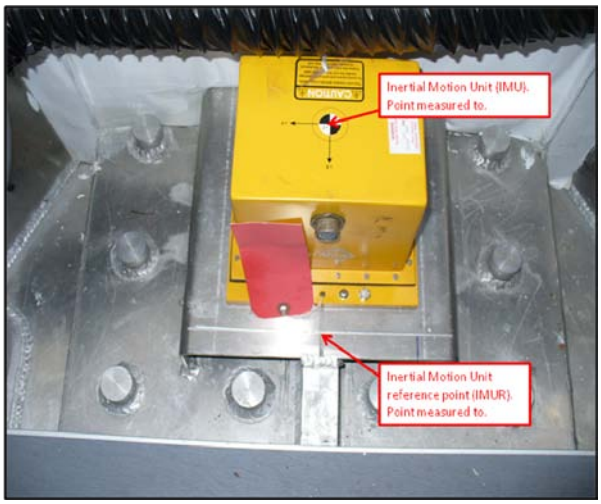
NOAA SURVEY VESSEL 2806
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

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 2806
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 2806

Pt Name	*North(Y)*	*East(X)*	*UP(Z)*	*ID*
IMU Target	0.00000	0.00000	0.00000	IMU
IMU Reference BM	0.13142	-0.01122	-0.16986	IMUR
Centerline Stern BM	-4.08215	0.02583	0.62671	CLS
Centerline Bow BM	3.44035	0.02583	1.42590	BMB
Portside GPS Ant. Ref. Point	-0.83249	-0.63695	3.14938	GPSP
Starboard GPS Ant. Ref. Point	-0.82526	0.81062	3.10821	GPSS
Multi-Beam Ref.Point	0.25447	-0.01284	-0.48083	MB
Keel BM	0.44302	-0.02150	-0.61052	MBF
Keel BM	-0.22767	-0.01641	-0.53926	MBA
Port Side BM	0.08725	-1.41542	1.09615	BMP
Starboard Side BM	0.09859	1.46945	1.01777	BMS
Centerline Cab BM	-0.21255	0.06840	2.64944	BMC

Units = meters

Appendix B

Point to Point Inverse Launch 2806

Pt. 1	*Pt. 2*	*Dist.*	*Northing*	*Easting*	*Elevation*	*ID*
24	42	0.001	0.000	-0.001	0.00012	SBF
6	22	0.000	0.000	0.000	0.00025	SBA
7	23	0.001	0.001	-0.001	0.00048	SB
33	35	0.004	0.003	0.001	0.00015	IMUR
36	32	0.004	-0.002	-0.004	0.00010	IMU
37	25	0.002	0.001	0.001	0.00013	CLS
12	26	0.002	-0.001	-0.002	0.00054	BMS
38	50	0.002	-0.002	0.000	0.00010	BMP
52	20	0.006	0.006	-0.003	0.00045	BMB
51	15	0.002	0.001	0.002	0.00011	BMC
13	27	0.003	0.003	-0.001	0.00080	GPSS
28	14	0.000	0.000	0.000	0.00023	GPSP

Units = meters

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2806 200kHz	Vessel

4/26/2011	116	Shilshole
Date	Dn	Local Area

Smith, Mallory, Morgan, Moehl

Calibrating Hydrographer(s)

7125 200kHz ED	2806 Hull	2009
MBES System	MBES System Location	Date of most recent EED/Factory Check

1008117	1812027
Sonar Serial Number	Processing Unit Serial Number

Hull mount	N/A
Sonar Mounting Configuration	Date of current offset measurement/verification

Applanix POS/MV	4/26/2011
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

4/26/2011	116	Shilshole	partial cloud coverage, sm chop, light winds, sunny
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Abraham, Pfundt, Smith, Mallory

Personnel on board

Times need to be reset on the CTDs

Comments

2011_116_2806.000

TrueHeave filename

2011_116_152230	1522	47/40/23.1N	122/25/54.7W	52.1284	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
2011_116_172648	1726	47/40/35.32N	122/25/31.56W	47.03	
SV Cast #2 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]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011_1161633	318	4.0	
	2011_1161637	316	8.0	
	2011_1161635	127	4.0	
	2011_1161638	128	8.0	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011_1161633	318	4.0	
	2011_1161635	127	4.0	
	2011_1161637	316	8.0	
	2011_1161638	128	8.0	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011_1161643	325	5.0	
	2011_1161644	130	4.5	
	2011_1161645	316	4.7	
	2011_1161647	120	3.5	
	2011_1161649	320	4.9	
	2011_1161651	131	4.3	
	2011_1161652	314	4.9	
	2011_1161654	127	4.4	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011_1161656	290	5.4	
	2011_1161658	109	4.2	
	2011_1161702	285	5.0	induced roll
	2011_1161704	105	4.0	induced roll

Processing Log

Date	Dn	Personnel
4/26/2011	116	ENS Smith

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

Tr ☑ Heave applied DDS

S\ ☑ applied NIDWT 2 hours
Can't process the cast files with the new configs

Tid ☑ applied DDS

Zone file HSRR_Shilshole.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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Ens Daniel Smith	0.00	-1.53	-0.17	0.64
ST Moehl	0.00	-1.57	-0.15	0.37
ST Mallory	0.00	-1.55	-0.10	0.74
CST Morgan	0.00	-1.55	-0.15	0.30
FOO	0.00	-1.57	-0.17	0.43
Averages	0.00	-1.55	-0.15	0.50
Standard Deviation	0.00	0.02	0.03	0.19
FINAL VALUES	0.00	-1.55	-0.15	0.50

Final Values based on averages

esulting HVF File Name FA_2806_200kHz_Rsn7125_256bms_2011.hvf

MRU Align StdDev gyro 0.19 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.02 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

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

Name: CST Morgan **Date:** 6/10/2011

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2806 400kHz
Vessel

4/19/2011	109	Shilshole
Date	Dn	Local Area

Smith, Mallory, Jaskoski, Morgan, Moehl
Calibrating Hydrographer(s)

Reson 7125	2806 - Hull	2009
MBES System	MBES System Location	Date of most recent EED/Factory Check

1908209	1812027
Sonar Serial Number	Processing Unit Serial Number

Hull Mount	N/A
Sonar Mounting Configuration	Date of current offset measurement/verification

Applanix POS/MV	4/26/2011
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

4/19/2011	109	Shilshole	Sunny, Light Winds, sm. Chop
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Loy, Mallory, Smith
Personnel on board

Comments

2011_109_2806.000
TrueHeave filename

	2012	47/40/26.32	-122/25/40.74	33	Dual CTD Cast for DQA
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	
SV Cast #2 filename		UTC Time	Lat	Lon	Depth

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
cast 1	2011M_1092039.HSX	125	8.0	
	2011M_1092046.HSX	122	4.8	
	2011M_1092045.HSX	320	8.0	
	2011M_1092048.HSX	318	4.5	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
cast 1	2011M_1092052.HSX	123	4.6	
	2011M_1092053.HSX	318	3.8	
	2011M_1092046.HSX	122	4.8	
	2011M_1092048.HSX	318	4.5	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
cast 1	2011M_1092057	122	4.5	
	2011M_1092100	121	4.6	
	2011M_1092059	316	4.6	
	2011M_1092102	320	4.5	
	2011M_1092104	125	4.7	
	2011M_1092106	322	4.5	
	2011M_1092107	130	4.9	
	2011M_1092109	324	4.6	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
cast 1	2011M_1092111	124	4.7	
	2011M_1092113	310	4.1	
	2011M_1092116	122	4.7	
	2011M_1092117	314	4.5	
	2011P_1161711	292	4.3	
	2011P_1161713	109	4.1	
	2011P_1161717A	294	4.9	Induced Roll
	2011P_1161720	104	4.1	Induced Roll

Processing Log

Date	Dn	Personnel
4/20/2011	110	ENS Smith

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

☑ **TrueHeave applied** DDS

☑ **SVP applied** Nearest in Distance within 3 hours
Can't process the cast files with the new configs

☑ **Tide applied** DDS

Zone file HSRR_Shilshole.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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Daniel Smith	0.00	-1.35	-0.11	0.28
Moehl	0.00	-1.34	-0.13	-0.35
Jaskoski	0.00	-1.40	-0.09	0.23
Mallory	0.00	-1.44	-0.08	0.10
CST Morgan	0.00	-1.50	-0.12	-0.10
Averages	0.00	-1.41	-0.11	0.03
Standard Deviation	0.00	0.07	0.02	0.26
FINAL VALUES	0.00	-1.41	-0.11	0.03

Final Values based on averages

Resulting HVF File Name FA_2806_400kHz_Rsn7125_512bms_2011.hvf

MRU Align StdDev gyro 0.26 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.04 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

Additional roll lines collected on Dn116, both 109 & 116 lines were used for roll evaluation above.

GAMS cal initially on 4/19/2011, had to be rerun for tighter values on 4/26/2011.

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

Name: CST Morgan **Date:** 6/9/2011

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2806 400kHz
Vessel

Acquisition Log

Date	Dn	Local Area	Wx
4/26/2011	116	Shilshole	Sunny, Light Winds, sm. Chop

Bottom Type	Approximate Water Depth

Personnel on board: Abraham, Pfunt, Smith, Mallory

Comments:

TrueHeave filename: 2011_116_2806.000

SV Cast #1 filename	UTC Time	Lat	Lon	Depth
2011_116_152230	1522	47/40/23.1N	122/25/54.7W	52.1284

SV Cast #2 filename	UTC Time	Lat	Lon	Depth
2011_116_172648	1726	47/40/35.32N	122/25/31.56W	47.03

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011_1161711	292	4.3	
	2011_1161713	109	4.1	
	2011_1161717A	294	4.9	induced roll
	2011_1161720	104	4.1	induced roll

Processing Log

Date	Dn	Personnel
4/26/2011	116	ENS Smith

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

☑ **TrueHeave applied** DDS

☑ **SVP applied** NIDWT 2 hours
Can't process the cast files with the new configs

☑ **Tide applied** DDS

Zone file HSRR_Shilshole.zdf

Lines merged ☑

Data cleaned to remove gross fliers ☐

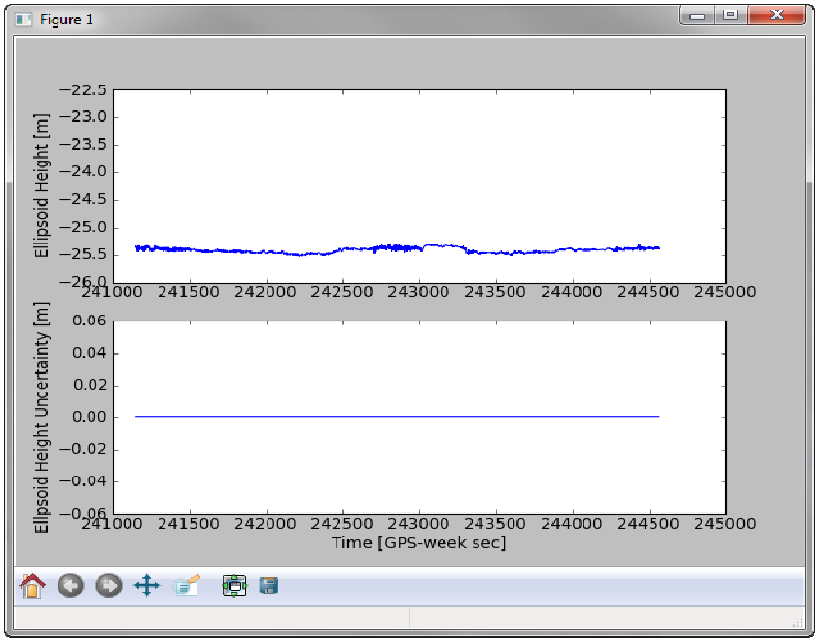
NARRATIVE

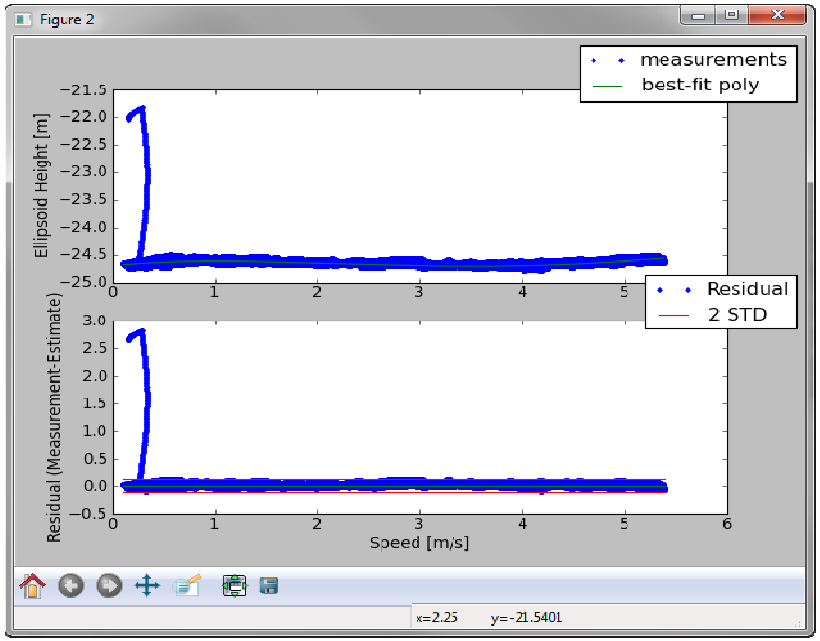
See Dn 109 for final values.

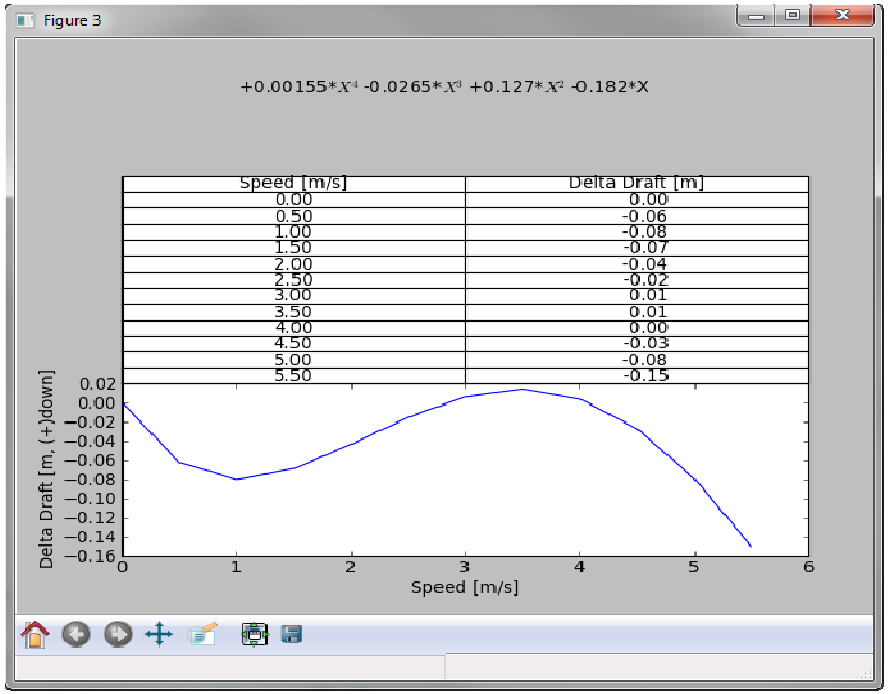
2011 ERDDM 2806

Location Shilshole
DN 109 4/19/2011
Personnel Brooks, Loy, Smith, Mallory
Fuel 63 gallons

Direction	Spd (kts)	UTC Start	UTC Stop
Wait 5 minutes then go			
013	4	1905	1910
013	6	1910	1915
013	8	1915	1920
013	10	1920	1925
Wait 5 minutes then turn around			
194	10	1930	1935
194	8	1935	1940
194	6	1940	1945
194	4	1945	1950
Wait 5 minutes then done			







Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	-0.06
1.00	-0.08
1.50	-0.07
2.00	-0.04
2.50	-0.02
3.00	0.01
3.50	0.01
4.00	0.00
4.50	-0.03
5.00	-0.08
5.50	-0.15

2807 Offsets and Measurements - Summary

2807 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	0.019	0.804	n/a	Scaler Distance 1.440	-0.786	-0.812	0.000	0.000
y	0.000	0.244	1.056	n/a		-0.812	-0.786	0.000	0.000
z	0.000	0.481	3.628	-0.090		-3.147	-3.147	0.000	0.000

*IMU is Reference Point

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

Calculations

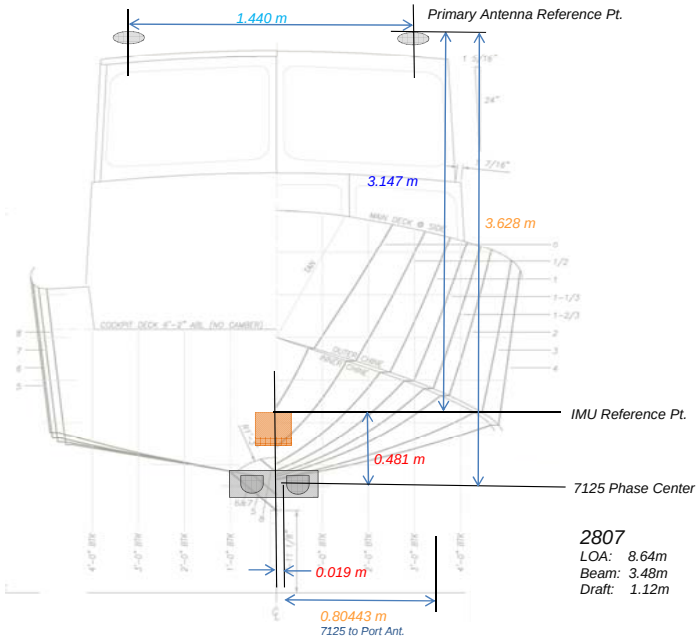
Coord. Sys./ Source	IMU to 7125			Port Ant to 7125			RP to Waterline			Port Ant to Stbd Ant			IMU to Port Ant			IMU to Heave		
NGS	IMU (m)	x	0.00000	IMU to	x	-0.78576	RP to Waterline (m)			IMU to	x	-0.78576	IMU (m)	x	0.00000	IMU (m)	x	0.00000
		y	0.00000	Port Ant (m)	y	-0.81181	(waterline	z	0.090	Port Ant (m)	y	-0.81181		y	0.00000		y	0.00000
		z	0.00000	(calculated)	z	3.14689	worksheet)			(calculated)	z	3.14689		z	0.00000		z	0.00000
	MBES RP	x	0.01867	IMU to	x	0.01867				IMU (m)	x, y, z	0.00000	Top of	x	-0.78576	Heave Pt m)	x	0.00000
	Rcvr - Phase (m)	y	0.24441	Phase Ctr	y	0.24441							Port Ant (m)	y	-0.81181	(by design)	y	0.00000
	Center	z	-0.48063	(calculated)	z	-0.48063				Top of	x	0.65423		z	3.13559		z	0.00000
										Stbd Ant (m)	y	-0.81691						
											z	3.16283	Base to top of Port Ant					
													(measured) (m)	z	0.073			
										Base to top of Stbd Ant								
										(measured) (m)	z	0.073	Bottom of Port Ant					
													(calculated) (m)	z	3.06259			
										Bottom of Stbd Ant								
										(calculated) (m)	z	3.08983	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						

