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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

Data Acquisition & Processing Report

Type of Survey: Hyrographic

Project No.:

Time frame: 2008 Field Season

LOCALITY

State: Alaska

General Locality:

2008

CHIEF OF PARTY

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DATE

INTRODUCTION

This Data Acquisition and Processing Report outlines the acquisition and processing procedures used for Hydrographic projects surveyed in 2008 by the 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 2008*, the *Field Procedures Manual (FPM), May 2008*, and all active Hydrographic Surveys Technical Directives (HTD).

Any additions and changes to the following will be included with the individual Descriptive Reports

A 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 was used throughout the 2008 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 included in Appendix II.

1.2 Echo Sounding Equipment

1.2.1 Reson 8111ER Multibeam Echosounder (MBES)

Fairweather is equipped with a RESON SeaBat 8111 MBES with the Extended Range (ER) and snippet options. The 8111ER is a 100 kHz multibeam system with swath coverage of 150°. The swath is made up of 101 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of 3 to 1200 meters, though the typical operational depth range of the 8111ER on the *Fairweather* is 20 to 600 meters. No calibration information was provided by the manufacturer for the system.

The 8111ER 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 Figures 1 & 2).

1.2.2 RESON 8160 Multibeam Echosounder (MBES)

Fairweather is equipped with a RESON SeaBat 8160 MBES with the snippet option. The 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. No calibration information was provided by the manufacture for 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 Figures 3 & 4).

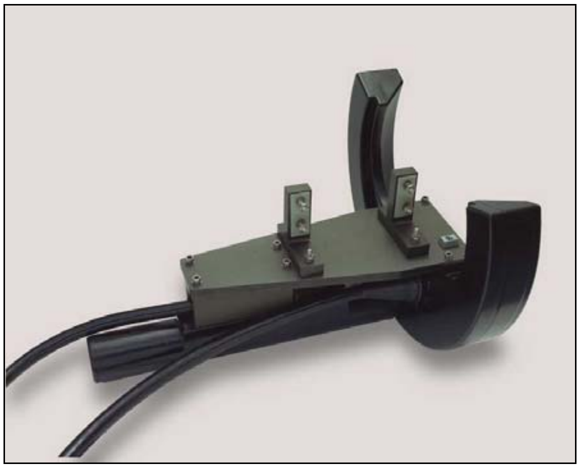


Figure 1: RESON SeaBat 8111ER MBES

Figure 2: RESON SeaBat 8111ER MBES on *Fairweather*

Figure 3: RESON SeaBat 8160

Figure 4: RESON SeaBat 8160 on *Fairweather*

1.2.3 RESON 8101ER Multibeam Echosounder (MBES)

Survey Launches 1010 and 1018 are each equipped with a RESON SeaBat 8101 MBES with the Extended Range and snippet option. The 8101ER is a 240 kHz multibeam system with a swath coverage of 150°. The swath is made up of 101 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of up to 500 meters. The typical operational depth range of the 8101 on launches 1010 and 1018 is 3 to 120 meters. Under optimal conditions with a hard bottom, high power and high gain, the depth range of the 8101 ER was observed to be as deep as 350 m producing a swath of ±45º from nadir. No calibration information was provided by the manufacturer for the system.

Each system is attached to a launch using a swing mount which is starboard of the keel and approximately centered fore and aft (see Figures 5 & 6).

Figure 5: Launch 1010 with 8101 extended

Figure 6: Launch 1010 with 8101 retracted

1.2.4 Odom Echotrac CVM (VBES)

The Odom Echotrac CVM Vertical Beam Echo Sounder (VBES) is portable, and is intended for use during shoreline acquisition or as necessary with vessels 2302 and 1706 (Figure 7). The CVM vertical beam system will utilize either a 4 degree or a smaller 9 degree 200 kHz side mounted transducer and has a depth range up to 180 meters (Figure 8). The eventual goal is to have the transducers hull mounted for improved data quality. The CVM links directly into the Trimble Pathfinder® Pro XRS unit and provides a real-time bottom profile. Files are logged in Odom format initially and then converted to .XTF format to provide accurate depth records used during the Shoreline NALL Buffer, VBES mainscheme, and/or VBES crosslines.

Figure 7: Odom Echotrac CVM

Figure 8: Four degree (left) & nine degree transducers

1.3 Manual Sounding Equipment

1.3.1 Diver's Least Depth Gauge

The diver's least depth gauge (DLDG) is a hand-held device that uses pressure to determine depth of water over a discrete point (e.g. mast of a shipwreck). A raw sounding obtained during a dive is corrected with verified tides and Conductivity/Temperature/Depth (CTD) information acquired in the vicinity of the object.

The divers least depth gauge (see Figure 9) was calibrated by PTC Electronics Incorporated on April 2, 2008, documentation is included in Appendix V. Prior to field season use, a raw DLDG sounding with a simultaneous lead line reading allowed for a comparison measurement for check purposes to ensure appropriate readings. Depths acquired with the DLDG are processed using the same procedures as other shoreline features that require tide correction as described in section B.2.2 of this report.

During projects that required DLDG use, periodic quality assurance checks were conducted as outlined in section 1.5.6 of the *FPM*. Daily DQA checks and pre and post dive DQAs were performed. Documentation and DQA files are included with the individual descriptive reports with the Sound Speed DQA data for the particular surveys that required the use of the DLDG.

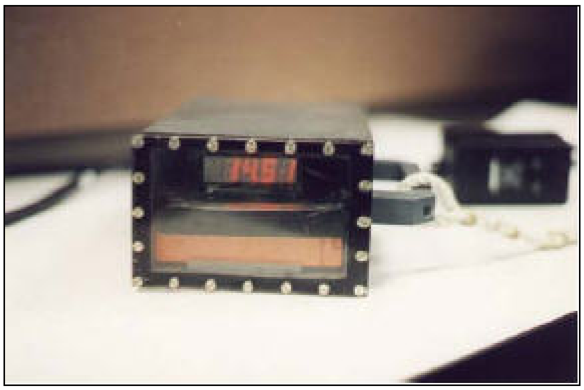


Figure 9: Diver's least depth gauge

1.3.2 Lead Lines

Vessels 1010, 1018, 1706, and 2302 are each equipped with a lead line. 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 during May and June 2008. Calibration reports for the leadlines are included in Appendix V.

1.4 Positioning, Heading, and Attitude Equipment

1.4.1 TSS Positioning and Orientation System for Marine Vehicles (POS/MV)

Fairweather and her launches are each equipped with a TSS POS/MV 320 V4, configured with TrueHeave™ and Precise Timing. The POS/MV calculates position, heading, attitude, and vertical displacement (heave) of a vessel. It consists of a rack mounted version POS Computer System (PCS) (Hardware Version 2.9-7 on *Fairweather* and version 2.6-7 on both Launches), a strap down IMU-200 Inertial Measurement Unit (IMU), and two GPS antennas corresponding to GPS receivers in the PCS. The port side antenna is designated as the primary receiver, and the starboard side antenna is the secondary receiver (see Figures 10 & 11). Differential correctors are supplied to the POS MV by a CSI wireless MBX-3S Automatic Differential GPS receiver. The POS MV firmware version 3.42 and the controller software version 3.4.0.0 are currently the installed versions utilized.

For all multibeam systems aboard *Fairweather* and her launches, timing between the sonar swath, position, heading and attitude information was synchronized by utilizing the TSS POS/MV 320 v.4's. A timing string was sent from the POS/MV to the RESON topside unit and to the ISIS computer recording the incoming data. Vessel wiring diagrams are included in Appendix III-*vssl*-5.

POS/MV controller software was used to monitor position accuracy and quality during data acquisition. This ensured that positioning accuracy requirements were met, as outlined in section 3.2.1 of the *HSSD,* April 2008. The POS/MV controller software provides clear visual indications whenever accuracy thresholds are exceeded.

1.4.2 POS/MV GAMS Calibration

GAMS (GPS Azimuth Measurement Sub-system) calibrations were performed on each of the three POS/MV units. The GAMS calibration procedure was conducted in accordance with instructions in chapter 4 of the *POSMV V4 Installation and Operation Guide,* 2005. Results are included in the individual vessel reports and spreadsheets, with calibration details located in Appendix III.

Figure 10: POS/MV antennas on 1018

Figure 11: POS/MV antennas on 1010

An additional GAMS calibration was performed on Launch 1018 after a configuration error was detected in August 2008. The primary and secondary GPS antennas were wired incorrectly, with the port antenna, defined as the primary, plugged into the secondary antenna port on the PCS, and the starboard antenna, defined as the secondary antenna, plugged into the primary port on the PCS. The configuration error resulted in a horizontal position error in data collected by 1018 until the problem was corrected. Since the offset is a very well-known quantity (exactly the separation between the POS/MV GPS antennas), an entry was made in the .hvf to correct the output position to the actual reference point of the launch. Additionally, a new patch test was conducted and is addressed in the Patch test section of this report.

1.4.3 CSI Wireless MBX-3S DGPS Receiver

Fairweather is equipped with commercial grade CSI Wireless MBX-3S DGPS Receivers that are used in conjunction with TSS POS/MV to provide vessel positioning during 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. Vessel wiring diagrams are in Appendix III-*vssl*-5.

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

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. *Fairweather*'s field computers consist of three Panasonic CF-18 Tuffbooks and one CF-29 Tuffbook. The receivers have integrated beacon/satellite differential antennas which allow access to digital real-time sub-meter accuracy solutions. Extensive data quality assurance testing was conducted by *Fairweather* personnel in March 2007. The Trimble backpack GPS unit testing was combined with the Ashtech testing and the results are located in the Horizontal Positioning Equipment Check file in Appendix V. In April of 2008, a smaller scale check of the Trimble units was conducted without a comparison to the Ashtech Z-Xtreme, with comparable Trimble results of positions within 2.5meters.

Figure 12: Trimble Backpack Unit

1.4.5 Impulse LR Hand-held Laser

The Impulse Laser Rangefinder and TruPulse 200 Laser Rangefinder 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 Rangefinder do not function properly in low light or in choppy seas when a feature is not distinguishable from surroundings.

Figure 13: IMPULSE LR laser

Figure 14: TruPulse 200 Laser Rangefinder

Data quality assurance testing was conducted on the Impulse LR on February 2006 by *Fairweather* personnel. Comparison testing among the Laser Rangefinder, the TruPulse 200 Laser Rangefinder and the Trimble Backpack units was performed on March 2006. Vertical and horizontal readings were taken with the laser level and compared to measurements taken with a fifteen meter steel tape and a graduated metric staff. Three marks were placed on the staff with SOLAS reflective tape in order to get a good fix. The laser level was set up on a bipod at 10, 20, 50 and 100 meter intervals from the staff. Three horizontal and three vertical readings were taken at each interval. The results of the Laser Level Accuracy testing are located in Appendix V.

The laser levels were tested less extensively in April 2008 with steel tape but their accuracy was not verified by comparison with the Trimble backpack units.

1.5 Sound Velocity Equipment

1.5.1 SBE 19*plus* SEACAT Profiler

Fairweather is equipped with three SBE 19*plus* SEACAT sound velocity 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 has a pressure sensor rated to 3,500 meters.

The SBE 19*plus* SEACAT sound velocity profilers were calibrated by the manufacturer and current calibration files were returned with the units. Calibration files are located in Appendix V.

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. This includes a thorough rinsing of the instrument with distilled water after each cast and periodically each CTD is flushed with a Triton X-100 solution.

1.5.2 SBE 45 Micro Thermosalinograph (TSG)

Fairweather is equipped with one SBE 45 MicroTSG. The SBE 45 uses continuously pumped sea water to measure conductivity and temperature near the ship’s hull mounted transducers. The intake is located 9 feet below the DWL (13 ft) between frames 11 and 12.

The conductivity and temperature information is converted to sound speed and output to the RESON 8160’s and 8111’s processing units. The 8160 requires sound velocity information for beam forming and pitch stabilization while the 8111 only requires it for pitch stabilization. The 8160 cannot be used to acquire data without real time sound speed information.

The unit was calibrated during the winter inport in Seattle. The current calibration report is included in Appendix V.

1.5.3 Moving Vessel Profiler 200

A Brooke Ocean Technology, Ltd. (BOT) Moving Vessel Profiler 200 (MVP200) is mounted in the aft starboard corner of the fantail (see Figure 15). The MVP200 system is a self contained sound velocity profiling system capable of sampling water column profiles to 200m depth 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 ship 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 version 2.26 is used to control the MVP system and to acquire SVP data. 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 and 2) the maximum depth. Either single, individually initiated casts can be performed at the discretion of the Hydrographer or the auto deploy function can be enabled and set with varying intervals (every 10 minutes, for example) for deployment.

The Applied Microsystems Ltd. Sound Velocity and Pressure Smart Sensors were calibrated by the manufacturer and current calibration files were returned with the units. Sensor 4986 was the spare sensor on board and not used during the 2006 and 2007 field seasons. An updated calibration was not required for sensor 4986 and the 2006 calibration file is adequate. Calibration files are located in Appendix V.

Periodic quality assurance checks include comparison casts between the MVP and one of the SBE 19*plus* 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 15: *Fairweather*'s MVP200 sound velocity system

1.6 Vertical Control Equipment

1.6.1 Water Level Gauges

Five Sutron 8210 tide gauges were provided to *Fairweather* by the Center for Operational Oceanographic Products and Services (CO-OPS) at the start of the 2008 field season. These gauges are equipped with Paros Scientific Sensors for pressure measurements. The tide gauges are checked annually by CO-OPS Field Operations Division personnel to ensure that their accuracy standards are being met.

CO-OPS does not provide calibration or quality assurance documentation to the *Fairweather*. Installation and removal of the water level gauges is the responsibility of *Fairweather* personnel. To ensure full functionality of the vertical control equipment prior to deployment for field operations, new gauges undergo testing by *Fairweather* personnel. Five gauges underwent testing in March 2008, the write up and results are included in Appendix V.

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.

A Kukkamaki procedure is performed prior to leveling in order to verify the collimation error. Procedures were followed as described in the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations,* October 1987. Kukkamaki results for 2008 are located in the Tides folder in Appendix V.

1.7 Horizontal Control Equipment

Fairweather is equipped with one Ashtech Z-Xtreme and one Magellan Z-Max.Net dual-frequency GPS receivers used for the positioning of tidal benchmarks, aids to navigation and portable DGPS reference stations (Fly-Away). The Ashtech Z-Xtreme 12 channel, L1/L2 receiver is connected to an Ashtech Geodetic GPS antenna. The Magellan Z-Max.Net 24 channel, L1/L2 receiver is connected to a Thales GPS antenna

The Ashtech antenna can be equipped with an optional ground plane and both receiver antennas can be mounted on a fixed height Seco GPS tripod.

Data quality assurance testing of the Ashtech Z-Xtreme GPS receiver equipment was performed in March of 2007 by *Fairweather* personnel. The Z-Xtreme receiver was set up over Benchmark No. 37 in Ketchikan, AK using a Seco fixed height tripod. Data was collected for 2 hours 30 minutes. The recorded observations were submitted to OPUS, the solution was computed with ultra-rapid orbits. The OPUS position was less than a centimeter off the published NGS Control Point for BM No. 37. The OPUS solution and a map of the results of the test with the Trimble units are located in Appendix V. Accuracy standards have been met according to NOAA Technical Memorandum NOS NGS-58.

Data quality assurance testing of the Magellan Z-Max GPS receiver was performed in July of 2008 by *Fairweather* personnel. The Magellan Z-Max GPS receiver and Ashtech Z-Xtreme GPS receiver were set up over Benchmark No. 6 for tide station 945-5517 using a Seco fixed height tripod. Data was collected for 3 hours and 32 minutes with the Z-Xtreme receiver and 20 hours and 47 minutes with the Z-Max.Net receiver. Both observations were submitted to OPUS, the solutions were computed with precise orbits. The two OPUS positions were 3.2 centimeters apart. The OPUS solutions are located in Appendix V. Accuracy standards have been met according to NOAA Technical Memorandum NOS NGS-58.

The Fly-Away DGPS Beacon setup aboard NOAA Ship Fairweather was tested in May 2008 over BM No. 37 in Ketchikan, AK. The testing setup parameters and results are included in Appendix V.

Horizontal control equipment serial numbers and installation dates are located in the hardware section of Appendix I, System Tracking.

2.0 Software

2.1 Software Systems Inventory

An extensive software inventory with documentation, of the software systems used by the NOAA ship *Fairweather*, is maintained as a *Survey Software* spreadsheet and is included with the Supplemental Survey Records for the individual Descriptive Reports. This spreadsheet includes specifics such as software applications, versions, and hot fixes, in addition to dates loaded on specific computers within the survey department.

2.2 Data Acquisition Software

2.2.1 Isis Sonar/ BathyPro/ TritonMap/

The *Fairweather* uses the Triton Imaging Inc. software package Sonar Suite to acquire multibeam echo sounder and backscatter data on all of its multibeam platforms. Sonar Suite has two software packages, Isis Sonar and TritonMap, which work together along with BathyPro to produce real-time data planning, acquisition, and execution.

Triton Imaging BathyPro is an add-on package for Isis Sonar which processes XTF data real-time to produce DTMs supported by TritonMap. TritonMap is a stand-alone GIS program which combines georeferenced bathymetric digital terrain models and reference files such as raster charts and vector shoreline files to display real-time bathymetric bottom coverage.

2.2.2 TerraSync/ Pathfinder Office

For GPS positioning and shoreline verification *Fairweather* uses two Trimble Navigation Limited software programs: TerraSync 2.41 and GPS Pathfinder 3.02.

GPS Pathfinder is run on a Microsoft Windows operating system and is used to manage and process Trimble GPS data, transfer files to and from GPS receivers and handheld data collectors, and export processed data.

Trimble TerraSync 2.41 supports data dictionaries built with S-57 objects and attributes and georeferenced TIFF images. The georeferenced TIFF images are used for reference and navigation purposes as well as for immediate S-57 attribution of positions in the field. TerraSync is installed and configured for data collection on all of the Tuffbook field computers, the TuffTab, and the TSCe handheld computer.

GPS precision masks in TerraSync using the following parameters:

- Horizontal Dilution of Precision (HDOP) ≤ 2.5
- Signal-to-Noise Ratio (SNR) ≥ 4
- Elevation Mask ≥ ~8°-15° (varies by location)

Differential GPS correction is applied in real-time, using the unit's integrated beacon as the first choice corrector, and specifying "wait for real-time" as the secondary option. Positions are filtered so that only those with a minimum of 4 satellites (3D position), and HDOP ≤ 2.5, and Positional Dilution of Precision (PDOP) ≤ 6 will be recorded.

2.2.3 CARIS Notebook

CARIS Notebook™ can be used to directly collect detached shoreline positions and 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) = 2.5
- 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.

2.3 Data Processing Software

2.3.1 NOAA Hydrographic Systems and Technology Programs (HSTP) Software

Sound velocity data is processed with Velocwin, in-house software produced and maintained by NOAA's Hydrographic Systems and Technology Programs (HSTP) division. Velocwin creates and archives water column profiles, performs quality assurance, and processes pressure based depth data. Velocwin creates a standard file format across NOAA's hydrographic fleet for sound velocity profiles applied to shallow water multibeam and single beam data.
Pydro, another NOAA program produced and maintained by HSTP, is used to process features such as detached positions (DP), geographic positions (GP), and Automated Wreck and Obstruction Information System (AWOIS) contacts. PYDRO also converts and attributes features according to S-57 standards for insertion into CARIS Notebook.

2.3.2 CARIS

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

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

2.3.3 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.

As an additional data quality assurance check, Fledermaus ™ is used to examine the CARIS surfaces prior to submission. The combined BASE surface is exported from CARIS and then converted to a Fledermaus .sd file via the Avggrid and Dmagic programs.

2.3.4 MapInfo™

MapInfo™ is used to review tables and workspaces associated with assigned projects received from Hydrographic Survey Division (HSD). MapInfo may also be used to produce scaled plots produced for public relation purposes. HydroMI, an HSTP produced MapBasic program, is used through MapInfo to convert tide and tidal zoning files into a format that is useable in CARIS HIPS, and to obtain latitude/longitude coordinates for pre-survey planning.

3.0 Vessels

3.1 Vessel Inventory

The NOAA Ship *Fairweather* (S220) and her survey launches 1010 and 1018 are equipped to acquire multibeam echosounder (MBES) and sound velocity profile (SVP) data. Launch 1018 is also the primary vessel for dive operations. The AMBAR (2302) and Monark (1706) are used during shoreline verification, bottom sampling, and horizontal and vertical control operations. All vessels may be used in support of tide gauge operations. See Appendix I for the complete vessel inventory.

3.2 Noise Analysis

The *Fairweather* sonar systems, RESON 8160 and RESON 8111ER, underwent noise analysis testing on October 10 and 11, 2004 respectively. The results are used during acquisition to enhance data quality and are included in Appendix III-S220-6. Standard operating procedures utilizing the RESON 8160 and RESON 8111ER aboard the *Fairweather* have survey speeds set to minimize noise based on these noise analyses.

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 *FPM* section 5.2.3.2.3.

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

Multibeam and shoreline data were 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.

4.2 Multibeam Echosounder Acquisition and Monitoring Procedures

Methods of acquisition took into consideration system performance limitations, the bottom topography, water depth, and the ability of the vessel to safely navigate the area.

All multibeam data were acquired in Triton Elic's extended transfer format (XTF) and monitored in real-time using the 2-D and 3-D data display windows and the on-screen displays for the RESON SeaBat 8101ER, 8111ER, and 8160. Adjustable parameters that were used to control the RESON from the ISIS software include range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure best data quality. Vessel speed was also adjusted 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 the *Fairweather* while setting and utilizing the RESON systems and Isis for acquisition of data.

Mainscheme multibeam sounding acquisition lines using the RESON SeaBat 8101ER, 8111ER, and 8160 are generally run parallel to the contours and spaced approximately three to four times the water depth. For discrete item developments, line separation was reduced to 2 times water depth to ensure least-depth determination by multibeam near-nadir beams. Triton Elic's TritonMap Real Time Bathy was used in lieu of planned line files. Real Time Bathy displays the acquired multibeam swath during acquisition and was monitored to ensure overlap and full bottom coverage. If coverage was not adequate, additional lines were run while still in the area.

4.3 Shoreline Verification

Fairweather personnel conduct field shoreline verification at times near predicted low water, in accordance with the Project Instructions and the FPM (May, 2008).

The composite source file (CSF) provided with the project instructions is the primary source for shoreline features to be verified. Additionally, AWOIS items and other features to be investigated are provided for a given survey and are included in the files utilized during shoreline verification. Specific details regarding the composite source and investigation features are included in the individual descriptive reports.

A Mean High Water (MHW) Buffer line, offset 0.8 mm at the scale of the largest chart in the area, was created from the composite source MHW line. This MHW Buffer line was used in the shoreline acquisition software and on the boat sheet as a reference, and to determine the Navigable Area Limit Line (NALL). The NALL was determined in the field as the farthest off-shore of either the MHW buffer specified above or the 4-meter depth contour. All shoreline features from the composite source seaward of the Navigable Area Limit Line (NALL) were verified (including an update to depth and/or position as necessary) or disproved during shoreline operations. Features off-shore of the NALL and not addressed or features of an ambiguous nature were flagged with a marker note for further clarification.

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.

5.0 Bottom Sample Acquisition

Bottom samples are acquired according to section 7.1 of the *HSSD*. Samples were acquired using the current shoreline acquisition system and processed similarly to other shoreline features as outlined in the descriptive report for the specific survey. Bottom sample results are included in the Notebook .hob deliverable layer, HXXXXX_Field_Verified.

B QUALITY CONTROL

The *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 4.2.3.6 and Appendix 4 – CARIS HVF Uncertainty Values of the *FPM*.

Estimates for the error in measuring vessel offsets, multibeam system biases (timing, pitch, roll and yaw), dynamic draft, and MRU alignment error are the standard deviations of the values determined by multiple personnel processing the data for each of these corrections.

The tidal errors for the gauge and for zoning are determined on a project by project basis and are entered during the Compute TPE step in CARIS HIPS. The values utilized for a given survey are included in the individual descriptive report.

The *Fairweather* TPE Values spreadsheet located in Appendix IV, 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.

2.0 Data Processing

2.1 Multibeam Echosounder Data Processing

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

Raw XTF multibeam data were converted to Caris HDCS format using established and internally documented settings. True heave, sound velocity and water level data were then applied to all lines and the lines merged. Once lines were merged Total Propagated Error (TPE) was computed.

BASE surfaces were created using the Combined Uncertainty and Bathymetric Estimator (CUBE) algorithm and parameters contained in the Cubeparams.xml file which is included with the HIPS Vessel Files with the individual survey data. The file contains parameter values that differ from the traditional default values which are listed in Table 1. The Capture Distance Scalar (CDS) and Capture Distance Minimum (CDM) are set to limit the soundings that contribute to the node to those in a set radius surrounding the node. The grid resolutions utilized are based on the beam footprint and expected data density. The minimum resolution of 2 meters was determined based on having a minimum of three soundings per node and to accommodate the beam foot print size at 60 degrees off-nadir. In areas where a 1 meter resolution surface is required, data is acquired so that inter-line overlap is at 45 degrees. These would be special circumstances such as developments and will be discussed in the individual Descriptive Report. Additional documentation files on Data Representation and CUBE Results are included in Appendix VI, these documents outline the testing conducted, the methodology utilized, and the results leading to the determination of the resolutions and CUBE parameters used by *Fairweather* personnel during the 2008 field season.

The general resolution, depth ranges, and CUBE parameter settings used by *Fairweather* are listed in Table 1. These values may be adjusted by managers for individual surveys based on bathymetry and conditions in the survey area. A detailed listing of the actual resolutions and depth ranges used during the processing of each survey, along with the corresponding fieldsheet(s), is provided in the descriptive report of each survey.

Surface Resolutions		**CUBE Parameters**				
Depth Range	**Grid Resolution**	**Profile Name**	**EO**	**CDS**	**CDM**	**HES**
0 to **20** m	**2 m**	2metergrid	4.0	1.00	1.41	2.95
15 to **40** m	**4 m**	4metergrid	4.0	1.00	2.83	2.95
35 to **80** m	**8 m**	8metergrid	4.0	1.00	5.67	2.95
70 m and up	**16 m**	16metergrid	4.0	10.00	11.31	2.95

Table 1: Resolutions and Depth Ranges

Multibeam data were reviewed and edited in HIPS swath editor and in subset mode as necessary. The BASE surfaces are used for directed data editing in subset editor, to demonstrate coverage, and to check for errors resulting from tide, sound velocity, attitude and timing.

Vessel heading, attitude, and navigation data were 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 were manually rejected or interpolated for small periods of time.

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 filtering was applied.

In areas of navigational significance, depths less than 30 meters, where the BASE surface did not depict the desired depth for the given area, a designated sounding was selected. Designated soundings were selected as outlined in section 5.1.1.3 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 problem areas and determine the severity of the situation. 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.

IHOness surfaces are utilized during data collection as an additional child layer of the finalized surfaces to indicate problem areas that need attention. Additionally, IHOness child layer(s) are included with the submitted combined surface(s).

A histogram is created in Fledermaus from the combined surface's IHOness layer exported from CARIS. This allows the Hydrographer to see the full data distribution rather than just the minimum and maximum values in the surface. This data distribution is used to assess the quality of the survey. The process is setup to highlight 95% of the data in the histogram which allows the Hydrographer to show whether 95% of the data for a given survey meets the appropriate IHO order as specified in section 2.55.1.1.1 of the *HSSD.* An image of the histogram from Fledermaus is included with the Descriptive Reports for the specific surveys.

Additionally the submitted combined surfaces are reviewed in Fledermaus to ensure that the data is sufficiently cleaned and accurately depicts the seafloor at that resolution.

2.2 Shoreline Data Processing

During shoreline verification, field detached positions (DP) were acquired either with TerraSync 2.41 or CARIS Notebook. Tide application is applied in either Pydro or CARIS Notebook for features requiring tide correction. The programs used for shoreline acquisition and tide applications are listed in the individual Descriptive Report.

An original composite source file (H#####_Original_Composite_Source.hob) is saved prior to being edited and is submitted with the individual survey. New features and any updates to the composite source shoreline, such as ledges or reefs, are acquired or digitized with S57 attribution and reside in the H#####_Field_Verified.hob. Updates to a source shoreline feature primarily include a change in depth/height, position, or S57 classification. Notebook's editing tools are used to modify source feature extents or positions.

The SORIND and SORDAT S57 attribute fields for new features or modified source features are updated to reflect the information for the associated survey number and date. All new or modified features are S57 attributed as applicable. All unmodified source features retain their original SORIND and SORDAT values.

Short descriptive comments taken from the boat sheets or DP forms along with investigation or survey methods were listed under the Remarks field. For significant features that deserve additional discussion or disprovals, the Hydrographer included recommendations 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 moved to the H#####_Disprovals.hob layer from the H#####_Field_Verified.hob layer. Features in the disprovals layer retain their original SORIND and SORDAT values.

Photos labeled and associated with a DP number are included with the survey data and stored in the PSS photo folder.

AWOIS investigation items were inserted into Pydro for processing if necessary. Shoreline features correlated to the AWOIS item are included in the H#####_Field_Verified.hob layer.

The CARIS Notebook files along with CARIS HIPS BASE surface(s) are viewed to compare soundings and features simultaneously. Standard operating procedures, for processing shoreline features in Pydro and/or CARIS Notebook, are followed by survey personnel aboard NOAA Ship Fairweather as outlined in chapter 4 of the FPM.

A detailed discussion of the procedures used and any deviations in shoreline processing from standard procedures or the FPM are documented in the individual Descriptive Reports.

Final Shoreline Deliverables may include the Pydro PSS, Pydro Feature Reports if necessary, and up to three Notebook HOB files:

HXXXXX_Original_Composite_Source,
HXXXXX_Field_Verified,
HXXXXX_Disprovals.

3.0 Data Review

Specific procedures were 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 preformed 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, HXXXXX_Data_Log, is submitted with the individual survey data.

C Corrections to Echo Soundings

1.0 Vessel HVFs

CARIS HIPS Vessel Files (HVF) were created by *Fairweather* personnel and used to define a vessel's offsets and equipment uncertainty. The HVF is used for converting and processing data collected by each survey platform. The HVFs used for a given project are included with the digital data submitted with those surveys.

2.0 Vessel Offsets

Sensor offsets were measured with respect to each vessel's reference point. The reference point for *Fairweather* and survey launches 1010 and 1018 is the IMU. Specific offset values were input into the POS/MV and the CARIS HIPS Vessel File (HVF).

A ship survey was completed for the *Fairweather* by Westlake Consultants, Inc on September 23, 2003 and a POS/MV component spatial relationship survey of the *Fairweather* was conducted by NGS in February 2007. The results of both of these surveys were used to determine the offsets for the ship. The reports from each survey are located in Appendix III-S220-1, and the final values for *Fairweather*'s offsets and explanations of how they were calculated are located in the S220 *Offsets & Measurements* spreadsheet in the same folder.

Permanent control points were established on launches 1010 and 1018 in July of 2004. Sensor offsets were measured by *Fairweather* personnel according to documented procedures. Total stations were utilized for positioning the permanent control points (see Figure 16). The total station specifications are located in Appendix II-6, the calibration certificates for the *Nikon DTM 310* and the *Sokkia SET 5F* are included in Appendix V. A steel tape was used to verify and update specific vessel offsets in April 2008 and the results are located in the respective vessel's *Minimum Physical Measurements_2008* spreadsheet in Appendix III-101*X*-1. The final offsets for survey launches 1010 and 1018 were derived from a combination of values from the original full survey and the values updated in the verification surveys. The measurements, derivations, descriptions of methodology used, diagrams, and coordinate system references are included in the respective vessel's *Offsets & Measurements* spreadsheet in Appendix III-101*X*-1.