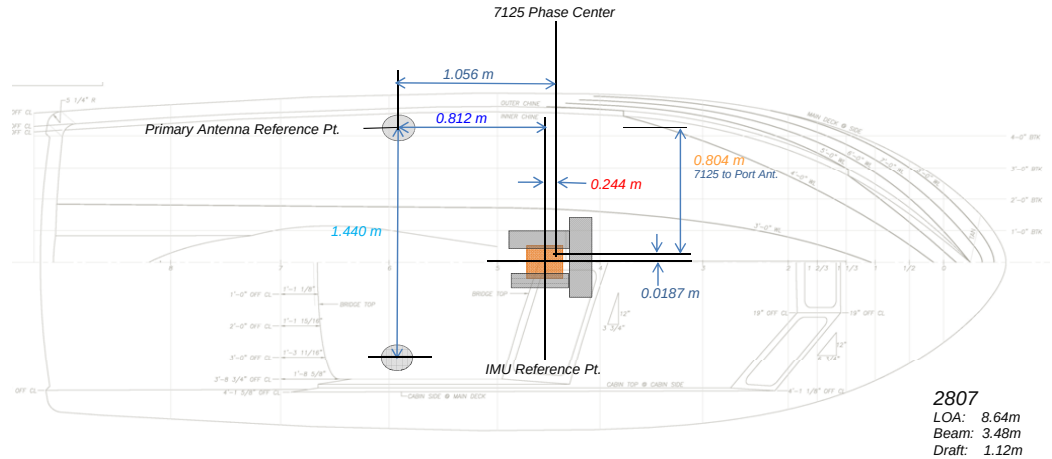
Coord. Sys.	IMU to 7125			Port Ant to 7125			RP to Waterline			Port Ant to Stbd Ant		IMU to Port Ant			IMU to Heave		
NGS	IMU to	x	0.01867		x	0.80443		x	n/a				x	-0.78576		x	0.00000
	Phase Ctr	y	0.24441		y	1.05622		y	n/a	Scalar Distance	1.4403		y	-0.81181		y	0.00000
		z	-0.48063		z	-3.62752		z	0.090				z	3.14689		z	0.00000
	Coord. Sys.	x	0.01867	Coord. Sys.	x	0.80443	Coord. Sys.	x	n/a			Coord. Sys.	x	-0.81181	Coord. Sys.	x	0.00000
	CARIS	y	0.24441	CARIS	y	1.05622	CARIS	y	n/a			Pos/Mv	y	-0.78576	Pos/Mv	y	0.00000
		z	0.48063		z	3.62752		z	-0.090				z	-3.14689		z	0.00000

Description of Offsets for Launch 2807

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 2807 was based from 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
0.019	0.244	0.481

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
0.804	1.056	3.628

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	-0.090

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
1.440

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
-0.786	-0.812	-3.147

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.

Waterline Measurements

Measuring Party:

2807

Waterline measurements should be negative and cm!

Fill in Yellow squares only!

	2807	
	Port Benchmark to Waterline	Stbd Benchmark to Waterline
Measure 1	-96.5	-99.7
Measure 2	-98.5	-94.5
Measure 3	-98.4	-94.5
Avg (cm)	-97.80	-96.23
Avg (m)	-0.9780	-0.9623
Stdev	0.01127	0.03002
BM Z-value (m)*	1.03292	1.08830
BM to WL (m)	0.055	0.126
Individual measurement	0.06792	0.09130
	0.04792	0.14330
StDev for TPU xls (of 6 #'s)	0.043882	0.04892	0.14330

Date: 4/6/2011

Fuel Level: 21 US Gal

Draft Tube:

Port-to-Stbd Z-difference

Theoretical	Actual	Error
-0.0554	0.0157	0.0710

RP to WL Average (m)

0.090 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

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

NOAA SURVEY VESSEL 2807
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
January, 2010

NOAA SURVEY VESSEL 2807
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 2807.

PROJECT DETAILS

This survey was conducted in Seattle, WA at the NOAA Western Center on the 27th of January, 2010. The weather was foggy early 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 2807
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 2807
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 0.001 m and a vertical accuracy of 0.000 m. The stability of the instrument setup was checked at conclusion of the data set collection by checking back to temporary control point 2.

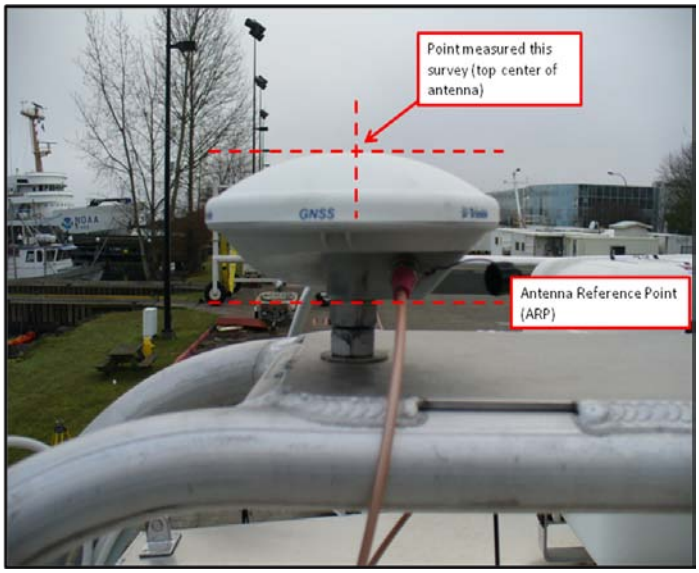
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

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;

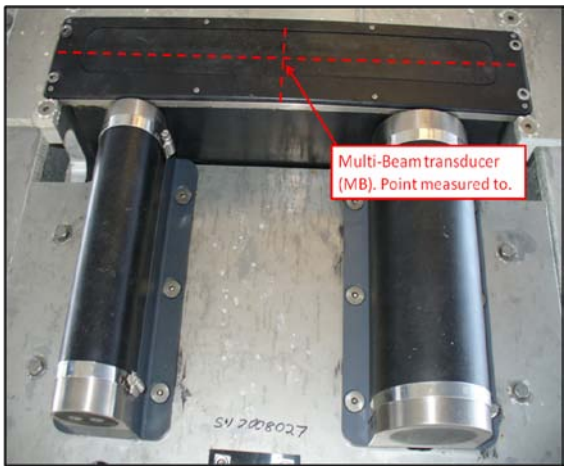
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This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



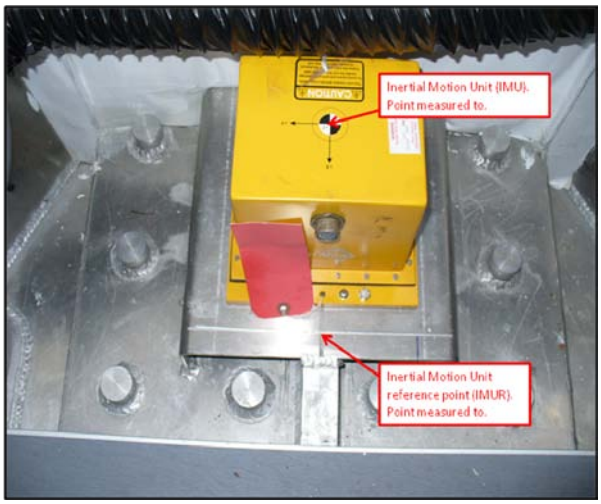
NOAA SURVEY VESSEL 2807
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

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 2807
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 2807

Pt Name	***North(Y)***	***East(X)***	***UP(Z)***	***ID***
IMU Target	0.00000	0.00000	0.00000	IMU
IMU Reference BM	0.13111	0.00714	-0.16724	IMUR
Centerline Stern BM	-4.06155	-0.02156	0.64902	CLS
Centerline Bow BM	3.44775	-0.02156	1.41160	BMB
Portside GPS Ant. Ref. Point	-0.81181	-0.78576	3.13559	GPSP
Starboard GPS Ant. Ref. Point	-0.81691	0.65423	3.16283	GPSS
Multi-Beam Ref.Point	0.24441	0.01867	-0.48063	MB
Keel BM	0.43114	0.01129	-0.61049	MBF
Keel BM	-0.23560	0.00988	-0.53203	MBA
Port Side BM	0.09979	-1.46918	1.03292	BMP
Starboard Side BM	0.08626	1.42671	1.08830	BMS
Centerline Cab BM	-0.21841	-0.05358	2.65245	BMC

Units = meters

Appendix B

Point to Point Inverse Launch 2807

Pt. 1	*Pt. 2*	*Dist.*	*Northing*	*Easting*	*Elevation*	*ID*
18	37	0.002	-0.002	0.000	0.00024	MBF
35	39	0.001	-0.001	-0.001	0.00027	MBA
19	36	0.004	0.001	0.004	0.00043	MB
29	27	0.006	0.001	0.006	0.00023	IMUR
26	30	0.006	0.005	0.004	0.00012	IMU
20	31	0.001	-0.001	-0.001	0.00038	CLS
32	45	0.000	0.000	0.000	0.00005	BMP
21	9	0.000	0.000	0.000	0.00057	BMS
49	16	0.007	0.007	0.000	0.00076	BMB
12	46	0.001	-0.001	0.000	0.00044	BMC
11	47	0.003	-0.002	0.001	0.00094	GPSP
10	48	0.002	-0.002	0.001	0.00068	GPSS

Units = meters

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2807 200kHz
Vessel

3/9/2011	068	Shilshole
Date	Dn	Local Area

Morgan, Jaskoski, Francksen, Faulkes, Pfundt
Calibrating Hydrographer(s)

7125 200kHz ED	Hull Mount	
MBES System	MBES System Location	Date of most recent EED/Factory Check
		S/N: 1812020
Sonar Serial Number		Processing Unit Serial Number
Fixed Hull Mount		
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2560	IMU S/N:10000978	3/3/2011
Description of Positioning System, include serial #		Date of most recent positioning system calibration

Acquisition Log

3/9/2011	068	Shilshole	O/C; Lt. Rain
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Francksen, Zacharias, Walker, Faulkes, Pfundt, Hough
Personnel on board

DGPS- 302, ED
Comments

2807_ref_patch_DN068.000
TrueHeave filename

Times need to be reset on the CTDs

2011_068_192915	1816	47/40/27.8	122/25/27.54	33	
SV Cast #1 filename	UTC T	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC T	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]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0682059	280	7.0	one line w/ roll from seas
	2011M_0682111	284	8.0	one line w/ roll from seas

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0682114	130	5.0	
	2011M_0682117	310	6.0	
	2011M_0682119	130	5.0	
	2011M_0682120	310	6.0	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0682122	130	5.0	
	2011M_0682123	310	6.0	
	2011M_0682125	130	5.0	
	2011M_0682126	315	6.0	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0682100	105	5.0	
	2011M_0682103	280	6.0	
	2011M_0682105	105	5.0	
	2011M_0682107	280	6.0	

Processing Log

Date	Dn	Personnel
3/8/2011	063	TMB

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

☑ **ueHeave applied** 2010_063_2807.000- TMB

☑ **/P applied**

Can't process the cast files with the new configs

☑ **le applied** TCARI file 09 and predicted WLs- TMB (needs to be redone with observed or verified)

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Morgan	0.00	-1.50	0.10	0.75
Francksen	0.00	-1.44	0.08	0.74
Faulkes	0.00	-1.40	0.10	0.93
Jaskoski	0.00	-1.56	0.08	0.76
Pfundt (after SBETS)	0.00	-1.58	0.13	0.58
Averages	0.00	-1.50	0.10	0.75
Standard Deviation	0.00	0.08	0.02	0.12
FINAL VALUES	0.00	-1.50	0.10	0.75

Final Values based on averages

Resulting HVF File Name FA_2807_200kHz_Rsn7125_256bms_2011.hvf

MRU Align StdDev gyro 0.12 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: CST Morgan **Date:** 6/24/2011

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2807 400kHz
Vessel

3/9/2011	068	Shilshole
Date	Dn	Local Area

Morgan, Jaskoski, Francksen, Faulkes, Pfundt
Calibrating Hydrographer(s)

7125 400kHz ED	Hull Mount	
MBES System	MBES System Location	Date of most recent EED/Factory Check
		S/N: 1812020
Sonar Serial Number		Processing Unit Serial Number
Fixed Hull Mount		
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2560	IMU S/N:10000978	3/3/2011
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/9/2011	068	Shilshole	O/C; Lt. Rain
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Francksen, Zacharias, Walker, Faulkes, Pfundt, Hough
Personnel on board

DGPS- 302, ED
Comments

2807_ref_patch_DN068.000
TrueHeave filename

Times need to be reset on the CTDs

2011_068_192915	1816	47/40/27.8	122/25/27.54	33	
SV Cast #1 filename	UTC T	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC T	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]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0681955	236	6.0	Noisy data at higher speeds
	0682025	105	7.0	
	0682030	105	7.0	
	0682038	236?	7.0	

PITCH

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	0682034	305	6.0	
	0682035	131	6.0	
	0682037	318	6.0	
	0682038	135	6.0	

HEADING/YAW

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2041?			
	2011M_0682042	119	6.0	
	2011M_0682044	314	6.0	
	0682045	129	6.0	
	0682046	322	6.0	

ROLL

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	0681958A	063	5.0	
	0682002	230	5.0	
	0682010	110	5.0	
	0682014	278	5.0	
	0682017	120	5.0	
	0682021	280	5.0	

Processing Log

Date	Dn	Personnel
3/8/2011	063	TMB

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

☑ **TrueHeave applied** 2010_063_2807.000- TMB

☐ **SVP applied**

Can't process the cast files with the new configs

☑ **Tide applied** TCARI file 09 and predicted WLs- TMB (needs to be redone with observed or verified)

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Francksen	0.00	-1.55	0.10	0.26
Faulkes	0.00	-1.50	0.08	0.30
Pfundt	0.00	-1.50	0.10	0.53
Morgan	0.00	-1.45	0.10	0.80
Jaskoski	0.00	-1.47	0.10	0.62
Averages	0.00	-1.49	0.10	0.50
Standard Deviation	0.00	0.04	0.01	0.23
FINAL VALUES	0.00	-1.49	0.10	0.50

Final Values based on averages

Resulting HVF File Name FA_2807_400kHz_Rsn7125_512bms_2011.hvf

MRU Align StdDev gyro 0.23 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.02 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

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

Name: CST Morgan **Date:** 6/24/2011

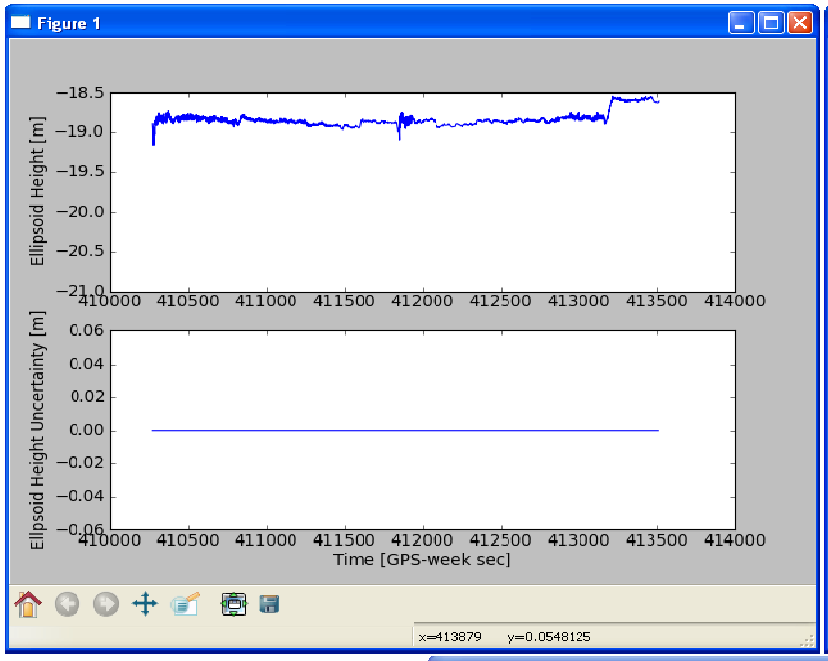
2807_ERDDM Lake Washington

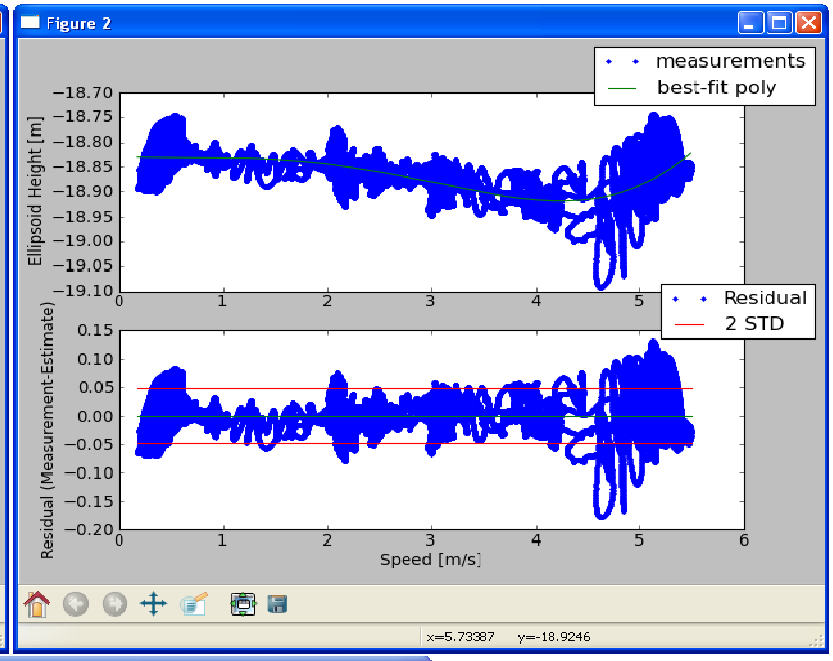
Dn 062 3/3/2011

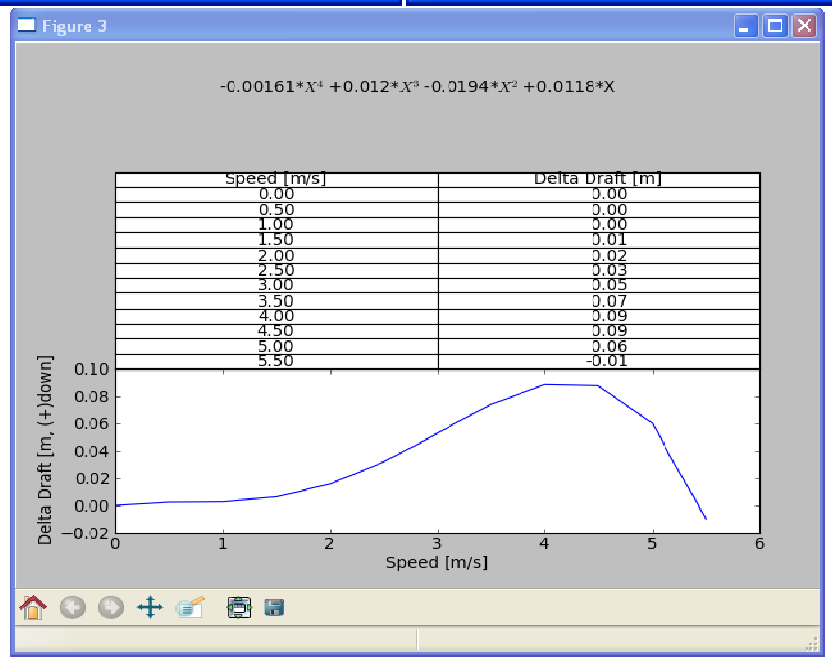
HDG (deg)	Time(UTC)	Spd (kts)
153.5	18:07:38	4
153.4	18:12:09	6
158.3	18:16:21	8
159	18:20:10	10
340	18:24:28	10
337	18:28:30	8
332	18:32:20	6
333	18:36	4

Fuel at Start: 42 US Gal

Personnel aboard: Francksen, Pfundt , Wilson, Loy, Faulks, Brooks







Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	0.00
1.00	0.00
1.50	0.01
2.00	0.02
2.50	0.03
3.00	0.05
3.50	0.07
4.00	0.09
4.50	0.09
5.00	0.06
5.50	-0.01

2808 Offsets and Measurements - Summary

2808 7125 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 **NGS**

IMU to 7125

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

Port Ant to 7125

IMU to Port Ant (m) (calculated)	x	-0.68151
	y	-0.83666
	z	3.15974
IMU to Phase Ctr (calculated)	x	0.00351
	y	0.24969
	z	-0.47677

RP to Waterline

RP to Waterline (m) (waterline worksheet) z 0.093

2010 RP to Waterline (m) (waterline worksheet) z 0.123

Port Ant to Stbd Ant

IMU to Port Ant (m) (calculated)	x	-0.68151
	y	-0.83666
	z	3.15974
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

IMU to Port Ant

IMU (m)	x	0.00000
	y	0.00000
	z	0.00000
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

IMU to Heave

IMU (m)	x	0.00000
	y	0.00000
	z	0.00000
Heave Pt (by design) m)	x	0.00000
	y	0.00000
	z	0.00000

Coord. Sys. **NGS**

IMU to 7125

IMU to Phase Ctr	x	0.00351
	y	0.24969
	z	-0.47677
Coord. Sys. **CARIS**	x	0.00351
	y	0.24969
	z	0.47677

Port Ant to 7125

	x	0.68502
	y	1.08635
	z	-3.63651
Coord. Sys. **CARIS**	x	0.68502
	y	1.08635
	z	3.63651

RP to Waterline

	x	n/a
	y	n/a
	z	0.093
Coord. Sys. **CARIS**	x	n/a
	y	n/a
	z	-0.093

Port Ant to Stbd Ant

Scalar Distance 1.4526

IMU to Port Ant

	x	-0.68151
	y	-0.83666
	z	3.15974
Coord. Sys. **Pos/Mv**	x	-0.83666
	y	-0.68151
	z	-3.15974

IMU to Heave

	x	0.00000
	y	0.00000
	z	0.00000
Coord. Sys. **Pos/Mv**	x	0.00000
	y	0.00000
	z	0.00000

2808 K5K Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to K5K Caris
x	0.000	-0.564
y	0.000	0.790
z	0.000	0.777

*IMU is Reference Point

Vessel Offsets for 2808 K5K are derived from the NGS Survey, January 2010, Trimble Equipment Specs, and 2011 Measured Values.

Calculations

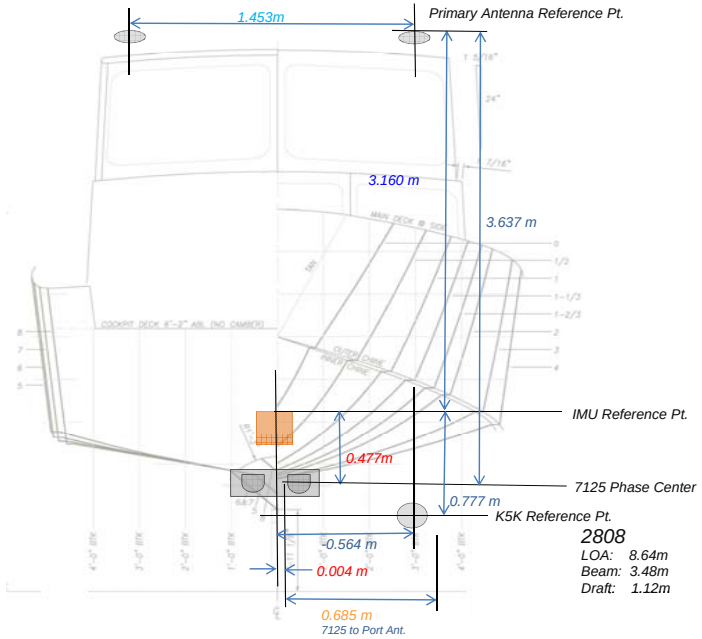
Coord. Sys./ Source		IMU to K5K	
NGS	IMU (m)	x	0.00000
		y	0.00000
		z	0.00000
	KEEL FORE BM	x	-0.00126
		y	0.44021
		z	-0.60545
	KEEL FORE BM to K5K Rcvr - Phase Center (measured)	x	-0.563
		y	0.350
		z	-0.172

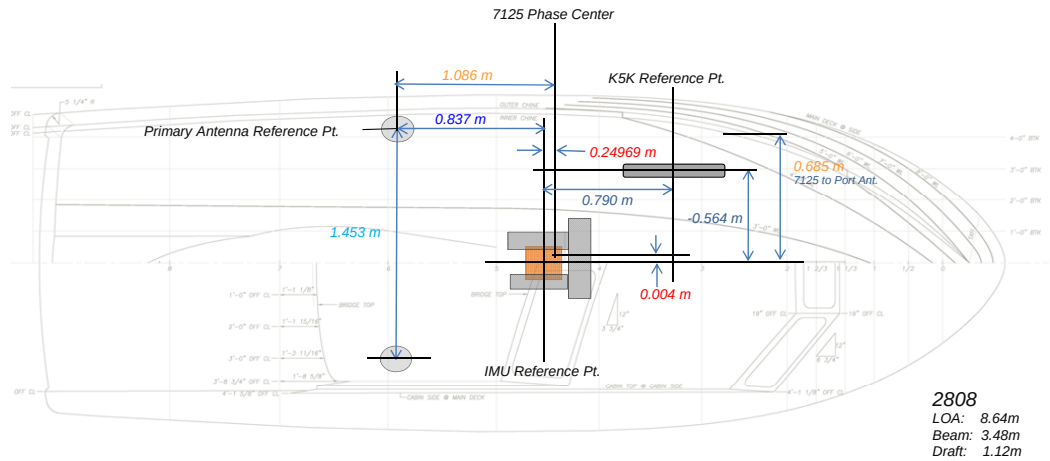
Coord. Sys.		IMU to K5K	
NGS	IMU to K5K Phase Ctr	x	-0.56426
		y	0.79021
		z	-0.77745
	Coord. Sys. CARIS	x	-0.56426
		y	0.79021
		z	0.77745

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

Kendall Fancher NOAA/NOS/NGS/GSD/I&M BRANCH
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kendall.fancher@noaa.gov

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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.

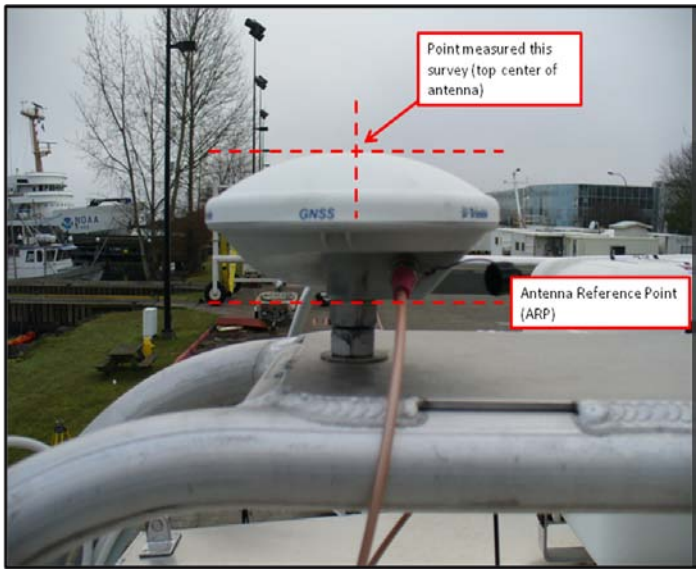
Inverses were computed between the two positions determined for all points surveyed to evaluate their accuracy relative to the temporary control network. Inverse reports are included in appendix B.

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;

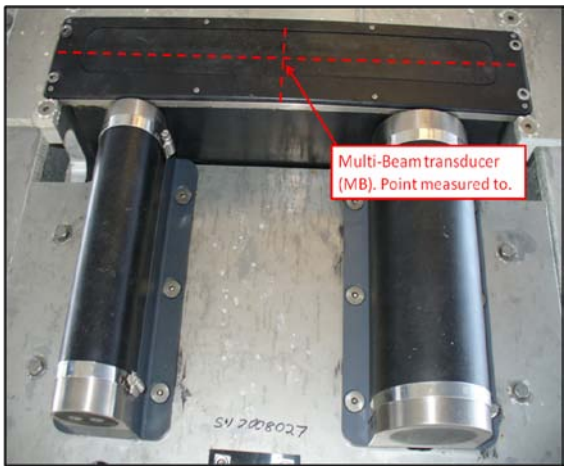
1) Determine the physical height of the GPS antenna. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This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



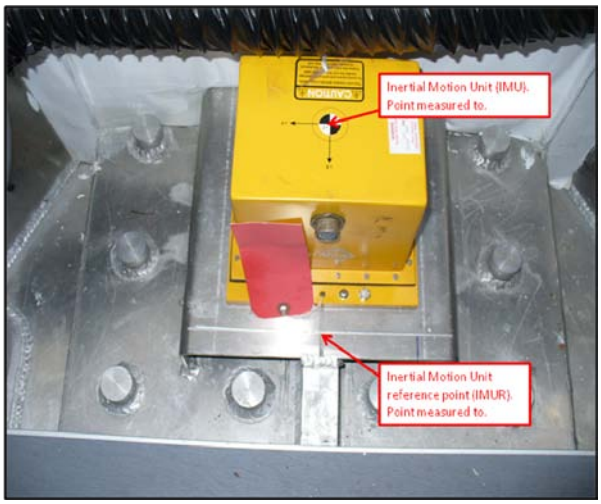
NOAA SURVEY VESSEL 2808
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

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

3/10/2011	069	Shilshole
Date	Dn	Local Area

Stuart, Jaskoski, Francksen, Faulkes, Pfundt
Calibrating Hydrographer(s)

7125 200kHz ED	Hull Mount	
MBES System	MBES System Location	Date of most recent EED/Factory Check
		S/N: 1812023
Sonar Serial Number		Processing Unit Serial Number
Fixed Hull Mount		
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2411	IMU S/N:991	3/2/2011
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/10/2011	069	Shilshole	O/C; Lt. Rain
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Francksen, Zacharias, Walker, Faulkes, Pfundt, Hough
Personnel on board

DGPS- 302, ED
Comments

TrueHeave filename

Times need to be reset on the CTDs

2011_069_182645	1826	47/40/29.3N	122/25/30.4W	36	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	
2011_069_2043	0:00	47/40/30.82	122/25/20.20	36	
SV Cast #2 filename		UTC Time	Lat	Lon	Depth

NAV TIME LATENCY

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0692017	278	7.0	
	2011M_0692019	116	7.0	

PITCH

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0691952	310	6.0	
	2011M_0691654	130	6.0	
	2011M_0691956	310	6.0	
	2011M_0691957	130	6.0	

HEADING/YAW

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2010M_0691959	313	6.0	
	2010M_0692000	136	6.0	
	2010M_0692002	315	6.0	
	2010M_0692003	131	6.0	

ROLL

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0692009	109	4.0	
	2010M_0692006	273	4.0	
	2010M_0692011	255	4.0	
	2011M_0692014	122	4.0	

Processing Log

Date	Dn	Personnel
3/12/2011	070	Francksen

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

☑ **TrueHeave applied** 2808_ref_patch_DN069.000

☑ **SVP applied** 2808_DN069_2011RefAndPatch.svp
Can't process the cast files with the new configs

☑ **Tide applied** 9447130.tid

Zone file NA

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Pfundt	0.00	-1.30	0.30	0.44
Faulkes	0.00	-1.33	0.30	0.55
Francksen	0.00	-1.45	0.30	0.61
Stuart	0.00	-1.55	0.25	0.63
Jaskoski	0.00	-1.58	0.25	0.67
Averages	0.00	-1.44	0.28	0.58
Standard Deviation	0.00	0.13	0.03	0.09
FINAL VALUES	0.00	-1.44	0.28	0.58

Final Values based on Mean Value

Resulting HVF File Name FA_2808_200kHz_Rsn7125_256bms_2011

MRU Align StdDev gyro 0.09 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.08 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

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

Name: _____ **Date:** _____

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 2808 400kHz
Vessel

3/10/2011	069	Shilshole
Date	Dn	Local Area

Morgan, Jaskoski, Francksen, Faulkes, Pfundt
Calibrating Hydrographer(s)

7125 400kHz ED	Hull Mount	
MBES System	MBES System Location	Date of most recent EED/Factory Check
		S/N: 1812023
Sonar Serial Number		Processing Unit Serial Number
Fixed Hull Mount		N/A
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV S/N:2411 IMU S/N:991		3/2/2011
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

3/10/2011	069	Shilshole	O/C; Lt. Rain
Date	Dn	Local Area	Wx
Bottom Type			Approximate Water Depth

Francksen, Zacharias, Walker, Faulkes, Pfundt, Hough
Personnel on board

DGPS- 302, ED
Comments

TrueHeave filename

Times need to be reset on the CTDs

2011_069_182645	18;26	47/40/29.3N	122/25/30.4W	35.97
SV Cast #1 filename	UTC Time	Lat	Lon	Depth
2011_069_2043	0:00	47/40/30.82	122/25/20.20	36
SV Cast #2 filename		UTC Time Lat	Lon	Depth

NAV TIME LATENCY

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0691847	275	7.0	may not use, inferior direction
	2011M_0691849	115	8.0	
	2011M_0691852	115	8.0	

PITCH

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0691923	310	6.0	
	2011M_0691925	120	5.0	
	2011M_0691926	310	6.0	
	2011M_0691928	120	5.0	

HEADING/YAW

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0691919	310	6.0	
	2011M_0691921	120	5.0	
	2011M_0691944	132	6.0	
	2011M_0691945	132	5.0	

ROLL

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_0691835	275	4.0	
	2011M_0691838	110	5.0	
	2011M_0691840	275	4.0	
	2011M_0691844	110	5.0	

Processing Log

Date	Dn	Personnel
3/12/2011	070	Francksen

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

☑ **TrueHeave applied** 2808_ref_patch_DN069.000

☑ **SVP applied** 2808_DN069_2011RefAndPatch.svp
Can't process the cast files with the new configs

☑ **Tide applied** 9447130.tid

Zone file NA

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Pfundt	0.00	-1.30	0.30	0.44
Faulkes	0.00	-1.33	0.30	0.55
Francksen	0.00	-1.45	0.30	0.61
Morgan	0.00	-1.30	0.30	0.70
Jaskoski	0.00	-1.43	0.30	0.38
Averages	0.00	-1.36	0.30	0.54
Standard Deviation	0.00	0.07	0.00	0.13
FINAL VALUES	0.00	-1.36	0.30	0.54

Final Values based on Mean value

Resulting HVF File Name FA_2808_400kHz_Rsn7125_256bms_2011

MRU Align StdDev gyro 0.13 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.04 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

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

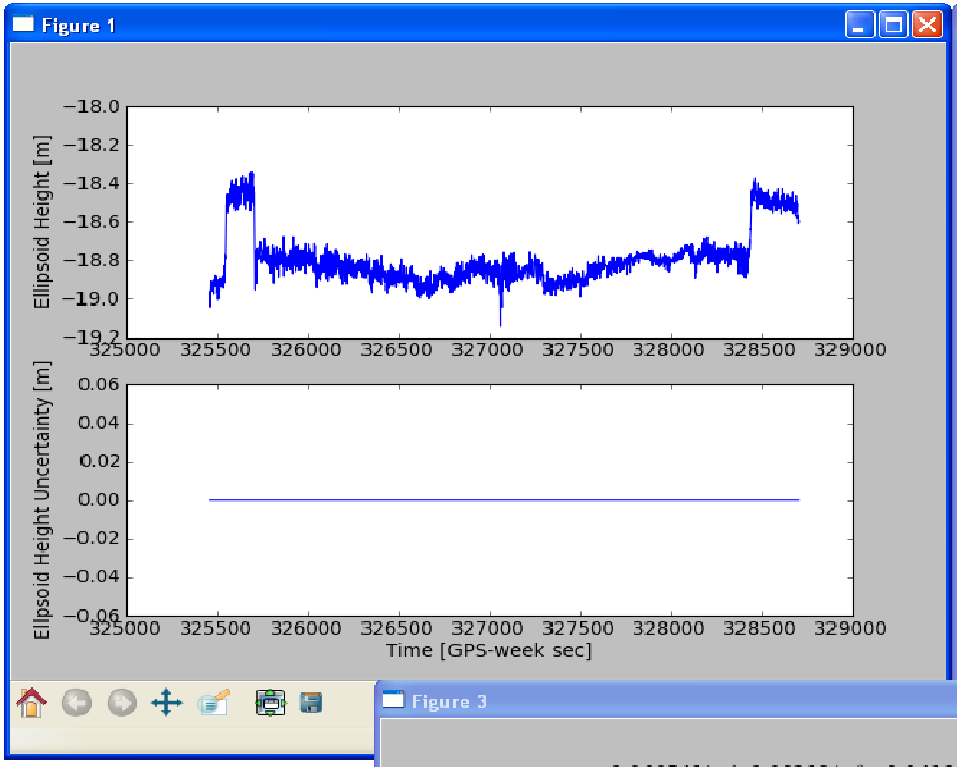
Name: FA_2808_400kHz_Rsn7125_256bms_2011 **Date:** 2011-069