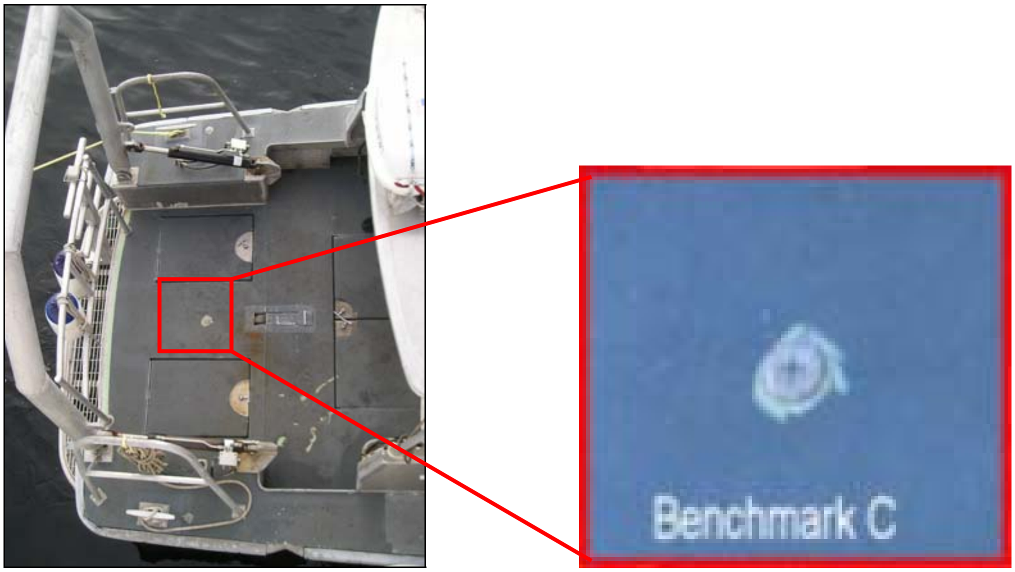


Figure 16: Permanent Control Point "Benchmark C" on launch 1018

3.0 Static and Dynamic Draft

The static drafts (*Waterline Height* in the HVF) for launch 1010 and 1018 were calculated based on steel tape measurements of the distance from benchmarks on the port and starboard quarter of the vessel to the waterline.

In 2007, the bow and stern draft marks were used to perform a linear interpolation of the static draft at the *Fairweather*'s IMU. The static draft was measured multiple times with the vessel under different loading conditions: with and without launches on board and with different amounts of fuel. The 2007 final value for the static draft was an average of the most likely loading conditions during survey operations. Less stringent measurements were able to be taken at the start of the 2008 field season, while values were obtained, they were not used. The 2007 static draft (*Waterline Height* in the HVF) and loading values were used as they were deemed more robust and appropriate for general surveying conditions. In October of 2008, *Fairweather* personnel identified offsets apparent in data between the launches and the ship. During the investigation into the cause of said offsets divers were deployed to use the DLDG unit and a leadline to verify the static draft measurement for the ship. The static draft value being utilized was confirmed as accurate within the measuring techniques used, results of DLDG measurements are included with the ship offset documentation in Appendix III-S220-1.

The values and calculations for static draft are listed in each vessel's *Minimum Physical Measurements and Offsets & Measurements* spreadsheets located in Appendix III-*vssl*-1.

Dynamic Draft measurements were conducted for *Fairweather* in April 2008 and for survey launches 1010 and 1018 in June 2008. Additional dynamic draft testing was conducted for *Fairweather* in Ernest Sound on October 25, 2008, after noticeable offsets were identified. Conditions and tide correctors were such that reliable data was not obtained. *Fairweather* personnel deemed that the 2006 dynamic draft values were more reliable then either the 2008 or 2007 values. Final dynamic draft values were obtained and the processing spreadsheets of dynamic draft measurement results for each vessel are located in the respective vessel's folder in Appendix III-*vssl*-3. The launches utilized the 2008 dynamic draft values obtained. The 2006 *Fairweather* dynamic draft values were used and applied for the entirety of the 2008 field season for the RESON SeaBat 8111 and 8160 MBES systems.

4.0 Patch Tests

Patch tests were conducted on *Fairweather* for the Reson 8111 multibeam acquisition system in April 2008, for the 8160 system and survey launch 1010 in June 2008. Survey launch 1018 was fully tested initially and for an additional roll calibration in June 2008. An additional patch test was required after the POS/MV configuration error was discovered and corrected in August 2008, as discussed in section 1.4.2. The results of the patch tests, along with the acquisition and processing logs, are included in the individual MBES Calibration Tables in Appendix III-*vssl*-2.

5.0 Attitude

All attitude corrections are generated by the POS/MV using data from the IMU-200 Inertial Measurement Unit (IMU). All attitude data are applied in post-processing in HIPS. Initially, the Reson 8160 had real-time roll and pitch stabilization applied, thus these components of attitude were not applied in post-processing as to not double apply the correctors. It was decided on Day Number 212 (30 July 2008) to make all four systems consistent in their processing methods. As of that date, real-time roll and pitch stabilization was turned off and those correctors are applied in post-processing.

IMU values for uncertainty of heave, pitch and roll are included in the manufacturer specification in Appendix II-2a and are included in the *Fairweather* TPE Values spreadsheet located in Appendix IV.

5.1 True Heave

Fairweather and her launches are equipped with the POS/MV TrueHeave™ (TH) option. True Heave™ is a ‘delayed’ heave corrector as opposed to ‘real time’ heave corrector and is fully described in Section 6 of the *POS/MV Version 4 Installation and Operation Manual*. Daily TH files were logged through the Ethernet Logging function in the POS/MV controller software. To ensure proper calculation of TH, files were logged for at least three minutes past the end of each day’s survey operations.

During daily processing the occurrence of “corrupted” True Heave files can occur. This is likely due to a formatting problem in the True Heave file. A temporary fix has been provided by CARIS in a tool called “fixTrueHeave.exe.” In cases where this is necessary a new “fixed” file is created with the extension “.fixed” (ex. TH_1010_123.000.fixed). The new fixed True Heave file is then applied to the data in the CARIS HIPS program. The original corrupted file is retained along with the fixed file with the raw xtf files. Occurrences of this for specific surveys are noted in the individual Descriptive Reports.
In cases where TrueHeave™ could not be applied, real time heave correctors were used. Real time heave data were recorded in Triton Elic’s Isis software, stored in the .xtf format and applied as the heave corrector for multibeam data. Data that does not have TrueHeave™ applied will be listed in the individual Descriptive Report for the survey.

6.0 Sound Velocity

Seacat SBE 19*plus* sound velocity profilers are used regularly to collect sound speed data for the Reson 8101 multibeam sonars on survey launches 1010 and 1018 and used on an as needed basis for the *Fairweather*’s Reson 8111 and 8160 multibeam systems. The Brooke Ocean Technology Moving Vessel Profiler (MVP) is primarily used to collect sound velocity data for sound speed correction of data acquired with *Fairweather*’s Reson 8111 and 8160 multibeam systems.

Daily sound speed profiles from the SBE 19*plus* are processed with Velocwin 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 .001, .001c, .001d, and .001e (collectively called BOT files) where the number increments by one with each subsequent cast. The .00#c file for each cast was opened with Velocwin and converted into CARIS .svp file format. The individual .svp profiles were concatenated into vessel specific .svp files for the entire survey. Individual sound velocity profile files taken by the MVP will not be submitted due to the large number of casts acquired; however, the daily concatenated files are submitted for backup purposes.

The concatenated sound velocity files were applied to multibeam data in CARIS HIPS during data processing. CARIS HIPS uses one of four different algorithms to automatically apply a sound velocity profile stored in a concatenated sound velocity file. They are: "previous in time," "nearest in time," "nearest in distance" and "nearest in distance within time." In general, "previous in time" is the method used for applying sound velocity information in HIPS for launch data and "nearest in distance within time" is used for ship data, although the other methods may be used in certain situations. The method of applying sound velocity is included in the processing logs that are submitted with each survey.

7.0 Water Level

The vertical datum for projects conducted is Mean Lower-Low Water (MLLW). Predicted, observed, and/or verified water level correctors from the primary tide station(s) listed in the project letter 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 in MapInfo using HydroMI.

Water level data in the .tid files are applied to data in CARIS HIPS using the zone definition file (.zdf) supplied by CO-OPS. Upon receiving final approved water level data, all data are reduced to MLLW using the final approved water levels (smooth tides) as noted in the Descriptive Report included with the survey data.

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 *FPM* section 5.2.3.2.3.

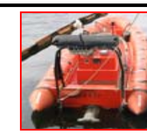
Appendix I

System Tracking

- **Vessel Inventory**
- **Hardware Inventory**
- **Computer Inventory**
- **Personnel Roster**

Hydrographic Vessel Inventory

Field Unit: FAIRWEATHER
Effective Date: April 23, 2008
Updated Through: October 30, 2008

SURVEY VESSELS						
Vessel Name	**FAIRWEATHER**	**Launch 1010**	**Launch 1018**	**Ambar 700**	**Skiff**	**FRB**
Vessel Image						
Hull Number	S 220	1010	1018	2302	1706	2301
Call Letters	WTEB					
Manufacturer	Aerojet-General Shipyards Jacksonville, FL	Jensen	Jensen	Marine Silverships, Inc	MonArk	Zodiak of North America
Year of Construction	1967	1973	1973	1998		2004
Type of Construction	Welded steel hull - ice strengthened	Aluminum hull	Aluminum Hull	RHIB	Aluminum Hull	RHIB
Length Overall	70.4 m (231 ft)	8.8 m (28ft 10in)	8.8 m (28ft 10in)	7.0 m (23 ft)	5.2 m (17 ft)	6.7 m (22 ft)
Beam	12.8 m (42 ft)	3.3 m (10ft 8in)	3.3 m (10ft 8in)	2.9 m (9ft 4in)	2.3 m (7ft 2in)	2.6 m (8ft 6in)
Draft	4.7 m (15ft 6in)	1.2 m (4 ft)	1.2 m (4 ft)	0.4 m (17 in)	0.4 m (1ft 3in)	0.6 m (22 in)
Date of Effective Full Vessel Static Offset Survey	Origninal Survey 9/2003 POS/MV Offsets Surveyed 2/2007	2004	2004			
Organization which Conducted the Effective Full Offset Survey	Original Survey - Westlake Consultants POS/MV Survey - NGS	NOAA Personnel (Wetzler, Sampadian, Froelich)	NOAA Personnel (Wetzler, Sampadian, Froelich)			
Date of Last Partial Survey or Offset Verification & Methods Used	n/a	April-2008 Steel Tape	April-2008 Steel Tape			
Date of Last Static Draft Determination & Method Used	April-2007 Draft Marks October-2008 DLDG & Leadline	April-2007 Waterline to Benchmarks	April-2008 Waterline to Benchmarks			
Date of Last Settlement and Squat Measurements & Method Used	April-2008, October-2008, used April-2006 Echosounder (DDSSM)	June-2008 Echosounder Method (DDSSM)	June-2008 Echosounder Method (DDSSM)			

Hydrographic Hardware Inventory

Field Unit: FAIRWEATHER

Effective Date: 4/23/2008

Updated Through: 10/15/2008

SONAR & SOUNDING EQUIPMENT

Equipment Type	Manufacturer	Model	Serial Number	Firmware and/or Software Version	Version Install Date	Location	Date of last Calibration	Date of last Service	Additional Information
Processor	Odom Hydrographic	Echotrac CVM	26034	Version: 4.01	May-08	2302/1706		N/A	New unit may 2008
Transducer (2)	Odom Hydrographic	SMBB200-4A	TR5162/TR5159	N/A	N/A	2302/1706	N/A	N/A	Two 4 degree (large)
Transducer (2)	Odom Hydrographic	SMBB200_9	TR5138/TR5139	N/A	N/A	2302/1706	N/A	N/A	Two 9 degree (small)
Processor	Reson	81-P (8111)	35652	N/A	May-04	S220	N/A		Bar Code : CD0001065312
Processor	Reson	81-P (8160)	35385	N/A	May-04	S220	N/A		Bar Code : CD0001065313
Transducer	Reson	8111ER	unknown	Dry: 8111-E209-6114 Wet: 8111-E101-AFAA	Apr-04	S220	4/20/2006		
Transducer	Reson	8160	unknown	Dry: 8160-2.09-7C6D Wet: 8160-1.00-E9E1	Apr-04	S220	incomplete		
Processor	Reson	81-P	34497	N/A	Jul-04	1010	N/A		Bar Code : CD0001065351
Transducer	Reson	8101 ER	2701011	Dry: 8101-2.09-E34D Wet: 8101-1.08-C215	Jul-04	1010	4/10/2006		
Processor	Reson	81-P	35737	N/A	Jul-04	1018	N/A		Bar Code : CD0001065349
Transducer	Reson	8101 ER	3102026	Dry: 8101-2.09-E34D Wet: 8101-1.08-C215	Jul-04	1018	incomplete		
Lead Line	FA Personnel	Traditional	10_01_04	N/A	N/A	any	6/11/2008		
Lead Line	FA Personnel	Traditional	10_01_05	N/A	N/A	any	6/11/2008		
Lead Line	FA Personnel	Traditional	10_02_05	N/A	N/A	any	6/11/2008		
Lead Line	FA Personnel	Traditional	20_01_05	N/A	N/A	any	6/11/2008		
Lead Line	FA Personnel	Traditional	20_02_05	N/A	N/A	Ambar	5/30/2008		
Lead Line	FA Personnel	Traditional	20_03_05	N/A	N/A	any	3/26/2007		
Lead Line	FA Personnel	Traditional	30_01_05	N/A	N/A	any	4/9/2007		
Lead Line	FA Personnel	V-100/Non-Traditional	pending	N/A	N/A	any	incomplete		work in progress
Lead Line	FA Personnel	V-100/Non-Traditional	pending	N/A	N/A	any	incomplete		work in progress
Divers Least Depth Gauge	PTC	MODIII	68322	N/A	N/A	S220	4/2/2008	4/2/2008	
Odom Echotrac CVM	Odom Hydrographic	ETCVM-A	26034	ET-CVM COM Ver 3.29 DSPDual Ver 3.28		any			Bar Code: CD0001703210, ChartView Dongle (100.001.001.098)

POSITIONING & ATTITUDE EQUIPMENT									
Equipment Type	Manufacturer	Model	Serial Number	Firmware and/or Software Version	Version Install Date	Location	Date of last Calibration	Date of last Service	Additional Information
POS/MV PCS	Applanix	320 V.4	2411	HW2.9-7, SW03.42 POS Cntrlr v. 3.4.0.0	Jun-08	S220 IP:129.100.1.231	4/24/2008		Bar Code : CD0001697462 Auth. No. 811025-00534537
POS/MV IMU	Applanix	LN200	292	N/A	Apr-04	S220			Bar Code : CD0001696450
POS/MV Port Ant.	Applanix	OEM2 3151R	BD950 SN:4611A66708 v.00211	HW1	Apr-04	S220			
POS/MV Stbd Ant.	Applanix	OEM2 3151R	BD950 SN:4602A62806 v.00211	HW1	Apr-04	S220			
DGPS Receiver	CSI Wireless	MBX-3S	0426- 16627- 0001	N/A	Jul-04	S220			
DGPS Antenna	CSI Wireless	MGL3		N/A	Apr-04	S220			
POS/MV PCS	Applanix	320 V.4	2564	HW 2.6-7, SW 03.42 POS Cntrlr v. 3.4.0.0	Jun-08	1010 IP:129.100.1.231	6/9/2008	1/15/2008	Bar Code : CD0001601275
POS/MV IMU	Applanix	LN200	294	N/A	Jul-04	1010			Bar Code : CD0001696449
POS/MV Port Ant.	Applanix	OEM2 3151R	S/N 60162863	HW1	Mar-07	1010			
POS/MV Stbd Ant.	Applanix	OEM2 3151R	S/N 60145247	HW1	Mar-07	1010			
DGPS Receiver	CSI Wireless	MBX-3S	0331-12579-0008	N/A	Jul-04	1010			
DGPS Antenna	CSI Wireless	MGL3	0331-12579-0009	N/A	Jul-04	1010			
POS/MV PCS	Applanix	320 V.4	2560	HW 2.6-7, SW 03.42 POS Cntrlr v. 3.4.0.0	Jun-08	1018 IP:129.100.1.231	8/13/2008	1/15/2008	Bar Code : CD0001601274
POS/MV IMU	Applanix	LN200	007	N/A	Feb-07	1018			Bar Code : CD0000832907
POS/MV Port Ant.	Trimble	39105-00 DC 4618	S/N 60145158	N/A	Feb-07	1018			
POS/MV Stbd Ant.	Trimbe	39105-00 DC 4604	S/N 60130644	N/A	Feb-07	1018			
DGPS Receiver	CSI Wireless	MBX-3S	0328-12362-0001	N/A	Jul-04	1018			
DGPS Antenna	CSI Wireless	MGL3	0328-12352-0002	N/A	Jul-04	1018			
StarFire Receiver	NavCom	SF-2050R		Unknown	Jul-08	S220		September-08	CD0001697402
Trimble Backpack 1	Trimble	Pathfinder Pro XRS	0224078543	Firmware v1.96 RevA	8-Mar	S220			Bar Code: CD0001269835
Trimble Backpack 1: Antenna	Trimble	33580-50	0220341062	N/A	N/A	S220			no Bar Code
Trimble Backpack 2	Trimble	Pathfinder Pro XRS	0224090101	Firmware v1.96 RevA	8-Mar	S220			Bar Code: CD0001269836
Trimble Backpack 2: Antenna	Trimble	33580-50	0220321059	N/A	N/A	S220			no Bar Code
Handheld data collector	Trimble	TSCe	37318	N/A	N/A	S220			no Bar Code , PN 45268-50
Laser	Laser Tech Inc.	Impulse Laser Rangefinder	i09290	N/A	N/A	S220			Bar Code: CD0001269812
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	001481	N/A	N/A	S220			no Bar Code
Laser	Laser Tech Inc.	TruPulse 200 Laser Rangefinder	000676	N/A	N/A	S220			no Bar Code
Antenna cable	Trimble		P/N22628			S220			
Camcorder Batteries	Trimble		P/N17466			S220			
NMEA/RTCM cable	Trimble		P/N30232-00			S220			
data/power cable	Trimble		P/N30231-00			S220			
dual battery cable	Trimble		P/N24333			S220			
GPS Pathfinder field device cable	Trimble		P/N45052			S220			

SOUND SPEED MEASUREMENT EQUIPMENT

Equipment Type	Manufacturer	Model	Serial Number	Firmware and/or Software Version	Version Install Date	Location	Date of last Calibration	Date of last Service	Additional Information
Moving Vessel Profiler winch	Brooke Ocean Technology Inc.	MVP-200-5	10328			S220			
Moving Vessel Profiler fish	Brooke Ocean Technology Inc.	MVP-FFF-SS-32-1	10478			S220			
Moving Vessel Profiler fish	Brooke Ocean Technology Inc.	MVP-FFF-SS-32-1	10329			S220			
Moving Vessel Profiler sensor	Brooke Ocean Technology Inc.	Smart SV +P	5229			S220	8/2/2008	8/2/2008	
Moving Vessel Profiler sensor	Brooke Ocean Technology Inc.	AML SV +P	4986			S220	1/13/2006	1/13/2006	
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4585	1.4D		S220	12/12/2007	12/12/2007	CON files: 4585.con
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4617	1.4D		1010 or 1018	12/13/2007	12/13/2007	CON files: 4617.con
SEACAT Profiler	Sea-Bird	SBE 19plus	19P36026-4616	1.4D		1010 or 1018	12/13/2007	12/13/2007	CON files: 4616.con
Micro Thermosalinograph	Sea-Bird	SBE 45 (TSG)	4536628-0117	N/A	N/A	S220	1/8/2008	1/9/2008	P/N 4536628

TIDES & LEVELING EQUIPMENT

Equipment Type	Manufacturer	Model	Serial Number	Firmware and/or Software Version	Version Install Date	Location	Date of last Calibration	Date of last Service	Additional Information
Level	Carl Zeiss	N12 333	100056	N/A	N/A	S220	March 2008	March 2008	
Level	Carl Zeiss	N12 333	103567	N/A	N/A	S220	March 2008	March 2008	
Level	Leica	NA2 100	5332739	N/A	N/A	S220			Spare
Level	Lecia	NA2 100	5332747	N/A	N/A	S220			Spare

HORIZONTAL AND VERTICAL CONTROL EQUIPMENT									
Equipment Type	**Manufacturer**	**Model**	**Serial Number**	**Firmware and/or Software Version**	**Version Install Date**	**Location**	**Date of last Calibration**	**Date of last Service**	**Additional Information**
Reciever	Magellan	Z-Max.Net	200709006	MD00		S220	8/19/2008		
GPS Antenna	Thales Navigation		20071410861	N/A	N/A	S220	8/19/2008		
Receiver	Ashtech	Z-Xtreme	ZE1200339016	ZE21	Mar-08	S220	3/20/2007	obtained April 2004	Bar Code: CD0001062363
GPS Antenna	Ashtech	Geodetic 4	8365	N/A	N/A	S220	3/20/2007	obtained April 2004	
Position Data Link High Powered Base Unit	Pacific Crest	PDL 4135	0424 0171	2.40	Apr-04	S220	5/3/2007	obtained April 2004	Bar Code: CD0001269910
Position Data Link Rover	Pacific Crest	PDL 4100	04240154	2.4	Apr-04	S220	5/3/2007	obtained April 2004	
Position Data Link Rover	Pacific Crest	PDL 4100	03473047	2.32	Apr-04	S220	5/3/2007	obtained April 2004	
Position Data Link Rover	Pacific Crest	PDL 4100	04240155	2.4	Apr-04	S220	5/3/2007	obtained April 2004	
Marine Deep Cycle Battery	Magnatron					S220		purchased July 2004	
Solar Panel	Uni-Solar	FLX-32	USF-32-14639	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14634	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14633	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14529	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14631	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14625	N/A	N/A	S220			no Bar Code
Solar Panel	Uni-Solar	FLX-32	USF-32-14645	N/A	N/A	S220			no Bar Code
Solutions Dongles	Ashtech	600586 (A)	KEB2083	N/A	N/A	S220			
Solutions Dongles	Ashtech	600586 (A)	KEB2077	N/A	N/A	S220			
GPS Receiver	Trimble	DSM-232	22511661	3.57	Mar-08	S220			Bar Code: CDCD0001697434
GPS Receiver	Trimble	DSM-232RS	225111655	3.57	Mar-08	S220			Bar Code: CDCD0001697422, DGPS Reference Station
DGPS Antenna	Trimble	33580-00	220395038	N/A	N/A	S220			
GPS Antenna	Trimble	Geodetic Reference Station Antenna	30325441	N/A	N/A	S220			

OTHER EQUIPMENT									
Equipment Type	**Manufacturer**	**Model**	**Serial Number**	**Firmware and/or Software Version**	**Version Install Date**	**Location**	**Date of last Calibration**	**Date of last Service**	**Additional Information**
Penetrometer	Brooke Ocean Technology Inc.	FFCPT-35-2	10416			S220			
Penetrometer sensor	Brooke Ocean Technology Inc.	AML SV +P	191-3			S220			

FAIRWEATHER Computers													
Machine Name	**Location**	**Make/Model**	**Operationg System**	**Date Purchased**	**Date of Last Rebuild**	**Processor Speed**	**RAM (original)**	**RAM (checked March 2006)**	**Number of Video Outputs**	**Video RAM**	**Service Tag**	**Barcode**	**Comments**
FA_Proc_1	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	9MP1PD1	CD0001615385	New DELL deskptop installed week of 12/4/07
FA_Proc_2	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	4NP1PD1	CD0001615382	New DELL deskptop installed week of 12/4/07
FA_Proc_3	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	6MP1PD1	CD0001615383	New DELL deskptop installed week of 12/4/07
FA_Proc_4	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	2NP1PD1	CD0001615380	New DELL deskptop installed week of 12/4/07
FA_Proc_5	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	3MP1PD1	CD0001615381	New DELL deskptop installed week of 12/4/07
FA_Proc_6	Plot Room	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	1JKCZF1	CD0001615471	New DELL deskptop installed week of 04/06/08
FA_Proc_7*	Plot Room	DELL Precision 490	XP Pro 2002 SP2	Nov-07		2.66 GHz	3GB		2	256 MB	8MP1PD1	CD0001615384	New DELL deskptop installed week of 12/4/07
FA_Proc_8	Plot Room	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	5JKCZF1	CD0001615467	New DELL deskptop installed week of 04/14/08
FA_Proc_9	Plot Room	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	3JKCZF1	CD0001615472	New DELL deskptop installed week of 04/06/08
FA_Proc_10	DP-2	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	JHKCZF1	CD0001615468	New DELL deskptop installed week of 04/06/08
FA_CST	Field Office	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	4JKCZF1	CD0001615469	New DELL deskptop installed week of 04/06/08
FA_FOO	Field Office	Dell Precision T3400	XP Pro 2002 SP2	Apr-08		3.0GHz	3GB		2	512MB	DHKCZF1	CD0001615470	New DELL deskptop installed week of 04/06/08
FA_O-LAB*	O-LAB	Dell Prcision 360	XP Pro 2002 SP2			3.0GHz	3.5GB		2	128MB	GBBG451	CD0001741480	
FA_Mobile1	Laptop	DELL Inspiron 1100	XP Pro 2002 SP2	~ March 2004	~ September 2005	2.4 GHz	2.5 GB	2.5 GB	1	64 MB	HGHWM41	CD0001272964	
FA_Mobile2	Laptop	DELL Inspiron 1101	XP Pro 2002 SP2	~ March 2004	~ September 2005	2.4 GHz	2.5 GB	2.5 GB	1	64 MB	GGHWM41	CD0001272965	
Toughbook 1	Laptop	Panasonic CF-18	XP Pro 2002 SP2	~ March 2004	~ July 2006	1.1 GHz	2.5 GB	N/A	1	64 MB	4HKSA59499	CD0001269860	*rebuilt after crash July 2006
Toughbook 2	Laptop	Panasonic CF-18	XP Pro 2002 SP2	~ March 2004	~ September 2005	1.1 GHz	2.5 GB	N/A	1	64 MB	4HKSA59560	CD0001269858	
Toughbook 3	Laptop	Panasonic CF-29	XP Pro 2002 SP2	March 2006	N/A	1.6 GHz	2.5 GB	N/A	1	128 MB	6AKSB06863	CD0001698251	
Toughtab 1	Laptop	.	XP Pro 2002 SP2	~ March 2004	~ September 2005	1.1 GHz	2.5 GB	N/A	1	64 MB	4GKSA55049	CD0001269589	
1010_ACQ	Launch 1010	ICI	XP Pro 2002 SP2	Mar-08		2.66GHz	3GB		3	128MB		CD0001615466	
1018_ACQ	Launch 1018	ICI	XP Pro 2002 SP2	Mar-08		2.66GHz	3GB		3	128MB		CD0001615463	
S220_ACQ	Plot Room	Dell Precision T3400	XP Pro 2002 SP2	Mar-08		3.0GHz	3GB		3	512MB	CSH8NF1	CD0001615444	
FA_MVP200	Plot Room	MVP-C1-2001	2000 SP4	~ March 2004	~ September 2005	2.4 GHz	230 MB	230 MB	1	64 MB	SN: 10330	CD0001269854	

Hydrographic Personnel Roster

Field Unit: **FAIRWEATHER S-220**
Effective Date: **3/27/2008**
Updated Through: **10/28/2008**

OFFICERS				
Name and Grade	**Current Position**	**Years of Hydro Experience (calculated)**	**Hydro Experience Since**	**Notes**
CDR Doug Baird	Commanding Officer	15 year(s) + 9 month(s)	January-93	
LCDR Richard Brennan	Executive Officer	16 year(s) + 6 month(s)	April-92	
Eric Heiner	Third Mate	9 year(s) + 6 month(s)	April-99	
LT Matt Ringel	Field Operations Officer	6 year(s) + 2 month(s)	August-02	
ENS Llian Breen	Junior Officer	1 year(s) + 10 month(s)	December-06	departed ship Aug 30, 2008
ENS Nick Morgan	Junior Officer	1 year(s) + 10 month(s)	December-06	
ENS Mark Andrews	Junior Officer	1 year(s) + 3 month(s)	July-07	
ENS Glen Rice	Junior Officer	1 year(s) + 3 month(s)	July-07	
ENS Patricia Raymond	Junior Officer	0 year(s) + 4 month(s)	June-08	
ENS Matt Forney	Junior Officer	0 year(s) + 4 month(s)	June-08	

SURVEY DEPARTMENT				
Name and Rate	**Current Position**	**Years of Hydro Experience**	**Hydro Experience Since**	**Notes**
Lynnette Morgan	Chief Survey Technician	8 year(s) + 9 month(s)	January-00	
Brenna Campbell	Survey Technician	2 year(s) + 1 month(s)	September-06	
Adam Argento	Survey Technician	1 year(s) + 7 month(s)	March-07	
Megan Bucher	Survey Technician	1 year(s) + 1 month(s)	September-07	
Weston Renoud	Assistant Survey Tech	0 year(s) + 5 month(s)	May-08	
Tami Beduhn	Assistant Survey Tech	0 year(s) + 2 month(s)	August-08	

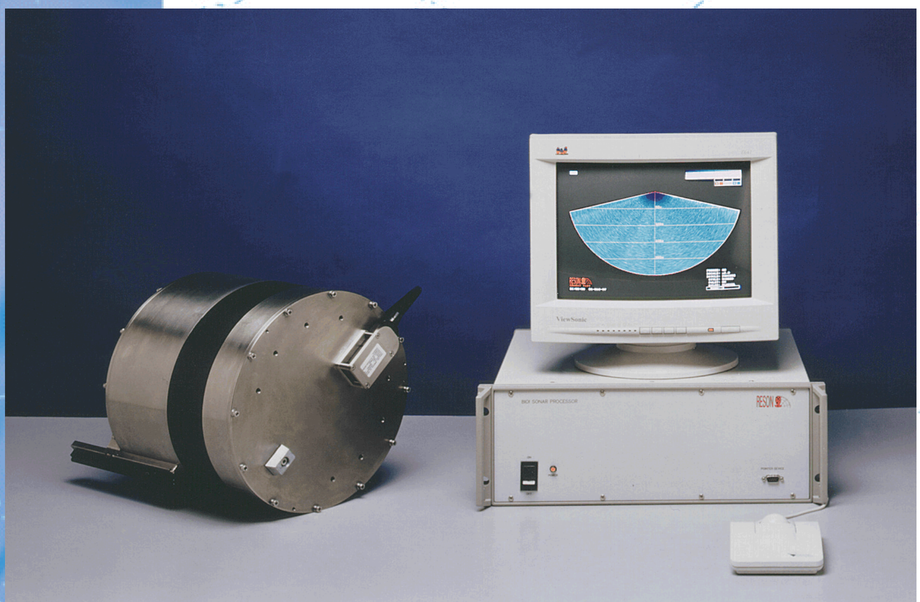
DECK DEPARTMENT (involved in survey work)				
Name and Rate	**Current Position**	**Years of Hydro Experience**	**Deck Experience Since**	**Notes**
Garry Guice	Chief Boatswain	N/A	April-82	
Ron Walker	BGL	N/A	June-84	
Emily Evans	SS	N/A	January-06	departed ship Sept 25, 2008
Chris Marcum	GVA	N/A	August-07	
Clarisse Osegueda	AB	N/A	May-08	

Appendix II

Equipment Specifications

1. **Sonar Systems**
    a. RESON
        i. 8101 Equipment Specs
        ii. 8111 Equipment Specs
        iii. 8160 Equipment Specs
    b. VBES
        i. Odom Echotrac CVM
        ii. SMBB200-9 Transducer Information
        iii. SMSW200-4a Transducer Information
2. **Positioning**
    a. POS MV
        i. v320
    b. DGPS
        i. MBX-3S
        ii. SF-2050
3. **Shoreline**
    a. Trimble
        i. Accuracy
        ii. Specs
        iii. TSCe
    b. Lasers
        i. TruPulse 200
        ii. Impulse 200 LR
4. **SV**
    a. MVP
        i. MVP 200
    b. SBE
        i. SBE 45
        ii. Specs-19p-4585
        iii. Specs-19p-4616
        iv. Specs-19p-4617
5. **Control**
    a. Leveling
        i. Leica NA2 level
        ii. Zeiss NI2 level
    b. HorCon
        i. PDL
        ii. Z-Max
        iii. Z-Xtreme Ashtech GPS
6. **Total Stations**
    a. Nikon DTM310
    b. Sokkia set5f

SeaBat 8101
PRODUCT SPECIFICATION
240kHz MULTIBEAM ECHO SOUNDER



- Phase and Amplitude Bottom Detection
- 150◦ Wide Swath Coverage
- 240 kHz Frequency
- Up to 500m Range Capability
- Portable Configuration
- Meets USACE Class 1 Standards
- Meets IHO Standards

The SeaBat 8101 Multibeam Echo Sounder measures discrete depths, enabling complex underwater features to be mapped with precision. Dense coverage is achieved utilizing up to 3,000 soundings per second for a swath that can be over 500 meters wide, even as the survey vessel travels at speeds of over 18 knots.