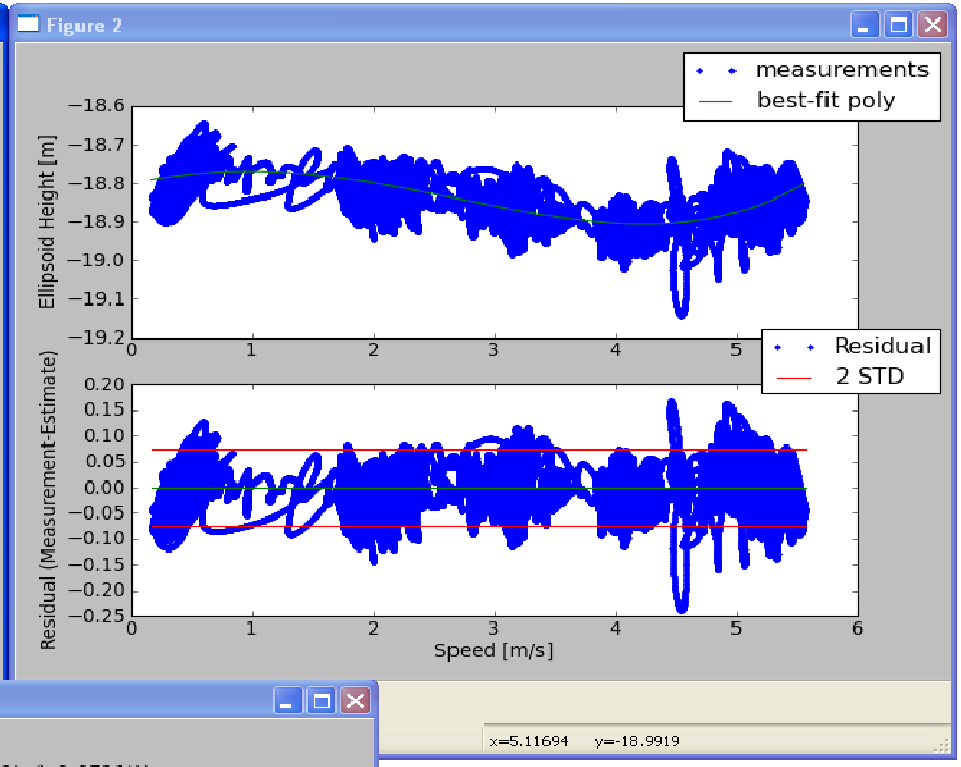
2011 ERDDM 2808 Lake Washington DN 061 03/02/11

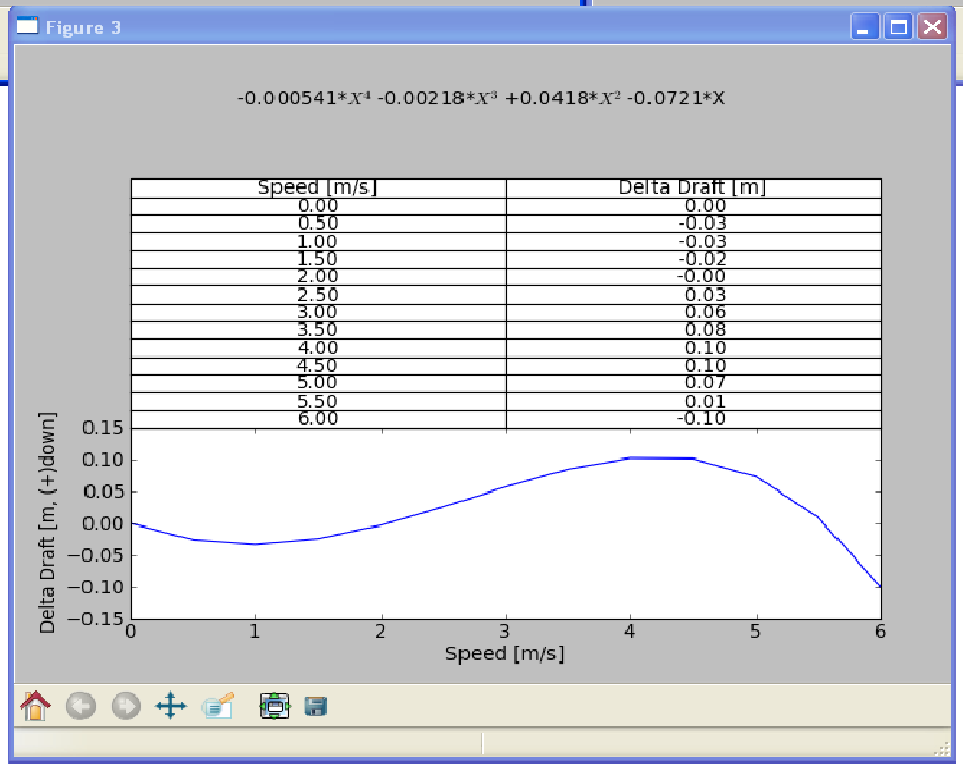
Personnel Brooks, Loy, Zacharias, Faulkes, Francksen, Pfundt

Fuel 39.5 gal starting 37.8 gal finish

Direction	Local Time	Spd
160	10:35	4
155	10:39	6
157	10:42	8
162	10:46	10
338	10:51	10
335	10:55	8
331	10:59	6
325	11:03	4







Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	-0.03
1.00	-0.03
1.50	-0.02
2.00	-0.00
2.50	0.03
3.00	0.06
3.50	0.08
4.00	0.10
4.50	0.10
5.00	0.07
5.50	0.01
6.00	-0.10

S220 Offsets and Measurements - Summary

Measurement	IMU to 7/8111 (MRU to Trans)	Port Ant to 7/8111 (Nav to Trans)	Waterline to RP*	Port Ant to Stbd Ant	IMU to Port Ant		IMU to Heave	
Coord. Sys.	Caris	Caris	Caris		Caris	Pos/Mv	Caris	Pos/Mv
x	2.868	2.071	n/a	Scaler Distance 1.997	0.797	-11.892	1.866	-7.028
y	8.252	20.144	n/a		-11.892	0.797	-7.028	1.866
z	4.752	17.821	0.081		13.068	-13.068	-2.086	-2.086

*Top of IMU is RP (Reference Pt)

Vessel Offsets for S220 7111 are derived from Westlake Survey Report NOAA Fairweather 09-23-03, Fairweather Centerline Survey (NGS) Report March 2009, and measurements by FA personnel in Measured Values 2010 and 2011.

Calculations

Coordinate Systems used as listed

IMU to 7/8111

Westlake
IMU Base (ft/m): easting 0.000, northing 0.000, elevation 0.000

8111 (from IMU Base to sensor) (ft): easting 27.072, northing 9.410, elevation 15.042

8111 (from IMU Base to sensor) (m): easting 8.252, northing 2.868, elevation 4.585

Base of IMU to Top of IMU (m): elevation -0.168

2010 value -> -0.322 Correction based on Ref Surface (m): elevation 0

Port Ant to 7/8111

NGS
Top of IMU to Port Ant (m): x -11.892, y 0.797, z 13.068

CARIS
Port Ant (m): x 0.797, y -11.892, z -13.068

Westlake
Top of IMU to 8111 (m): easting 8.252, northing 2.868, elevation 4.752

CARIS
(m): x 2.868, y 8.252, z 4.752

Waterline to RP*

Westlake
IMU Base to baseline at Keel (ft): elevation 12.856
IMU Base to baseline at Keel (m): elevation 3.919

Waterline to Keel (ft): elevation 13.67
Waterline to Keel (m): elevation 4.167

See Ship's Draft Spreadsheet

Top of IMU to Base of IMU (m): elevation 0.168
Top of IMU to Keel (m): 4.086

Port Ant to Stbd Ant

NGS
Phase Center Port Ant (m): x -11.892, y 0.797, z 13.068

Top of old Stbd Ant (pre-2010) (m): x -11.886, y 2.794, z 13.051

Top to Base of Old (pre-2010) Ant measured (in): z 2.477
(m): z 0.0629

Top of Stbd Ant Post (m): x -11.886, y 2.794, z 12.988

Base to Phase Ctr New(2010) Ant listed on Antm): z 0.0843

IMU to Port Ant

NGS
IMU Top (m): x 0.000, y 0.000, z 0.000

Top of old Port Ant (pre-2010) (m): x -11.892, y 0.797, z 13.047

Top to Base of Old (pre-2010) Ant measured (in): z 2.477
(m): z 0.0629

Top of Port Ant Post (m): x -11.892, y 0.797, z 12.984

Base to Phase Ctr New(2010) Ant listed on Ant (m): z 0.0843

IMU to Heave

Westlake
IMU to Bulkhd (Frame) 52 (ft): easting -11.638
(m): easting -3.547

Frame 0 (FP) to Frame 52 (m): easting -27.737

IMU to Frame 0 (FP) (m): easting 24.190

Heave Pt* to Frame 0 (FP) (ft): easting 102.42
(m): easting 31.218

IMU to Centerline (ft): northing 6.122
(m): northing 1.866

Heave Pt* to Centerline (m): northing 0

IMU Base to baseline at Keel (ft): elevation 12.856
(m): elevation 3.919

Top of IMU to Base of IMU (m): elevation 0.168
Top of IMU to Keel (m): elevation 4.086

Center of Gravity above baseline (ft): elevation 16.37
Mean Metacentric height (ft): elevation 3.88

Heave Pt* to baseline at Keel (ft): elevation 20.25
(m): elevation 6.172

(*Heave Pt is Metacenter)
(FP is Forward Perpendicular)

IMU to 7/8111

Westlake Top-IMU to 8111 (m): easting 8.252, northing 2.868, elevation 4.752

Coord Sys. CARIS
x 2.868
y 8.252
z 4.752

Port Ant to 7/8111

CARIS (m): x 2.071, y 20.144, z 17.821

Coord Sys. CARIS
x 2.071
y 20.144
z 17.821

Waterline to RP*

Westlake Waterline to IMU (m): easting N/A, northing N/A, elevation 0.081

Coord. Sys CARIS
x N/A
y N/A
z 0.081

Stbd Antenna

NGS (m): x -11.886, y 2.794, z 13.072
Top of IMU to Stbd Ant (aka Stbd Ant Phase Center)

Port Ant to Stbd Ant

Scalar Distance (m) 1.997

IMU to Port Ant

NGS (m): x -11.892, y 0.797, z 13.068
Top of IMU to Port Ant (aka Port Ant Phase Center)

Coord Sys. POS/MV
x -11.892
y 0.797
z -13.068

IMU to Heave

Westlake Top-IMU to Heave Pt* (m (*see Description Tab): easting -7.028, northing 1.866, elevation -2.086

Coord. Sys. POS/MV
x -7.028
y 1.866
z -2.086

S220 Offsets and Measurements - Summary

Measurement	IMU to 8160 (MRU to Trans)	Port Ant to 8160 (Nav to Trans)	Waterline to RP*	Port Ant to Stbd Ant	IMU to Port Ant		IMU to Heave	
Coord. Sys.	Caris	Caris	Caris		Caris	Pos/Mv	Caris	Pos/Mv
x	0.493	-0.304	n/a	Scaler Distance 1.997	0.797	-11.892	1.866	-7.028
y	7.665	19.557	n/a		-11.892	0.797	-7.028	1.866
z	4.726	17.794	0.081		13.068	-13.068	-2.086	-2.086

*Top of IMU is RP (Reference Pt)

Vessel Offsets for S220 8160 are derived from Westlake Survey Report NOAA Fairweather 09-23-03, Fairweather Centerline Survey (NGS) Report March 2009, and measurements by FA personnel.

Derivations

Coord. Sys.

IMU to 8160

Westlake

IMU	easting	0.000
Base	northing	0.000
(ft/m)	elevation	0.000

8160 (from IMU Base to sensor)

	easting	25.149
(ft)	northing	1.619
	elevation	14.956

8160 (from IMU Base to sensor)

	easting	7.665
(m)	northing	0.493
	elevation	4.559

Base of IMU to Top of IMU

(m)	elevation	-0.168

2010 value -> -0.206

Correction based on Ref Surface

(m)	elevation	0

Port Ant to 8160

NGS 2009

Top of IMU	x	-11.892
to Port Ant	y	0.797
(m)	z	13.068

CARIS

Port	x	0.797
Ant	y	-11.892
(m)	z	-13.068

Westlake

(m)	easting	7.665
Top of IMU	northing	0.493
to 8160	elevation	4.726

CARIS

(m)	x	0.493
Top of IMU	y	7.665
to 8160	z	4.726

IMU to 8160

Westlake	easting	7.665
Top of IMU	northing	0.493
to 8160 (m)	elevation	4.726

Coord Sys **CARIS**

x	0.493
y	7.665
z	4.726

Port Ant to 8160

CARIS	x	-0.304
	y	19.557
(m)	z	17.794

Coord Sys **CARIS**

x	-0.304
y	19.557
z	17.794

S220 Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	IMU to TOW PT K5K Caris
x	0.000	1.866
y	0.000	-42.642
z	0.000	-7.402

*IMU is Reference Point

Vessel Offsets for S220 Tow Point are derived from Fairweather Centerline Survey (NGS) Report March 2009, and 2011 Measured Values.

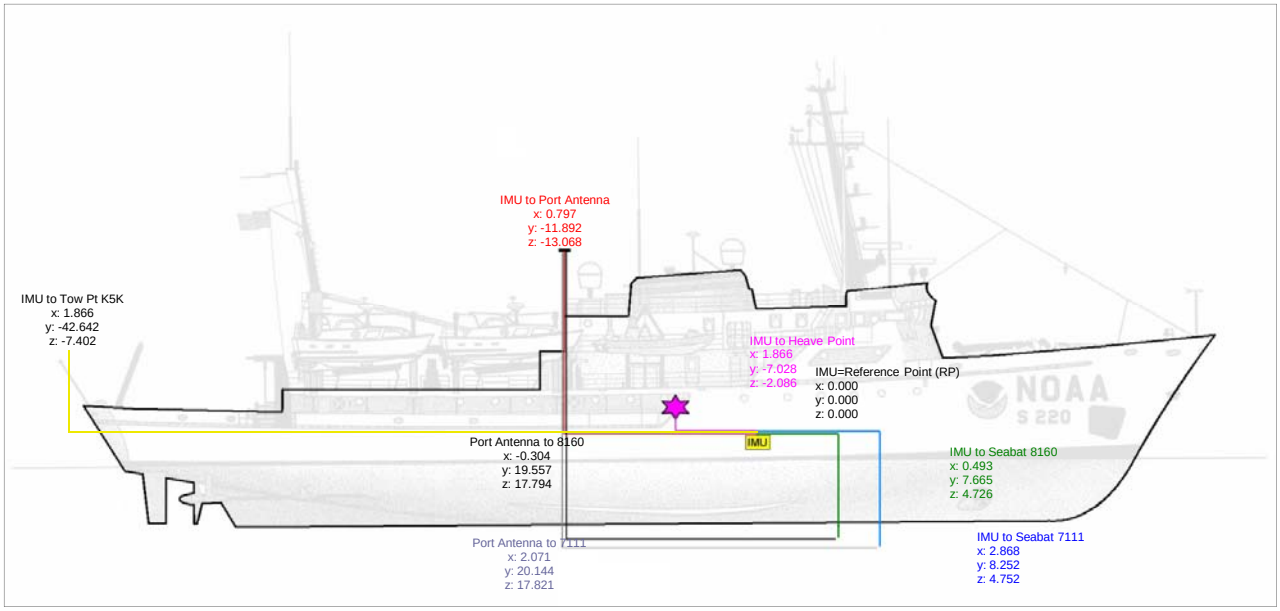
Calculations

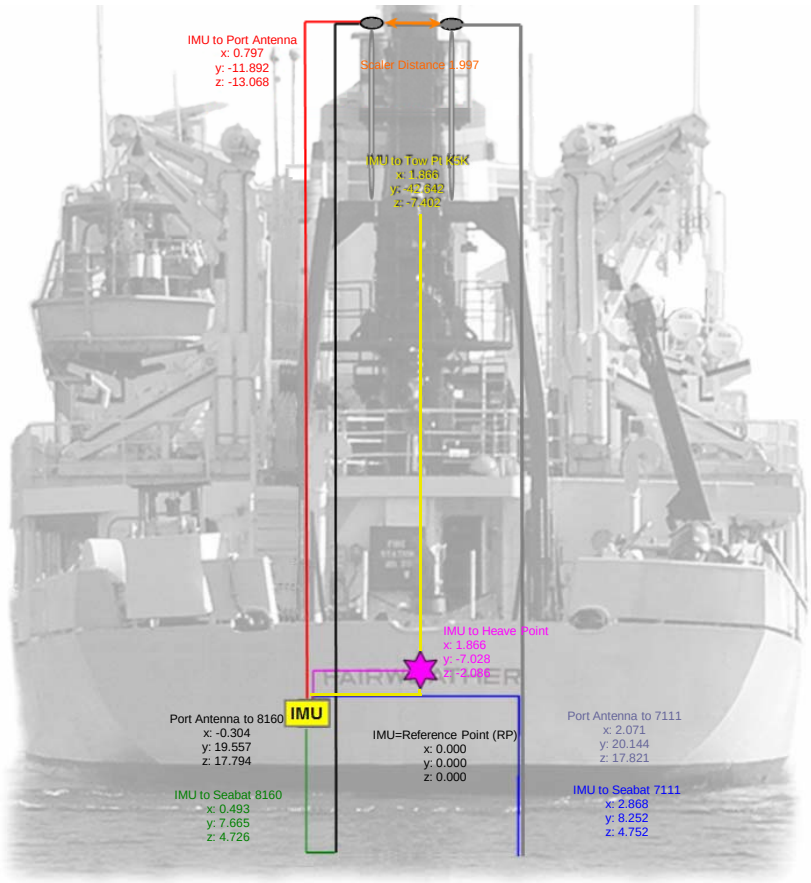
Coord. Sys./ Source	IMU to TOW PT K5K		
NGS	IMU (m)	x	0.00000
		y	0.00000
		z	0.00000
	A-FRAME PIVOT STBD (m)		
		x	-39.727
		y	3.366
		z	2.385
	A-FRAME PIVOT STBD to TOW PT (measured)	x	-2.915
		y	-1.500
		z	5.017

Coord. Sys.	IMU to TOW PT K5K		
NGS	IMU to TOW PT	x	-42.642
		y	1.866
		z	7.402
	Coord. Sys. CARIS	x	1.866
		y	-42.642
		z	-7.402

Description of Offsets for FAIRWEATHER S-220

All Values Shown are in CARIS Coordinates





IMU to 7/8111 (MRU to Trans)

x	y	z
2.868	8.252	4.752

The lever arms between the IMU and phase center of the 7111 transducer are taken from the Westlake report along with the the -0.168 m offset included for the height of the IMU.

IMU to 8160 (MRU to Trans)

x	y	z
0.493	7.665	4.726

The lever arms between the IMU and phase center of the 8160 transducer are taken from the Westlake report with the addition of the -0.168 m offset included for the height of the IMU.