With high accuracy and a measurement rate up to 30 profiles per second, the SeaBat 8101 enables surveys to be completed faster and in greater detail than previously realized. The SeaBat is an integral part of the new, integrated bathymetry surveying systems.

The SeaBat transducer is available pressurized for depths from 100 to over 3,000 meters. Small and lightweight, it can be can be mounted on small un vehicles (ROV, AUV or towed) and taken to where accurate measure required.

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SeaBat 8101 Built-In Test Environment ("BITE") Screen

SYSTEM SPECIFICATIONS

Operating Frequency:	240kHz
Range Scales:	5, 10, 15, 20, 25, 35, 50, 75, 100, 125, 150, 175, 200, 250, 300, 350, 400, 450, 500m.
Range Resolution:	1.25 cm
Number of Beams:	101
Horizontal Beamwidth:	1.5°
Horizontal Coverage:	150°
Vertical Beamwidth:	1.5°
Update Rate:	Range-variable up to 30 times per second

SONAR HEAD SPECIFICATIONS

Power Requirement:	24VDC, 2 Amps max. (Power available from surface processor.)
Uplink:	Digital, 76.8 Mbaud
Down Link Control:	RS-232 or RS-422, 19,200 baud
Operating Depth:	100 meters (300m, 1500m, 3000m & 6000m avbl.)
Dimensions:	266x320mm W/Diam (does not include projector)
Temperature:	Operating: -5° to +40°C Storage: -30° to +55°C
Weight (aluminum):	Dry: 26.8 kg (59 lbs) Wet: 4.8 kg (10.6 lbs)
Weight (titanium):	Dry: 40 kg (88 lbs) Wet: 18 kg (39.6 lbs)

DISPLAY SPECIFICATIONS

Screen Size:	14 inch Diagonal
Input:	SVGA (800x600, 72 Hz)
Display:	High Resolution Color
Power Consumption:	62 W

PROCESSOR SPECIFICATIONS

Power Requirements:	115/230VAC, 50/60Hz, 100W max.
Data Output:	Selectable, 300-155.2 Kbaud or Ethernet 10 base T or 10 base 2
Video Output:	SVGA (800x600, 72 Hz) or NTSC or PAL video.
Graphics Colors:	256 colors (8-bit)
Display Mode:	Sector Format
Display Arc:	150°
Input Device:	3-Button Trackball
Dimensions:	19" rack, 4U high (266x483x434mm HWD)
Temperature:	Operating: 0° to +40°C Storage: -30° to +55°C
Weight:	20 kg (44 lbs)

SeaBat 8101 Head with Optional Fairings

OPTIONS

Option 033:	Side Scan Upgrade
Option 034:	Mounting Plate Assembly
Option 035:	Fairings (pictured above)
Option 036:	Spares Kit
Option 037:	Titanium Housing
Option 038:	210° Swath
Option 040:	Extended-Range Projector
Option 049:	Increase Transducer Depth Rating

Version 4.0
032399

RESON

Due to our policy of continuous product improvement, specifications are subject to change without notice.

SeaBat 8111

PRODUCT SPECIFICATION

MULTIBEAM ECHOSOUNDER

- **Phase and amplitude bottom detection**
- **100 kHz frequency**
- **150° swath coverage**
- **Real-time quality control**
- **Sidescan upgradeable**
- **Modular and portable**
- **Pitch stabilization**

The SeaBat 8111 is a modular multibeam echosounder system operating at 100 kHz. When installed on a vessel, it produces high-density, high-accuracy soundings on the seafloor over a 150° swath. Major system components include a transducer array, a transceiver unit, and a processor unit.

The SeaBat 8111 transducer array is comprised of a cylindrical receive array and a linear transmitter array, mounted together on a support cradle that provides mounting points to the vessel. Lightweight and portable, the array can be installed temporarily over the side of a vessel of opportunity—a first for a system in this frequency range.

The SeaBat 8111 transceiver features plug-in cards for easy maintenance and is controlled from the sonar processor.

The Seabat 8111 processor is compatible with other SeaBat sonar heads, can be updated in minutes to accommodate future requirements, and features a user-friendly point-and-click interface.

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SeaBat 8111 SYSTEM SPECIFICATIONS

SYSTEM PERFORMANCE

Frequency:	100 kHz
Range Resolution:	3.7 cm
Swath Coverage:	150º
Range:	3m to 1200m (with Option 040)
Number of Beams:	101
Along-Track Beamwidth:	1.5º 3.0º 4.5º 6.0º*
Across-Track Beamwidth:	1.5º
Stabilization:	Pitch stabilization within +/-15º
Projector Beam Control:	External motion sensor required
Accuracy:	IHO Compliant
Operational Speed:	Up to 20 knots
Max. Update Rate:	35 Hz
Transducer Pressure Rating:	100m

*operator selectable

INTERFACE

System Supply:	90 to 260VAC, 50/60 Hz, 200W max.
Video Display:	SVGA, 800 x 600, 72 Hz
System Control:	Trackball or from Ethernet
Data Output:	10 MB Ethernet or serial RS232C
Data Uplink:	High-speed digital coax with fiber-optic option
Temperature:	Operating: 0° to +40° C Storage: -30° to +55° C

RELATED PRODUCTS

- Option 040 — Extended range capabilities
- Option 033 — Sidescan upgrade
- Option 051 — 24DC power supply for SeaBat 81-P Processor

MECHANICAL INTERFACE

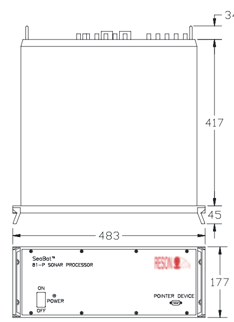
Dimensions (in mm):

Transducer Array:	
Hydrophone:	636 x 118 (Dia./Length)
Projector:	113 x 650 (Dia./Length)
Processor:	177 x 483 x 417
Transceiver:	267 x 483 x 489

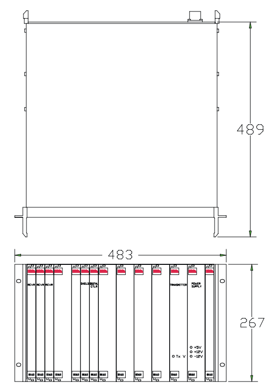
Weight:

Transducer Array:	72 kg (dry) / 59 kg (wet) with cables
Processor:	20 kg
Transceiver:	13.6 kg

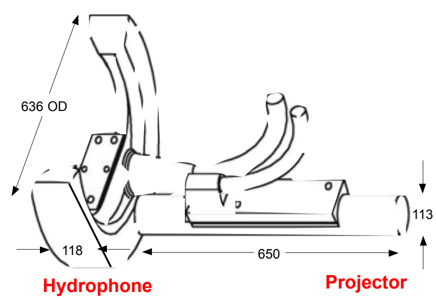
Cable Length: 15m



Processor



Transceiver



Transducer Array

SEAFLOOR COVERAGE

(with Extended Range option)

Bottom Depth (meters)	Swath Width (meters)
5 to 150	Up to 1110 (7.4 x water depth)
300	960 (3.2 x water depth)
450	810 (1.8 x water depth)
600	600 (1.0 x water depth)
750	450 (0.6 x water depth)
900	360 (0.4 x water depth)

RESON

Version: B006 030205

SeaBat 8160

PRODUCT SPECIFICATION

MULTIBEAM ECHOSOUNDER SYSTEM

- **Swath coverage greater than 4x water depth**
- **Operational depth: 10m to 3000m**
- **50 kHz frequency**
- **126 beams**
- **Hull-mount or portable**
- **Meets IHO accuracy**
- **Sidescan upgradable**

The SeaBat 8160 is a new addition to the 8100 series of multibeam echosounders. Operating at 50 kHz, the system ensonifies the whole swath in a single ping, generating 126 simultaneous high-resolution receive beams.

The SeaBat 8160 transducer array is comprised of a linear receive and transmit array mounted together on a support base. The T-shaped array geometry provides the basis for a compact, high-resolution sonar which is easily installed for portable or hull mounts—a first for a high-resolution system in this frequency range.

The system features a pitch-stabilized transmitter and an active roll-compensated receiver.

The SeaBat 8160 processor is compatible with other SeaBat sonar heads. It can be updated in minutes to accommodate future requirements, and features a user-friendly point-and-click interface.

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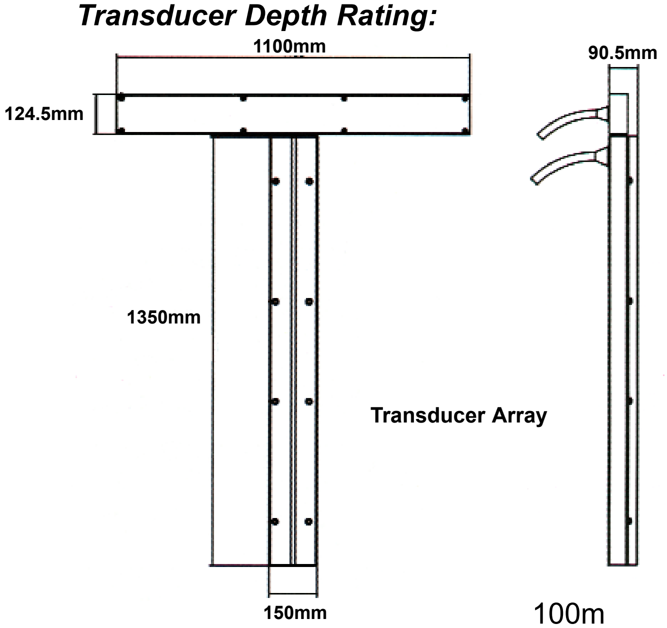
SeaBat 8160 SYSTEM SPECIFICATIONS

SYSTEM PERFORMANCE

Frequency:	50 kHz
Depth Resolution:	2.4 cm / 9.6 cm
Swath Coverage:	Greater than 4x water depth
Max Operational Depth:	3000 m
Number of Beams:	126
Along-Track Beamwidth:	1.5º
Across-Track Beamwidth:	1.5º
Pitch Stabilization:	±10º
Accuracy:	IHO Special Order
Operational Speed:	Up to 20 knots
Max. Update Rate:	15
Transducer Depth Rating:	100m



Mounting Frame
Option 034H

INTERFACE

System Supply:	115V/230V 50/60 Hz, 350W
Video Display:	SVGA, 800 x 600, 72 Hz
System Control:	Trackball or from Ethernet
Data Output:	10 MB Ethernet or serial RS232C
Data Uplink:	High-speed digital coax with fiber-optic option
Temperature:	Operating: 0° to +40° C Storage: -30° to +55° C

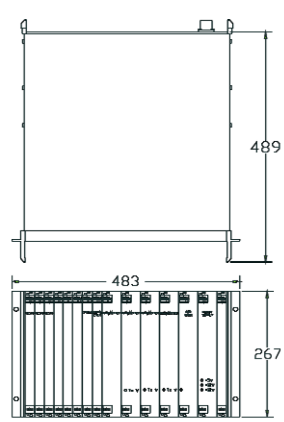
MECHANICAL INTERFACE

Dimensions (HWD in mm):

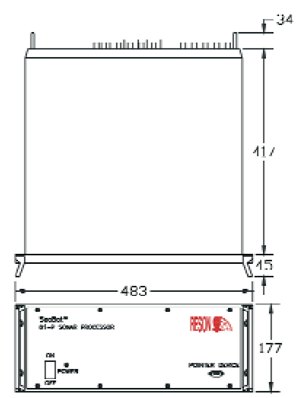
Transducer Array:	1474.5 x 1100 x 90.5
Processor:	177 x 483 x 417
Transceiver:	265 x 483 x 492

Weight:

Transducer Array:	50 kg (dry) / 30 kg (wet)
Processor:	20 kg
Transceiver:	13.6 kg



Transceiver



Processor

Version: B34-PDF-011009

Due to our policy of continuous product improvement,
RESON reserves the right change specifications without notice.

ODOM

ECHOTRAC CVM™

odom
HYDROGRAPHIC SYSTEMS

MOBILE HYDROGRAPHIC SYSTEM

- Portable carry-on case style includes a single or dual frequency echo sounder with optional DGPS receiver, notebook PC and bundled data acquisition software.
- Features include Ethernet LAN interface, frequency agile configurable transceivers, standard serial interfaces for data acquisition systems, motion sensors and DGPS receivers.

ODOM

ECHOTRAC CVM™

The rugged and weatherproof **Echotrac CVM™** outperforms other echo sounders in its class, offering the utmost in portability without sacrificing Odom performance standards.

With dual or single frequency configurations, optional built-in DGPS and bundled notebook PC and your choice of data acquisition software, the **CVM™** has everything you need in an echo sounder – even when portability isn't an issue.

Buy Odom – invest in your peace of mind.

SPECIFICATIONS

Frequency
- High band: 100 kHz – 340 kHz
- Low band: 24 kHz – 50 kHz

Output Power
- High: 200 kHz – 400 W RMS max
- Low: 33 kHz – 200 W RMS max

Input Power
- 12 to 24 V DC (nominal) 15 watts
- 110 or 220 V AC

Resolution
- 0.01 m/0.1 ft

Accuracy
- 0.01 m / 0.10 ft +/- 0.1% of depth @ 200 kHz
- 0.10 m / 0.30 ft +/- 0.1% of depth @ 33 kHz

Depth Range
- 0.2 – 200 m / 0.5 – 600 ft. @ 200 kHz
- 0.5 – 600 m / 1.5 – 1968 ft. @ 200 kHz

Phasing
- Automatic scale change, 10%, 20%, 30% overlap or manual

Sound Velocity
- 1370 – 1700 m/s
- Resolution 1 m/s

Transducer Draft Setting
- 0 – 15 m (0 – 50 ft)

Depth Display
- On control PC

Clock
- Internal battery backed time, elapsed time and date clock

Annotation
- Internal – date, time, GPS position
- External – from RS232 or Ethernet

Interfaces
- 2 x RS232
- Inputs from external computer, motion sensor, sound velocity
- Outputs to external computer
- Ethernet interface
- Heave – TSS and sounder sentence

Blanking
- 0 to full scale

Software
- Echotrac Control software
- ChartView display and logging software

Help
- The function of each parameter and its minimum and maximum values can be displayed.

Environmental Operating Conditions
- 0° – 50° C, 5 – 90% relative humidity, non-condensing

Dimensions
- 53 cm (20.75 in) W x 44 cm (17.25 in) D x 21.5 cm (8.5 in) H

Weight
- 13.8 kg (31 lbs)

Options
- One or two acoustic channels
- Side scan transducer – single or dual channel side looking 200 kHz or 340 kHz for search and reconnaissance
- Built-in DGPS
- Ruggedized notebook PC bundled with data aquisition software

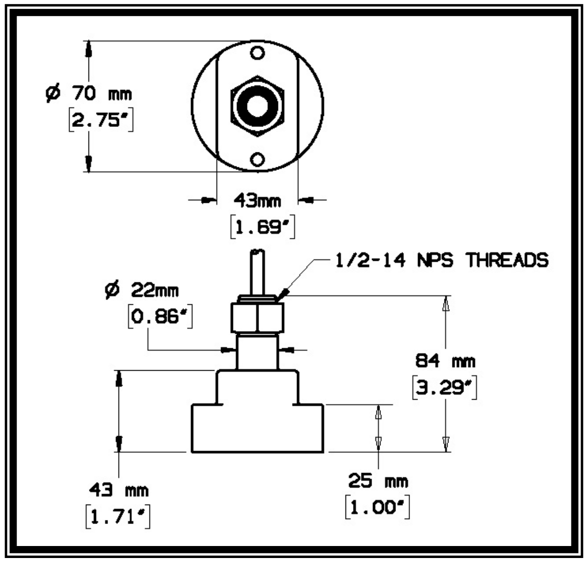
odom
HYDROGRAPHIC SYSTEMS

1450 Seaboard Avenue
Baton Rouge, Louisiana 70810-6261 USA
E-mail: email@odomhydrographic.com
www.odomhydrographic.com

odomhydrographic.com

Odom Hydrographic Systems, Inc.
1450 Seaboard Avenue
Baton Rouge, LA. 70810 –6261
225.769.3051, Facsimile 225.766.5122

SMBB200-9



Performance Data

Frequency	200kHz - BClq
Beam Width	9°
Q (transmit)	2.5
Rated RMS Power	500 W
Balanced Impedance	60 ohms
Peak Figure of Merit	-16
Bandwidth	
Acoustic Window Material	Urethane
Threads	½" –14NPS
Cable Type	C33 (2-20 AWG)
Cable Size	6mm
Weight	1.3Kg.

Broadband with superlow Q of 2.5. Small housing with short stem used primarily for navigation and survey applications. This model is usually mounted on an extension tube but is adaptable to portable survey and navigation systems. It contains a transformer which can be used to match the impedance of the echosounder or allow the use of longer cables. The transducer is available in either a bronze or stainless steel housing. Model SS510 provides good definition in hard bottoms with side lobes.

odomhydrographic.com

Odom Hydrographic Systems, Inc.
1450 Seaboard Avenue
Baton Rouge, LA. 70810 –6261
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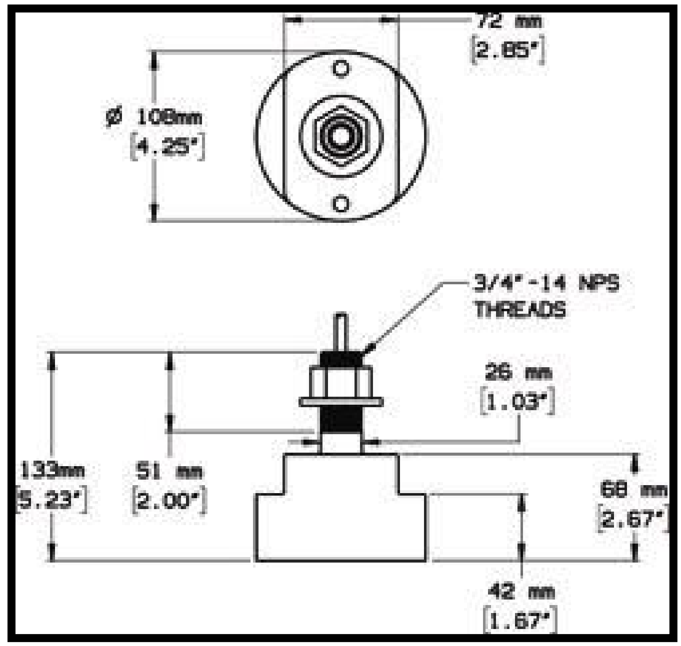
SMSW200-4a



Performance Data

Frequency	200kHz
Beam Width	4°
Q (transmit)	
Rated RMS Power	
Balanced Impedance	60 ohms
Peak Figure of Merit	
Bandwidth	
Acoustic Window Material	Urethane
Threads	¾" –14NPS
Cable Type	C37 (2-20 AWG)
Cable Size	6mm
Weight	1.3Kg.

The compact stainless steel housing is easily adapted to portable or hull mounted applications. This unit is primarily used for shallow and mid-depth survey applications where delineation of steep slopes and sounding in very shallow water are important features. It contains a transformer that matches the impedance of the transducer to that of the echo sounder and allows for the use of longer cables without affecting performance.

POS MV™ **marine vessels**

DATASHEET

The New POS MV - Providing the Marine Industry with robust, reliable, and repeatable position and orientation solutions

The new POS MV V4 - a tightly-coupled system utilizing advanced Inertially-Aided Real-Time Kinematic (IARTK) technology designed to increase your operational capability and reduce downtime.

Tightly integrated inertial navigation – Continuous positioning data can be generated while surveying in areas where GPS reception is compromised by multipath effect and signal loss, such as close to offshore structures, or in ports, harbors, near-shore coastal waters and rivers. Raw GPS data from as few as one satellite can now be processed directly within the POS MV reducing position drift and RTK re-acquisition time.

The V4 Advantage

The Major Benefits

- Faster, more robust heading aiding from GPS Azimuth Measurement Subsystem (GAMS) when compared to V3
- Proprietary Inertially Aided RTK providing almost instantaneous reacquisition of RTK following a GPS outage
- Superior low elevation tracking performance using lighter, smaller Trimble Zephyr ™ geodetic antenna technology
- Faster initial system calibration
- Maintains heading accuracy longer when in a high multipath environment
- Increased component reliability
- Automatic identification and error estimation for lever arm distances and angles

The Latest Technology
V4 uses the latest Trimble BD950 receivers with the following attributes:

- Extremely fast response time
- Latency of less than 20 milliseconds (at 20 times per second)
- Very low noise L1 and L2 carrier phase measurements
- Uses the Maxwell 4 Custom Survey GPS chip for enhanced tracking capability

Straightforward Installation and Operation

- All components mounted and installed using a straightforward, one-time-only, systematic procedure.

Faster, More Reliable Networking Potential

- An improved Ethernet raw data logging capability for streamlined data acquisition of all motion variables with microsecond-accurate time stamping

Upgradeability*

- Convenient upgrade program for PCS and antennas, to allow for maximum interoperability when moving from L1 only to a full L1/L2 RTK unit

The Most Accurate Position and Orientation Solution
POS MV V4 maintains positioning accuracy under the most demanding conditions regardless of vessel dynamics. With its high data update rate, the system delivers a full six degree-of-freedom position and orientation solution to provide the following:

- Position (latitude, longitude and elevation)
- Velocity (north, east and vertical)
- Attitude (roll, pitch and true heading)
- Heave (real-time, delayed)
- Acceleration Vectors
- Angular Rate Vectors

** For detailed upgrade information please call your Applanix Marine office*

SYSTEM COMPONENTS

POS Computer System (PCS) – A rugged, compact computer system contains the core POS processor and IMU interface electronics, plus two GPS receivers and an optional removable PC-card disk drive. The PCS provides system timing, position and velocity aiding, together with GPS raw observables for use with GAMS.

POS Inertial Measurement Unit – The system's primary sensor allows for the continuous output of position and orientation data.

Primary GPS Receiver Antenna – A dual frequency antenna for use with GAMS.

Secondary GPS Receiver Antenna – A dual frequency antenna for use with GAMS.

APPLANIX™
A TRIMBLE COMPANY

POS MV™ marine vessels

SPECIFICATIONS

Accuracy

POS MV 320 Main Specifications (with Differential Corrections)

Roll, Pitch accuracy:	0.02° (1 sigma with GPS or DGPS)
	0.01° (1 sigma with RTK)
Heave Accuracy:	5 cm or 5% (whichever is greater) for periods of 20 seconds or less
Heading Accuracy:	0.02° (1 sigma) with 2 m antenna baseline, 0.01 (1 sigma) with 4 m baseline
Position Accuracy:	0.5 - 2 m (1 sigma) depending on quality of differential corrections
	0.02 - 0.10 m (RTK) with input from auxiliary RTK or optional internal RTK receiver
Velocity Accuracy:	0.03 m/s horizontal

POS MV 320 during GPS Outages

Roll, Pitch accuracy:	0.02° (1 sigma)
Heave accuracy:	5 cm or 5% (whichever is greater) for wave periods of 18s or less
Heading accuracy:	Drift less than 1° per hour (negligible for outages < 60s)
Position accuracy degradation:	2.5 m (1 sigma) for 30 s outages <6 m (1 sigma) for 60 s outages

POS MV 220 Main Specifications (with Differential Corrections)

Roll, Pitch accuracy:	0.05° (1 sigma with GPS or DGPS)
	<0.05° (1 sigma with RTK)
Heave Accuracy:	5 cm or 5% (whichever is greater) for periods of 20 seconds or less
Heading Accuracy:	0.1° (1 sigma) with 2 m antenna baseline, 0.05° (1 sigma) with 4 m baseline
Position Accuracy:	0.5 - 4 m (1 sigma) depending on quality of differential corrections
	0.02 – 0.10 m (RTK) with input from auxiliary RTK or optional internal RTK receiver
Velocity Accuracy:	0.05 m/s horizontal DPGS, .03 m/s horizontal RTK

POS MV 220 during GPS Outages

Roll, Pitch accuracy:	0.05° (1 sigma)
Heave accuracy:	5 cm or 5% (whichever is greater) for wave periods of 18s or less
Heading accuracy:	Drift less than 3° per hour (negligible for outages < 60s)
Position accuracy degradation:	2.5 m (1 sigma) for 30 s outages <6 m (1 sigma) for 60 s outages

Physical Characteristics

Size

IMU:	204 mm X 204 mm X 168 mm	7.95 in X 7.95 in X 6.55 in
PCS:	432 mm X 89 mm X 356 mm	17.00 in X3.50 in X 14.05 in
	2.0U 19 in rack mount	
GPS Antenna (x2):	187 mm X 53 mm	7.4 in X 2.1 in

Weight

IMU:	3.5 kg	7.7 lb (international)
Processor:	5 kg	11.0 lb (international)
GPS Antenna:	<0.5 kg	<1.1 lb (international)

Power

Processor:	110/230 Vac, 50/60 Hz, auto-switching 80 Watt
IMU:	Power provided by PCS
GPS Antennas:	Power provided by PCS

Environmental

Temperature Range (Operating)

IMU:	-40 °C to +60 °C	-40 °F to +140 °F
Processor:	0 °C to +55 °C	+32 °F to +131 °F
GPS Antenna:	-40 °C to +70 °C	-40 °F to +158 °F

Temperature Range (storage)

IMU:	-40 °C to +60 °C	-40 °F to +140 °F
Processor:	-25 °C to +85 °C	-13 °F to +185 °F
GPS Antenna:	-50 °C to +70 °C	-58 °F to +158 °F

Humidity

IMU:	10 - 80% RH, Ingress Protection of 65
Processor:	10 - 80% RH, non-condensing
GPS Antenna:	0 - 100% RH

Shock & Vibration (IMU)

Operating:	90 g, 6 ms terminal saw tooth
Non-Operating:	220 g, 5 ms half-sine

Applanix Marine Offices

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85 Leek Crescent
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17461 Village Green Drive, Houston TX 77040
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REPAIR REPORT

TO: NOAA- Ship Fairweather
1801 Fairview Ave E.
Seattle, WA 98102

RMA #: **L07-024**

Date: 15 January, 2008

Repaired By: Bruce A. Francis

TEL: 713-896-9900

ATTN: Larry Loewen
TEL:
FAX:

PART NO.	DESCRIPTION	SERIAL NUMBER
PCS-29	POSMV 320 V4	2560
PCS-29	POSMV 320 V4	2564

ORIGINAL COMPLAINT / FAULT DESCRIPTION / VERIFICATION
IMU errors, GPS data gaps.

ITEM	REPAIR DETAILS
1	We were able to reproduce problems with both PCS units in the shop- intermittant IMU failures.
2	Found resistor R9 on the power supply board not soldered correctly. This has been identified as a fault in POS systems and have confirmed that these serial numbered units did received the faulty batch of power supplies with this problem.
3	Resoldered R9 and retested both systems on the bench for a number of days. No faults observed.
4	Installed latest firmware version 3.42 on both units whereas the previous version was 3.41. Version 3.42 adds ASCII IP address output to COM5 at bootup only to identify setting should it get changed by previous user.
5	
6	
7	
8	
9	
	Please verify all settings before use

ITEM	QTY	MATERIAL	
1	16hrs	Labor	N/C

ADDITIONAL INFORMATION & COMMENTS
As this issue with R9 was of our own making, there is no charge for this repair.

MBX-3S

The most popular commercial-grade Coast Guard Beacon Receiver

- Dual-channel Coast Guard beacon receiver
- Supplements GPS systems with free differential corrections, enhancing accuracy
- Fast signal acquisition
- Wide input voltage range for a variety of power sources
- Low power consumption extends battery life
- Automatic tuning mode for hands-free operation
- Integrated signal splitter outputs GPS signal from combined GPS /differential antennas
- Front-panel interface for easy configuration and status monitoring

ESRI Technology
AUTHORIZED BUSINESS PARTNER

csi wireless™
www.csi-wireless.com

MBX-3S

The most popular commercial-grade DGPS Beacon Receiver

Receiver Specifications

Channels:	2 independent channels
Channel Spacing:	500 Hz
Frequency Range:	283.5 to 325.0 Hz
MSK Bit Rates:	50, 100, 200 bps
Cold Start Time:	<1 min
Warm Start Time:	<2 seconds
Demodulation:	Minimum shift keying
Sensitivity:	2.5 µV/m for 6 dB SNR
Dynamic Range:	100 dB
Frequency Offset:	±8 Hz (27 ppm)
Adjacent Channel Rejection:	61 dB f_o ± 400 Hz
Correction Output Protocol:	RTCM SC-104
Input Status Protocol:	NMEA 0183

Communications

Interface:	RS-232C or RS-422
Baud Rates:	2400, 4800, 9600

Environmental Specifications

Operating Temperature:	-30°C to +70°C
Storage Temperature:	-40°C to +80°C
Humidity:	95% non-condensing
EMC:	EN 60945 EN 50081-1 EN 50082-1 FCC: Part 15, sub-part J, class A digital device

Power Specifications

Input Voltage Range:	9 to 40 VDC
Nominal Power:	2.5 W
Nominal Current:	210 mA
Antenna Voltage Output:	10 VDC (5 VDC optional)
Antenna Input Impedance:	50 Ω

Mechanical Specifications

Dimensions:	150 mm L x 125 mm W x 51 mm H (5.9" L x 4.9" W x 2.0" H)
Weight:	0.64 kg (1.4 lb)
Display:	2-line x 16-character LCD
Keypad:	3-key switch membrane
Power Connector:	2-pin circular locking
Data Connector:	DB9-S
Antenna Connector:	BNC-S
Optional GPS Output Port:	TNC-S

Operating Modes

MBX-3 Mode (Default):	RTCM SC-104 correction and NMEA status message output (Default Mode)
MBX-E Mode:	RTCM SC-104 correction and NMEA status message output and GPS NMEA message input for position and satellite status display

NMEA 0183 I/O

- Receiver Automatic and Manual tune command
- Frequency and data rate query
- Receiver performance and operating status queries
- Automatic search almanac queries (proprietary)
- Baud rate selection command
- Receiver tune command
- Force cold start command (proprietary)
- Software upgrade command (proprietary)
- Configuration up-load command (proprietary)

Accessories

Antenna:	Various
Power Cables:	Various
Antenna Cables:	Various
Data Cables:	Various
CSI Beacon Command Center:	MS Windows 95® beacon control software

Pin-out

RS, 232C (DB9 PIN#)

Pin 2	TXD, RTCM SC-104/Status Output
Pin 3	RXD, configuration input
Pin 5	Signal return

RS-422 (DB9 PIN#)

Pin 1	TXD +, RTCM SC-104 / Status Output
Pin 2	TXD -, RTCM SC-104 / Status Output
Pin 4	RXD -, configuration input
Pin 5	Signal return
Pin 7	RXD +, configuration input

Warranty: Each CSI Wireless product is covered by a limited one-year warranty on parts and labor.

CSI Wireless Dealer

Avery label #05260 (laser print)

Printed in Canada.

csi wireless™

4110 - 9th Street SE • Calgary • AB • Canada • T2G 3C4
Phone (403) 259•3311 • Fax (403) 259•8866

SF-2050G
SF-2050M

NavCom's SF-2050G and SF-2050M modular StarFire™ receivers provide instant position information for decimeter-level position accuracy, anywhere in the world, anytime. Onboard memory, and a geodetic quality antenna enable millimeter level accuracy from post-processing.

APPLICATIONS

The rugged and reliable SF-2050 series is designed for productivity with minimal setup time. The SF-2050G is designed for backpack GIS and mapping applications while the SF-2050M is ideal for vehicle mounting to suit a wide variety of machine guidance and control applications. The primary operating mode uses the StarFire™ service, and offers decimeter level accuracy for immediate results in the field; great for navigation and relocation of existing assets. The two onboard WAAS/EGNOS channels provide free GPS corrections, which coupled with dual frequency measurements and NavCom's enhanced SBAS algorithm typically provides half-meter real-time accuracy. Simply connect your controller solution to the serial port and receive NMEA format position information, or use a NavCom Partner controller solution for additional configuration and monitoring capabilities.

BENEFITS

The SF-2050 receivers use our NCT-2100D GPS Engine, the fourth generation of the Touchstone™ ASIC family, of which more than 25,000 are in use worldwide. This incorporates our patented interference suppression and multi-path mitigation, up to 50Hz raw data rate, geodetic quality measurements, and up to 25Hz positioning.

The SF-2050 utilizes a compact tri-band antenna capable of receiving GPS and StarFire signals. This antenna provides excellent phase center stability in a small, robust, lightweight format.

Coupled with NavCom Technology's StarFire subscription service, the SF-2050 delivers 10 cm position fixes without the use of a second receiver serving as a base station. Add the RTK option to your SF-2050, and an external radio capable of receiving RTK corrections from a Base station, and now your SF-2050 is able to do RTK level surveys for unsurpassed accuracy.

FLEXIBLE INTERFACE

The SF-2050 receivers are easily configured by the provided Windows®-based utility program. For system integrators needing maximum flexibility, the receivers offer a binary user interface that allows for complete command and control of the GPS and L-Band Module, thus enabling customization of the interface and receiver operation. The sensor can receive GPS corrections in NCT (NavCom's ultra compact binary format), RTCM and CMR thus permitting optimum correction source usage with seamless position output.

FEATURES

- Fully integrated receiver in robust housing
- "All-in-view" tracking on 26 channels (12 L1/L2 GPS + 2 SBAS)
- Global decimeter level accuracy using StarFire™ corrections
- Fully automatic acquisition of StarFire broadcast corrections
- Two dedicated WAAS/EGNOS channels
- L1 & L2 full wavelength carrier phase tracking
- C/A, P1 & P2 code tracking
- 64MB internal memory for data recording
- User programmable measurement and navigation data rates
- Minimal data latency
- Superior interference suppression
- Patented multipath rejection
- Output format NMEA 0183 or NavCom binary format
- CAN bus interface (SF-2050M Only)
- 1PPS Output (SF-2050M Only)
- Event Marker (SF-2050M Only)
- TruBlu™ Wireless Connectivity, Bluetooth® compatible

UPGRADES

- Raw measurement data rates up to 50Hz
- Positioning rates up to 25Hz
- RTK positioning rates up to 25Hz (external comm-link required)
- RTK Extend™ - RTK positioning during comm. outages

Modular GPS and StarFire™ receiver provides worldwide decimeter level accuracy anywhere, anytime

NAVCOM
A John Deere Company

www.navcomtech.com

20780 Madrona Avenue, Torrance, CA 90503 • tel: + 1 310.381.2000 • fax: + 1 310.381.2001 • sales@navcomtech.com

SF-2050 Series
TECHNICAL SPECS

PHYSICAL/ENVIRONMENTAL

- Size (L x W x H): ....8.18in x 5.67in x 3.06in (208mm x 144mm x 78mm)
- Weight: ....4lbs (1.81 kg)
- External Power:
  Input Voltage: ....10 VDC to 30 VDC
  Consumption: ....< 8 W
- Connectors:
  I/O: ....2 x 7 pin Lemo
  DC Power: ....4 pin Lemo
  GPS Antenna: ....TNC-F
  CAN bus + Event: ....5 pin Lemo (SF-2050M Only)
  1PPS Output: ....BNC (SF-2050M Only)
- Temperature (ambient):
  Operating: ....-40° to +55°C (-40° to +131°F)
  Storage: ....-40° to +85°C (-40° to +185°F)
- Humidity: ....95% non-condensing
- Tested in accordance with MIL-STD-810F for: low pressure, solar radiation, rain, humidity, salt fog, sand & dust, and vibration

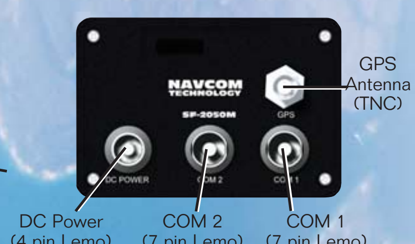
PERFORMANCE [1]

- Measurement Precision (RMS):
  Raw C/A code: ....20 cm @ 42 dB-Hz
  Raw carrier phase noise: ....L1: 0.95 mm @ 42 dB-Hz
  L2: 0.85 mm @ 42 dB-Hz
- Velocity: ....0.01 m/s
- Real-time StarFire Accuracy (RMS):
  Position (H): ....<10 cm
  Position (V): ....<15cm
- Enhanced SBAS (WAAS/EGNOS) Positioning Accuracy:
  Horizontal: 0.5m
  Vertical: 0.7m
- Code Differential GPS Positioning <200kms (RMS):
  Horizontal: ....12 cm + 2ppm
  Vertical: ....25 cm + 2ppm
- RTK Positioning <10kms (Software option) (RMS):
  Horizontal: ....1 cm + 1ppm
  Vertical: ....2 cm + 1ppm
- RTK Extend (Software option) (RMS):
  Horizontal: ....2 cm + 1ppm
  Vertical: ....4 cm + 1ppm
- User programmable output rates:
  Position Velocity Time: ....5 Hz (10Hz, 25Hz Optional)
  Raw measurement data: ..5 Hz (10Hz, 25Hz, 50Hz Optional)
- Data Latency:
  Position Velocity Time: ....< 20 ms at all rates
  Raw measurement data: ....< 20 ms at all rates
- Time-to-first-fix:
  Cold Start, Satellite Acquisition: ....< 60 seconds (typical)
  Satellite Reacquisition: .... < 1 second
- Dynamics: (Speed & Altitude restricted by export laws)
  Acceleration: ....up to 6g
  Speed: ....< 1,000 knots (515 m/s)
  Altitude: ....< 60,000 ft (18.3km)
- 1PPS Resolution: ....12.5ns relative accuracy (SF-2050M Only)

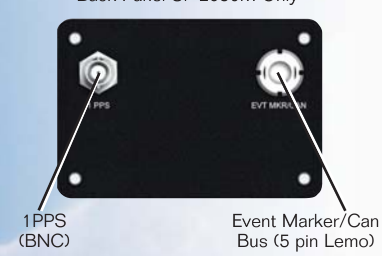
[1] *Performance dependent on location, satellite geometry, atmospheric conditions and GPS corrections.*

COMMUNICATIONS

- Messages:
  Data/Control: ....NCT Binary Messages
  NMEA: ....ALM, GGA, GLL, GSA, GST, GSV, RMC, VTG, ZDA
- Corrections: ....RTCM Code (Msg. 1, 3 & 9)
  SBAS (WAAS/EGNOS)
  StarFire™
- RTK Corrections: ....NCT Proprietary
  (Optional) RTCM (Msg. 18/19 or 20/21)
  CMR (Msg. 0, 1, 2)
  CMR+

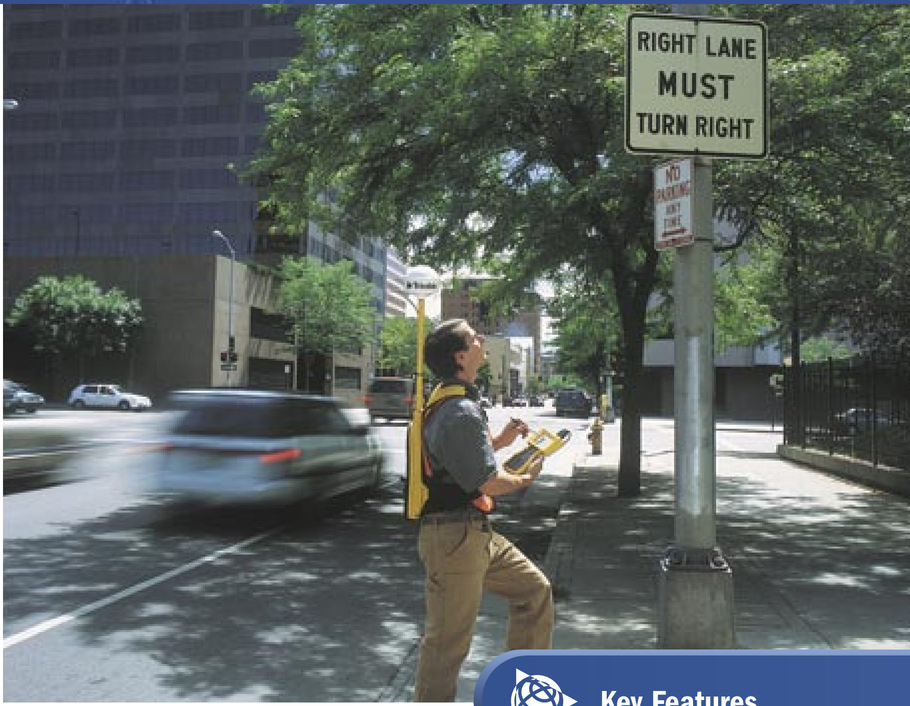


Back Panel SF-2050M Only



Technical specifications are subject to change at NavCom's discretion.
NCT-SF-2050/060119-6

GPS Pathfinder Pro XRS



High-performance GPS with a world of real-time options

The versatile GPS Pathfinder® Pro XRS receiver is the thoroughbred of GPS receivers. Offering a full range of accurate real-time correction sources, great performance in all GPS conditions, and rugged design for the toughest environments, the Pro XRS is an essential tool for collecting and maintaining GPS data.

Built to meet your demands

With the Pro XRS, you don't have to worry whether your GPS receiver can stand up to harsh conditions. All its components are sealed in a robust casing. Waterproof, dustproof, and shock-resistant, the Pro XRS can work anywhere you can.

Just as tough is the custom-designed ergonomic backpack. But it's light and comfortable, so you can wear it all day.

You're spoiled for real-time choice

If you're navigating in the field, or finding your way back to a previously recorded feature, you've got all the real-time options covered. Corrections from a radiobeacon, a satellite differential service such as OmniSTAR, or a satellite-based augmentation system (SBAS) like WAAS[1] or EGNOS[2] are not just built in, they're seamlessly integrated into the receiver. Want the freedom to connect to an external correction source like a virtual reference station (VRS)? You've got it. This array of real-time sources makes the Pro XRS the most adaptable real-time GPS receiver around.

High quality, accurate data for your GIS

With the Pro XRS, you can be sure that the data you collect meets your high standards. Offering submeter accuracy in real time, and centimeter-level postprocessed accuracy, it's the obvious choice for collecting the high quality GPS data you need in your GIS. And it has advanced design features, like EVEREST™ multipath rejection technology, to ensure you get only the best positions.

Get the results you want

The GPS Pathfinder Pro XRS's advanced design gives you complete control over GPS quality. You can focus on productivity, to keep working even in adverse GPS conditions. Or you can configure the receiver to deliver only the most precise positions. It's up to you.

Flexible data collection options

Pick the field device and software that fits your workflow. The Pro XRS is ready to use with a variety of field computers, including Trimble's own range of handheld computers: the GIS TSCe™ field device, the Trimble® Recon™ handheld, and the GeoExplorer® series.

Choosing software? Try the TerraSync™ software, for a complete solution from the field to the office and back. Choose off-the-shelf GPS field software. Or use the GPS Pathfinder Tools SDK to build your own application that's totally customized to your needs.

Key Features

- Real-time submeter accuracy
- Integrated satellite, beacon, and WAAS/EGNOS differential receiver
- EVEREST multipath rejection
- Rugged design
- Ergonomic, comfortable backpack system
- Choice of field device and field software

All you need

You need equipment that's as adaptable and hard-working as you are. So when you're choosing GPS equipment, don't compromise. Get a GPS Pathfinder Pro XRS receiver and have it all.

Trimble®

Introduction

The GPS Pathfinder Systems receivers calculate very accurate GPS positions on a second-by-second basis. After postprocessed differential correction, the horizontal accuracy of each position for the GPS Pathfinder Pro XR and Pro XRS receivers is better than 50 cm (RMS) + 1 part per million (ppm) times the distance between the base and the rover. For the GPS Pathfinder Power receiver, the horizontal accuracy is submeter (RMS) + 1 ppm. Using real-time corrections, each position can be as accurate as submeter with the GPS Pathfinder Systems, but is subject to a number of operational conditions.

Note – *RMS means that approximately 63% of the positions are within the specified value.*

Differential GPS Positioning Techniques

Differential GPS (DGPS) requires two or more receivers. One receiver, called the reference station, is located at a known point to determine the GPS measurement errors and compute corrections to these errors. An unlimited number of mobile GPS Pathfinder Systems receivers, commonly called *rovers*, collect GPS data at unknown locations within the vicinity of the reference station. Errors common at both the reference and rover receivers are corrected with DGPS either in real time or during postprocessing.

Note – *For more information about GPS and DGPS, review the All About GPS tutorial on the Trimble website at www.trimble.com.*

The GPS Pathfinder Systems receivers, in combination with Trimble controlling software and the GPS Pathfinder Office software, provide three ways of obtaining submeter positions:

- Real-time DGPS
- Postprocessed DGPS
- Postprocessed real-time DGPS

The accuracy figures given in the sections below are obtained under the following conditions:

- Number of satellites used: ≥ 4
- PDOP: ≤ 6
- Signal-to-noise ratio: ≥ 4
- Satellite elevation mask: ≥ 15°
- Reference station receiver is a Trimble GPS Pathfinder Pro XL, Pro XR, Pro XRS, 4700, 4800, 5700, 5800, 4600 LS™, Series 4000 GPS receiver, DSM™, Reference Station, or equivalent.
- Synchronized measurements are logged at the reference station.
- The logging interval for the roving receiver is the same as, or a multiple of, the logging interval at the reference station.
- The reference station uses the correct antenna.

Real-Time DGPS

When using real-time DGPS, the reference station broadcasts the correction values to the rovers within coverage range, through a transmitter such as a radiobeacon (beacon DGPS) or a satellite (satellite DGPS). The rover applies the corrections to its position in real time.

The positions calculated by the GPS Pathfinder Systems receivers using real-time DGPS are of submeter accuracy + 1 ppm. If you use a provider of real-time DGPS that uses VRS/VBS techniques, there is no degradation associated with distance from the reference station, and the accuracy always stays at the submeter level (RMS).

GPS Pathfinder Systems also supports corrections from satellite-based augmentation systems (SBAS) such as WAAS and EGNOS.

For information on postprocessing GPS data collected with real-time DGPS, see Postprocessed real-time DGPS, page 20.

Postprocessed DGPS

When real-time DGPS is not available, or is available only part of the time, you have to postprocess the autonomous GPS data in your rover file to obtain the stated accuracy. When using postprocessed DGPS, the reference station stores the correction values in base data files on a computer.

Many reference station owners provide their base data to the community through the Internet or other means of communication. Often this means that you do not have to set up your own reference station for postprocessed DGPS, but can use an existing one. For a list of available reference stations, visit the Trimble website www.trimble.com/trs/findtrs.asp.

Postprocessed real-time DGPS

Postprocessed DGPS positions are generally more accurate than DGPS positions obtained in real time. If you collect SuperCorrect records as well as GPS positions using Trimble TerraSync or GPScorrect™ software, or applications developed using the GPS Pathfinder Tools SDK, you can use the SuperCorrect option in the GPS Pathfinder Office software to process the data if the accuracy of the real-time DGPS positions is not sufficient, provided that you have access to suitable reference station base files.

The accuracy using postprocessed real-time DGPS is the same as for postprocessed DGPS (see the previous section).

Factors Affecting Postprocessed DGPS Accuracy

The accuracy that you obtain after data collection depends on several factors, including:

- Number of visible satellites
- Multipath
- Distance between reference station and rover receivers

- Position Dilution of Precision (PDOP)
- Signal-to-noise ratio (SNR)
- Satellite elevations
- Occupation time at a point
- Receiver type at reference station
- Accuracy of the reference station position
- Synchronized measurements are logged at the reference station.
- The logging interval for the roving receiver is the same as, or a multiple of, the logging interval at the reference station.
- The reference station uses the correct antenna.

Number of visible satellites

Generally, you need a minimum of four satellites to get a good position. If you have five or more satellites, accuracy increases by a small amount. You can obtain positions from only three satellites by supplying a height value manually. However, Trimble recommends that you do not use this method, as an inaccurate height can significantly reduce horizontal accuracy.

Note – *The TerraSync software always uses a minimum of four satellites. You cannot configure this setting.*

When the number of visible satellites drops below the required number, the controlling software stops logging positions and displays the message Too few satellites.

Multipath

GPS signals are sometimes reflected off nearby objects, particularly metallic objects, creating false or erroneous results. This phenomenon is known as *multipath*. Severe multipath may cause position errors of many meters, while mild multipath may cause small, undetectable errors. For optimal accuracy, collect data in an environment that is free of large reflective surfaces, such as buildings and trees. EVEREST multipath reduction technology in the receiver helps reduce the effects of multipath.

Distance between reference station and rover

When you postprocess GPS Pathfinder Pro XR and Pro XRS data using the GPS Pathfinder Office software Differential Correction utility, the horizontal accuracy of the positions received is 50 cm (RMS) at a 1 km base line (distance from reference station). For the GPS Power receiver, the horizontal accuracy of the positions received is submeter (RMS) at a 1 km base line.

Accuracy degrades by 1 ppm as the distance between the reference station and the rover increases. This means that 1 mm of degradation occurs for every kilometer between the reference station and the rover. For example, you must collect data within 500 km (310 miles) of your reference station to obtain submeter accuracy for the GPS Pathfinder Pro XR and Pro XRS receiver.

PDOP

PDOP (Position Dilution of Precision) is a unitless measure of the current satellite geometry. It indicates when the most accurate results are provided. When satellites are spread around the sky, the PDOP value is low, and the computed position is more accurate. When the satellites are grouped closely together, the PDOP value is high, and the computed position is less accurate. The lower the PDOP value, the more accurate the GPS positions.

You can configure the PDOP mask so that if the PDOP exceeds the mask value, the controlling software stops logging positions. A PDOP mask of 6 is required for submeter accuracy.

SNR

SNR (signal-to-noise ratio) is a measure of the satellite signal strength relative to the background noise. A strong signal with low noise provides better accuracy. You can raise the SNR mask so that weak signals with an SNR below the mask are excluded from the position computation. In areas of dense canopy, the SNR mask can be lowered so that you can collect GPS positions, although you may not achieve submeter accuracy. For best results, the recommended setting for the SNR mask is 4.

Elevation mask

When a satellite is low on the horizon, the GPS signals must travel further through the atmosphere, delaying reception by the receiver. To minimize noisy data, adjust the elevation mask. Satellites below the mask are excluded from the position computation. For best results, the recommended setting is 15°.

Occupation period

The GPS Pathfinder Systems receivers achieve the specified horizontal accuracy with a one-second occupation time.

***Note** – To achieve higher levels of accuracy using a GPS Pathfinder Systems receiver, collect carrier-phase data and postprocess using the GPS Pathfinder Office software.*

Receiver type

The following Trimble receiver models use Maxwell™ technology and, when used as the reference station, yield submeter accuracy with GPS Pathfinder Systems receivers:

- GPS Pathfinder Pro XRS
- GPS Pathfinder Pro XR
- GPS Pathfinder Pro XL

- 5800 GPS receiver
- 5700 GPS receiver
- 4800 GPS receiver
- 4700 GPS receiver
- 4600 LS Surveyor
- 4000 series receiver
- DSM Reference Station

Warning – If the GPS receiver at the reference station has fewer than 12 channels, you may be unable to differentially correct some of your data. If the reference station is not capable of logging data from all of the satellites the rover is using, the data collected by the rover cannot be differentially corrected using postprocessing.

Accuracy of the reference station position

Any inaccuracy in the reference station position is reflected in your rover position accuracy. For information on the accuracy of your local DGPS reference station coordinates, contact the provider of that service, and check the Integrity Index in the GPS Pathfinder Office version 3.00 Differential Correction utility when selecting a new base station provider.

The Integrity Index provides you with an indication as to the quality of available base data in comparison to other available sources. Poor base data can result from a number of factors, such as an incorrect reference position, bad environmental location, or a large distance between the base and rover receivers. Base data downloaded from each station is analyzed to formulate the quality indicator values and three key measures are taken into account:

- Bias (the measure of distance between an averaged GPS position and a specified reference position)
- Precision (the measure of the spread of actual GPS positions)
- The distance between the base and rover receivers

Use the Integrity Index to avoid selecting base data that may provide an inferior differential correction result. The quality indicator has a range of 0 to 100, where 0 represents low quality base data and 100 represents high quality base data. For more information, refer to the GPS Pathfinder Office 3.00 Differential Correction Help.

Synchronized measurements

To obtain optimal accuracy from differential correction, the reference station must record reference data (or output differential corrections) from synchronized measurements. Synchronized measurements occur when the reference station receiver and rover receivers simultaneously make measurements to all the satellites they are tracking.

When you use one of the receivers listed in Receiver type, page 23, as a reference station receiver, the data is always synchronized. When measurements are not synchronized, there is no equivalent reference station position measured at exactly the same time as the rover position. A simultaneous reference station position must be interpolated, which reduces accuracy.

Logging intervals

Ideally, the logging interval at the reference station should be the same as the logging interval at the rover. For example, if the reference station is using a 5-second logging interval, the rover logging interval should be 5 seconds. The rover logging interval can also be a direct integer multiple of the interval at the reference station. For example, if the reference station is logging every 5 seconds, the rover can log every 10 seconds.

If the rover logging interval is not synchronized with the reference station, the accuracy of the GPS positions logged by the rover may not be submeter. This is because the reference station measurements must be interpolated to correct the roving receiver's measurements. For more information, see Synchronized measurements, page 25.

If the synchronized measurement logging interval at the reference is 1 second, you can use any logging interval at the rover. However, this generates a large file at the reference station. If the computer or data collector at the reference station runs out of space, you cannot differentially correct any rover data collected after the base file ends.

When disk space is at a premium, the best option is a 5-second logging interval for synchronized measurement data at the reference station and a 5-second logging interval for positions at the rover. This is frequent enough to be practical at the rover and uses the default reference station logging interval, which results in base files that are not too large.

Table 3.1 gives examples of various reference station and rover intervals and their effect on accuracy. They are valid for both postprocessed and real-time corrections.

Table 3.1 Logging Interval Accuracy

Reference station interval (seconds)	Rover interval (seconds)	Base data interpolated?	Notes
1	1	No	Recommended for best accuracy.
5	5	No	Recommended if reference station disk space is at a premium.
1	3, or 5, or 6, etc.	No	The rover interval is a direct integer multiple of the reference station interval.
5	10	No	The rover interval is a direct integer multiple of the reference station interval.
5	1	Yes	Base data is interpolated at seconds 1, 2, 3, and 4. A slight degradation of accuracy occurs with interpolation. One in five of the rover positions is not interpolated.

Factors Affecting Real-Time DGPS Accuracy

Real-time DGPS offers similar accuracies to postprocessed GPS. However, in addition to the factors discussed in Factors Affecting Postprocessed DGPS Accuracy, page 20, there are other factors that affect the accuracy of real-time DGPS positions. These factors include:

- Update rate of the corrections
- Corrections based on a different datum

Update rate of the corrections

The frequency, or rate, at which the RTCM differential correction messages are output from the reference station affects the accuracy of the GPS positions recorded by the roving receiver. The latency of the corrections (that is, the time it takes for up-to-date information to get from the reference station to the rover) also affects the rover position accuracy.

Datum of corrections

Errors can occur if the reference stations use a datum other than WGS-84 as the basis for the DGPS corrections. The error introduced by using a reference station that transmits coordinates using a different datum is generally quite small. However, in some places the margin of error can be 5–10 meters. To avoid this type of error, set Trimble controlling software to collect SuperCorrect data. You can then postprocess the real-time DGPS positions if required.

What Can the GPS Pathfinder Systems Receivers Do?

The GPS Pathfinder Systems receivers, with Trimble controlling software, make an ideal system for all GIS data collection and maintenance projects. The system allows you to collect precise data for utility, urban, and natural resource databases. As the demand for accurate and up-to-date position and attribute information increases, the system allows you to update existing GIS data, ensuring that decisions made with the GIS are based upon the most accurate, current, and reliable data available.

The foundation of the GPS Pathfinder Systems receivers is precise GPS positioning technology. The GPS receivers feature 12 parallel channels for continuous satellite tracking. Using differential GPS, the GPS Pathfinder Systems receivers deliver differentially corrected C/A code positions to submeter accuracy on a second-by-second basis under the most challenging operating conditions.

Integrated Satellite Based Augmentation System (SBAS) receiver

Satellite Based Augmentation System (SBAS) support is integrated into the GPS Pathfinder Pro XR, Pro XRS, and Power receiver. It allows you free access to real-time solutions transmitted from geostationary SBAS satellites, such as the Wide Area Augmentation System (WAAS) in the United States and the European Geostationary Navigation Overlay Service (EGNOS) in Europe.

Integrated beacon receiver

The MSK beacon receiver is included in the GPS Pathfinder Pro XR and Pro XRS receivers. It allows you free access to real-time solutions transmitted from DGPS radiobeacons operating in the MF (medium frequency) band from 283.5 kHz to 325 kHz. The integrated MSK beacon receiver is an advanced dual-channel radiobeacon receiver. It tracks broadcasts from DGPS radiobeacons conforming to the IALA Standard. The beacon receiver uses its *all-digital signal processing* techniques to track and demodulate signals from DGPS radiobeacons.

For an up-to-date list of beacon stations, visit the following Web page:

- www.trimble.com/findbeacon.asp

Integrated satellite differential receiver

The integrated satellite differential capability of the GPS Pathfinder Pro XRS and Power receivers decodes and uses satellite differential corrections to provide submeter position accuracy. To receive and decode these satellite signals, you must subscribe to a satellite differential correction service. The GPS Pathfinder Pro XRS and Power receivers support the OmniSTAR satellite differential correction services. For information on obtaining a subscription, subscription rates, and satellite coverage maps, visit www.omnistar.com

Once you have a subscription, you activate the service through an on-the-air signal or an encrypted activation message entered into the controlling software.

Satellite differential signals provide valid corrections over a large area. Integrated virtual reference/base station (VRS/VBS) technology permits the satellite corrections to be uniformly accurate over the entire satellite coverage area, without the degradation in accuracy associated with increasing distance from fixed reference stations.

Satellite differential signals are line-of-sight and can be blocked by mountains, buildings, or tree canopy. Wet canopy, from a heavy rain, reduces the signals even more. The same environmental factors that affect the GPS signal, such as radar and microwave transmitters, can interfere with the satellite signal. Power lines usually have no effect.

External differential correction receiver

The GPS Pathfinder Systems receivers can also receive differential corrections from any external differential correction receiver that communicates in the standard RTCM SC-104 data format.

Standard GPS Pathfinder Pro XR and Pro XRS Features

The GPS Pathfinder Pro XR and Pro XRS receivers offer the following:

- 12-channel DGPS receiver with EVEREST™ multipath rejection technology, L1 C/A code tracking with carrier-phase smoothing, and instantaneous full-wavelength carrier-phase measurements.
- Submeter accuracy – Typically horizontal accuracy less than 50 cm RMS with GPS Pathfinder Office software postprocessing. This requires data to be collected with a minimum of 4 satellites, maximum PDOP of 6, minimum SNR of 4, minimum elevation of 15 degrees, and reasonable multipath conditions.
- Integrated WAAS/EGNOS differential corrections
- 1 Hz position and velocity update rate.
- Velocity computations incorporate carrier-phase data.
- Time to First Fix typically less than 30 seconds.
- Two RS-232 serial ports.
- NMEA-0183 output to external NMEA devices (supported messages are ALM, GGA, GLL, GSA, GSV, VTG, and ZDA).
- RTCM-SC 104 input from an external differential correction receiver.
- TSIP protocol to/from the field device.
- Fully automatic and manual beacon operating modes, fast acquisition of differential beacon signals.

- Immunity to MSK jamming signals, advanced techniques for combating atmospheric noise in the beacon receiver.
- Integrated GPS/MSK beacon antenna.
- User-upgradeable receiver firmware.
- Receiver manual.
- CE Mark compliance.

Additional GPS Pathfinder Pro XRS receiver features

The GPS Pathfinder Pro XRS GPS/MSK/beacon/satellite differential receiver offers the items previously listed, and also:

- Integrated L-band satellite differential correction receiver
- Combined L1 GPS/beacon/satellite differential antenna

Combined L1 GPS/beacon/satellite differential antenna

The GPS Pathfinder Pro XRS receiver integrated L1 GPS/beacon/satellite differential antenna (P/N 33580-50) features two antenna components:

- L1 GPS/satellite differential antenna

  This active antenna is designed to filter out unwanted signals and amplify the L1 GPS and satellite differential signals for transmission over the antenna cable to the receiver.

- MSK H-field loop beacon antenna

  This antenna features a pre-amplifier for filtering out signal interference such as AM radio broadcasts and noise from switching power supplies. After filtering, the pre-amplifier amplifies the MF signal for transmission over the same antenna cable to the beacon receiver.

The coaxial antenna cable also carries DC power to the pre-amplifier of both the L1 GPS/satellite differential and beacon antennas over the center conductor of the cable.

The antenna assembly integrates the L1 GPS/satellite differential antenna and a beacon antenna into a single antenna assembly, as shown in Figure 2.2. The antenna assembly is completely weatherproof and is designed to withstand harsh environmental conditions.

Figure 2.2 Combined L1 GPS/beacon/satellite differential antenna (for the GPS Pathfinder Pro XRS receiver)

Introduction

This appendix lists specifications for GPS Pathfinder Systems receivers and antennas, and pinouts for cables that are supplied with the receivers.

Specifications

Table B.1 lists specifications for the GPS Pathfinder Pro XR and Pro XRS receiver.

Table B.1 GPS Pathfinder Pro XR and Pro XRS receiver specifications

Parameter	Specification
General	12 channel, L1/CA code tracking with carrier phase filtered measurements and multibit digitizer
Update Rate	1 Hz
Time to First Fix	< 30 seconds, typical
Size	11.1 cm × 5.1 cm × 19.5 cm (4.4" × 2.0" × 7.7")
Weight	0.76 kg (1.68 lb)
Power	XR 6 W (maximum) XRS 7 W (maximum) both 10 to 32 VDC
Temperature	–20 °C to 65 °C (–4 °F to 149 °F) operating –30 °C to 85 °C (–22 °F to 185 °F) storage
Humidity	100% non-condensing
Casing	Dustproof, splashproof, shock-resistant, sealed to 5psi

Table B.3 lists specifications for the GPS Pathfinder Pro XRS antenna.

Table B.3 Combined L1 GPS/beacon/satellite differential antenna specifications

Parameter	Specification
General	Right-hand, circular polarized; omnidirectional; hemispherical coverage
Size	15.5 cm diameter × 14 cm high (6.1" × 5.5")
Weight	0.55 kg (1.2 lb)
Temperature	–20 °C to 65 °C (–4 °F to 149 °F) operating –40 °C to 85 °C (–40 °F to 185 °F) storage
Humidity	100% fully sealed
Casing	Dustproof, waterproof, shock resistant

Pinouts

Table B.5 lists the pinouts for the GPS Pathfinder Pro XR and Pro XRS receiver's data/power cable.

Table B.5 Data/power cable pinout (P/N 30231-00)

To GPS Pathfinder Pro XR and Pro XRS receiver				**Field Device**		**Input Power**		
Conn P1			**7 Cond Cbl #1**	**Conn P2 DE9-F**		**2 Conn Cbl #2**	**Conn P3 TA3-M**	
Event In	1	in	—	—		—	—	
TXD out	2		Orange	2	RXD	—	—	
RXD	3	in	Red	3	TXD	—	—	
Chg Ctrl	4	in	Black	4	DTR	—	—	
Sig Gnd in/out	5		Shield	5	Sig Gnd	—	—	
DSR out	6		Yellow	6	DSR	—	—	
Pwr On	7	in	Brown	7	RTS	—	—	
CTS out	8		Green	8	CTS	—	—	
Charge out	9		Blue	9	RI	—	—	
V+ In	10	in	—	—		White	1	V+ In
V– In	11	in	—	—		Black	2	V– Out
PPS —	12		—	—		—	—	

Table B.7 lists the pinouts for the GPS Pathfinder Pro XR and Pro XRS receiver's NMEA/RTCM cable.