IMU to TOW PT K5K

x	y	z
1.866	-42.642	-7.402

The offsets were determined using the NGS 2009 survey values for the A-Frame Stbd Pivot and measurements by FA personnel. Measurements between the A-Frame Pivot and the Tow point were made with a steel tape and digital level to determine the deployed angle of the A-Frame.

Port Ant to 7/8111 (Nav to Trans)

x	y	z
2.071	20.144	17.821

Relative positions obtained from Port Ant to 7/8111 via IMU.

Port Ant to 8160 (Nav to Trans)

x	y	z
-0.304	19.557	17.794

Relative positions obtained from Port Ant to 7/8111 via IMU.

Port Ant to Stbd Ant

Scaler Distance	1.997

Using the NGS 2009 survey values for the antennas, a calculated vector for antenna separation was determined. The distance from Top of Antenna to Phase Center does not affect this calculation and therefore was not included.

IMU to Port Ant

x	y	z
0.797	-11.892	13.068

This information comes from a combination of the Westlake, NGS surveys, and measurements by FA personnel. The NGS 2009 survey was to the top of the antenna, that distance (z-value) was measured in 2010 and subtracted to get the xyz of the antenna post. Then the distance (z-value) up to the phase center to the new 2010 antanna was added to obtain the xyz of the phase center of the newly installed (May2010) antenna.

Waterline to RP*

x	y	z
n/a	n/a	0.081

The height of the IMU above the keel comes from the Westlake survey value of 3.919 m plus the measured value of the top of the IMU to the base plate, to get an IMU height above the keel. The draft (waterline to keel) used for the FAIRWEATHER is based on observations, Ship's Draft spreadsheet. Differencing the value of IMU to keel and waterline to keel gives the waterline to RP distance.

IMU to Heave

x	y	z
1.866	-7.028	-2.086

Key points on the IMU, from the Westlake survey, are its location with respect to the ship's reference frame. It is 4.087 m (3.919 m to base line + 0.168 m for IMU height above base plate) above the keel, 1.866 m port of centerline and 3.547 m forward of frame 52. This information is needed to reference the IMU to the ship's Heave Measurement Location (Heave Point). *

IMU to Heave

IMU to Heave

From pg 3 of the Westlake Survey

SUMMARY

- IMU foundation plate is level to within +/-0.001 feet.
- IMU foundation plate is located 12.856 feet above baseline established at the keel.
- IMU is parallel to ship's centerline to within +/- 0.001 feet.
  Location of scribed centerline intersection is 6.122 feet port of ship's centerline.
- IMU foundation plate centerline is located 11.638' feet forward of bulkhead 52.

* From the Art Anderson inclination experiment the position of the metacenter was used as the position of the ship's Heave Point. (There may be a better way to determine the Heave Point, but this decision was based upon available information). The metacenter is defined by the center of buoyancy. As a vessel inclines through small angles, the center of buoyancy moves through the arc of a circle whose center is at the metacenter.

Important numbers and information determined from the Art Anderson report are the location of the metacenter and how it is positioned with respect to the vessel. The longitudinal location of the metacenter is defined as 102.42 feet (31.217 m) aft of the forward perpendicular. The height of the metacenter is 20.25 feet (6.172 m) above the keel. There is an assumption of the metacenter being on the centerline of the vessel. Similar values for the RAINIER's metacenter are 32.52 m aft of the forward perpendicular and 5.2 m above the keel. The difference in the height of the metacenter can be attributed to the difference between the FA's and RA's average draft which is 13.12 feet as opposed to approximately 14.5 feet respectively.

Referencing the metacenter (Heave Point, HP) to the IMU information requires information about the frame spacing of the vessel. From the Westlake survey, the IMU is located 3.547 m forward of frame 52. From Inclination document, the HP is 31.217 m aft of the forward perpendicular. From engineering drawings of the ship frame spacing is approximately 21 inches. The calculation for the longitudinal location of the HP with respect to frame zero, the Forward Perpendicular (FP) is as follows:

52 (frame) * 21 (inches/frame)/12(inches/ft)*.3048(m/ft)-3.547 m = 24.190 m from frame 0.

31.217 m (HP aft of FP) – 24.190 m (IMU aft of FP) = 7.027 m (HP aft of IMU)

The calculation for the vertical separation between the IMU and the HP is based on the height of the metacenter being 6.172m and the height of the IMU being 4.087 m above the keel. Differencing yields the metacenter being 2.085 m above the IMU.

The calculation for the athwartship separation is based upon the assumption that the HP is on the centerline and the knowledge that the IMU is 1.866 m to port of the centerline.

Sources

Offset values for the ship were derived from three sources. Three static offset surveys, an inclination experiment, and values measured or approximated by ship's personnel.

On September 23, 2003 an offset survey of the NOAA Ship FAIRWEATHER was conducted by:
Westlake Consultants, Incorporated
15115 SW Sequoia Parkway, Suite 150
Tigard, Oregon 97224
Phone (503) 684-0652

The relocation of the POS M/V antenna forced a partial resurvey in Feb-2007 by Steven Breidenbach of NGS (values no longer utilized).

While in drydock, another NGS (Centerline) survey was conducted March, 2009.

These values relate the physical positions of one sensor to the next with the base plate of the IMU being the point of origin. All dimensions in the document are given in feet and decimal feet.

On July 16, 2004 an inclination experiment was conducted at MOC-P by:

Art Anderson Associates
202 Pacific Avenue
Bremerton, WA 98337-1932

Calculations

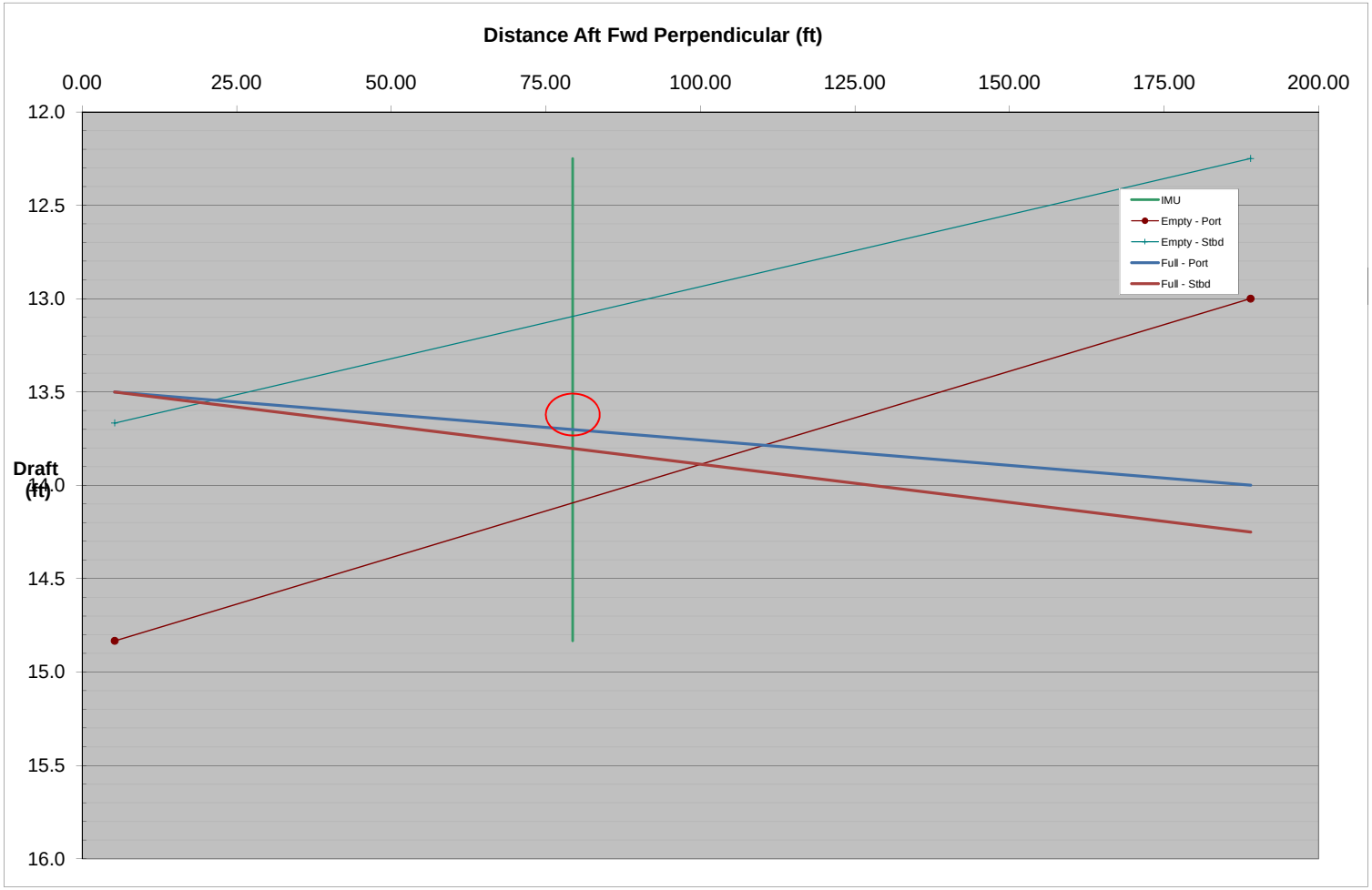
The values for the required lever arms are listed in the S220_Offsets and Measurements spreadsheet. The reference point and the IMU are identical. Difference in documentation between Westlake and FA calculations are based off of measuring up from the IMU base (Westlake's origin) and the top of the IMU. The top center of the IMU for the POS/MV is the defined origin for the POS/MV and the origin that is being used on all FAIRWEATHER vessels. The distance from the base plate to the top of the IMU is 0.168 m, a value measured by ship's complement. Conversions factor from feet to meters is 0.3048 m/ft.

As a requirement for the TPU, the standard deviation for each position is 3 mm. This value is based upon a conversation with Elaine McDonald of Westlake and is followed up by an Email documenting that fact. The email is located at the end of this document.

Fairweather Draft - 2011

Immediately prior to the FA field season, the draft measurements were taken prior to fueling when the tanks were very empty (Empty) . And again after fueling and once the engineers had transferred the fuel in a satisfactory manner (Full). The waterline at the IMU was then calculated based on a linear interpolation.

2011	3-Jun		Fwd		Aft	slope	IMU Depth (ft)	IMU Depth (m)		Min	Max
		x1	y1	x2	y2						
(34,500 gal)	Empty - Port	5.25	14.83	189	13.00	-0.00998	14.09	4.296		12.25	14.83
(34,500 gal)	Empty - Stbd	5.25	13.67	189	12.25	-0.00771	13.10	3.991			
(90,641 gal)	Full - Port	5.25	13.50	189	14.00	0.00272	13.70	4.176			
(90,641 gal)	Full - Stbd	5.25	13.50	189	14.25	0.00408	13.80	4.207			
	Description (ie empty, full)	5.25		189		0.00000	0.00	0.000			
						Draft at IMU (ft)	13.67	4.168	AVG	Value Used in Offsets	
	The IMU	x-value (ft):	79.36				0.420	0.128	STDEV	Value used for Waterline Loading Uncertainty	
		x-value (m):	24.19								



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

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall Fancher
March , 2009

PRIMARY CONTACTS

Glen Rice NOAA 757-615-6465

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

PURPOSE

The primary purpose of the survey was to precisely determine the spatial relationship of various components of a POS MV navigation system aboard the NOAA ship FAIRWEATHER. Additionally, various reference points (bench marks) were re-established onboard the vessel to aid in future spatial surveys aboard the boat.

PROJECT DETAILS

This survey was conducted while the ship was in dry dock at the Lake Union dry dock in Seattle, WA. The weather conditions over the two days required to conduct this survey were windy, cool, with intermittent rain.

INSTRUMENTATION

The Leica TC2003 total station was used to make all measurements.

Technical Data:

Standard Deviation

Horizontal angle	0.5 seconds
Vertical angle	0.5 seconds
Distance measurement	0.2mm + 2ppm

A Leica precision prism was used as a sighting target. This prism was configured to have a zero mm offset.

PERSONNEL

Kendall Fancher NOAA/NOS/NGS/GSD/I&M BRANCH
(540) 373-1243

Dennis Lokken NOAA/NOS/NGS/GSD/I&M BRANCH
(540) 373-1243

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

DEFINITION OF THE REFERENCE FRAME

To conduct this survey a local coordinate reference frame was established where the Northing (Y) axis runs along the centerline of the ship and is positive from the IMU towards the bow of the ship. The Easting (X) axis is perpendicular to the centerline of the ship and is positive from the IMU towards the right, when looking at the ship from the stern. The Up (Z) axis is positive in an upward direction from the IMU.

SURVEY METHODOLOGY

02/15/2009

Coordinates of 100.000N, 100.000E, and 100.000U were assumed for temporary control point 1. A distance and height difference were measured between temporary control points 1 and 3. These values were used to determine the coordinates at temporary control point 3. Temporary control points 1 and 3 were located along the top deck and on the north side of the dry dock vessel.

Temporary control point 1 was occupied and temporary control point 3 was observed for a backsight. After initialization, temporary control points 2 and 4(located on the top deck of the dry dock vessel), H1 (located on the bottom deck of the dry dock vessel), and BOW BM were observed in both direct and reverse.

Temporary control point 2 was occupied and temporary control point 3 was observed for a backsight. After initialization, temporary control point W1 (located on the top deck of the dry dock vessel) and D1 (located inside the ship on the D deck along the port side) were observed in both direct and reverse. Temporary control point 1 was also observed and yielded an inverse check of 0.001m horizontally and 0.001m vertically.

Temporary control point 4 was occupied and control point 1 was observed for a backsight. After initialization, temporary control point 5 (located on the south side and on the top deck of the dry dock vessel) was observed in both direct and reverse.

Temporary control point 5 was occupied and control point 4 was observed for a backsight. After initialization, temporary control point D2 (located inside the ship on the D deck along the starboard side) was observed in both direct and reverse.

Temporary control point H1 was occupied and control point 1 was observed for a backsight. After initialization, temporary control point H2 (located on the bottom deck of the dry dock vessel), and USBL BM were observed in both direct and reverse.

Temporary control point H2 was occupied and temporary control point H1 was observed for a backsight. After initialization, 8111 BM and 8160 BM were observed in both direct and reverse. Temporary control point W1 was also observed and yielded an inverse check of 0.019m horizontally and 0.033m vertically.

Temporary control point D1 was occupied and temporary control point D2 was observed for a backsight. After initialization, temporary control point D3 (located in the doorway leading to the mess hall on the D deck) was observed in both direct and reverse.

Temporary control point D3 was occupied and temporary control point D1 was observed for a backsight. After initialization, temporary control point C1 (located on the C deck near the IMU) was observed in both direct and reverse. Temporary control point D2 was also observed and yielded an inverse check of 0.026m horizontally and 0.0001m vertically.

Temporary control point C1 was occupied and temporary control point D3 was observed for a backsight. After initialization, IMU, IMU BOW PORT CORNER, IMU BOW STAR CORNER, IMU STERN STAR CORNER, and IMU STERN PORT CORNER were observed in both direct and reverse.

02/16/2009

Temporary control point 4 was occupied and control point 1 was observed for a backsight. After initialization, temporary control point 6 (located on the south side and on the top deck of the dry dock vessel) and BOW BM were observed in both direct and reverse. Temporary control point D2 was also observed and yielded an inverse check of 0.0004m horizontally and 0.083m vertically.

Temporary control point 6 was occupied and temporary control point 4 was observed for a backsight. After initialization, TRANSOM PIVOT POINT PORT, STERN BM, POS GPS ANT RAIL BM, POS IMU ANT DECK BM, POS GPS ANT STARBOARD, and POS GPS ANT PORT were observed in both direct and reverse.

Temporary control point 3 was occupied and temporary control point 1 was observed for a backsight. After initialization, TRANSOM PIVOT POINT STARBOARD, STERN BM, POS GPS ANT STARBOARD, and POS GPS ANT PORT were observed in both direct and reverse. Temporary control point 6 was also observed and yielded an inverse check of 0.0006m horizontally and 0.001m vertically.

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

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

INVERSE RESULTS

Inverses were computed between the determined positions of those ship benchmarks and sensor points which were determined from two separate locations The results of these inverses are:

ID	Horizontal Dist.(m)	Elevation Diff(m)
BOW BM	0.0150	0.0240
STERN BM	0.0060	0.0010
POS GPS ANT STARBOARD	0.0100	0.0001
POS GPS ANT PORT	0.0100	0.0000

DISCUSSION

The Fairweather was in dry dock during this survey, however, the dry dock vessel was still subject to movement due to wave action. Conducting a survey such as this while the ship is moving requires that the automatic compensators in the survey instrument be turned off. The survey is therefore conducted with all survey instrumentation set up relative to the mean movement of the related level vials. While every effort was made to make the most precise measurements possible, some additional error accumulation cannot be avoided under these type observing conditions.

The POS GPS antenna coordinates were determined to the top center of the antennas. The Z value should be corrected to the Antenna Reference Point (ARP). In order to apply this correction, the mechanical height of the antenna should be determined and subtracted from the Z value determined during this survey for both of the POS GPS antennas.