Table B.7 NMEA/RTCM cable pinout (P/N30232-00)

To GPS Pathfinder Pro XR and Pro XRS receiver				NMEA/RTCM output connectors		
Conn P1			**9 Cond Cbl #1**	**Conn P2 DE9-M**	**7 Conn Cbl #1**	**Conn P3 DE9-F**
Event In	1	in	—	—	—	—
TX– (232)	2	out	—	—	Orange	2 TXD
RX– (232)	3	in	Red	2 RXD	—	—
Chg Ctrl	4	in	—	—	Shield	
Sig Gnd	5	in/out	Shield	5 Sig Gnd	—	5 Sig Gnd
TX+ (422)	6	out	—	—	—	
Pwr On	7	in	—	—	—	—
RX+ (422)	8	out	—	—	—	—
Charge	9	out	Yellow	9 Pwr	—	—
V+ In	10	in	—	—	—	—
V– In	11	in	—	—	—	—
PPS	12	—	—	—	Brown	4 DTR

Reference Materials

If you have a problem and cannot find the information you need in the product documentation, *contact your local Distributor*. Alternatively, go to the Trimble Support page at www.trimble.com/support.html, and then do one of the following:

- Browse the available online support resources.
- Request technical assistance from Trimble Support, click the submit an inquiry link, fill in the form, and then click **Send.**

Trimble: www.trimble.com/support.html

Survey Controller: www.trimble.com/tsce.html

Survey Pro: www.tdsway.com

GIS TSCe: www.trimble.com/gistsce.html

ActiveSync™: www.microsoft.com/windowsmobile/
resources/downloads/pocketpc/default.mspx

Windows CE: www.microsoft.com/windows/embedded/ce.net

Hardware Specifications

Feature	TSCe
Processor	Intel StrongARM SA-1110, 206 MHz
Memory	64 MB low-power SDRAM
Storage	512 MB non-volatile flash disk
Screen	1/4 VGA transflective color LCD
Touch Screen	Passive - 87% transmissivity
Keyboard	57 key tactile action
9-Pin serial port	RS232 COM1
26-Pin MultiPort	RS232 COM2, Ethernet 10BaseT, USB client, power in/out and audio in/out
Infrared	IrDA Type1 COM3
Audio	Integrated speaker and microphone
Batteries	NiMH rechargeable pack, 3800 mAH, 18.5 W-h, 4.8 V
AC Adaptor	Line voltage: 100 - 240 V AC 47-63 Hz

SPECIFICATIONS FOR LASER TECH TRUPULSE 200 LASER RANGEFINDER

Dimensions	5" x 2" x 3.5" (12cm x 5cm x 9cm)
Weight	8 ounces (220 g)
Data Communication	Serial, via wired RS232 (standard)
Power	3.0 volts DC nominal
Battery Type	(2) AA or (1) CRV3
Battery Duration	AA: Approximately 7,500 measurements CRV3: Approximately 15,000 measurements
Eye Safety	FDA Class 1 (CFR 21)
Environmental	Impact, Water & Dust Resistant. NEMA 3, IP 64
Temperature	-4°F to +140°F (-20°C to +60°C)
Optics	7X Magnification (Field-of-view; 330 ft @ 1000 yards)
Display	In-scope LCD
Units	Feet, Yards, Meters, and Degrees
Monopod/tripod mount	¼ " - 20 female thread
Measurement Range	
Distance	0 to 3280 ft (1000 m) typical, 6560 ft (2000m) max to reflective target
Inclination	± 90 degrees
Accuracy	
Distance	±1 ft (± 30 cm) to high quality targets, ±1 yd (±1 m) to low quality targets
Inclination	±0.25 degrees
Measurement Modes	Horizontal Distance, Vertical Distance, Slope Distance and Inclination, and 3-point flexible height routine with auto sequencing
Target Modes	Standard, Closest, Farthest, Continuous, and Filter (requires reflector and foliage filter)

Impulse 200 LR Laser

Our Impulse lasers are specifically designed for optimal performance under whatever conditions you might encounter in the field. They are lightweight, extremely rugged, completely waterproof and versatile. Use them as a handheld unit or mount them on a tripod for added stability.

Hardware Specifications:

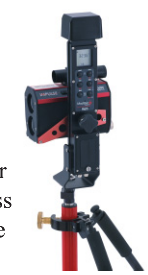
Impulse Laser w/ 1.5 to 4 X Zoom Scope and Mounting Bracket

Typical Target Accuracy & Range	IMPULSE 200 LR	
	(Imperial)	(Metric)
Accuracy (Typical)	0.1 - 0.2 ft	3 - 5 cm
Accuracy (Max)	0.5 ft	15 cm
Overhead cable / Stake	330 ft	100 m
Phone pole / Stockpile	655 ft	200 m
Tree / Tower	985 ft	300 m
Rock Face / Building	1640 ft	500 m
Max Distance	1885 ft	575 m
Range Resolution	.01 ft	0.01 m
Inclination Limits	+/- 90 deg	+/- 90 deg
Inclination Accuracy	+/- 0.1 deg	+/- 0.1 deg
Weight	2.2 lbs.	1 kg
Size	6 x 2.5 x 5 in.	15.2 x 6.4 x 12.7 cm
Power Supply	(2) AA batteries (20 hours of use)	
Environment	Waterproof to IP 67 and NEMA 6	
Temperature	- 22 to + 140 F	-30 to + 60 C

(Max distances are approximate)

For 3-D data collection, integrate the Impulse with a MapStar System.

MapStar Angle Encoder



MapStar Compass Module

Key Features:

- Custom backlit LCD display
- Audible and visual indicators
- RS232 serial output for electronic data storage
- Selective range gating for positive target acquisition
- Built-in tilt sensor
- Filter system to discriminate reflective targets
- Cumulative distance capability
- Determines the distance between two in-line objects
- Integrates with GPS

Package Includes:

- Impulse laser
- Red-dot scope
- Hand strap
- Tripod / monopod mounting bracket
- (2) AA batteries
- Operator's manual
- Padded carrying case

Optional Accessories:

- 1.5 to 4 X zoom scope
- Yoke and staff
- Remote trigger data cable

Impulse Laser w/ Red-dot Scope and Hand Strap

LASER TECHNOLOGY INC
Redefining Measurement

7070 S. Tucson Way, Centennial, CO 80112 USA
Toll Free: 1 (800) 280-6113 | Local: 1 (303) 649-1000
Web Page: www.lasertech.com | E-mail: info@lasertech.com

* All specifications are subject to change without notice.
(Rev. 11/15/03)

MVP200
OPERATION AND MAINTENANCE MANUAL

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1 SYSTEM DESCRIPTION

The MVP200 system is a self-contained profiling system capable of sampling water column profiles to 200m depth from a vessel moving at up to 12 knots, and deeper depths at slower speeds. The system provides vertical profiles of oceanographic data such as Sound Velocity, CTD, particle counts, etc. for various operations including the calibration of multi-beam sounder systems for hydrographic operations. The MVP200 is completely autonomous and can be controlled by computer without the requirement for personnel on deck. The system consists of a single or multi-sensor free-fall fish (fish), an integrated winch and hydraulic power unit, towing boom and a remotely located user interface controller. The MVP200 system is shown in Figure 1. The system block diagram is shown in Figure 2.

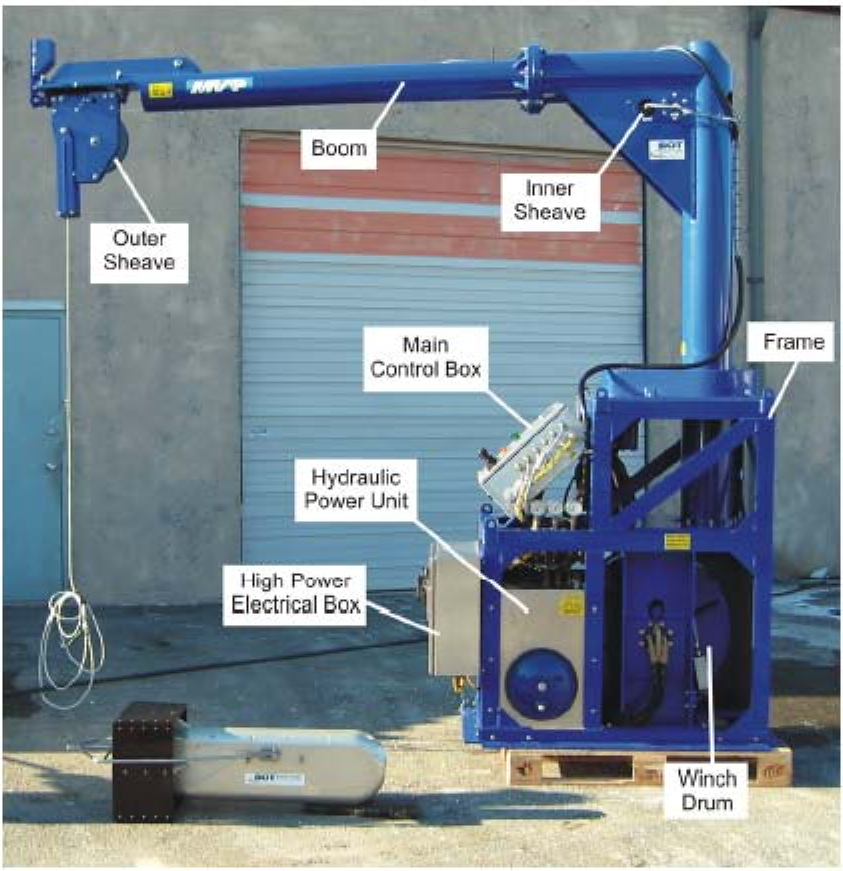


Figure 1: MVP200

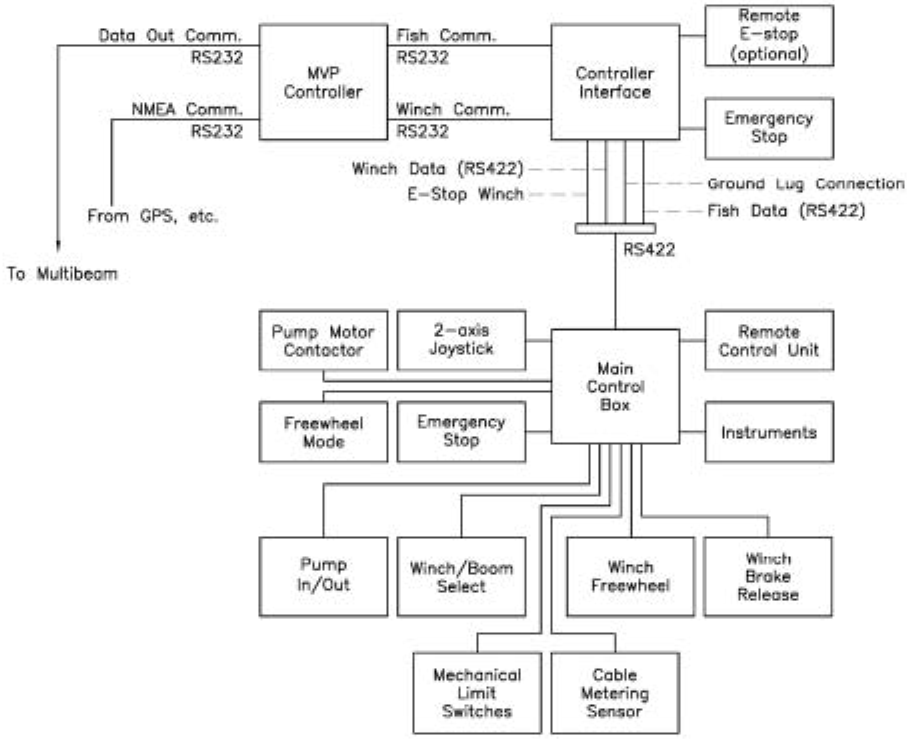


Figure 2: System Block Diagram

Upon actuation, the system deploys the fish from a towed position by setting the winch in 'freewheel' mode and releasing the brake. This allows the fish to free-fall almost straight down through the water at its terminal velocity of approximately 3 m/s. Once the (pre-set) depth limit is reached, the brake is applied to stop the cable pay-out. When the winch drum has stopped, the motor is engaged to haul in the cable until the fish is towed at the surface. Subsequent deployments occur from this position, either actuated by the operator or timed automatically with the automatic deployment setting.

The system operates in the automatic mode described above or in manual mode operated from controls at the winch. Manual mode is used as a convenient method to launch and recover the fish, but is not intended for moving vessel profiling.

1.1 FREE-FALL FISH

The free-fall fish can be either a single sensor or a multi sensor fish. The fish houses the main instrument, either a CTD or SV&P sensor. The instrument is normally configured for RS-485 serial communications.

The multi-sensor fish can support auxiliary sensors in addition to the main CTD/SV&P instrument. If auxiliary sensors are used, a DTM/Mux is required in the fish. The DTM/Mux is a data telemetry module with additional digitization and multiplexing circuitry. This allows data from various analog and digital sensors to be added to the main instrument's serial output stream, which is transmitted to the surface.

1.1.1 Single-Sensor Free-Fall Fish

The Single Sensor Free-Fall Fish (SSFFF) (see Figure 3) is machined from brass with a stainless steel towing bridle. The sensor guard at the tail of the fish is made from stainless steel. The shape of the fish allows minimal resistance while providing stability during free-fall and retrieval. The fish can be fitted with an Applied Microsystems Ltd. (AML) Sound Velocity and Pressure (SV&P) Smart Sensor or an AML CTD Micro Sensor. (A small plastic support is built into the sensor guard for use with the sound velocity sensor). An Impulse underwater connector allows the fish to be removed easily from the electromechanical cable.

The AML CTD Micro Sensor measures conductivity, temperature and pressure. The AML SV&P Smart Sensor measures sound velocity and pressure. The information is sent through the Electro-Mechanical cable to the main control box, through the deck cable to the Instrument Interface box where it then connects to the MVP Controller. If the sensor is a CTD, software in MVP Controller then computes sound velocity and salinity from the measured parameters using the UNESCO equations of state.

Figure 3: Single Sensor Free-Fall Fish

3 SPECIFICATIONS

3.1 OPERATING DEPTH

- 600 m @ 0 knots*
- 350 m @ 5 knots
- 200 m @ 12 knots

*** Ensure sensor(s) are rated for this depth before operations**

3.2 WINCH AND HYDRAULIC POWER UNIT

- Drum dimensions: 324 mm (12.7") barrel diameter
  99 mm (3.9") wide
  711 mm (28.0") flange OD
- Line Pull: Bare Drum - 410 kg (900 lbs.)
- Capacity: 660 m (2132 ft) of 6.0 mm (0.24") cable
- Cable: Jacketed Electro-Mechanical , 4 conductor,
  1089 kg (2400 lbs.) maximum break strength
- Hydraulic Winch Motor: Valmet Black Bruin # 403 040 2120
- Rotator Motor: White # 700540C8540ALAAA
- Slip Ring: Focal Technologies Model 180 ESR
- Hydraulic Pump: Rexroth #AA10VG18EP21/10R-NSC66-F004S
- Reservoir: 40 litre Stainless Steel Reservoir
- Maximum operating pressure: 3000 psi (207 Bar)
- Electric motor: 15 hp TEFC 230/460VAC 60 Hz, 208/416VAC 50 Hz, 3-phase
- Suction line filter: LHA Element #SPE-15-BTA-10
- Footprint: 1.22m x 0.71m (48" x 28") excluding boom
- Height: 3.18m (125")
- Approximate Weight: 680 kg (1500 lbs.)

3.3 FREE-FALL FISH

3.3.1 Single Sensor Free-Fall Fish

- Weight: 32 kg (72 lbs.) with sensor, in air
- Body Length: 673 mm (26.5") excluding bridle
- Body Diameter: 114 mm (4.5")
- Sensors: - AML Sound Velocity and Pressure (SV&P) "Smart Sensor", or
  - AML SVP&T Micro Sensor
  - AML CTD Micro Sensor

3.3.2 Multi-Sensor Free-Fall Fish

- Weight: 88.5 kg (195 lbs.) with sensor, in air
- Body Length: 1041 mm (41") excluding bridle
- Body Section: 147 mm x 279 mm (5.8" x 11.0")

Sensors: - AML Sound Velocity and pressure (SV&P) "Smart Sensor"
- AML CTD Micro Sensor
- AML Dissolved Oxygen (DO) Sensor
- Wet Labs fluorometers (Wet star, FLF300, and ECO)
- Satlantic OCR-500 series digital optical sensors
- Brooke Ocean Technology Ltd. - Laser Optical Plankton Counter (LOPC)

3.4 MVP CONTROLLER

Minimum requirements (refer to system factory configuration for details)

- Operating system: Windows 2000 Professional
- Processor: Pentium 600 or higher
- Ram: 128 Mb
- Hard Disk: 5 GB Hard drive
- Video: 1024x768 SVGA with 64 thousand colors
- Pointing Device: Microsoft Wheel Mouse
- Serial ports: 4 serial (RS232) ports
- Drive: CD-ROM drive and a 1.44 Mb Floppy drive
- Monitor: 15" Video Monitor
- Keyboard: PS/2 Keyboard
- Hardware: Network Card

3.5 POWER REQUIREMENTS

Winch Power Ratings:

- Vessel circuit breaker value 90A at 230v and 45A at 460v, maximum setting
- Voltage: 3-phase, 4-wire
  - 230/460V ±10%, 34/17A at 60 Hz or
  - 208/416V ±10%, 42/21A at 50 Hz

(Note that system supply voltage must be selected at time of order. It is not a field configurable item)

- 50A main disconnect, circuit breaker
- 15 HP Motor, dual frequency rating with 110V anti-condensation heater
- Motor contactor with thermal overload.
- Includes internal 110V auxiliary distribution: 7A/120V/840W

MVP Controller (Lab Computer) Power Ratings:

- Voltage: 1-phase, 100-230 VAC
- Current: 5-8A
- Frequency: 50 or 60 Hz

MicroTSG (Thermosalinograph)

SBE 45

The SBE 45 MicroTSG Thermosalinograph is an externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. Salinity and sound velocity can also be computed. The MicroTSG is constructed of plastic and titanium to ensure long life with minimum maintenance.

OPERATION OVERVIEW

Communication with the MicroTSG is over an internal, 3-wire, RS-232C link, providing real-time data transmission. Commands can be sent to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – On command, the MicroTSG takes one sample and sends the data to the computer.
- **Autonomous sampling** – At pre-programmed intervals, the MicroTSG samples and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.
- **Serial Line Sync** – A pulse on the serial line causes the MicroTSG to wake up, sample, and enter quiescent state automatically.

Calibration coefficients stored in EEPROM allow the MicroTSG to transmit data in engineering units.

SENSORS

The MicroTSG retains the temperature and conductivity sensors used in the SBE 21 Thermosalinograph, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroTSG's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroTSG's internal-field conductivity cell is unaffected by external fouling, and uses expendable anti-foulant devices.

OPTIONAL PN90402 - SBE 45 POWER, NAVIGATION, and REMOTE TEMPERATURE INTERFACE BOX

An optional AC- or DC-powered Interface Box:

- Provides isolated DC power and an optically isolated RS-232 data interface.
- Contains a NMEA 0183 port for appending navigation information from a NMEA navigation device to the data stream.
- Contains an RS-232 port for appending the output of an optional remote temperature sensor (SBE 38), allowing for measurement of sea surface temperature with minimal thermal contamination from the ship's hull.
- Outputs the data stream (MicroTSG, NMEA navigation device, and SBE 38 data) to the computer over an RS-232 interface.

SOFTWARE

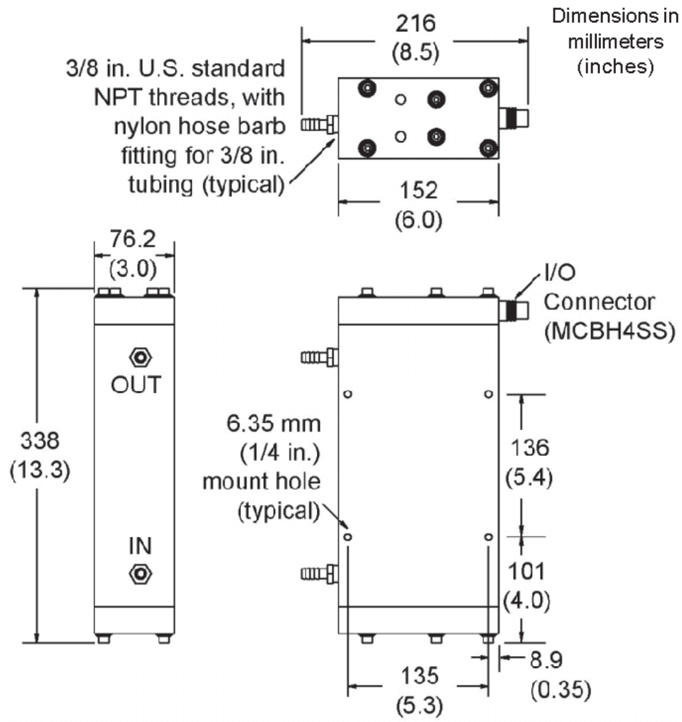
The MicroTSG is supplied with a powerful Win 95/98/NT/2000/XP software package, SEASOFT©-Win32. SEASOFT's modular programs include:

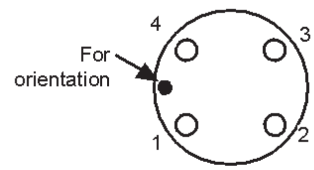
- SEATERM — terminal program for instrument setup and data display.
- SEASAVE — real-time data acquisition and display
- SBE Data Processing — filtering, aligning, averaging, and plotting of data and derived variables.

SPECIFICATIONS

Measurement Range	
Conductivity:	0-7 S/m (0-70 mS/cm)
*Temperature *:*	-5 to 35 °C
Initial Accuracy	
Conductivity:	0.0003 S/m (0.003 mS/cm)
*Temperature *:*	0.002 °C
Salinity:	0.005 PSU, typical
Typical Stability ***(per month)***	
Conductivity:	0.0003 S/m (0.003 mS/cm)
*Temperature *:*	0.0002 °C
Salinity:	0.003 PSU, typical
Resolution	
Conductivity:	0.00001 S/m (0.0001 mS/cm)
*Temperature *:*	0.0001 °C
Salinity:	0.0002 PSU, typical
Calibration Range	
Conductivity:	0-6 S/m (60 mS/cm); physical calibration 2.6-6 S/m (26-60 mS/cm), plus zero conductivity (air)
*Temperature *:*	+1 to +32 °C
Time Resolution	1 second
Clock Stability	13 seconds/month
Input Power	8-30 VDC
Acquisition Current	34 mA at 8 VDC; 30 mA at 12-30 VDC
Quiescent Current	10 microamps
Acquisition Rate	1 Hz maximum
Operating Pressure	34.5 decibars (50 psi) maximum
Flow Rate	10 to 30 ml/sec (0.16 to 0.48 gal/min)
Materials	PVC housing
Weight	4.6 kg (10.2 lbs)

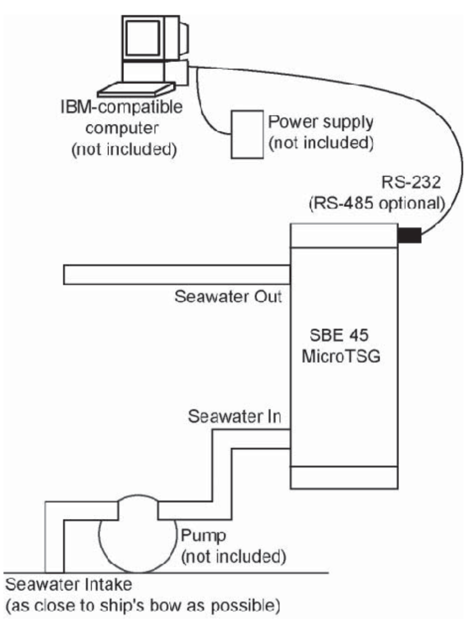
* For specifications for optional SBE 38 remote temperature sensor, see SBE 38 datasheet.



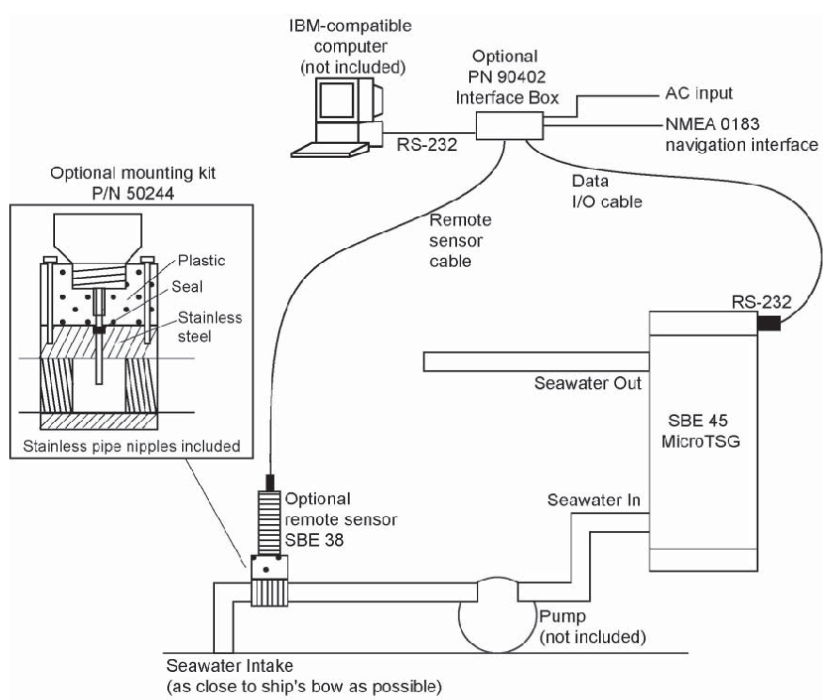


Pin	Signal
1	Common
2	RS-232 RX from computer
3	RS-232 TX to computer
4	External power in (8 - 30 VDC)

System Schematic: SBE 45



System Schematic: SBE 45 with Optional PN 90402 Interface Box and Remote Temperature Sensor



03/04

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SBE 19plus
SEACAT PROFILER

Conductivity, Temperature, and Pressure Recorder with RS-232 Interface

Serial Number: 19P36026-4585

Sea-Bird Electronics, Inc.
1808 136th Place NE
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LIMITED LIABILITY STATEMENT

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use of servicing of this system.

WARNING !!

**Do not submerge this instrument (S/N 19P36026-4585)
beyond the depth rating of the lowest rated component listed below!**

Main Housing (Titanium)	7000 meters
Pressure Sensor (3500 dBar) Druck	**3500 meters**
Pump (SBE 5M)	10500 meters

SYSTEM CONFIGURATION 14 June 2004

Model SBE 19plus	**S/N 19P36026-4585**
Instrument Type	**SBE 19plus SeaCaT Profiler**
Firmware Version	**1.4D**
Communications	**9600 baud, 8 data bits, no parity, one stop bit**
Memory	**8192K**
Housing	**7000 meter (3AL-4V Titanium)**
0 Conductivity Raw Frequency	**2630.97 Hz**
Pressure Sensor	**Strain Gauge: 3500 dBar, S/N 5433**
Number of Voltages Sampled:	**0**
Serial RS-232C Sensor	**None**
Data Format:	
Count	**Temperature**
Frequency	**Conductivity**
Count	**Pressure, Strain gauge**
Pump (SBE 5M)	**050647**
Voltage Delay Setting (standard)	**(standard) 0 seconds**

IMPORTANT SOFTWARE & HARDWARE CONFIGURATION INFORMATION

Sea-Bird supplies two versions of our software package for communication, real-time data acquisition, and data analysis and display:

- SEASOFT-Win32 - Windows software for PC running Win 95/98/NT/2000/XP
- SEASOFT-DOS - DOS software for IBM-PC/AT/386/486 or compatible computer with a hard drive

Detailed information on the use of the **Windows** software follows:

SEASOFT-Win32

SEASOFT-Win32 software was supplied on a CD-ROM with your CTD. This software package is designed to run on a PC running Win 95/98/NT/2000/XP. The CD-ROM also contains software manuals that describe the appropriate applications for the various programs, the procedure for installing the software, and instructions on using the programs. There are three primary programs used with the CTD for setup, data collection and retrieval, data display, and data processing:

- SEATERM - terminal program for setup of the CTD and uploading of data from the CTD memory (**Note**: If using the CTD with the 90208 Auto Fire Module or SBE 17*plus* V2 SEARAM, use SeatermAF instead of SEATERM)
- SEASAVE - real-time data acquisition program
- SBE Data Processing - data processing program

Instructions for using the software are found in their Help files.

To communicate with the CTD to set it up or to upload data from the CTD memory to the computer hard drive, **SEATERM** must have information about the CTD hardware configuration (communication parameters, internal firmware, etc.) and about the computer. To communicate with the CTD, double click on Seaterm.exe:

1. In the Configure menu, select the CTD. The Configuration Options dialog box appears.
   A. On the COM Settings tab, select the firmware version (if applicable), baud rate, data bits, and parity to match the CTD's configuration sheet. If necessary, change the com port to match the computer you are using.
   B. On the Upload Settings tab, enter upload type (all as a single file, etc.) as desired.
   For the SBE 17 and 25 only: enter the serial number for the SBE 3 (temperature) and SBE 4 (conductivity) modular sensors, exactly as they appear in the configuration (.con) file.
   C. On the Header Information tab, change the settings as desired.

   Click OK when done. SEATERM saves the settings in a SEATERM.ini file.
2. On the Toolbar, click Connect to communicate with the CTD.
3. To set up the CTD prior to deployment:
   On the Toolbar, click Status. SEATERM sends the Status command and displays the response. Verify that the CTD setup matches your desired deployment. If not, send commands to modify the setup.
4. To upload data from the CTD:
   On the Toolbar, click Upload to upload data from the CTD memory to the computer.

Sea-Bird CTDs store and/or transmit data from their primary and auxiliary sensors in the form of binary or hexadecimal number equivalents of the sensors' frequency or voltage outputs. This is referred to as the *raw* data. The calculations required to convert from *raw* data to *engineering* units of the measured parameters (temperature, conductivity, pressure, dissolved oxygen, pH, etc.) are performed using the software, either in real time, or after the data has been stored in a file. SEASAVE creates the file in real time. As noted above, SEATERM uploads the recorded data and creates the file on the computer hard drive.

To successfully store data to a file on the computer and subsequently convert it to engineering units, the software must know the CTD type, CTD configuration, and calibration coefficients for the sensors installed on the CTD. This information is unique to each CTD, and is contained in a *configuration* file. The configuration file, which has a .con extension, was written onto a floppy disk and the CD-ROM shipped with the CTD. The .con file for a given CTD is named with the last four digits of the serial number for that CTD (e.g., 1234.con). The configuration file is created or modified (e.g., changing coefficients after recalibration, or adding another sensor) by using the Configure menu in **SEASAVE** or **SBE Data Processing**. The configuration file is used by SEASAVE to convert raw data to engineering units when it acquires, stores, and displays real-time data. The configuration file is also used by some modules in SBE Data Processing (Data Conversion and Derive) that convert raw data to engineering units during data processing.

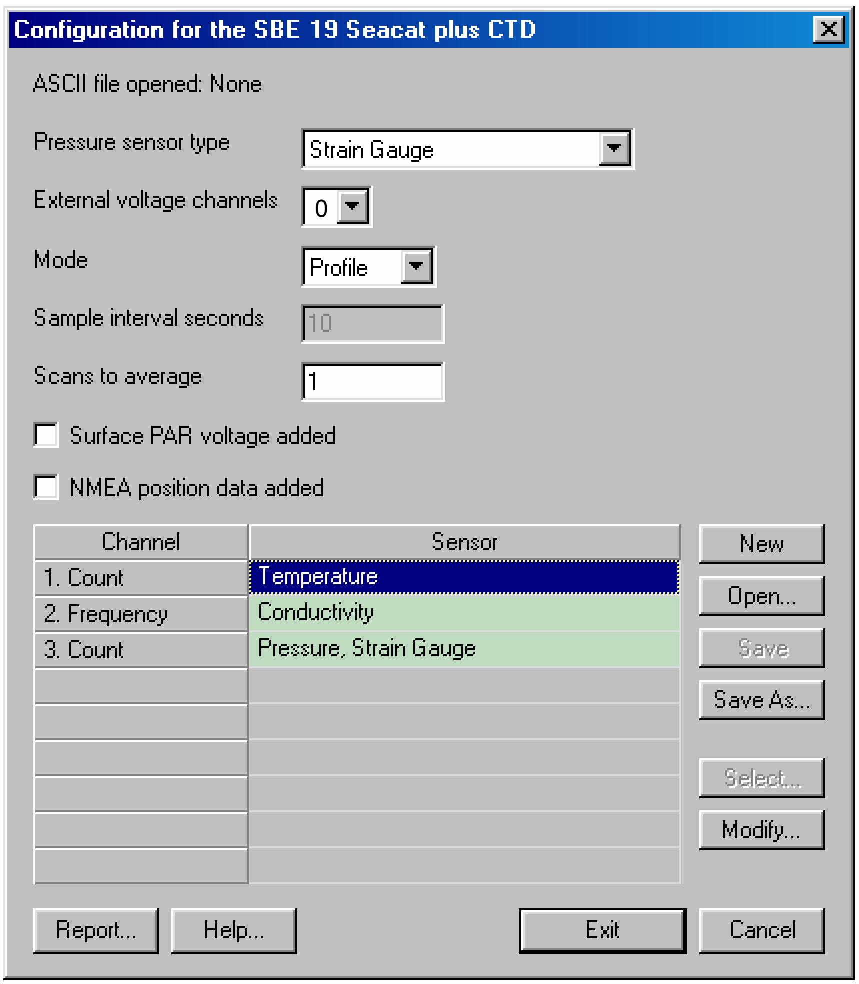
The instrument type and instrument configuration settings of the .con file and the required setup for the SEATERM.ini file for the CTD *as delivered* are documented below. The calibration coefficients for the CTD's sensors are contained in the calibration coefficient section of the CTD manual.