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

Coordinate Listing using IMU as the Reference Frame Origin

ID	X(NORTHING)m	Y(EASTING)m	Z(UP)m
IMU CENTER	0.000	0.000	0.000
IMU STERN PORT CORNER	-0.071	-0.089	-0.001
IMU BOW PORT CORNER	0.070	-0.086	-0.001
IMU BOW STARBOARD CORNER	0.069	0.087	0.000
IMU STERN STARBOARD CORNER	-0.073	0.086	0.000
BOW BM	28.378	1.805	7.796
STERN BM	-40.306	1.805	2.255
USBL BM	-28.354	1.738	-4.204
8160 BM	8.407	0.395	-4.400
8111 BM	8.532	3.002	-4.666
POS GPS ANT RAIL BM	-12.011	1.785	10.381
POS IMU ANT DECK BM	-11.790	1.780	9.305
POS GPS ANT STARBOARD	-11.886	2.794	13.051
POS GPS ANT PORT	-11.892	0.797	13.047
TRANSOM PIVOT POINT STARBOARD	-39.727	3.366	2.385
TRANSOM PIVOT POINT PORT	-39.722	0.240	2.345

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

IMU Reference Points

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

POS GPS ANTENNAS

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POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

BOW CENTERLINE REFERENCE POINT

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

CENTERLINE REFERENCE POINT ON G DECK

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

CENTERLINE REFERENCE POINT ON RAIL AT G DECK

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

CENTERLINE STERN REFERENCE POINT

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POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

TRANSOM REFERENCE POINT ON PORT SIDE

TRANSOM REFERENCE POINT ON STARBOARD SIDE

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POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

8111 REFERENCE POINT

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POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

8160 REFERENCE POINT

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POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

USBLE REFERENCE POINT

STABILITY TEST: **NOAA Ship FAIRWEATHER (16 Jul 2004)**

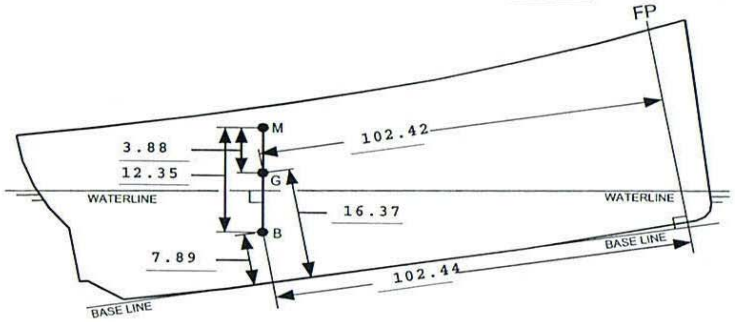
SHIP AT TIME OF STABILITY TEST--CONDITION 0

			FROM HYDROSTATIC CURVES	FROM INDEPENDENT CALCULATION
Corrected diaplacement			tons	1638.79 tons
Mean virtual metacentric height obtained from plot of inclining moments versus tangents of angles of heel	$\frac{\text{moment}}{\text{displacement x tangent}}$	= 5987.252 / 1638.790	feet	3.65 feet
Correction for free surface		= 374.0 / 1638.790	feet	0.23 feet
Mean metacentric height G.M. =			feet	3.88 feet
Transverse metacenter above base line corresponding to draft at LCF (corrected for hog or sag)			feet	
Transverse metacenter above base line corrected for trim, and hog or sag			feet	
C.G. above base line			feet	16.37 feet (from figure)
				16.36 feet (from GHS)
Longitudinal metacenter above C.G.			feet	
Moment to alter trim 1 foot, (Long GM x Δ) / L			ft-tons	
Trim by stern			feet	
Trimming lever = (Trim x moment to trim) / displacement			feet	
Longitudinal center of buoyancy (LCB) from origin			feet	
C.G. from origin			feet	102.44 feet (from figure)
				102.42 feet (from GHS)

Period of complete roll _____ seconds

Apparent radius of gyration of vessel $\alpha = \frac{T\,GM}{1.108}$ _____ feet

Rolling constant $C = \frac{T\,GM}{B}$ _____



Definitions and Basis for Dimensions/Locations

Northings

Northings (Port - Starboard) are with reference to the IMU Foundation Plate centerline scribe.
Positive values are starboard of the IMU.
Negative values are port of the IMU.
Calculated values are in italics.

Eastings

Eastings (Stern to Bow) are with reference to the IMU Foundation Plate centerline scribe.
Positive values are forward of the IMU.
Negative values are aft of the IMU.
Calculated values are in italics.

Elevations

Elevations are with reference to the IMU Foundation Plate centerline scribe = 0 elevation.
Positive values are below the IMU (toward the keel).
Negative values are toward the topside.

Dimensions

All dimensions are in feet and decimal feet. All dimensions provided are "offsets" to IMU centerline.

Ship's Centerline Data

At project initiation, control was established to define the ship's centerline
as a plane running from a point on the centerline of the keel at the stern through a
point on the centerline of the keel near the bow, to a point on the bow splitting the bow chock.

IMU Referenced Data - Procedure

All data was originally referenced to the ship's geometry.
Following location of the IMU, data was transformed to the IMU as point of origin for
Northings, Eastings, and Elevation. All dimensions provided with reference to the IMU are "offsets."

Ship's Centerline - Control Measurements

(Prior to location of IMU and referencing of data to IMU as point of origin (0,0,0)

Defined by measurements at the keel centerline

	longitude	transverse	elevation
near the bow	1190.674	1000.000	135.8672
at the stern (point of origin)	1000.000	1000.000	100.0000
along the keel (approx 180' forward)	1180.121	1000.000	116.6810

Ship's Baseline

Defined by measurements on the keel

	longitude	transverse	elevation
at the stern (point of origin)	1000.000	1000.000	100.0000
and approx. 129' forward of stern	1129.120	999.985	100.0022

IMU Foundation Plate

	EASTING	*NORTHING*	*ELEVATION*
Horizontal alignment per scribed lines			
on IMU foundation plate		**0.001**	
		0.000	
Scribed lines - intersection/centerline of IMU plate			
	0.000	**0.000**	**0.000**
Elevation checks near four corners of IMU Foundation plate *			
** elevation check adjusted for target*			**0.001**
that created 10 mm offset =.03281			**-0.001**
feet			**0.000**
			-0.001

SUMMARY

- IMU foundation plate is level to within +/-0.001 feet.
- IMU foundation plate is located 12.856 feet above baseline established at the keel.
- IMU is parallel to ship's centerline to within +/- 0.001 feet.
  Location of scribed centerline intersection is 6.122 feet port of ship's centerline.
- IMU foundation plate centerline is located 11.638' feet forward of bulkhead 52.

Granite Block

	EASTING	*NORTHING*	*ELEVATION*	
Horizontal alignment per scribed lines				
		1.584		
		1.583		
Scribed lines - intersection/centerline of granite block				
	-0.003	**1.583**		
				Deviation
Elevation checks near four corners of granite block				from level
** elevation check adjusted for target that created 10*			**-0.217**	-0.001
mm offset = 0.03281 feet			**-0.217**	-0.001
			-0.216	0.001
			-0.215	0.001

SUMMARY

- Granite block is level to within +/-0.001 foot
  of average elevation = -0.21632 feet
- Granite block is parallel to ship's centerline to within 0.001 foot
  Location is 4.54 feet to port of ship's centerline and 1.583 feet starboard of IMU.
- Granite block is aligned with IMU to within 0.003 feet longitudinally.

Array Acoustical Centers - Referenced to IMU

	EASTING	NORTHING	ELEVATION
PORT ARRAY (81-60)	***25.149***	***1.619***	***14.956***

Explanation of Calculations

Acoustic center is defined as the center of the transmitter array with the elevation = 83 mm below mounting face of array.

Easting

Center of array is defined by the foundation plate bolt centerlines (1/2 distance between bolts)

27.008	Forward edge of foundation as measured
- 0.104	Forward edge of foundation to centerline of forward bolt hole
- 1.755	Distance from bolt hole centerline to center of array
25.149	feet forward of IMU

Northing

Center of array is defined as the mid-point between the bolt holes on the foundation.

1.369	Port edge of foundation as measured
+ 0.078	Port edge of foundation to centerline of bolt hole - per Cascade General
+ 0.172	Distance from bolt hole centerline to array center
1.619	feet starboard of IMU

Elevation

Per Reson drawing 2148M011_001 the elevation is 83 mm below array mounting surface

14.679	Array foundation elevation as measured.
0.005	Isolation "shim" added between foundation and array
0.272	83 mm below array mounting surface to acoustical center
14.956	feet below IMU

Array Acoustical Centers - Referenced to IMU

	EASTING	NORTHING	ELEVATION
STARBOARD ARRAY (81-11)	***27.072***	**9.41**	***15.042***

Explanation of Calculations

Acoustic center is defined as midpoint of the transmitter array in the longitudinal and transverse axes. The elevation is defined as the center of the receiving array.

Easting

Center of array is defined as 0.235' aft of the forward bolt centerlines on transmitter array foundation

28.563	Forward edge of foundation fixture plate as measured (receiving plate forward edge)
27.349	Forward edge of transmitter array foundation as calculated
- 0.042	Forward edge of foundation to centerline of forward bolt hole - per design
- 0.235	Distance from bolt hole centerline to center of array - per design
27.072	feet forward of IMU

Northing

Center of array is defined as the mid-point between the bolt holes on the transmitter array foundation.

9.410	Centerline of array foundation as measured on scribe - aft section of fixture plate
9.410	feet starboard of IMU

Elevation

Elevation is 0.401 feet above receiver array mounting surface

16.085	Mounting foundation fixture plate as measured.
15.447	Receiver foundation elevation - as calculated
+ 0.005	Isolation "shim" added between foundation and array
- 0.410	Design distance from mounting surface of array to acoustic center
15.042	feet below IMU

Longitudinal Array Foundation - Port Side

	EASTING	NORTHING	ELEVATION	
Horizontal alignment *measured* at port edge of array foundation				
		1.369		
		1.369		
Forward edge of array foundation - *measured*				
	27.008			
Horizontal alignment - *calculated* to array centerline				
Foundation edge is 0.25 feet port of		***1.619***		
array centerline		***1.619***		
				deviation from
Elevation checks near four corners of array foundation				level (average)
			14.680	0.001
			14.681	0.002
			14.678	-0.001
			14.677	-0.002

SUMMARY

- Port longitudinal array foundation average elevation is 14.679 feet.
  Variation in elevation is +0.002 to -0.002 feet.
- Port longitudinal array foundation is parallel to ship's centerline and 1.369 feet starboard of IMU.
  Calculated array centerline is 1.619 feet starboard of IMU

Longitudinal Array Foundation - Starboard Side

	EASTING	NORTHING	ELEVATION	deviation from parallel
Horizontal alignment *measured* on fixture plate scribe -				
Design location is 3.292 feet		**9.410**		0.002
starboard of ship centerline		**9.406**		-0.002
Forward edge of array foundation fixture plate - *measured*				
	28.563			
Elevation checks near four corners of array foundation "fixture plate"				deviation from *average*
			16.085	0.000
			16.085	0.000
			16.084	0.000
			16.085	0.000

Calculated locations of longitudinal and transverse array foundations

Forward edge	
Receiver (transverse)	**28.563**
Transmitter (longitudinal)	***27.349***
difference = 1.214	

NOTE: *On Transmitter array foundation - from forward edge to center of forward holes = 0.042'*
On Receiver array foundation distance from forward edge to center of forward holes = 0.076'

Calculated elevation of longitudinal and transverse array foundations

Receiver/Transverse Foundation	***15.446***
Transmitter/Longitudinal Foundation	***15.709***
difference = 0.263	

SUMMARY

- Starboard longitudinal array foundation (measured at fixture plate) average elevation is 16.085 feet.
  Deviation from level (average elevation) is less than 0.001 feet.
- Starboard longitudinal array foundation averages 9.408 feet starboard of IMU.
  Variation from parallel is from -0.002 feet to +0.002 feet from average.
- Starboard longitudinal array foundation forward edge is 28.563 feet forward of IMU.

Transverse Array Foundation - Port Side

	EASTING	NORTHING	ELEVATION	
Forward Edge - Transverse array foundation - *measured*				
	28.343			
	28.338			
Port edge - Transverse array - *measured*				
		-0.181		
Centerline of array - *calculated*				
Foundation forward edge minus	***28.093***			
0.25 feet to array centerline	***28.088***			
Port edge of foundation plus 1.806 feet		***1.624***		
to calculated array centerline				
				deviation from
Elevation checks near four corners of array foundation				level
			14.679	0.002
0.861 feet below baseline with 0.965			**14.675**	-0.001
foot offset = 98.180 feet average			**14.675**	-0.001
elevation			**14.677**	0.001

SUMMARY

- Transverse array foundation average measured elevation is 14.677 feet below IMU (0.006 feet above design location).
  Deviation from level (average elevation) is 0.003 to -0.001 feet
- Transverse array foundation centerline (calculated) averages 28.090 feet forward of IMU.
  Variation from parallel to ship's centerline is from -0.003 to 0.003 feet (from average).
- Transverse array centerline is calculated to be 1.624 feet starboard of IMU.

Transverse Array Foundation - Starboard Side

NOTE: Direct Measurements were not taken to the transverse array because a single "fixture plate" covered bo
transmitter and receiver foundations. The data provided here is primarily *"calculated".*

	EASTING	NORTHING	ELEVATION
Forward edge - as measured on fixture plate			
Receiver - (transverse)	**28.563**		
as measured			
Transmitter (longitudinal)	***27.349***		
difference = 1.214			

NOTE: *On Transmitter array foundation - from forward edge to center of forward holes = 0.042'*
On Receiver array foundation distance from forward edge to center of forward holes = 0.076'

Horizontal Alignment		**9.406**	
centerline scribe on fixture plate			
as measured - forward portion of plate			
(near receiver array)			
Average of measurements on fixture plate		***9.408***	
Elevation of longitudinal and transverse array foundations			
Receiver/Transducer Transverse Foundation			***15.446***
Transmitter/Longitudinal Foundation			***15.709***
difference = 0.263			

Based on measured elevations averaging 16.085 feet across fixture plate

SUMMARY

- Transverse array foundation is calculated to be 15.446 feet below IMU - calculated from measured elevation of 16.085 feet. Deviation in elevation measurements across the array fixture plate is less than 0.001 fe
- Transverse array foundation forward edge (measured) is 28.563 feet forward of IMU.
- Transverse array centerline is measured to be 9.406 feet starboard of IMU.

  Variation from parallel of the fixture plate across entire starboard array is ± 0.002 feet (from average).

Antennae

	EASTING	*NORTHING*	*ELEVATION*
Stbd POS MV Antenna -Location	**-35.866**	**12.925**	**-38.209**
Port POS MV Antenna - Location	**-35.739**	**-0.409**	**-38.283**
Foundation Plate Stack Antenna Alignment		**7.677**	
Foundation Plate Stack Antenna Alignment		**7.677**	
Port GYRO Foundation Plate Alignment		**2.411**	
Port GYRO Foundation Plate Alignment		**2.411**	
Stbd GYRO Foundation Plate Alignment		**3.866**	
Stbd GYRO Foundation Plate Alignment		**3.867**	

SUMMARY

- Foundation plate stack antenna alignment is parallel to ship's centerline.
- Port GYRO Foundation Plate is aligned parallel to ship's centerline.
- Starboard GYRO Foundation Plate is aligned parallel to ship's centerline.

FAIRWEATHER

Multibeam Echosounder Calibration

S220 7111	Vessel

6/13/2011	164	Marmot Bay Patch Test
Date	Dn	Local Area

Moehl, Bravo

Calibrating Hydrographer(s)

RESON 7111	Hull Mount S220	TPU installed Oct 2009, Sonar installed Mar 2009
MBES System	MBES System Location	Date of most recent EED/Factory Check
Unknown		2009003
Sonar Serial Number		Processing Unit Serial Number
Hull Mount		9/23/2003, 2/2007, and 2/15/2009
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV v.4		6/2/2011
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

6/13/2011	164	Marmot Bay	
Date	Dn	Local Area	Wx
			20 - 100 m
			Bottom Type / Approximate Water Depth

Moehl, Bravo

Personnel on board

Comments

2011_164_S220.000

TrueHeave filename

SV Cast #2 filename		UTC Time	Lat	Lon	Depth

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	use roll lines			

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011__1641642	274	4.1	
	2011__1641657	086	3.7	Bad line heading east, missed feature.
	2011__1641706	274	4.1	
	2011__1641721	086	4.1	Bad line heading east, missed feature.
	2011__1641732	270	4.8	
	2011__1641835	092	3.8	
	2011__1641855	02	4.2	Not online 25 m east
	2011__1641905	180	4.3	15m east

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011__1641741	092	4.7	
	2011__1641759	270	4.6	
	2011__1641812	090	4.0	
	2011__1641824	270	4.4	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011__1641915	0	4.8	
	2011__1641928	180	4.9	

Processing Log

Date	Dn	Personnel
6/13/2011	164	Moehl, Bravo

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

☑ **TrueHeave applied** 2011_164_S220_Patch.000

☑ **SVP applied** BOT0000.svp NIDWT 3
Can't process the cast files with the new configs

☑ **Tide applied** P136FA2011CORP.zdf

Zone file Kodiak project

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 (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	-1.07	0.01	0.59
Morgan	0.00	-0.50	0.00	-0.10
Eisenberg	0.00	-0.40	0.00	-0.20
Faulkes	0.00	-0.27	0.01	-0.43
Francksen	0.00	-0.02	0.02	-0.53
Froelich	0.00	-0.51	-0.03	-0.50
Averages	0.00	-0.46	0.00	-0.35
Standard Deviation	0.00	0.35	0.02	0.19
FINAL VALUES	0.00	-0.46	0.00	-0.35
Final Values based on	Average	Average	Average	Average w/ outlier removed

Resulting HVF File Name FA_S220_Rsn7111_301bms_2011.hvf

MRU Align StdDev gyro 0.19 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.18 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

Averages were used to determine values with the exception of Yaw, where the outlier was disregarded for the patch value and was not used in the standard deviation calculation.

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

Name: CST Morgan **Date:** 6/23/2011

FAIRWEATHER

Multibeam Echosounder Calibration

S220 8160
Vessel

6/13/2011	164	Kodiak, Marmot Bay
Date	Dn	Local Area

Moehl, Bravo
Calibrating Hydrographer(s)

RESON 8160	Hull Mount S220	2004
MBES System	MBES System Location	Date of most recent EED/Factory Check
Unknown		35385
Sonar Serial Number		Processing Unit Serial Number
Hull Mount		
Sonar Mounting Configuration		Date of current offset measurement/verification
Applanix POS/MV v.4		
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

6/13/2011	164	Marmot Bay, Kodiak Island	Cldy, Seas <1ft
Date	Dn	Local Area	Wx
			20-100m
Bottom Type			Approximate Water Depth

Moehl, Bravo
Personnel on board

Comments

2011_164_S220.000
TrueHeave filename

SV Cast #2 filename		UTC Time	Lat	Lon	Depth

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	Use Roll Lines			

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011S_1641642	273	4.2	
	2011S_1641657	093	3.8	Bad line heading east, missed feature
	2011S_1641706	273	4.1	
	2011S_1641721	093	4.1	Bad line heading east, hit feature on nadir, but…
	2011S_1641732	273	4.6	
	2011M_1641835	090	4.2	
	2011M_1641855	0	4.0	Not on line, 25m east
	2011M_1641905	180	4.0	15m west

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011S_1641741	090	5.3	
	2011S_1641759	270	5.0	
	2011S_1641812	090	4.3	
	2011S_1641824	270	4.5	

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

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	2011M_1641915	0	4.8	
	2011M_1641928	180	5.0	

Processing Log

Date	Dn	Personnel
6/13/2011	164	Moehl, Bravo

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

☑ **TrueHeave applied** 2011_164_S220_Patch.000

☑ **SVP applied** BOT0000.svp NIDWT 3
Can't process the cast files with the new configs

☑ **Tide applied** P136FA2011CORP.zdf

Zone file Kodiak project

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 (sec)	Pitch (deg)	Roll (deg)		Yaw (deg)
Moehl	0.00	-0.19	-0.12	*	-0.04
Eisenberg	0.00	-0.30	-0.05		-0.10
Faulkes	0.00	-0.63	-0.57	*	-0.30
Francksen	0.00	0.11	-0.10		-0.74
Froelich	0.00	-0.52	-0.04		-0.44
Morgan	0.00	-0.25	-0.02		-0.20
Averages	0.00	-0.30	-0.05		-0.30
Standard Deviation	0.00	0.26	0.21		0.26
FINAL VALUES	0.00	-0.30	-0.05		-0.30

Final Values based on Averages for Pitch and Yaw; Average with two values removed for Roll*.

Resulting HVF File Name FA_S220_Rsn8160_5to750_2011.hvf

MRU Align StdDev gyro 0.26 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.23 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

*Value for Roll did not use the outlier nor the -0.12 value to determine patch value for use in the hvf, though all the values for Roll were retained for the Standard Deviation calculation.

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

Name: CST Morgan **Date:** 6/23/2011

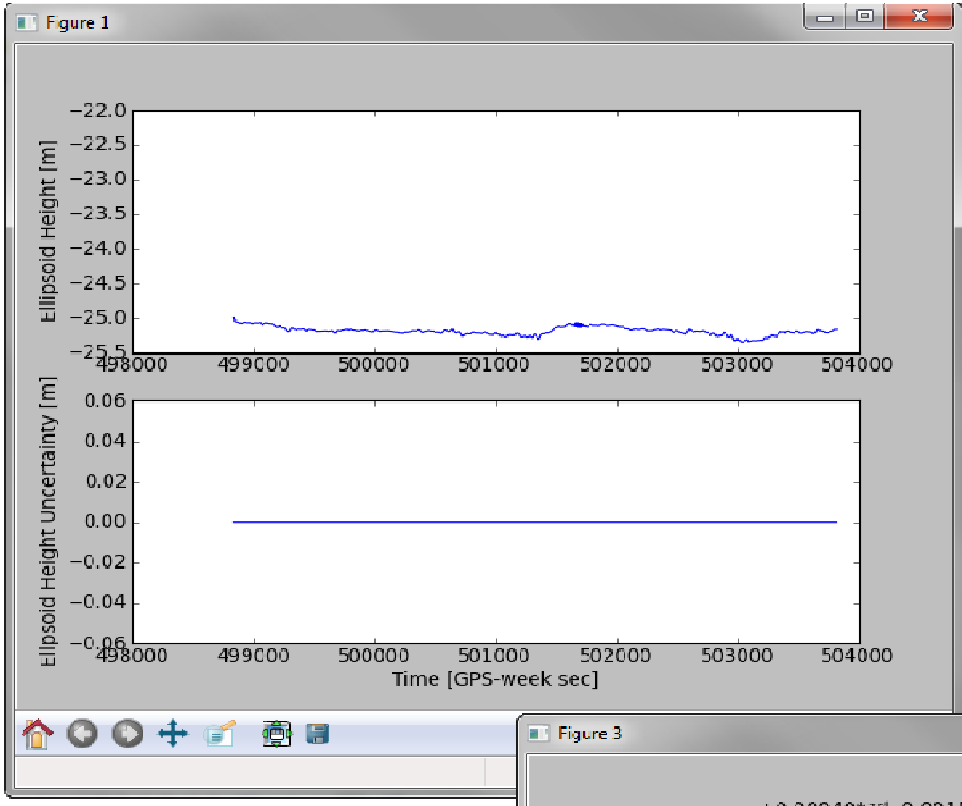
SHIP DDM DATA ACQUISITION FORM

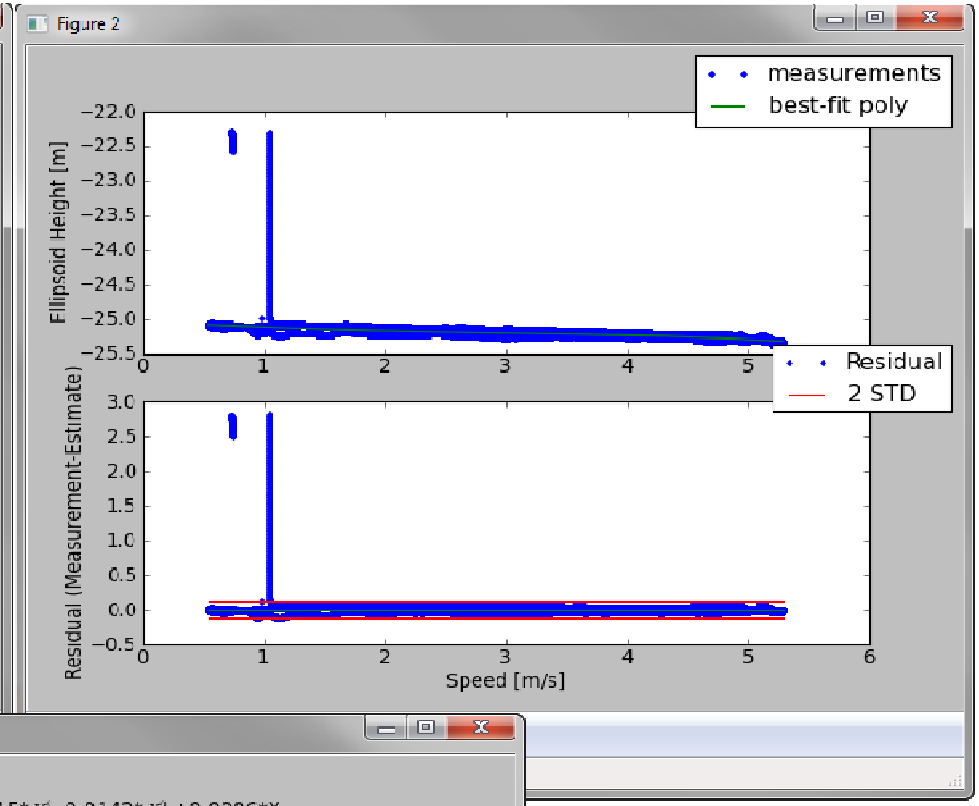
Date 6/3/2011
Vessel # S220
Average Depth 400ft

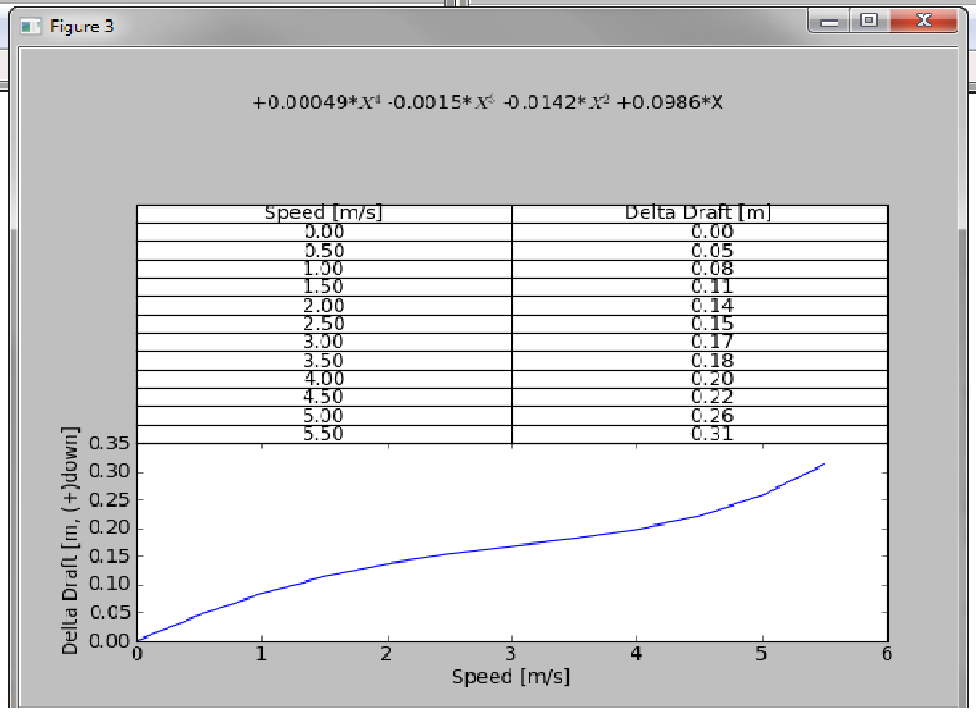
DN 154
Location Puget Sound
Personnel Moehl

Wind 5kts from N
Seas Calm

RPM	Speed	Az	Line Name	Acquisition Comments
140/45	4.25kts	15		1855->1903
160/50	6.15kts	15		1904->1908
175/70	8.20kts	15		1909->1913
180/75	10.10kts	15		1914->1917
145/35	4.1	195		1928->1934
160/55	6.5	195		1935->1938
170/65	8.1	195		1939->1942
180/75	10.1	195		1943->1947

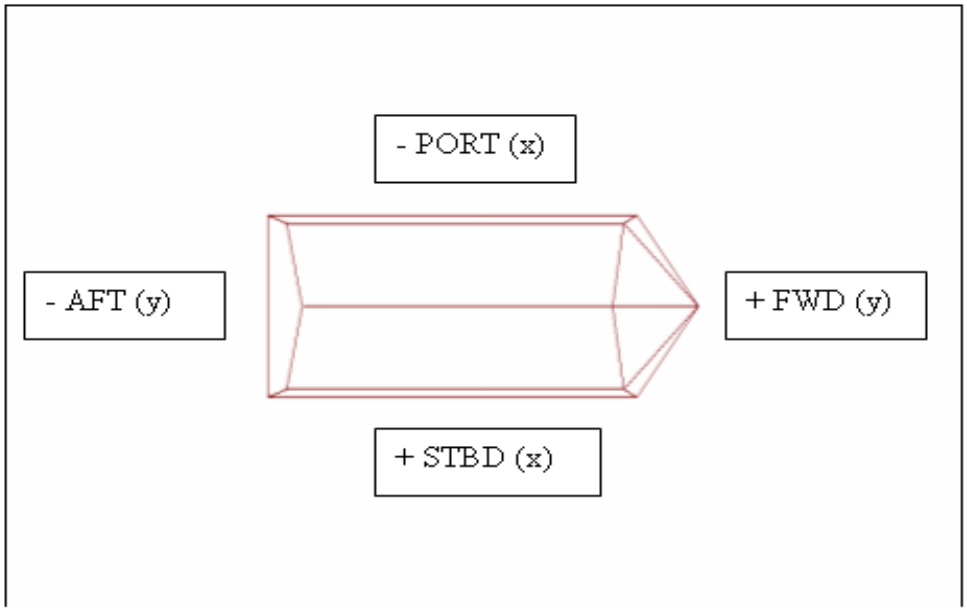


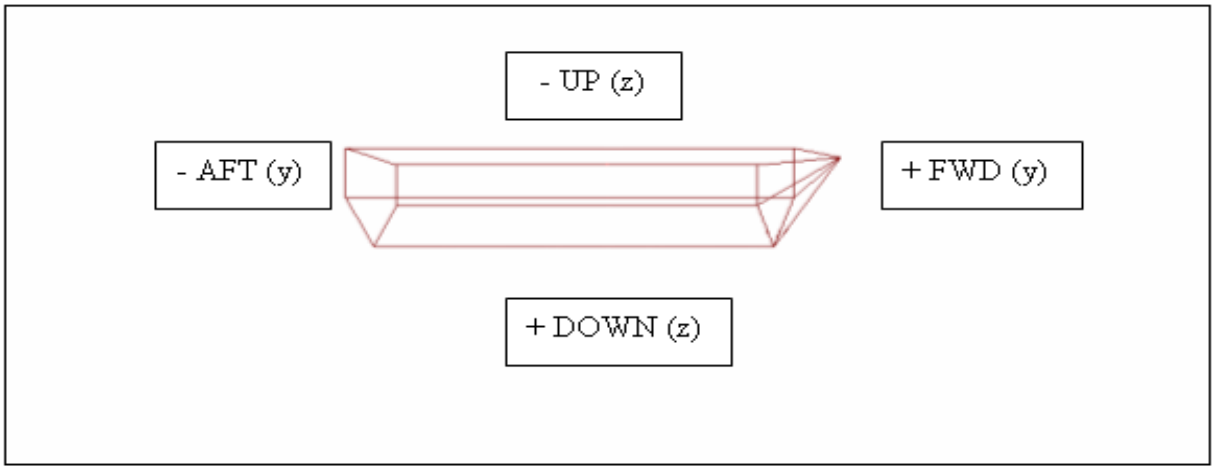


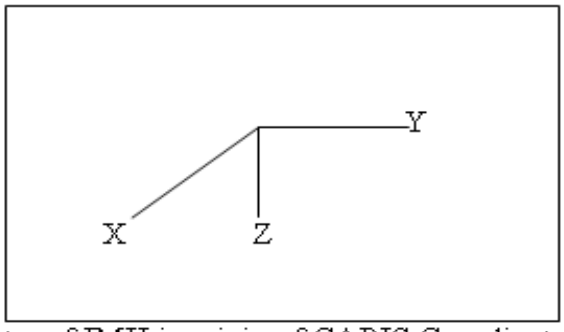


Speed [m/s]	Delta Draft [m]
0.00	0.00
0.50	0.05
1.00	0.08
1.50	0.11
2.00	0.14
2.50	0.15
3.00	0.17
3.50	0.18
4.00	0.20
4.50	0.22
5.00	0.26
5.50	0.31