NOTE:

SEATERM will not upload data correctly without a properly configured SEATERM.ini file. SEASAVE and SBE Data Processing will not interpret the data correctly without the correct .con file.

SEASOFT CONFIGURATION:

The correct instrument type for your instrument is SBE 19plus SEACAT Profiler. The correct settings for the configuration of your instrument as delivered are documented below:



SPECIFICATIONS

SEACAT Profiler

SBE 19*plus*

The SBE 19*plus* is the next generation *Personal CTD*, bringing numerous improvements in accuracy, resolution (in fresh as well as salt water), reliability, and ease-of-use to the wide range of research, monitoring, and engineering applications pioneered by its legendary SEACAT predecessor. The 19*plus* samples faster (4 Hz vs 2), is more accurate (0.005 vs 0.01 in T, 0.0005 vs 0.001 in C, and 0.1% vs 0.25% — with *seven* times the resolution — in D), and has more memory (8 Mbyte vs 1). There is more power for auxiliary sensors (500 ma vs 50), and they are acquired at higher resolution (14 bit vs 12). Cabling is simpler and more reliable because there are four differential auxiliary inputs on two separate connectors, and a dedicated connector for the pump. All exposed metal parts are titanium, instead of aluminum, for long life and minimum maintenance.

The 19*plus* can be operated without a computer from even the smallest boat, with data recorded in non-volatile FLASH memory and processed later on your PC. Simultaneous with recording, real-time data can be transmitted over single-core, armored cable directly to your PC's serial port (maximum transmission distance dependent on number of auxiliary sensors, baud rate, and cable properties). The 19*plus'* faster sampling and pump-controlled TC-ducted flow configuration significantly reduces salinity spiking caused by ship heave, and allows slower descent rates for improved resolution of water column features. Auxiliary sensors for dissolved oxygen, pH, turbidity, fluorescense, PAR, and ORP can be added, and for moored deployments the 19*plus* can be set to *time-series* mode using software commands. External power and two-way real-time communication over 10,000 meters of cable can be provided with the SBE 36 CTD Deck Unit and Power and Data Interface Module (PDIM).

The 19*plus* uses the same temperature and conductivity sensors proven in 5000 SEACAT and MicroCAT instruments, and a superior new micro-machined silicon strain gauge pressure sensor developed by Druck, Inc. Improvements in design, materials, and signal acquisition techniques yield a low-cost instrument with superior performance that is also easy to use. Calibration coefficients, obtained in our computer-controlled high-accuracy calibration baths, are stored in EEPROM memory. They permit data output in ASCII engineering units (degrees C, Siemens/m, decibars, Salinity [PSU], sound velocity [m/sec], etc.). The 19*plus* can be factory-configured to emulate the .hex output format and 2 Hz data rate of old SEACATs for compatibility with existing software or instrument fleets.

Accuracy, convenience, portability, software, and support; compelling reasons why the 19*plus* is today's best low-cost CTD.

CONFIGURATION AND OPTIONS

A standard SBE 19*plus* is supplied with:
- Plastic housing for depths to 600 meters
- Strain-gauge pressure sensor
- 8 Mbyte FLASH RAM memory
- 9 D-size alkaline batteries
- Impulse glass-reinforced epoxy bulkhead connectors: 4-pin I/O, 2-pin pump, and two 6-pin (two differential auxiliary A/D inputs each)
- SBE 5M miniature pump and T-C Duct

Options include:
- Titanium housing for depths to 7000 meters
- Sensors for oxygen, pH, fluorescence, light (PAR), light transmission, and turbidity
- SBE 5T pump in place of SBE 5M for use with dissolved oxygen and/or other pumped sensors
- Stainless steel cage
- MCBH *Micro* connectors
- Ni-Cad batteries and charger

Shown with optional cage, SBE 5T pump, & SBE 43 DO sensor

SOFTWARE

SEASOFT©-Win32, our complete Windows 95/98/NT/2000/XP software package, is included at no extra charge. Its modular programs include:
- SEATERM© — communication and data retrieval
- SEASAVE© — real-time data acquisition and display
- SBE Data Processing© — filtering, aligning, averaging, and plotting of CTD and auxiliary sensor data and derived variables

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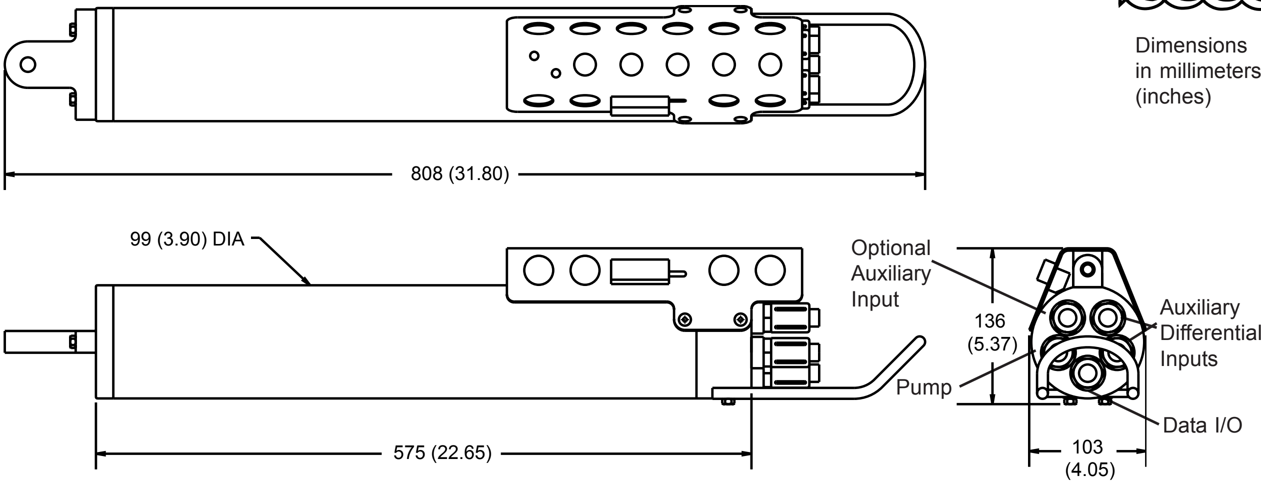
SEACAT Profiler

SBE 19*plus*



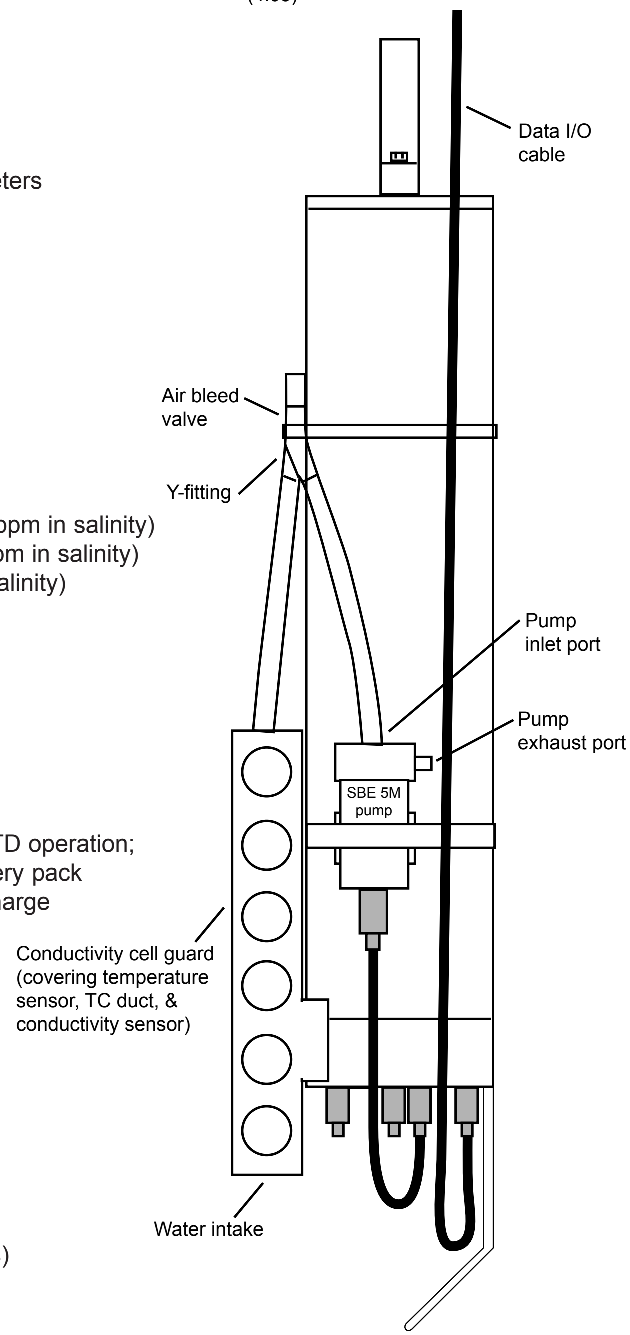
SPECIFICATIONS

Measurement Range	
Temperature	-5 to +35 °C
Conductivity	0 to 9 S/m
Pressure	0 to 20 / 100 / 350 / 1000 / 2000 / 3500 / 7000 meters
Initial Accuracy	
Temperature	0.005 °C
Conductivity	0.0005 S/m
Pressure	0.1% of full scale range
Typical Stability (*per month*)	
Temperature	0.0002 °C
Conductivity	0.0003 S/m
Pressure	0.004% of full scale range
Resolution	
Temperature	0.0001 °C
Conductivity	0.00005 S/m (most oceanic waters; resolves 0.4 ppm in salinity) 0.00007 S/m (high salinity waters; resolves 0.4 ppm in salinity) 0.00001 S/m (fresh waters; resolves 0.1 ppm in salinity)
Pressure	0.002% of full scale range
Memory	8 Mbyte non-volatile FLASH memory

Data Storage

Recorded Parameter	Bytes/Sample
T + C	6
pressure	5
each external voltage	2

Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Internal Batteries	9 alkaline D-cells provide 60 hours continuous CTD operation; optional 9-cell rechargeable nickel-cadmium battery pack provides approximately 24 hours operation per charge
External Power Supply	9 - 28 VDC
Power Requirements	
Sampling	65 mA
SBE 5M pump	95 mA
Quiescent	30 µA
Auxiliary Voltage Sensors	
Auxiliary power out	up to 500 mA at 10.5 - 11 VDC
A/D resolution	14 bits
Input range	0 - 5 VDC



Housing Materials — Depth Rating — Weight

Acetal Copolymer *Plastic* housing — 600 meter (1950 feet) — 7.3 kg (16 lbs)
3AL-2.5V *Titanium* housing — 7000 meter (22,900 feet) — 13.7 kg (30 lbs)

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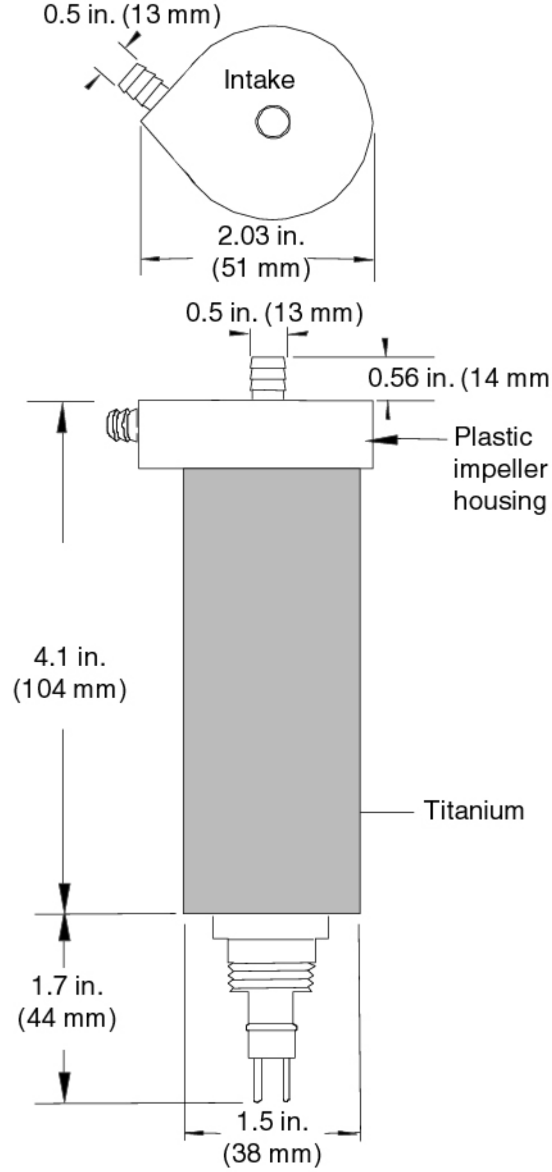
Mini Submersible Pump — SBE 5M

The SBE 5M pump module consists of a centrifugal pump head and a long-life, DC ball bearing motor contained in a compact, titanium, pressure housing usable to 10,500 meters deep. The pump impeller and electric drive motor are coupled magnetically through the housing, providing high reliability by eliminating moving seals. Motor speed and pumping rate remain constant over the entire input voltage range. The motor drive electronics is intrinsically protected against accidental reversed polarity.



APPLICATIONS

The SBE 5M is standard on the SBE 19 and 19*plus* SEACAT Profiler CTD. It is optional on the SBE 16, 16*plus*, and 16*plus*-IM SEACAT C-T Recorder. The pump flushes water through the conductivity cell at a constant rate, independent of the CTD's motion, improving dynamic performance. For applications requiring pumping through additional sensors (for example, a dissolved oxygen sensor), use the SBE 5T pump instead.

Specify:

- Option 5M-1 for profiling (continuous duty) applications such as the SBE 19*plus*.
- Option 5M-2 for moored (pulsed duty) applications such as the SBE 16*plus* or 16*plus*-IM.

Contact Sea-Bird for use in other applications.

SPECIFICATIONS

Option 5M-1 (continuous duty):
Input voltage range 9 - 18 VDC

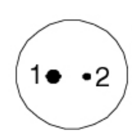
Flow Rate 25 ml/s   supply current 95 ma

Note: Supply current is independent of operating voltage.

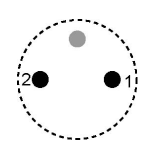
Option 5M-2 (pulsed duty):
Input voltage range 6 - 18 VDC

Pulse Duration	*Flow Volume*	*Electrical Charge*
0.5 seconds	15 ml	0.148 amp-seconds
1.0 seconds	21 ml	0.283 amp-seconds
1.5 seconds	31 ml	0.418 amp-seconds
2.0 seconds	40 ml	0.553 amp-seconds

XSG-2BCL-HP-SS



Pin	Signal
(1)	Ground
(2)	+ Power



Optional wet-pluggable connector, MCBH-2MTI

Weight

In Air: 0.42 kg (0.91 lbs)
In Water: 0.28 kg (0.60 lbs)

06/03

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Website: http://www.seabird.com Email: seabird@seabird.com

SBE 5M MINI SUBMERSIBLE PUMP CONFIGURATION SHEET

Serial Number: 0647

Job Number: 36026

Customer: NOAA/PMC

Delivery Date: 6/14/2004

Single Connector Housing with Titanium screws

Pressure Case: 10,500 meters (titanium)

Maxon Motor Type:

P/N 90337, Motor PN 20130 (Low power 6 VDC, 2000 RPM MAX) ☐

P/N 90335, Motor PN 20130 (Low power 9 VDC, 2000 RPM MAX) ☑

Vin 15V voltage across C2:	8.015	VDC	Current	7.73	mA
Vin 9V voltage across C2:	8.014	VDC	Current	7.4	mA
Vin 6V voltage across C2:	5.888	VDC	Current	7.61	mA

Pump submerged test, no load, Vin 12VDC Average current draw in water: 121 mA

SBE 19plus
SEACAT PROFILER

Conductivity, Temperature, and Pressure Recorder with RS-232 Interface

Serial Number: 19P36026-4616

Sea-Bird Electronics, Inc.
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Tel: 425/643-9866
Fax:425/643-9954

WARNING !!

**Do not submerge this instrument (S/N 19P36026-4616)
beyond the depth rating of the lowest rated component listed below!**

Main Housing (Plastic)	**600 meters**
Pressure Sensor (1000 dBar) Druck	1000 meters
Pump (SBE 5M)	10500 meters

SYSTEM CONFIGURATION 14 June 2004

Model SBE 19plus	**S/N 19P36026-4616**
Instrument Type	**SBE 19plus SeaCaT Profiler**
Firmware Version	**1.4D**
Communications	**9600 baud, 8 data bits, no parity, one stop bit**
Memory	**8192K**
Housing	**600 meter (Celcon plastic)**
0 Conductivity Raw Frequency	**2686.52 Hz**
Pressure Sensor	**Strain Gauge: 1000 dBar, S/N 5512**
Number of Voltages Sampled:	**0**
Serial RS-232C Sensor	**None**
Data Format:	
Count	**Temperature**
Frequency	**Conductivity**
Count	**Pressure, Strain gauge**
Pump (SBE 5M)	**050651**
Voltage Delay Setting (standard)	**(standard) 0 seconds**

IMPORTANT SOFTWARE & HARDWARE CONFIGURATION INFORMATION

Sea-Bird supplies two versions of our software package for communication, real-time data acquisition, and data analysis and display:

- SEASOFT-Win32 - Windows software for PC running Win 95/98/NT/2000/XP
- SEASOFT-DOS - DOS software for IBM-PC/AT/386/486 or compatible computer with a hard drive

Detailed information on the use of the **Windows** software follows:

SEASOFT-Win32

SEASOFT-Win32 software was supplied on a CD-ROM with your CTD. This software package is designed to run on a PC running Win 95/98/NT/2000/XP. The CD-ROM also contains software manuals that describe the appropriate applications for the various programs, the procedure for installing the software, and instructions on using the programs. There are three primary programs used with the CTD for setup, data collection and retrieval, data display, and data processing:

- SEATERM - terminal program for setup of the CTD and uploading of data from the CTD memory (**Note**: If using the CTD with the 90208 Auto Fire Module or SBE 17*plus* V2 SEARAM, use SeatermAF instead of SEATERM)
- SEASAVE - real-time data acquisition program
- SBE Data Processing - data processing program

Instructions for using the software are found in their Help files.

To communicate with the CTD to set it up or to upload data from the CTD memory to the computer hard drive, **SEATERM** must have information about the CTD hardware configuration (communication parameters, internal firmware, etc.) and about the computer. To communicate with the CTD, double click on Seaterm.exe:

1. In the Configure menu, select the CTD. The Configuration Options dialog box appears.
   A. On the COM Settings tab, select the firmware version (if applicable), baud rate, data bits, and parity to match the CTD's configuration sheet. If necessary, change the com port to match the computer you are using.
   B. On the Upload Settings tab, enter upload type (all as a single file, etc.) as desired.
      For the SBE 17 and 25 only: enter the serial number for the SBE 3 (temperature) and SBE 4 (conductivity) modular sensors, exactly as they appear in the configuration (.con) file.
   C. On the Header Information tab, change the settings as desired.

   Click OK when done. SEATERM saves the settings in a SEATERM.ini file.
2. On the Toolbar, click Connect to communicate with the CTD.
3. To set up the CTD prior to deployment:
   On the Toolbar, click Status. SEATERM sends the Status command and displays the response. Verify that the CTD setup matches your desired deployment. If not, send commands to modify the setup.
4. To upload data from the CTD:
   On the Toolbar, click Upload to upload data from the CTD memory to the computer.

Sea-Bird CTDs store and/or transmit data from their primary and auxiliary sensors in the form of binary or hexadecimal number equivalents of the sensors' frequency or voltage outputs. This is referred to as the *raw* data. The calculations required to convert from *raw* data to *engineering* units of the measured parameters (temperature, conductivity, pressure, dissolved oxygen, pH, etc.) are performed using the software, either in real time, or after the data has been stored in a file. SEASAVE creates the file in real time. As noted above, SEATERM uploads the recorded data and creates the file on the computer hard drive.

To successfully store data to a file on the computer and subsequently convert it to engineering units, the software must know the CTD type, CTD configuration, and calibration coefficients for the sensors installed on the CTD. This information is unique to each CTD, and is contained in a *configuration* file. The configuration file, which has a .con extension, was written onto a floppy disk and the CD-ROM shipped with the CTD. The .con file for a given CTD is named with the last four digits of the serial number for that CTD (e.g., 1234.con). The configuration file is created or modified (e.g., changing coefficients after recalibration, or adding another sensor) by using the Configure menu in **SEASAVE** or **SBE Data Processing**. The configuration file is used by SEASAVE to convert raw data to engineering units when it acquires, stores, and displays real-time data. The configuration file is also used by some modules in SBE Data Processing (Data Conversion and Derive) that convert raw data to engineering units during data processing.

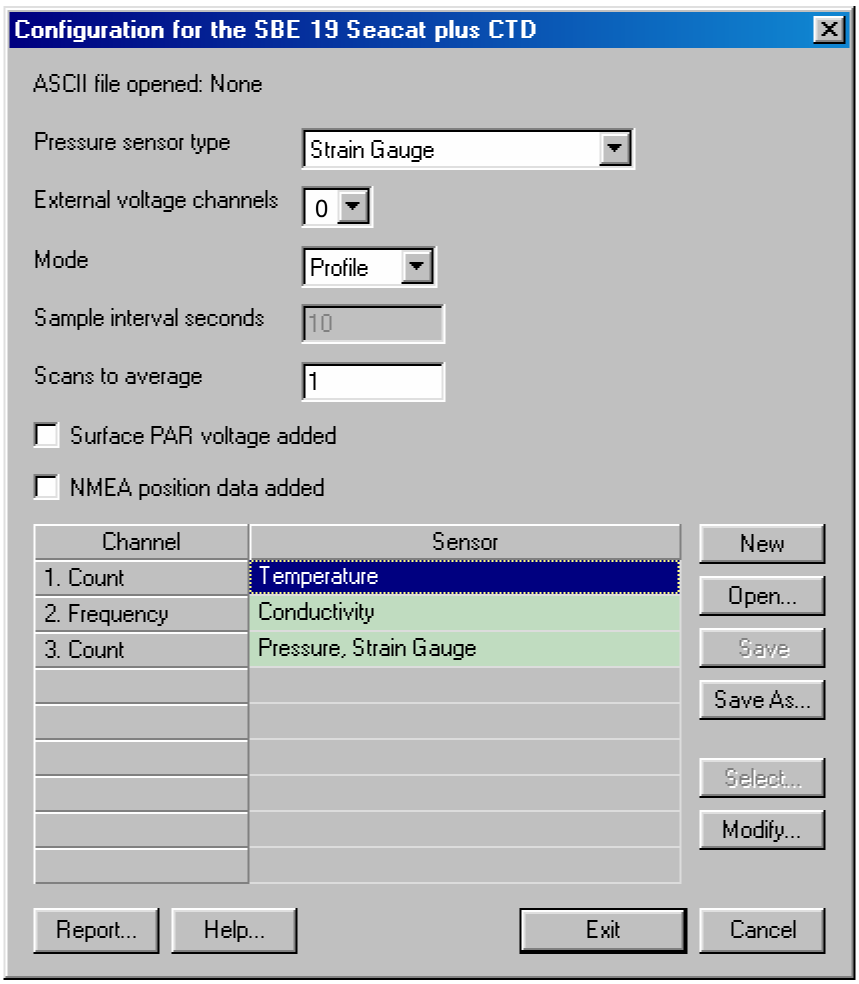
The instrument type and instrument configuration settings of the .con file and the required setup for the SEATERM.ini file for the CTD *as delivered* are documented below. The calibration coefficients for the CTD's sensors are contained in the calibration coefficient section of the CTD manual.

NOTE:

SEATERM will not upload data correctly without a properly configured SEATERM.ini file. SEASAVE and SBE Data Processing will not interpret the data correctly without the correct .con file.

SEASOFT CONFIGURATION:

The correct instrument type for your instrument is SBE 19plus SEACAT Profiler. The correct settings for the configuration of your instrument as delivered are documented below:



SPECIFICATIONS

SEACAT Profiler

SBE 19*plus*

The SBE 19*plus* is the next generation *Personal CTD*, bringing numerous improvements in accuracy, resolution (in fresh as well as salt water), reliability, and ease-of-use to the wide range of research, monitoring, and engineering applications pioneered by its legendary SEACAT predecessor. The 19*plus* samples faster (4 Hz vs 2), is more accurate (0.005 vs 0.01 in T, 0.0005 vs 0.001 in C, and 0.1% vs 0.25% — with *seven* times the resolution — in D), and has more memory (8 Mbyte vs 1). There is more power for auxiliary sensors (500 ma vs 50), and they are acquired at higher resolution (14 bit vs 12). Cabling is simpler and more reliable because there are four differential auxiliary inputs on two separate connectors, and a dedicated connector for the pump. All exposed metal parts are titanium, instead of aluminum, for long life and minimum maintenance.

The 19*plus* can be operated without a computer from even the smallest boat, with data recorded in non-volatile FLASH memory and processed later on your PC. Simultaneous with recording, real-time data can be transmitted over single-core, armored cable directly to your PC's serial port (maximum transmission distance dependent on number of auxiliary sensors, baud rate, and cable properties). The 19*plus'* faster sampling and pump-controlled TC-ducted flow configuration significantly reduces salinity spiking caused by ship heave, and allows slower descent rates for improved resolution of water column features. Auxiliary sensors for dissolved oxygen, pH, turbidity, fluorescense, PAR, and ORP can be added, and for moored deployments the 19*plus* can be set to *time-series* mode using software commands. External power and two-way real-time communication over 10,000 meters of cable can be provided with the SBE 36 CTD Deck Unit and Power and Data Interface Module (PDIM).

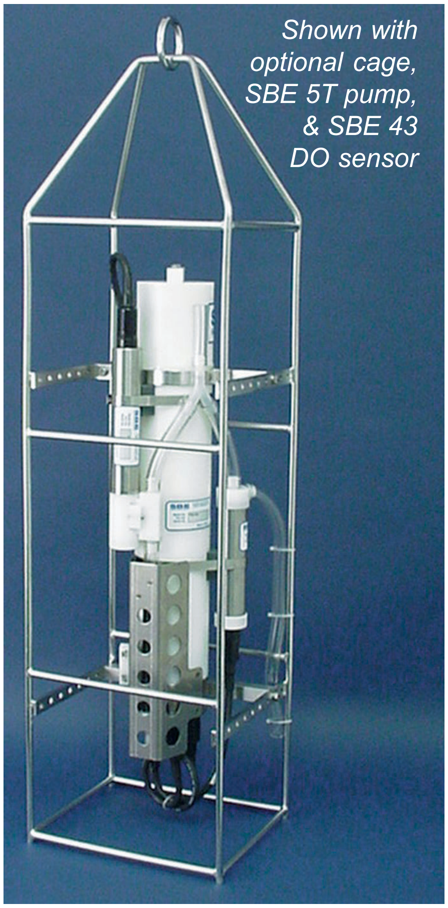
The 19*plus* uses the same temperature and conductivity sensors proven in 5000 SEACAT and MicroCAT instruments, and a superior new micro-machined silicon strain gauge pressure sensor developed by Druck, Inc. Improvements in design, materials, and signal acquisition techniques yield a low-cost instrument with superior performance that is also easy to use. Calibration coefficients, obtained in our computer-controlled high-accuracy calibration baths, are stored in EEPROM memory. They permit data output in ASCII engineering units (degrees C, Siemens/m, decibars, Salinity [PSU], sound velocity [m/sec], etc.). The 19*plus* can be factory-configured to emulate the .hex output format and 2 Hz data rate of old SEACATs for compatibility with existing software or instrument fleets.

Accuracy, convenience, portability, software, and support; compelling reasons why the 19*plus* is today's best low-cost CTD.

CONFIGURATION AND OPTIONS

A standard SBE 19*plus* is supplied with:
- Plastic housing for depths to 600 meters
- Strain-gauge pressure sensor
- 8 Mbyte FLASH RAM memory
- 9 D-size alkaline batteries
- Impulse glass-reinforced epoxy bulkhead connectors: 4-pin I/O, 2-pin pump, and two 6-pin (two differential auxiliary A/D inputs each)
- SBE 5M miniature pump and T-C Duct

Options include:
- Titanium housing for depths to 7000 meters
- Sensors for oxygen, pH, fluorescence, light (PAR), light transmission, and turbidity
- SBE 5T pump in place of SBE 5M for use with dissolved oxygen and/or other pumped sensors
- Stainless steel cage
- MCBH *Micro* connectors
- Ni-Cad batteries and charger



Shown with optional cage, SBE 5T pump, & SBE 43 DO sensor

SOFTWARE

SEASOFT©-Win32, our complete Windows 95/98/NT/2000/XP software package, is included at no extra charge. Its modular programs include:
- SEATERM© — communication and data retrieval
- SEASAVE© — real-time data acquisition and display
- SBE Data Processing© — filtering, aligning, averaging, and plotting of CTD and auxiliary sensor data and derived variables

SBE

Sea-Bird Electronics, Inc.
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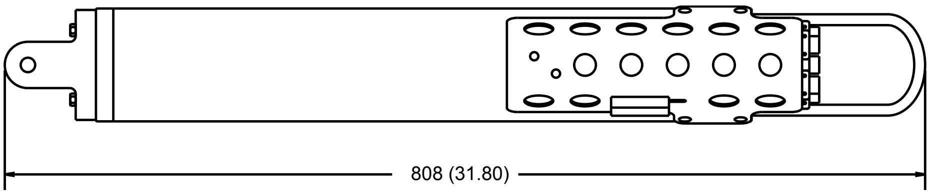
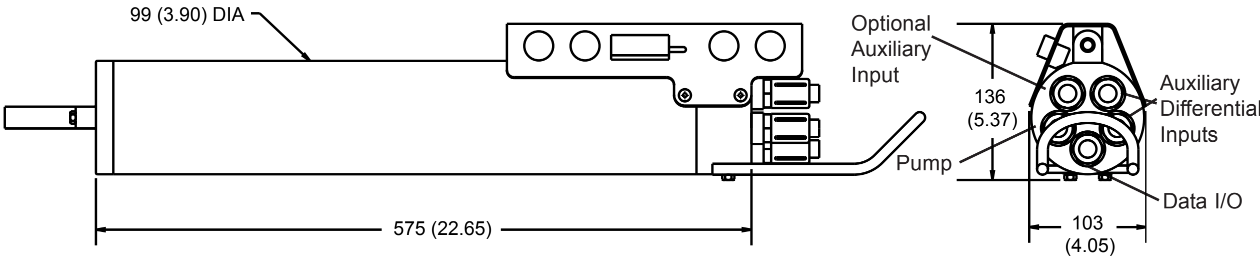
Email: seabird@seabird.com
Telephone: (425) 643-9866
Fax: (425) 643-9954

SEACAT Profiler

SBE 19*plus*

Dimensions
in millimeters
(inches)





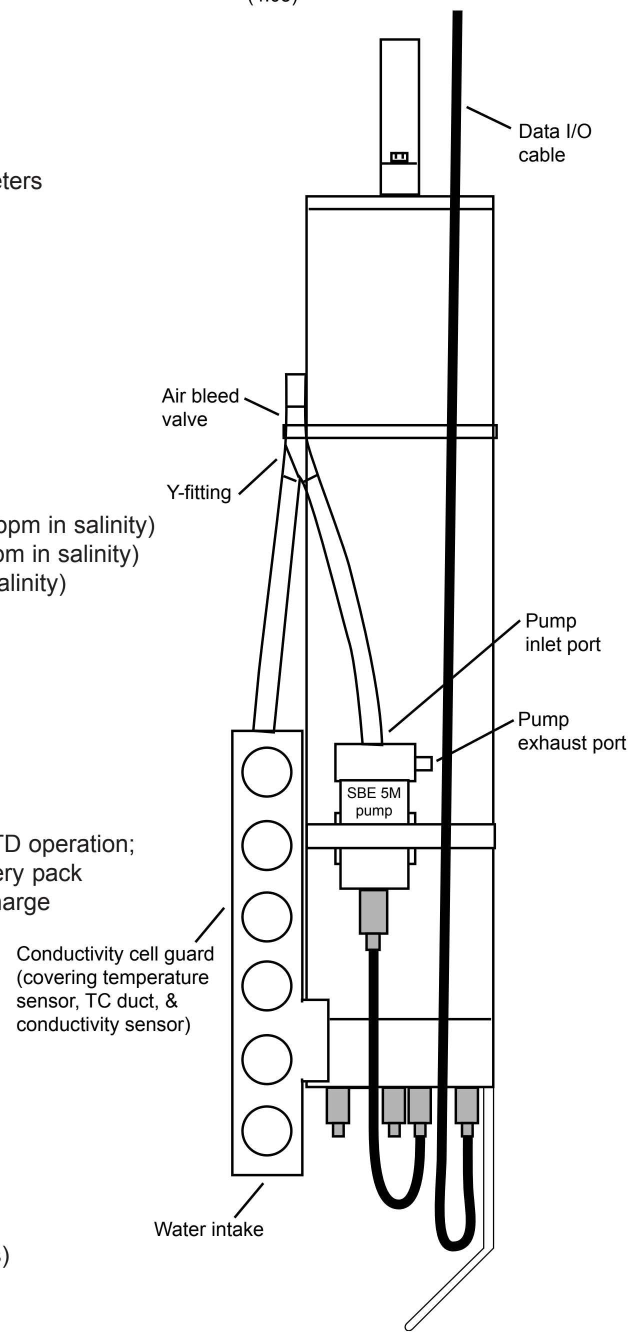
SPECIFICATIONS

Measurement Range	
Temperature	-5 to +35 °C
Conductivity	0 to 9 S/m
Pressure	0 to 20 / 100 / 350 / 1000 / 2000 / 3500 / 7000 meters
Initial Accuracy	
Temperature	0.005 °C
Conductivity	0.0005 S/m
Pressure	0.1% of full scale range
Typical Stability (*per month*)	
Temperature	0.0002 °C
Conductivity	0.0003 S/m
Pressure	0.004% of full scale range
Resolution	
Temperature	0.0001 °C
Conductivity	0.00005 S/m (most oceanic waters; resolves 0.4 ppm in salinity) 0.00007 S/m (high salinity waters; resolves 0.4 ppm in salinity) 0.00001 S/m (fresh waters; resolves 0.1 ppm in salinity)
Pressure	0.002% of full scale range
Memory	8 Mbyte non-volatile FLASH memory
Data Storage	Recorded Parameter — Bytes/Sample T + C — 6 pressure — 5 each external voltage — 2
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Internal Batteries	9 alkaline D-cells provide 60 hours continuous CTD operation; optional 9-cell rechargeable nickel-cadmium battery pack provides approximately 24 hours operation per charge
External Power Supply	9 - 28 VDC
Power Requirements	
Sampling	65 mA
SBE 5M pump	95 mA
Quiescent	30 μA
Auxiliary Voltage Sensors	
Auxiliary power out	up to 500 mA at 10.5 - 11 VDC
A/D resolution	14 bits
Input range	0 - 5 VDC

Housing Materials — Depth Rating — Weight

Acetal Copolymer *Plastic* housing — 600 meter (1950 feet) — 7.3 kg (16 lbs)

3AL-2.5V *Titanium* housing — 7000 meter (22,900 feet) — 13.7 kg (30 lbs)



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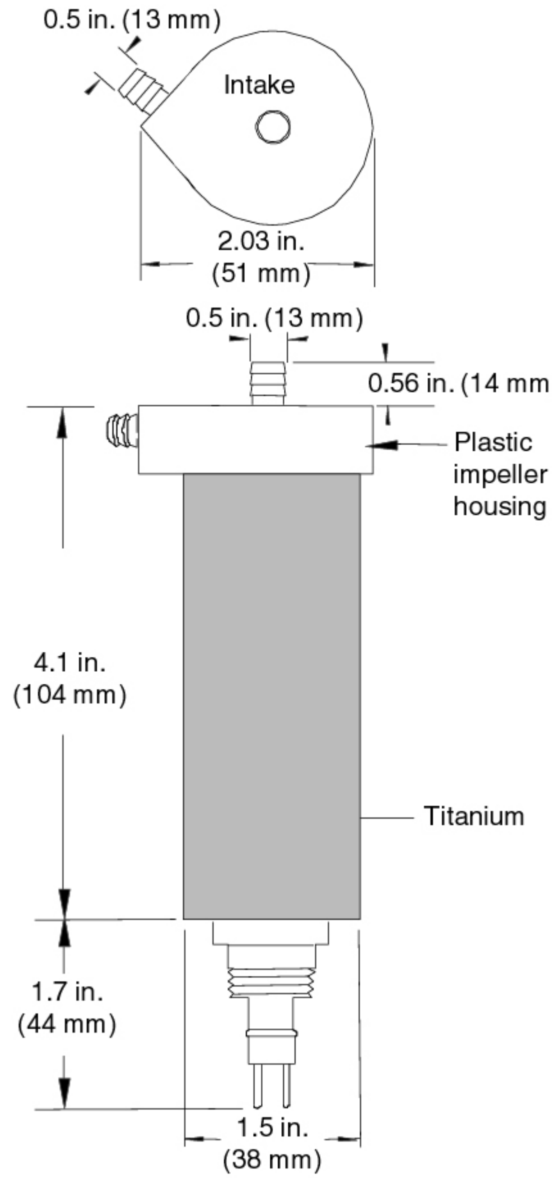
Mini Submersible Pump SBE 5M

The SBE 5M pump module consists of a centrifugal pump head and a long-life, DC ball bearing motor contained in a compact, titanium, pressure housing usable to 10,500 meters deep. The pump impeller and electric drive motor are coupled magnetically through the housing, providing high reliability by eliminating moving seals. Motor speed and pumping rate remain constant over the entire input voltage range. The motor drive electronics is intrinsically protected against accidental reversed polarity.



APPLICATIONS

The SBE 5M is standard on the SBE 19 and 19*plus* SEACAT Profiler CTD. It is optional on the SBE 16, 16*plus*, and 16*plus*-IM SEACAT C-T Recorder. The pump flushes water through the conductivity cell at a constant rate, independent of the CTD's motion, improving dynamic performance. For applications requiring pumping through additional sensors (for example, a dissolved oxygen sensor), use the SBE 5T pump instead.

Specify:

- Option 5M-1 for profiling (continuous duty) applications such as the SBE 19*plus*.
- Option 5M-2 for moored (pulsed duty) applications such as the SBE 16*plus* or 16*plus*-IM.

Contact Sea-Bird for use in other applications.

SPECIFICATIONS

Option 5M-1 (continuous duty):
Input voltage range 9 - 18 VDC

Flow Rate 25 ml/s supply current 95 ma

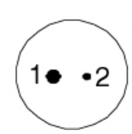
Note: Supply current is independent of operating voltage.

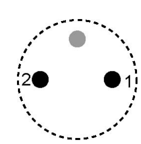
Option 5M-2 (pulsed duty):
Input voltage range 6 - 18 VDC

Pulse Duration	*Flow Volume*	*Electrical Charge*
0.5 seconds	15 ml	0.148 amp-seconds
1.0 seconds	21 ml	0.283 amp-seconds
1.5 seconds	31 ml	0.418 amp-seconds
2.0 seconds	40 ml	0.553 amp-seconds

XSG-2BCL-HP-SS

Pin	Signal
(1)	Ground
(2)	+ Power





Optional wet-pluggable connector, MCBH-2MTI

Weight

In Air: 0.42 kg (0.91 lbs)
In Water: 0.28 kg (0.60 lbs)

06/03

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Website: http://www.seabird.com Email: seabird@seabird.com

SBE 5M MINI SUBMERSIBLE PUMP CONFIGURATION SHEET

Serial Number: 0651

Job Number: 36026

Customer: NOAA/PMC

Delivery Date: 6/14/2004

Single Connector Housing with Titanium screws

Pressure Case: 10,500 meters (titanium)

Maxon Motor Type:

P/N 90337, Motor PN 20130 (Low power 6 VDC, 2000 RPM MAX) ☐

P/N 90335, Motor PN 20130 (Low power 9 VDC, 2000 RPM MAX) ☑

Vin 15V voltage across C2:	7.929	VDC	Current	9.29	mA
Vin 9V voltage across C2:	7.928	VDC	Current	8.8	mA
Vin 6V voltage across C2:	5.885	VDC	Current	7.99	mA

Pump submerged test, no load, Vin 12VDC Average current draw in water: 120 mA

SBE 19plus SEACAT PROFILER

Conductivity, Temperature, and Pressure Recorder with RS-232 Interface

Serial Number: 19P36026-4617

Sea-Bird Electronics, Inc.
1808 136th Place NE
Bellevue, Washington 98005 USA
Tel: 425/643-9866
Fax:425/643-9954

LIMITED LIABILITY STATEMENT

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use of servicing of this system.

WARNING !!

Do not submerge this instrument (S/N 19P36026-4617)
beyond the depth rating of the lowest rated component listed below!

Main Housing (Plastic)	**600 meters**
Pressure Sensor (1000 dBar) Druck	1000 meters
Pump (SBE 5M)	10500 meters

SYSTEM CONFIGURATION 14 June 2004

Model SBE 19plus	**S/N 19P36026-4617**
Instrument Type	**SBE 19plus SeaCaT Profiler**
Firmware Version	**1.4D**
Communications	**9600 baud, 8 data bits, no parity, one stop bit**
Memory	**8192K**
Housing	**600 meter (Celcon plastic)**
0 Conductivity Raw Frequency	**2801.47 Hz**
Pressure Sensor	**Strain Gauge: 1000 dBar, S/N 5513**
Number of Voltages Sampled:	**0**
Serial RS-232C Sensor	**None**

Data Format:

Count	**Temperature**
Frequency	**Conductivity**
Count	**Pressure, Strain gauge**

Pump (SBE 5M)	**050649**
Voltage Delay Setting (standard)	**(standard) 0 seconds**

IMPORTANT SOFTWARE & HARDWARE CONFIGURATION INFORMATION

Sea-Bird supplies two versions of our software package for communication, real-time data acquisition, and data analysis and display:

- SEASOFT-Win32 - Windows software for PC running Win 95/98/NT/2000/XP
- SEASOFT-DOS - DOS software for IBM-PC/AT/386/486 or compatible computer with a hard drive

Detailed information on the use of the **Windows** software follows:

SEASOFT-Win32

SEASOFT-Win32 software was supplied on a CD-ROM with your CTD. This software package is designed to run on a PC running Win 95/98/NT/2000/XP. The CD-ROM also contains software manuals that describe the appropriate applications for the various programs, the procedure for installing the software, and instructions on using the programs. There are three primary programs used with the CTD for setup, data collection and retrieval, data display, and data processing:

- SEATERM - terminal program for setup of the CTD and uploading of data from the CTD memory (**Note**: If using the CTD with the 90208 Auto Fire Module or SBE 17*plus* V2 SEARAM, use SeatermAF instead of SEATERM)
- SEASAVE - real-time data acquisition program
- SBE Data Processing - data processing program

Instructions for using the software are found in their Help files.

To communicate with the CTD to set it up or to upload data from the CTD memory to the computer hard drive, **SEATERM** must have information about the CTD hardware configuration (communication parameters, internal firmware, etc.) and about the computer. To communicate with the CTD, double click on Seaterm.exe:

1. In the Configure menu, select the CTD. The Configuration Options dialog box appears.
   A. On the COM Settings tab, select the firmware version (if applicable), baud rate, data bits, and parity to match the CTD's configuration sheet. If necessary, change the com port to match the computer you are using.
   B. On the Upload Settings tab, enter upload type (all as a single file, etc.) as desired.
   For the SBE 17 and 25 only: enter the serial number for the SBE 3 (temperature) and SBE 4 (conductivity) modular sensors, exactly as they appear in the configuration (.con) file.
   C. On the Header Information tab, change the settings as desired.

   Click OK when done. SEATERM saves the settings in a SEATERM.ini file.
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To successfully store data to a file on the computer and subsequently convert it to engineering units, the software must know the CTD type, CTD configuration, and calibration coefficients for the sensors installed on the CTD. This information is unique to each CTD, and is contained in a *configuration* file. The configuration file, which has a .con extension, was written onto a floppy disk and the CD-ROM shipped with the CTD. The .con file for a given CTD is named with the last four digits of the serial number for that CTD (e.g., 1234.con). The configuration file is created or modified (e.g., changing coefficients after recalibration, or adding another sensor) by using the Configure menu in **SEASAVE** or **SBE Data Processing**. The configuration file is used by SEASAVE to convert raw data to engineering units when it acquires, stores, and displays real-time data. The configuration file is also used by some modules in SBE Data Processing (Data Conversion and Derive) that convert raw data to engineering units during data processing.

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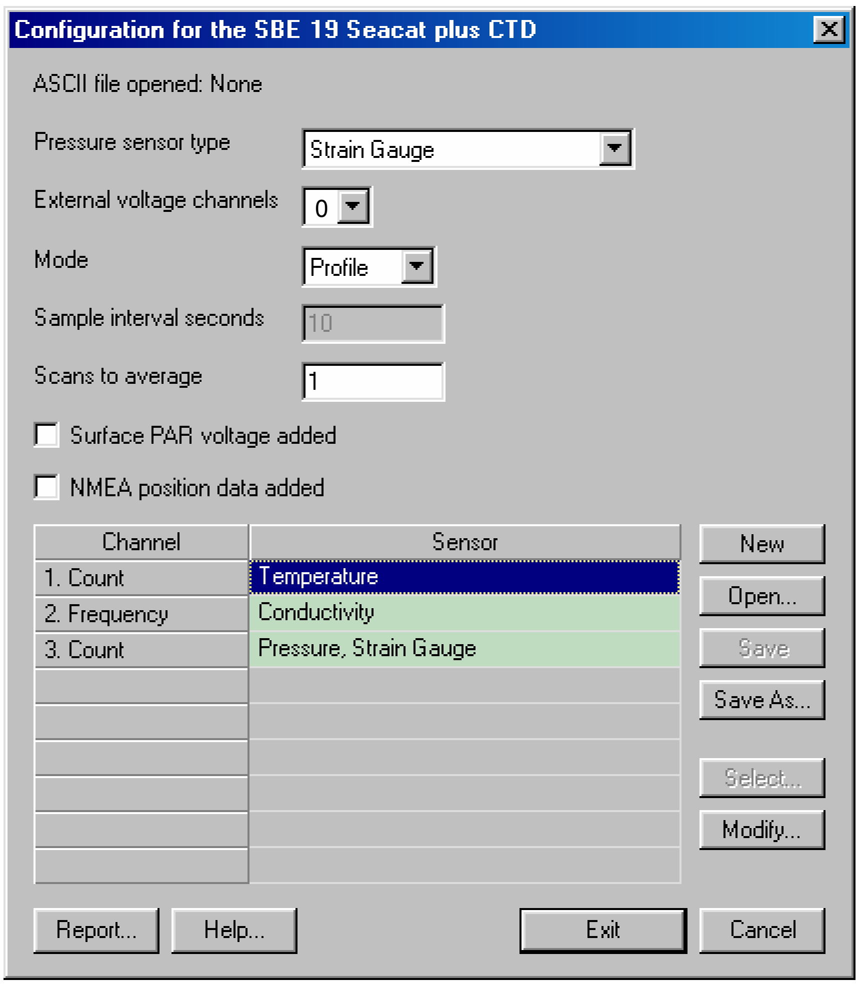

SPECIFICATIONS

SEACAT Profiler

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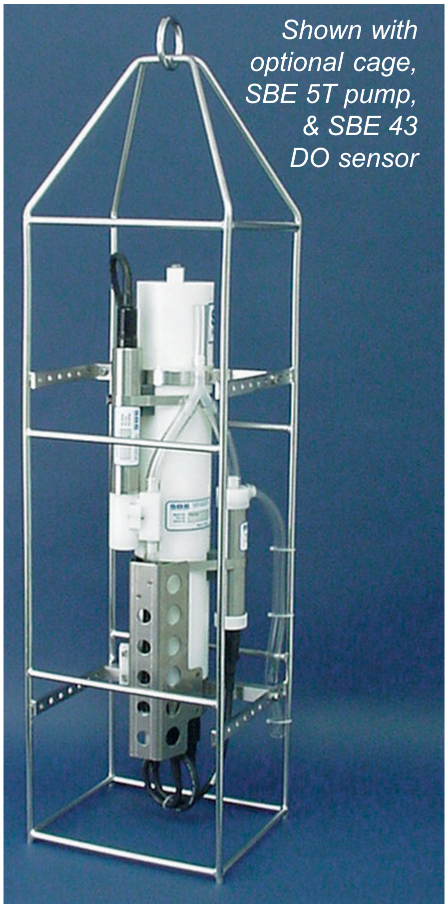

Shown with optional cage, SBE 5T pump, & SBE 43 DO sensor

SOFTWARE

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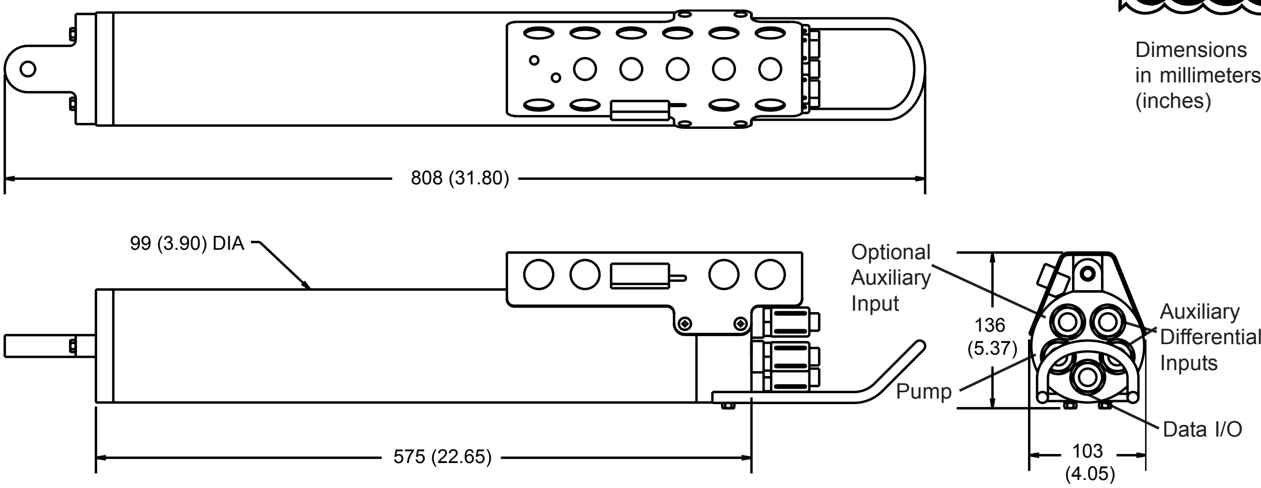
SEACAT Profiler

SBE 19*plus*



SPECIFICATIONS

Measurement Range	
Temperature	-5 to +35 °C
Conductivity	0 to 9 S/m
Pressure	0 to 20 / 100 / 350 / 1000 / 2000 / 3500 / 7000 meters
Initial Accuracy	
Temperature	0.005 °C
Conductivity	0.0005 S/m
Pressure	0.1% of full scale range
Typical Stability (*per month*)	
Temperature	0.0002 °C
Conductivity	0.0003 S/m
Pressure	0.004% of full scale range
Resolution	
Temperature	0.0001 °C
Conductivity	0.00005 S/m (most oceanic waters; resolves 0.4 ppm in salinity) 0.00007 S/m (high salinity waters; resolves 0.4 ppm in salinity) 0.00001 S/m (fresh waters; resolves 0.1 ppm in salinity)
Pressure	0.002% of full scale range
Memory	8 Mbyte non-volatile FLASH memory

Data Storage

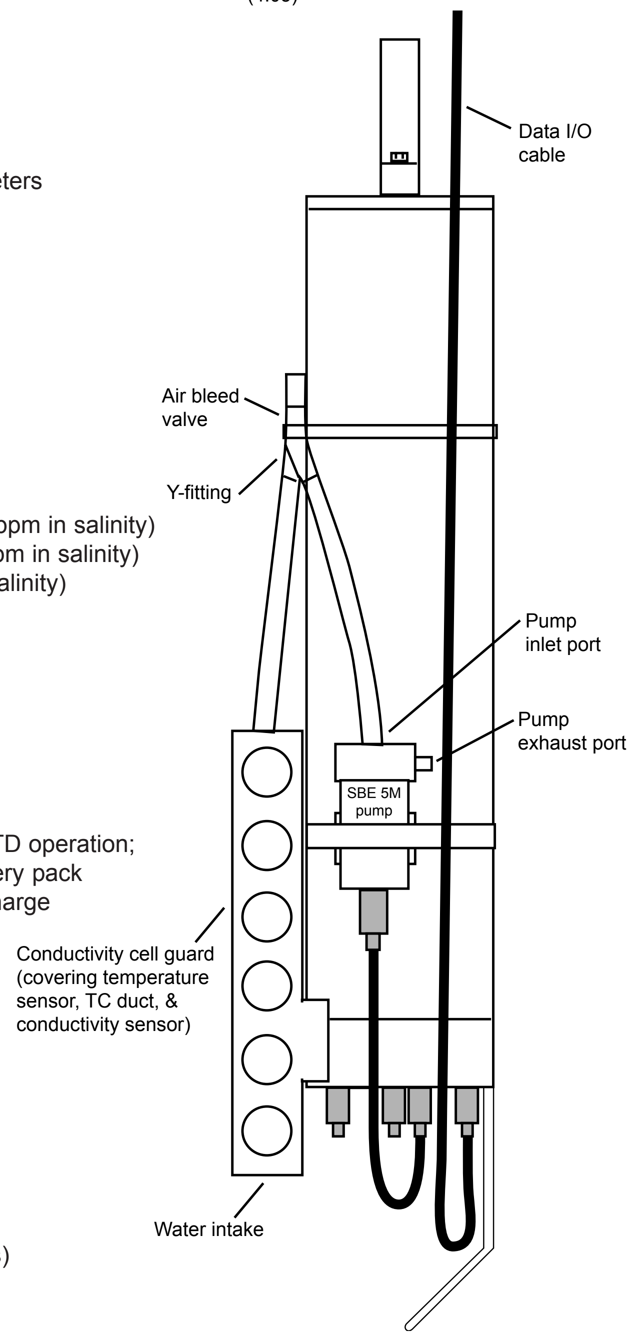
Recorded Parameter	Bytes/Sample
T + C	6
pressure	5
each external voltage	2

Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Internal Batteries	9 alkaline D-cells provide 60 hours continuous CTD operation; optional 9-cell rechargeable nickel-cadmium battery pack provides approximately 24 hours operation per charge
External Power Supply	9 - 28 VDC
Power Requirements	
Sampling	65 mA
SBE 5M pump	95 mA
Quiescent	30 µA
Auxiliary Voltage Sensors	
Auxiliary power out	up to 500 mA at 10.5 - 11 VDC
A/D resolution	14 bits
Input range	0 - 5 VDC

Housing Materials — Depth Rating — Weight

Acetal Copolymer *Plastic* housing — 600 meter (1950 feet) — 7.3 kg (16 lbs)

3AL-2.5V *Titanium* housing — 7000 meter (22,900 feet) — 13.7 kg (30 lbs)



Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com
Email: seabird@seabird.com
Telephone: (425) 643-9866
Fax: (425) 643-9954

Mini Submersible Pump SBE 5M

The SBE 5M pump module consists of a centrifugal pump head and a long-life, DC ball bearing motor contained in a compact, titanium, pressure housing usable to 10,500 meters deep. The pump impeller and electric drive motor are coupled magnetically through the housing, providing high reliability by eliminating moving seals. Motor speed and pumping rate remain constant over the entire input voltage range. The motor drive electronics is intrinsically protected against accidental reversed polarity.

APPLICATIONS

The SBE 5M is standard on the SBE 19 and 19*plus* SEACAT Profiler CTD. It is optional on the SBE 16, 16*plus*, and 16*plus*-IM SEACAT C-T Recorder. The pump flushes water through the conductivity cell at a constant rate, independent of the CTD's motion, improving dynamic performance. For applications requiring pumping through additional sensors (for example, a dissolved oxygen sensor), use the SBE 5T pump instead.

Specify:
- Option 5M-1 for profiling (continuous duty) applications such as the SBE 19*plus*.
- Option 5M-2 for moored (pulsed duty) applications such as the SBE 16*plus* or 16*plus*-IM.

Contact Sea-Bird for use in other applications.

SPECIFICATIONS

Option 5M-1 (continuous duty):
Input voltage range 9 - 18 VDC

Flow Rate 25 ml/s supply current 95 ma

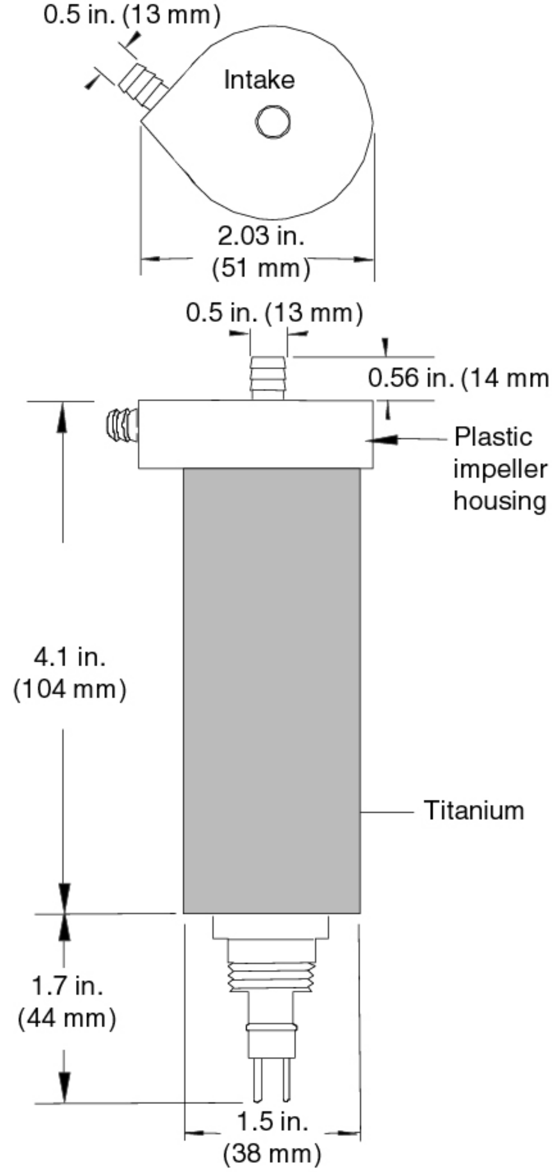
Note: Supply current is independent of operating voltage.

Option 5M-2 (pulsed duty):
Input voltage range 6 - 18 VDC

Pulse Duration	*Flow Volume*	*Electrical Charge*
0.5 seconds	15 ml	0.148 amp-seconds
1.0 seconds	21 ml	0.283 amp-seconds
1.5 seconds	31 ml	0.418 amp-seconds
2.0 seconds	40 ml	0.553 amp-seconds

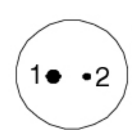
Weight

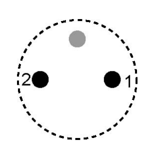
In Air:	0.42 kg (0.91 lbs)
In Water:	0.28 kg (0.60 lbs)



XSG-2BCL-HP-SS

Pin	Signal
(1)	Ground
(2)	+ Power





Optional wet-pluggable connector, MCBH-2MTI

06/03

Sea-Bird Electronics, Inc. FAX: (425) 643-9954
1808 136th Place NE, Bellevue, Washington 98005 USA Tel: (425) 643-9866
Website: http://www.seabird.com Email: seabird@seabird.com

SBE 5M MINI SUBMERSIBLE PUMP CONFIGURATION SHEET

Serial Number: 0649

Job Number: 36026

Customer: NOAA/PMC

Delivery Date: 6/14/2004

Single Connector Housing with Titanium screws

Pressure Case: 10,500 meters (titanium)

Maxon Motor Type:

P/N 90337, Motor PN 20130 (Low power 6 VDC, 2000 RPM MAX) ☐

P/N 90335, Motor PN 20130 (Low power 9 VDC, 2000 RPM MAX) ☑

Vin 15V voltage across C2:	7.947	VDC	Current	11.8	mA
Vin 9V voltage across C2:	7.948	VDC	Current	11.0	mA
Vin 6V voltage across C2:	5.868	VDC	Current	10.2	mA

Pump submerged test, no load, Vin 12VDC Average current draw in water: 124 mA

LEICA NA2 · NAK2

Universal automatic level

Leica
Geosystems

LEICA NA2
The classical level from Leica Geosystems

The NA2 universal automatic level meets all requirements regarding precision, convenience and reliability.

It was designed by surveyors and development engineers with years of experience and who know what a field instrument has to be able to do.

The NA2 soon pays for itself, because it can be used for all types of surveying job; on building sites for routine levelling, in engineering projects, and for geodetic control at all levels of accuracy.

Universal application

- Levelling of all types and all orders of accuracy
- Precise levelling and settlement determinations on buildings
- Routine heighting for the construction of roads, railways, pipelines, tunnels and so forth
- Setting-out work and control measurements on the construction site
- Area levelling of high accuracy
- Tacheometric levelling with the K-version on flat terrain by combining stadia and angular measurements with height readings
- Deformation measurement and monitoring of bridges

Quickly set up, simple to use

Strong tripods

In principle, the NA2 can be set up on any Leica Geosystems tripod. In practice, for all-round purposes, we recommend the heavy-duty GST20 telescopic-leg tripod. For precise levelling the GST40 fixed-leg tripod is suitable because of its extreme rigidity.

The modular relationship between instrument and tripod is an advantage when transport space is limited.

Centring is easy

The circular level only needs to be centred approximately to bring the compensator well into its working range of ~30', and so setting-up goes quicker.