CARIS Coordinate System

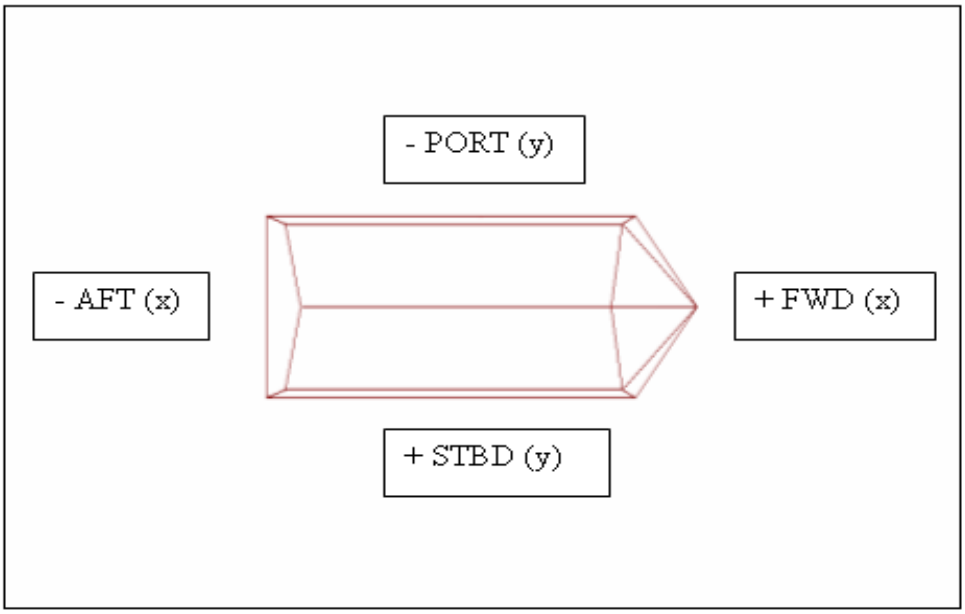


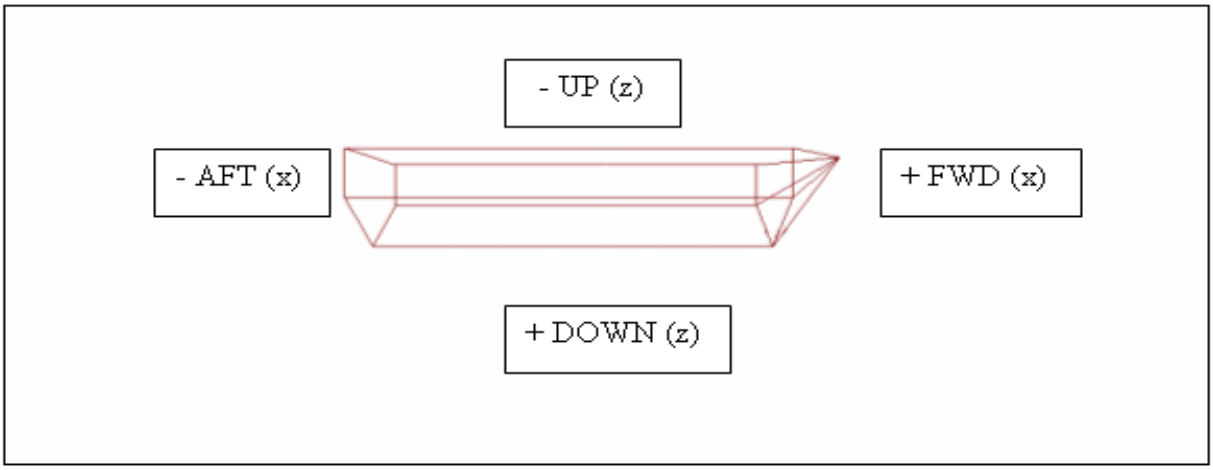


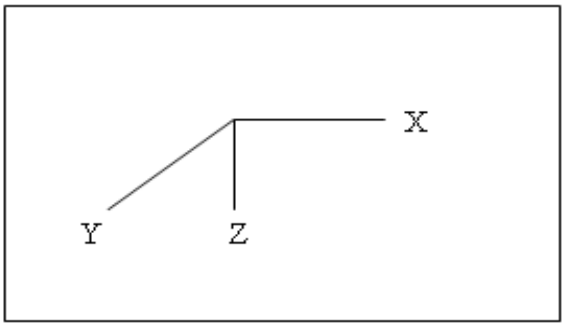


Top Center of IMU is origin of CARIS Coordinate System

POS/MV Coordinate System

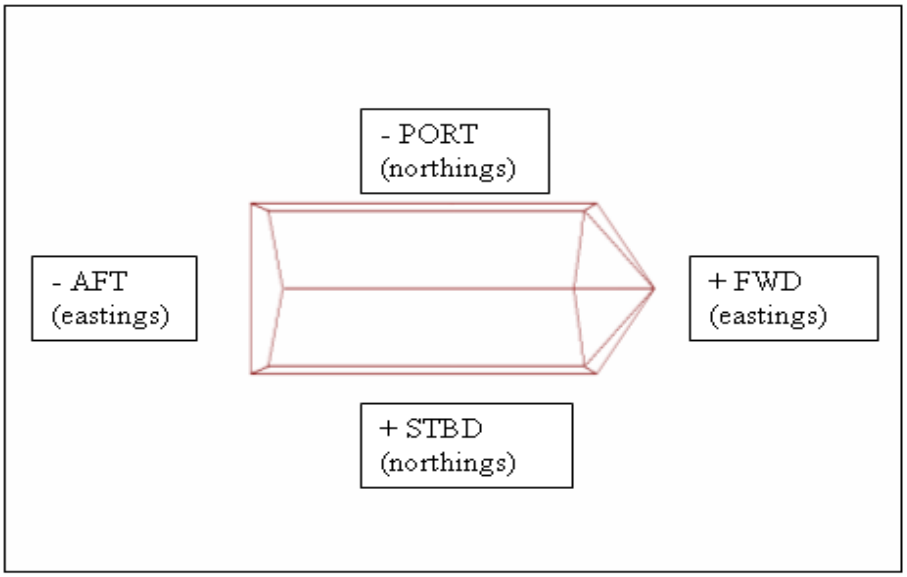


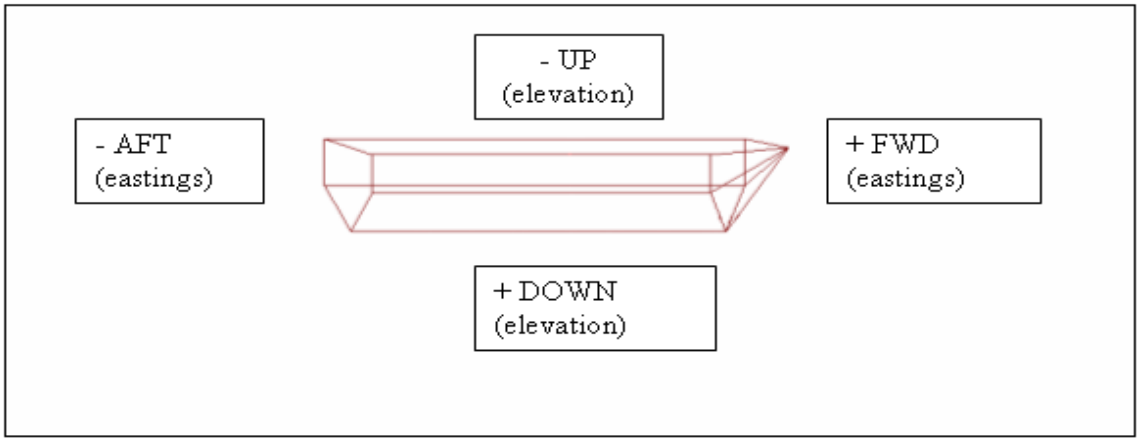


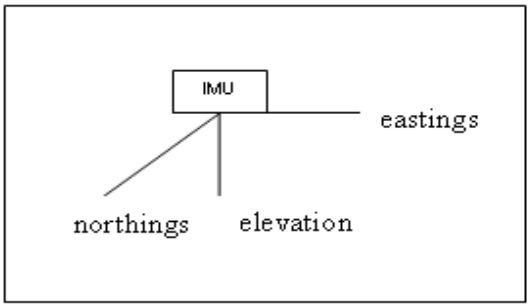


Top Center of IMU is origin of POS/MV Coordinate System

WESTLAKE Coordinate System

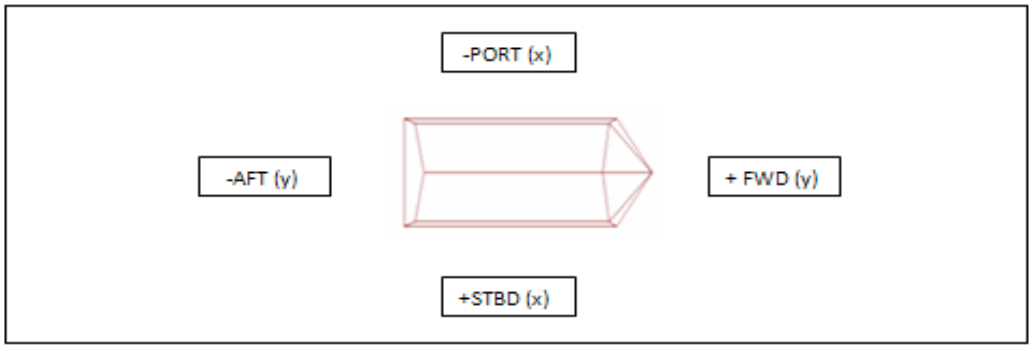


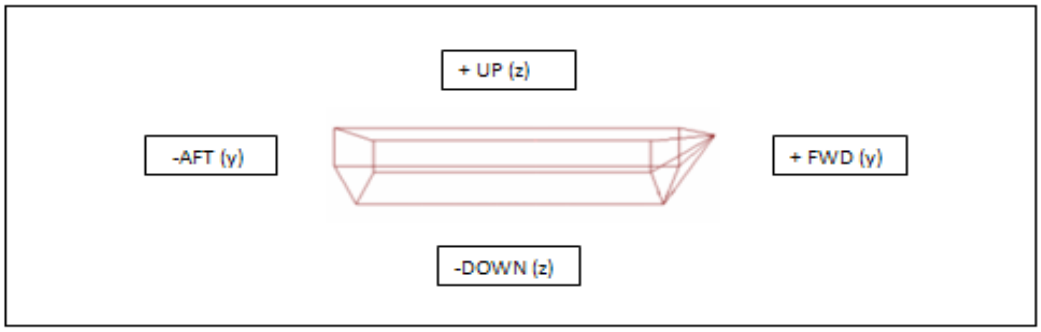


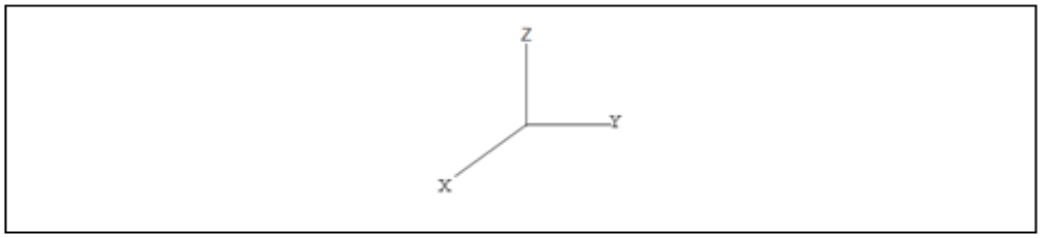


Bottom Center of IMU is origin of Westlake Coordinate System

NGS/ RESON Coordinate System

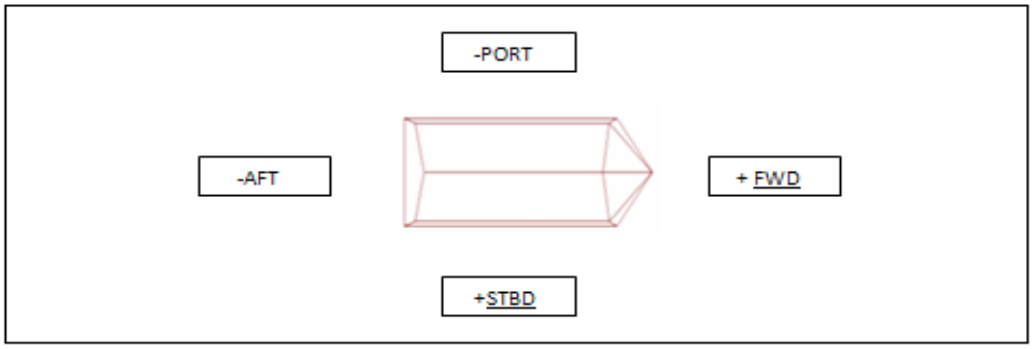


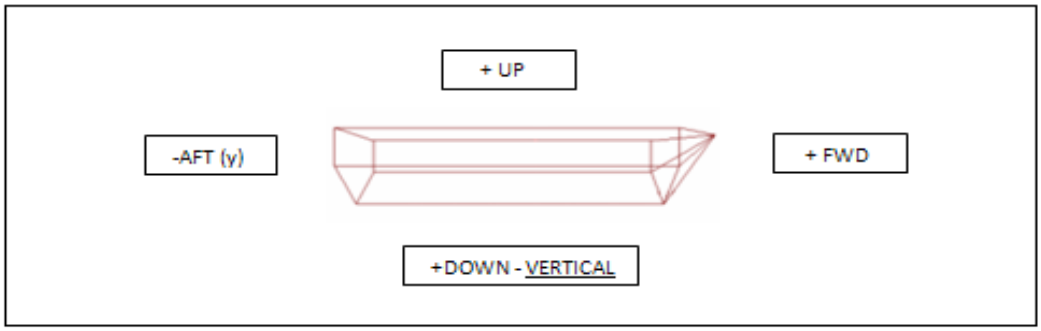


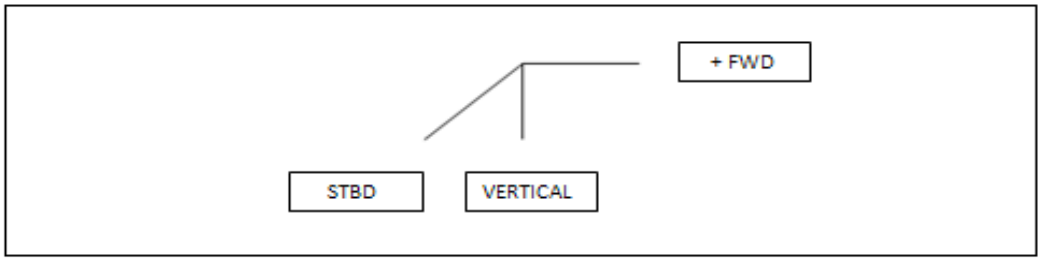


The Center of IMU is origin of NGS/ Reson System

Hypack Coordinate System







Top Center of IMU is origin of Hypack Coordinate System

Reference Surface Comparison

Frequency: 200 kHz
Resolution: 1 m
Surface Difference = Surface1 - Surface2

Average Surface Difference (m)		Surface 2					
		2805	2806	2807	2808	8160	7111
Surface 1	2805		-0.017	-0.089	-0.105	-0.016	-0.279
	2806			-0.105	-0.064	-0.305	-0.238
	2807				-0.001	-0.224	-0.154
	2808					-0.208	-0.134

Standard Deviation		Surface 2					
		2805	2806	2807	2808	8160	7111
Surface 1	2805		0.174	0.178	0.181	0.16	0.223
	2806			0.181	0.175	0.353	0.205
	2807				0.163	0.364	0.245
	2808					0.376	0.238

Frequency: 400 kHz
Resolution: 1 m
Surface Difference = Surface1 - Surface2

Average Surface Difference (m)		Surface 2			
		2805	2806	2807	2808
Surface 1	2805		-0.016	-0.018	-0.111
	2806			-0.009	-0.093
	2807				-0.039

Standard Deviation		Surface 2			
		2805	2806	2807	2808
Surface 1	2805		0.16	0.15	0.166
	2806			0.204	0.165
	2807				0.199

200 kHz to 400 kHz comparison
Resolution: 1 m
Surface Difference = Surface1 - Surface2

Average Surface Difference (m)		Surface 2 400kHz			
		2805	2806	2807	2808
Surface 1 200KHz	2805	0.02			
	2806		0.032		
	2807			0.078	
	2808				0.03

Standard Deviation		Surface 2 400 kHz			
		2805	2806	2807	2808
Surface 1 200KHz	2805	0.029685			
	2806		0.049888		
	2807			0.056678219	
	2808				0.056074811

NOAA Ship *Fairweather* MBES to Leadline Comparison 2011

		Observed Depths (m)				HVF Offset Values (m)		Corrected MBES Depth (m)		Mean Value (m)		IHO Order 1		Within IHO1 TVU		Dif. MBES - LL (m)	
3/15/2011 Ship's System	Sounding System	PORT	StDev	STBD	StDev	TXdcr to IMU	IMU to WL	PORT	STBD	PORT	STBD	PORT	STBD	PORT	STBD	PORT	STBD
L: 47-33-25.27N	Reson 7111, #1	6.79	0.21	5.08	0.07	4.43	-0.15	*11.07*	*9.36*	11.26	9.43	0.52	0.51	**Yes**	**Yes**	0.18	0.28
λ: 122-20-30.97W	Reson 7111, #2	7.20		5.22		4.43	-0.15	*11.48*	*9.50*								
	Reson 7111, #3	6.97		5.17		4.43	-0.15	*11.25*	*9.45*								
Draft:	Reson 8160, #1	8.05	0.06	7.25	0.09	4.52	-0.15	*12.42*	*11.62*	12.45	11.57	0.53	0.52	**No**	**No**	1.03	1.78
[fore P/S] 12'6" 12'6"	Reson 8160, #2	8.15		7.25		4.52	-0.15	*12.52*	*11.62*								
[aft P/S] 13'6" 13'6"	Reson 8160, #3	8.05		7.10		4.52	-0.15	*12.42*	*11.47*								
Personnel:	Leadline PINK1	11.90	0.40	9.56	0.14					11.44	9.71	0.52	0.52				
Hedgepeth	Leadline PINK2	11.25		9.83													
Faulkes	Leadline PINK3	11.18		9.74													
Younkin	Leadline GREY1	11.90	0.42	9.82	0.03					11.42	9.79	0.52	0.52				
Wilson	Leadline GREY2	11.10		9.77													
	Leadline GREY3	11.27		9.77													
3/15/2011 2807	Sounding System	PORT	StDev	STBD	StDev	TXdcr to IMU	IMU to WL	PORT	STBD	PORT	STBD	PORT	STBD	PORT	STBD	PORT	STBD
L: 47-33-24.54N	Reson 7125, #1, 200khz	8.01	0.05	7.58	0.00	0.48	-0.09	*8.40*	*7.97*	8.46	7.97	0.51	0.51	**Yes**	**Yes**	0.37	0.16
λ: 122-20-24.44W	Reson 7125, #2, 200khz	8.10		7.58		0.48	-0.09	*8.49*	*7.97*								
	Reson 7125, #3, 200khz	8.10		7.58		0.48	-0.09	*8.49*	*7.97*								
Personnel:	Reson 7125, #1, 400khz	8.10	0.05	7.62	0.04	0.48	-0.09	*8.49*	*8.01*	8.43	7.97	0.51	0.51	**Yes**	**Yes**	0.46	0.23
Hedgepeth	Reson 7125, #2, 400khz	8.02		7.54		0.48	-0.09	*8.41*	*7.93*								
Faulkes	Reson 7125, #3, 400khz	8.02		7.58		0.48	-0.09	*8.41*	*7.97*								
Younkin																	
Wilson	Leadline PINK1	8.80	0.04	8.12	0.02					8.83	8.13	0.51	0.51				
	Leadline PINK2	8.81		8.12													
	Leadline PINK3	8.87		8.16													
	Leadline GREY1	8.90	0.01	8.12	0.07					8.90	8.20	0.51	0.51				
	Leadline GREY2	8.90		8.25													
	Leadline GREY3	8.89		8.22													

Comments:
Difficult to discern a bottom from the 8160 wedge display. There may have been a substantial amount to penetration into the soft silty bottom of the Duwamish with this low frequency sonar. The combination of these factors are likely contributors to 8160 calculated depths falling outside of the IHO order 1 TVU allowances -mjj. IMU to WL values calculated using the observed Draft values input into the ships Draft spreadsheet and the S220 vessel offsets spreadsheet - mjj.

Appendix III

Total Propagated Uncertainty (TPU)

Fairweather TPU Values

	FAIRWEATHER SURVEY		*Appendix III*	*Process Owner* Survey
	Documents Title **FA_TPU_Values_2011**	*Last update* June 23, 2011	*Version* 2011.2	*Effective Date* March 1, 2011

Offsets

	Vessel	FAIRWEATHER-S220	FAIRWEATHER-S220	2805	2806	2807	2808	2808
	Sonar System	Reson 7/8111	Reson 8160	Reson 7125	Reson 7125	Reson 7125	Reson 7125	Reson 8125
	Frequency			200kHz / 400kHz	200kHz / 400kHz	200kHz / 400kHz	200kHz / 400kHz	455kHz
	Positioning System	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4
Offsets	MRU to Trans X	2.868	0.493	0.004	-0.013	0.019	0.004	0.652
	MRU to Trans Y	8.252	7.665	0.245	0.254	0.244	0.250	0.531
	MRU to Trans Z	4.752	4.726	0.482	0.481	0.481	0.477	0.713
	Nav to Trans X	2.071	-0.304	0.686	0.624	0.804	0.685	1.333
	Nav to Trans Y	20.144	19.557	1.051	1.087	1.056	1.086	1.368
	Nav to Trans Z	17.821	17.794	3.656	3.617	3.628	3.637	3.873
	Trans Roll	0.00	0.00	0.000	0.000	0.000	0.000	-25.000

Standard Deviation

	Vessel	FAIRWEATHER-S220	FAIRWEATHER-S220	2805	2806	2807	2808	2808		Status
	Sonar System	Reson 7111	Reson 8160	Reson 7125	Reson 7125	Reson 7125	Reson 7125	Reson 8125		
	Frequency			200kHz / 400kHz	200kHz / 400kHz	200kHz / 400kHz	200kHz / 400kHz	200kHz		
	Positioning System	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V4		
Motion Sensor	Motion Gyro (deg)	0.02	0.02	0.04	0.04	0.04	0.04	0.04	Vessel Configuration File	Finalized
	Heave% Amp	5	5	5	5	5	5	5		Finalized
	Heave (m)	0.05	0.05	0.05	0.05	0.05	0.05	0.05		Finalized
	Roll (deg)	0.02	0.02	0.02	0.02	0.02	0.02	0.02		Finalized
	Pitch (deg)	0.02	0.02	0.02	0.02	0.02	0.02	0.02		Finalized
	Position Nav (m)	0.5*	0.5	0.5	0.5	0.5	0.5	0.5		Finalized
	Vessel Speed (m/s)	0.03	0.03	0.03	0.03	0.03	0.03	0.03		Finalized
Latency	Timing Trans (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
	Nav Timing (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
	Gyro Timing (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
	Heave Timing (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
	Pitch Timing (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
	Roll Timing (s)	0.005	0.005	0.005	0.005	0.005	0.005	0.005		Finalized
Vessel Offsets	Offset X (m)	0.007	0.007	0.006	0.004	0.007	0.006	0.007		Finalized
	Offset Y (m)	0.007	0.007	0.006	0.004	0.007	0.006	0.007		Finalized
	Offset Z (m)	0.008	0.008	0.006	0.004	0.007	0.006	0.007		Finalized
Waterline	Loading	0.128	0.128	0.018	0.051	0.044	0.032	0.032		Finalized
	Draft (m)	0.128	0.128	0.019	0.051	0.044	0.032	0.032		Finalized
	DeltaDraft (m)	0.10	0.10	0.10	0.10	0.05	0.075	0.04		Finalized
MRU Alignment	MRU alignStdev gyro	0.19	0.26	0.07 / 0.19	0.19 / 0.26	0.12 / 0.23	0.09 / 0.13	0.17		Finalized
	MRU align roll/pitch	0.18	0.23	0.07 / 0.07	0.02 / 0.04	0.05 / 0.02	0.08 / 0.04	0.18		Finalized
Tides	Tide Meas (m)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Compute TPE Dialog Box	Project Dependent**
	Tide Zoning (m)	Project Dependent	Project Dependent	Project Dependent	Project Dependent	Project Dependent	Project Dependent	Project Dependent		Default=0.2, Project Dependent**
Sound Velocity	SV Meas (m/s)	0.5	0.5	2.0	2.0	2.0	2.0	2.0		Defaults, Project Dependent**
	Surface SV (m/s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5		Defaults, Project Dependent**

*Position Nav adjusted in the HVF to 5m when acquiring in Coarse Acquisition mode, additional information will be submitted in the DAPR and/or the DR.
**Default values listed, descriptive report will list actual values applied if supplied with Project Instructions or calculated with the Sound speed estimator.
^MRU values may change if new patch test values are used.