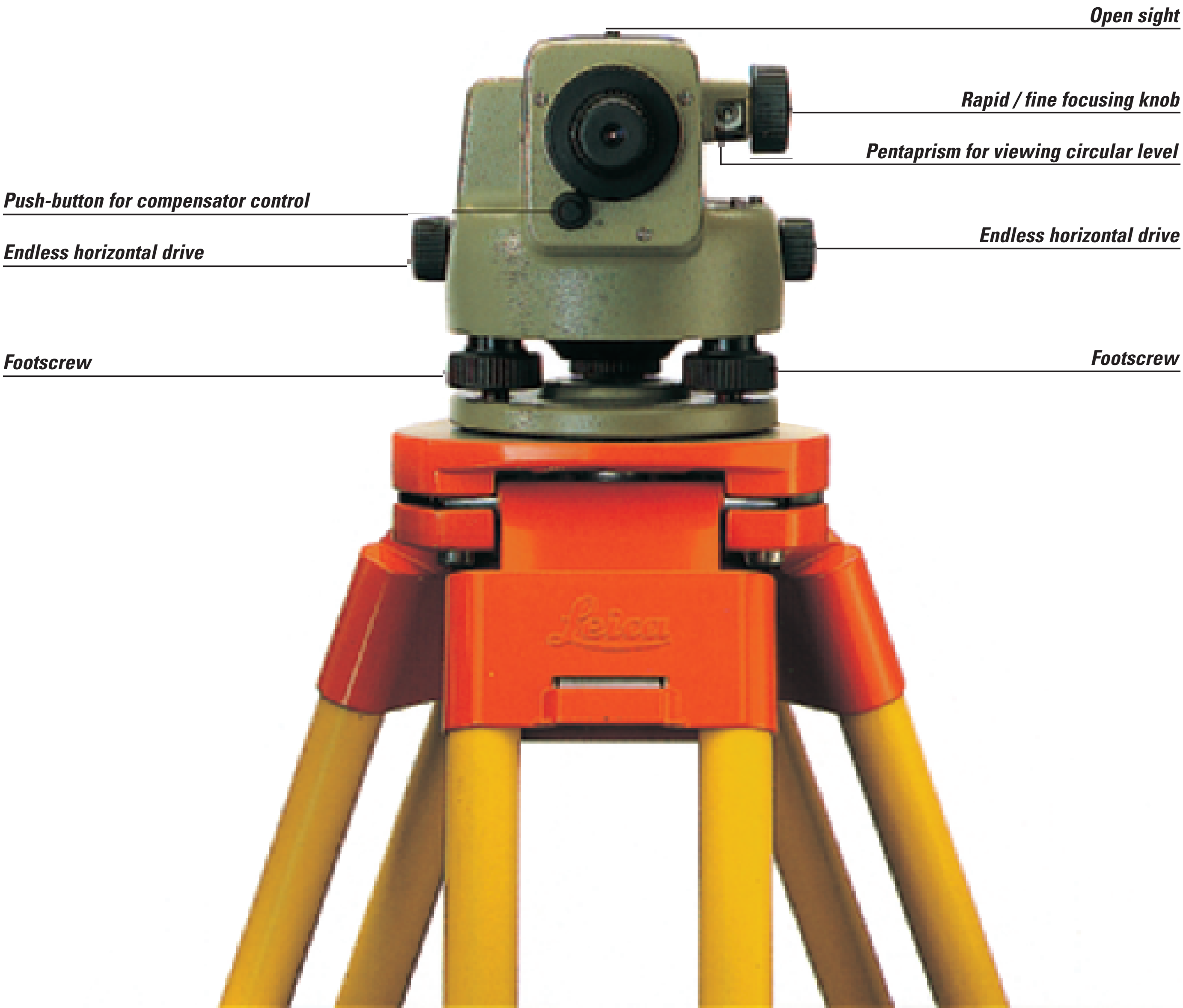
The bubble is viewed positively via a pentaprism and is monitored down the eyepiece.

Play-free footscrews

The pitch of the smooth-running and backlash-free footscrews is such that the bubble can be centred in a very short time.

Independent of temperature

Unlike the tubular level of a traditional instrument, the NA2 universal automatic level is relatively insensitive to direct solar radiation and an umbrella need only be considered for the most precise levelling.



Adjust the line of sight automatically

Easy to level up

The advantage of this instrument is that, as soon as the bubble is centred, the line of sight is horizontal for all pointings of the telescope. The observer is freed of the time-consuming centring procedure involved with the traditional tubular level, and can concentrate on the business of staff readings.

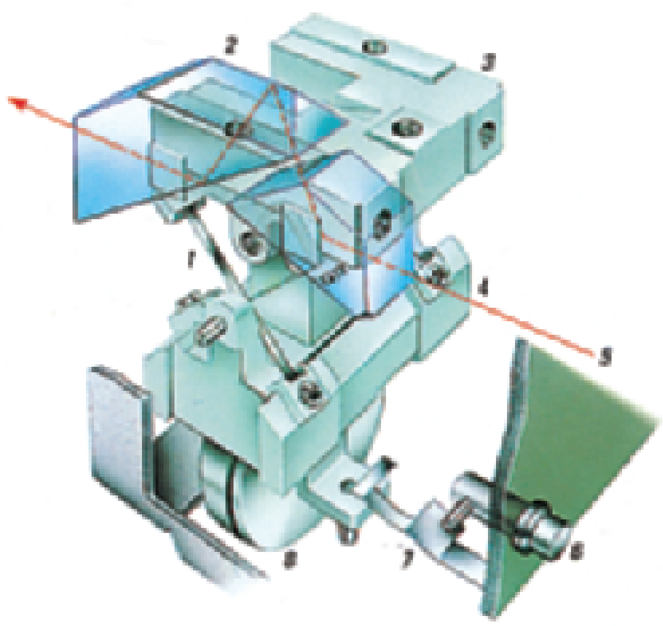
Robust and automatic

The compensator is essentially a pendulum with a prism (4).

The suspension system comprises four flexed tapes (1) made of a special alloy to ensure faultless functioning even at extreme temperatures. The compensator, which is located between the focusing lens and the crosshair reticle, is pneumatically damped against mechanical vibration and is screened against magnetic fields.

Minimum maintenance

In the unlikely event that the compensator is damaged (and this can only happen as a result of extremely harsh treatment) it is replaced easily, being held only by three screws.



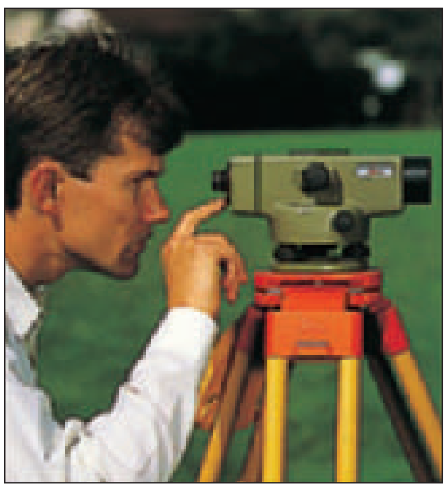
2/NAK2 compensator

'uspension tapes
'rism (fixed)
'ompensator body
'endulum with prism
ine of sight
'ush-button
'pring which taps pendulum
'neumatic damping mechanism

Push-button control – added security

With most automatics one taps the tripod or instrument to check if the compensator is functioning. Leica Geosystems offers a far more sophisticated solution.

Pressing the button under the NA2 eyepiece gives the compensator a gentle tap, so that you see the staff image swing smoothly away and then float gently back to give the horizontal line of sight. This check, which takes less than a second, is technically perfect, as the pendulum itself is activated and swings through its full range. It is also immediately apparent if the bubble is not centred.



Top-class optics

Top-class optics

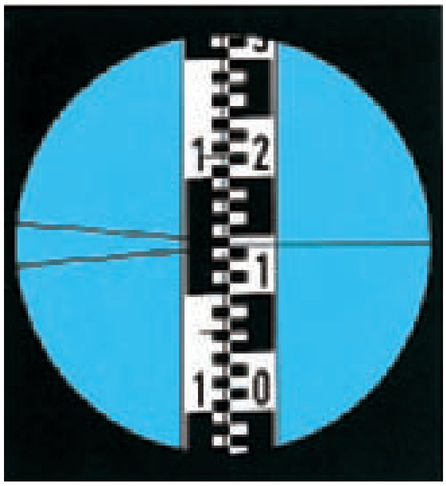
The telescope is of excellent quality and gives a bright, high-contrast, erect image, even in poor light – an essential for accurate levelling. With the standard eyepiece the magnification is 32×, the optimum for most applications of the instrument. Optional eyepieces are available; the 40× may be preferred for precise levelling, the 25× in hot, shimmer conditions. Eyepiece exchange takes only a second or so.

The focusing knob has a coarse/fine movement:
– coarse, for rapid setting with minimum turning
– fine, for the final delicate touch to give the perfect image.

Fatigue-free viewing

The reticle has:
– a single horizontal hair for reading normal staffs
– a wedge-shaped hair for use with invar staffs
– stadia hairs for distance measurement and three-wire levelling.

The general layout of the controls, the smooth friction-braked rotation of the instrument, and the endless horizontal drive with bilateral knobs, all combine to make the instrument easy to use.



NA2 field of view with metric levelling staff
Reading at horizontal hair: 1.143 m

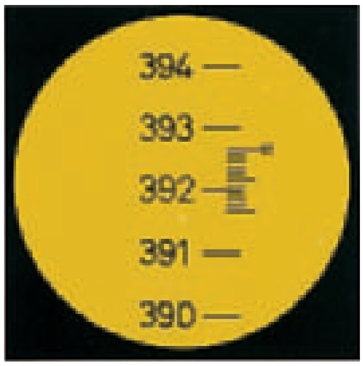
At an advantage on unstable ground

If a tubular level is used on unstable ground it tilts out of range and has to be continuously reset. By contrast, the pendulum of the NA2 "compensates" and keeps the line of sight horizontal.

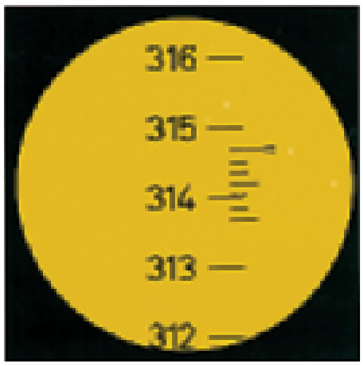
Angle measurement with the NAK2

Civil engineers and contractors often require a circle for angle measurement and setting-out work. Even simple detail surveys, by taking angle, distance and height, and plotting with the polar method, can be done with a level.

The model NAK2 has an internal glass circle which is read via a scale microscope and which can be set to any value by turning the rim around the base of the instrument.



NAK2
circle reading (400 gon)
392.66 gon



NAK2
circle reading (360°)
314°42'

High-performance accessories for precise levelling

GPM3 parallel-plate micrometer

This optional accessory slips over the telescope objective and blends perfectly with the smooth lines of the NA2. With a compensator setting accuracy of ±0.3" (equivalent to 0.01 mm in 10 m) and a micrometer reading to 0.1 mm direct and 0.01 mm by estimation, the NA2 with GPM3 is an ideal combination for precise levelling, deformation studies, and even optical tooling. The micrometer drive for raising and lowering the line of sight is conveniently located and readings are taken on a glass scale viewed through an eyepiece just above the telescope eyepiece. This optical reading system, which is digital apart from the last and estimated figure in the metric and inch versions, is superior to the usual metal drum system.

GPM6 parallel-plate micrometer

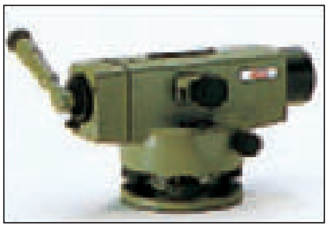
There are tasks for which a micrometer is needed, yet for which the very high accuracy of the GPM3 is not essential.

To meet this requirement, a simpler micrometer attachment, the GPM6 with drum reading, is available for the NA2.

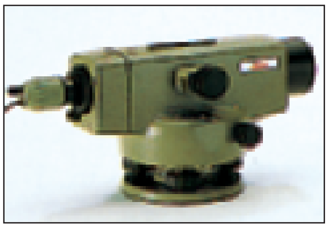
The GPM6 fits on to the telescope objective in the same manner as the GPM3, but the graduation is engraved on a metal drum.

Eyepiece accessories for specialized tasks

Because of the bayonet fastening of the interchangeable eyepiece, all theodolite eyepiece accessories can be used with the NA2.



- Diagonal eyepiece for observing from above, below, and from the side; useful in cramped spaces



- Eyepiece lamp for converting the NA2 into a horizontal collimator for laboratory work

- Autocollimation eyepiece for setting machine parts and instrument components precisely vertical

Compact

The rugged NA2 is indifferent to weather conditions and is extremely reliable in the rough world of the building site. The pendulum compensator is protected against knocks and shocks. There is a highly-effective vibration-damping mechanism.

Precise

The high setting accuracy ensures that the line of sight stays put. The attachable parallel-plate micrometer renders the NA2 ideal for precise fine levelling.

Reliable, automatic, maintenance-free

The instantaneous check facility with the push-button control not only makes work easier; it also promotes confidence.

Easy handling

The convenient, well-arranged controls are designed for maximum convenience. The bilateral, endless horizontal drive promotes rapid fine-pointing.

Quick levelling-up

The instrument is quickly set up with the three rapid-action footscrews. Their self-adjusting threads make subsequent resetting unnecessary.

Superb telescope

Telescope with excellently-corrected optics for bright, high-contrast images.
All optical components are coated on both sides.

Effortless focusing

The erect image seen down the telescope is quickly and accurately brought into focus with the convenient rapid and fine focusing knob.

Abundant accessories; many applications

Additional items such as the parallel-plate micrometer, the laser eyepiece, or theodolite eyepiece accessories, offer almost unlimited possibilities.

LEICA NA2 · NAK2
Proven reliability ensures precise results

Versatile accessories for demonstrable success

A comprehensive program of accessories enables you to expand the performance and applications range of each instrument. This way, you can match your equipment exactly to requirements.

The possibilities are described in brochure "Survey accessories" 710 883en.

Robust container for safe transport

The NA2 is supplied in a foam-padded container made of high performance synthetic material. The foam padding absorbs all jolts and shocks. The container provides perfect protection for the NA2.

Technical data

Standard deviation for 1 km double-run levelling, depending on type of staff and on procedure	up to 0.7 mm
With parallel-plate micrometer	0.3 mm
Telescope	erect image
Standard eyepiece	32×
FOK73 eyepiece (optional)	40×
FOK117 (optional)	25×
Clear objective aperture	45 mm
Field of view at 100 m	2.2 m
Shortest focusing distance	1.6 m
Multiplication factor	100
Additive constant	0
Working range of compensator	~30′
Setting accuracy of compensator (stand. dev.)	0.3"
Sensitivity of circular level	8′/2 mm
Glass circle (K version)	400 gon (360°)
Graduation diameter	70 mm
Graduation interval	1 gon (1°)
Reading by estimation to	10 mgon (1′)
Water- and dust resistance	IP53
Temperature range:	
Operation	–20°C to +50°C (– 4°F to 122°F)
Storage	–40°C to +70°C (–40°F to 158°F)

Parallel-plate micrometer (optional accessory)	Range	Interval	Estimation
GPM3, with glass scale	10 mm	0.1 mm	0.01 mm
GPM6, with metal drum	10 mm	0.2 mm	0.05 mm

TQM
ISO 9001 / ISO 14001

Total Quality Management – Our commitment to total customer satisfaction

Ask your local Leica Geosystems agent for more information about our TQM program.

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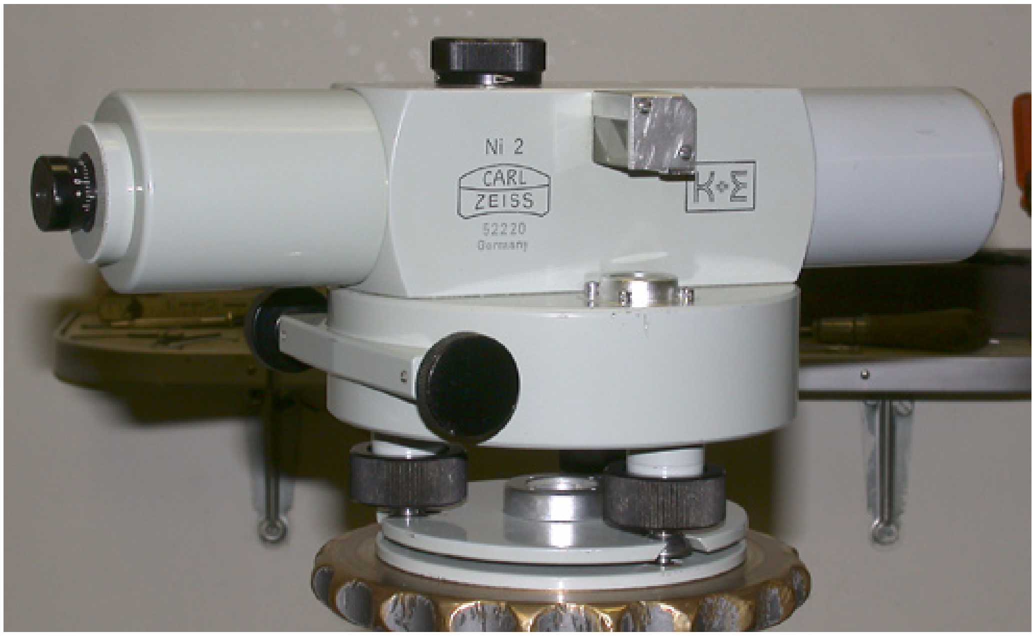
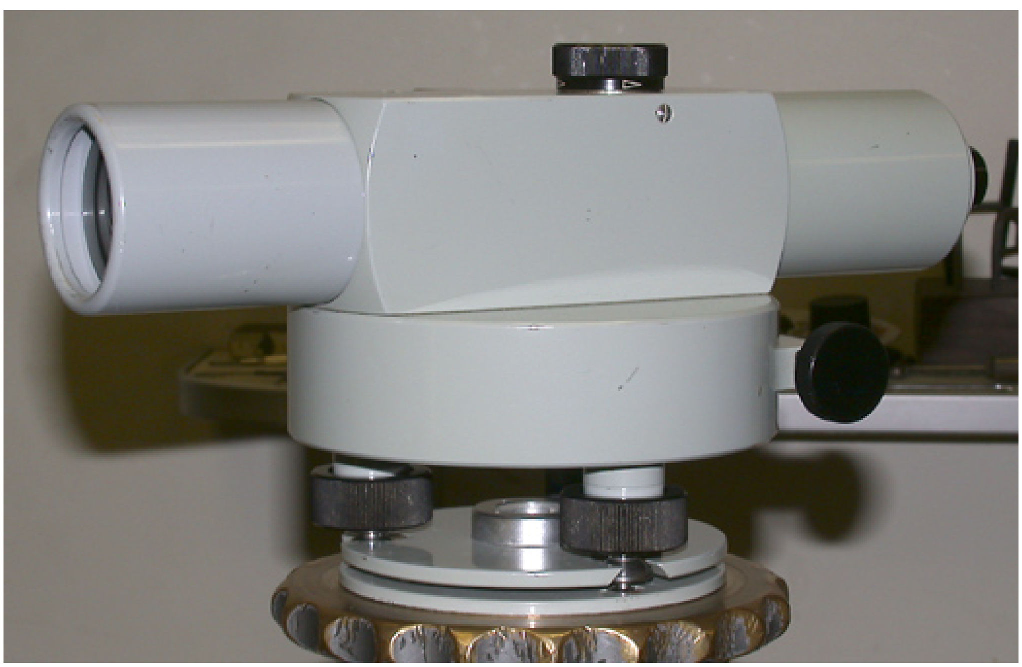
Geosystems

Leica Geosystems AG
CH-9435 Heerbrugg
(Switzerland)
Phone +41 71 727 31 31
Fax +41 71 727 46 73
www.leica-geosystems.com

710 837en – V.03 – RDV

Carl Zeiss NI-2 Level





Contents

Optical Data

Telescope with Zeiss T-coating

Magnification	32 ×
Aperture	1 58 in (40 mm)
Shortest sighting distance	11 ft (3 3 m)
Field of view	23 ft at 1000 ft

Estimation of 1/1000 ft. on 1/100 ft. graduation up to 120 ft (1 mm on a 1 cm graduation up to 120 m)

Circular Level

Sensitivity	15 per 2 mm

Circle (on request)

Material	Glass
Diameter	2 95 in (75 mm)
Graduation	360° or 400^g
Graduation interval	1° or 1^g

Readings through reading microscope

Magnification	17 ×
Scale interval	10 or $0\,1^g$
Estimation to	1 or $0\,01^g$

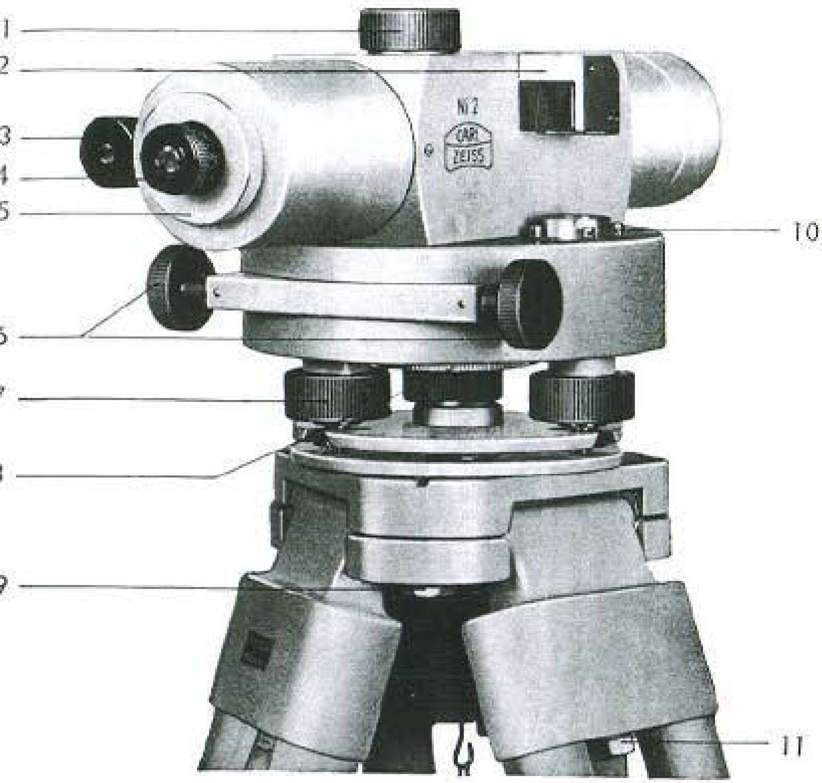


Fig. 1 Ni 2 with horizontal circle

(about ⅓ natural size)

1 Focus control with quick-fine movement
2 Viewing prism for circular level
3 Eyepiece of reading microscope for circle
4 Telescope eyepiece with dioptre scale
5 Screw cover over reticle adjusting screw
6 Lateral fine movement controls
7 Leveling screw
8 Knurled setting ring for circle orientation
9 Adjusting screw for tripod hinges
10 Adjusting screws for circular level
11 Clamping screw for tripod leg fitting

Mechanical Data

Dimensions:

Length of telescope	10.6 in. (27 cm.)
Height of instrument	5.1 in. (13 cm.)
Diameter of base	5.1 in. (13 cm.)
External dimensions of case	13×6.9×6.1 in. (33×17.5×15.6 cm.)
S 3 tripod extending from	3 ft. 5 in. to 5 ft. 7 in. (approx.) (102 – 170 cm.)
S 2 tripod extending from	3 ft. 5 in. to 5 ft. 7 in. (approx.) (102 – 170 cm.)

Weights:

Ni 2 without circle	4.6 lbs. (2.1 kg.)
Ni 2 with circle	5.3 lbs. (2.4 kg.)
Case for Ni 2 without circle	6.4 lbs. (2.9 kg.)
Case for Ni 2 with circle, with plumb bob	6.6 lbs. (3.0 kg.)
Parallel plate micrometer in leather case	1.3 lbs. (0.6 kg.)
Torch with supports	0.7 lbs. (0.3 kg.)
Leather case for torch	1.7 lbs. (0.7 kg.)
S 3 tripod	11.6 lbs. (5.3 kg.)
S 2 tripod	13.6 lbs. (6.2 kg.)
Leveling staff (03) 4 m. folding to 2 m.	12 lbs. (5.5 kg.)
Leveling staff (05) 3 m. folding to 1.5 m.	6.4 lbs. (2.9 kg.)
Invar staff (06) 3 m., rigid	9 lbs. (4.0 kg.)
"Scotch light" staves, additional weight	0.45 lbs. (0.2 kg.)

01 Tripod leg
only, not n
stiffness o
(1 m.) apar
tips moder

02 Lift instrum
secure tigh

03 Center circ
hairs on a
the eyepiec

Caution: D
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allowed to
of the cont

04 Aim telesc
edge of the

05 For fine se
the fine mo

06 Focus for
focus cont
matically in

07 Read staff
necessary
slightly tap
movement

ng for
or tripod
for circular
or tripod

Mechanical Data

Dimensions:

Length of telescope	10.6 in. (27 cm.)
Height of instrument	5.1 in. (13 cm.)
Diameter of base	5.1 in. (13 cm.)
External dimensions of case	13×6.9×6.1 in. (33×17.5×15.6 cm.)
S 3 tripod extending from	3 ft. 5 in. to 5 ft. 7 in. (approx.) (102–170 cm.)
S 2 tripod extending from	3 ft. 5 in. to 5 ft. 7 in. (approx.) (102–170 cm.)

Weights:

Ni 2 without circle	4.6 lbs. (2.1 kg.)
Ni 2 with circle	5.3 lbs. (2.4 kg.)
Case for Ni 2 without circle	6.4 lbs. (2.9 kg.)
Case for Ni 2 with circle, with plumb bob	6.6 lbs. (3.0 kg.)
Parallel plate micrometer in leather case	1.3 lbs. (0.6 kg.)
Torch with supports	0.7 lbs. (0.3 kg.)
Leather case for torch	1.7 lbs. (0.7 kg.)
S 3 tripod	11.6 lbs. (5.3 kg.)
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Invar staff (06) 3 m., rigid	9 lbs. (4.0 kg.)
"Scotch light" staves, additional weight	0.45 lbs. (0.2 kg.)

Setting up, Reading

01 Tripod legs should be extended to a convenient height only, not necessarily to their maximum; observe correct stiffness of joints (see No. 43); spread legs about 3 ft. (1 m.) apart; level tripod head to eyesight; tread tripod tips moderately into ground.

02 Lift instrument slightly to find thread for center screw and secure tightly.

03 Center circular level with leveling screws. Focus cross-hairs on a bright background by turning the milled ring of the eyepiece (4, fig. 1).

Caution: Do not store wet instrument in the container over an extended period of time. Instrument should be dried with a cloth on the outside as soon as possible and allowed to get completely dry overnight (to be taken out of the container for that purpose).

04 Aim telescope roughly onto target by viewing along one edge of the telescope housing.

05 For fine setting observe through telescope and use one of the fine movement screws (6).

06 Focus for a parallax-free staff image with dual speed focus control (1). Reversing the sense of rotation automatically introduces a slow motion (range: ¼ turn).

07 Read staff graduation against horizontal crosshairs (if necessary also stadia lines, fig. 2). As a checking measure slightly tap the telescope with a pencil or operate the fine movement screw jerkily to and fro. After a small oscillat-

Positioning Data Link™

PDL™

High Performance Data Link

Designed for Survey Systems

19,200 Baud Rate

Higher Over-the-Air Link Rate
Extends Your Battery Life

Enhanced User Interface

Change Channels in the Field
View Status Information

Compatible with GPS RTK Equipment Worldwide

Complete Kit Solutions Available for Your Application

Reliable

Rugged, All Season Operation

2 Year Warranty

Lower Cost of Ownership

Surveyors utilizing Global Positioning Systems require a rugged radio modem data link for precise positioning information. The PDL is compact and lightweight and offers power efficient operation. It is easy to use, and provides high performance and rugged dependability for the toughest survey environments.

PDL Products are designed to easily mount on all standard tripods and range poles. Complete kit solutions are available.

PACIFIC CREST
CORPORATION

Positioning Data Link™

	High Power Base	Low Power Base	Rover
General Specifications			
DTE – DCE Interface	3 Wire, RS-232, 38.4k Baud Maximum.		
User Interface	On/Off Button. Channel Button with AutoBase™ and AutoRover.™ Digital Display. Modem/Power Status Indicators. RF Power Select Toggle Switch.	On/Off Button. Channel Button with AutoBase™ and AutoRover.™ Digital Display. Modem/Power Status Indicators.	On/Off Button. Channel Button with AutoBase™ and AutoRover.™ Digital Display. Modem/Power Status Indicators.
Power			
External	9 – 16 VDC.		
Internal Battery	N/A	N/A.	Lithium Ion Battery Pack.
During TX (nominal)	110 Watts.	11 Watts.	N/A.
During RX (nominal)	1.9 Watts.	0.9 Watts.	0.3 Watts.
Antenna			
External	50 Ohm, BNC.	50 Ohm, NMO.	50 Ohm, NMO.
Modem Specifications			
Link Rate/Modulation	19,200 bps/4 Level FSK. 9600 bps/4 Level FSK. 9600 bps/GMSK. 4800 bps/GMSK.		
Link Protocols	Transparent, Packet Switched, Digipeater, TRIMTALK.™	Transparent, Packet Switched, Digipeater, TRIMTALK.™	Transparent, Packet Switched, TRIMTALK.™
Forward Error Correction	Hamming Code (12, 8) with Data Interleaving.		
Radio Specifications			
Frequency Bands	Refer to price list for available frequency bands.		
Frequency Control	Synthesized 12.5k Hertz Resolution. ±2.5 ppm Stability.		
RF Power Select	Low/High. Factory Programmable.	N/A.	
RF Transmitter Output	3/35 Watts Maximum.	0.5 – 2 Watts.	0 Watt (Receive Only).
Sensitivity	-116 dBm (12 dB SINAD).		
Adjacent Channel Selectivity	>-60 dB.	>-70 dB at 9600 bps/GMSK. >-60 dB at 19,000 bps/4 Level FSK.	>-60 dB.
Type Certification	All models are type accepted and certified for operation in the U.S. and Canada. For detailed information concerning your country's type certification, please contact your sales representative.		
Environmental Specifications			
Operating Temperature	-22° to +140° F (-30° to +60° C).		-4° to +140° F (-20° to +85° C).
Storage Temperature	-67° to +185° F (-55° to +85° C).		-4° to +185° F (-20° to +85° C).
Vibration/Shock	ANSI/ASAE EP455.		
Enclosure	IEC 60529 I.P. 66. Water Tight and Dust Proof.		
Mechanical Specifications			
Dimensions	6.23" W x 2.77" H x 6.58" L.	8.25" L x 2.40" Diameter.	8.25" L x 2.40" Diameter.
	(15.8 cm W x 7.0 cm H x 16.7 cm L).	(21.0 cm L x 6.1 cm Diameter).	(21.0 cm L x 6.1 cm Diameter).
Weight	2.96 lbs. (1.34 Kg).	0.65 lbs. (0.30 Kg).	0.75 lbs. (0.34 Kg).
Data/Power Connector	5 Pin LEMO #1 Shell.	5 Pin LEMO #0 Shell.	5 Pin LEMO #0 Shell.
Mount	Tripod Bracket.	5/8" – 11 Range Pole.	5/8" – 11 Range Pole.

PACIFIC CREST
CORPORATION

990 Richard Avenue, Suite 110, Santa Clara, CA 95050
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Web: www.paccrst.com, E-mail: sales@paccrst.com

INSTANT-RTK TECHNOLOGY

Z-Xtreme Survey System

Z-Xtreme

The Ashtech® Z-Xtreme™ from Thales Navigation professional products is a rugged, weather-proof, dual-frequency GPS receiver designed to provide surveyors with cost-effective, centimeter-accurate positions in a variety of system configurations.

The Z-Xtreme receiver begins with state-of-the-art satellite electronics coupled with patented Z-Tracking™ to deliver the highest GPS signal reception level. A removable battery and flash memory card provide enough capacity to last all day for maximum utility. Components are completely integrated inside a weather-proof, high impact plastic housing, ensuring your investment is safe, rain or shine. Use the easy-to-operate interface on the front panel for important functions such as site information entry, survey status, and set-up of RTK base stations without the additional cost of a handheld controller. The result: Z-Xtreme with Instant-RTK® outperforms all other receivers in its class!

ZX-Solutions

The Z-Xtreme survey system from Thales Navigation provides a range of solutions designed for the vast array of positioning needs – from entry level static or kinematic post-processed surveys, all the way up to real-time functions such as stake out. The entry level ZX-Solutions™ system dramatically increases your productivity for control surveys and other post-processed applications. Add an optional kinematic kit to make topographic feature collection more cost effective. Use Ashtech Solutions™ software to easily process the field data, export results and generate reports. Purchase only what you need for the job at hand because ZX-Solutions is fully upgradeable.

ZX-SuperStation

Eclipse the productivity of optical instrument stake out with a ZX-SuperStation™. The ZX-SuperStation is a field-to-finish GPS surveying system that combines the Z-Xtreme receiver with a powerful data collector and wireless modems for centimeter accuracy in real-time. Instant-RTK gives you the ability to initialize the centimeter solution in a fraction of the time of conventional RTK systems. Powerful data collection software gives you the ability to efficiently perform GPS surveying techniques and to interface seamlessly with optical total stations.

Z-XTREME

TECHNICAL SPECIFICATIONS

Ashtech Technology

- 12 channel all-in-view operation
- Full-wavelength carrier on L1 and L2
- Z-Tracking
- Multipath mitigation
- Dual-frequency smoothing for improved code differential
- Instant-RTK

Performance Figures[1]

Static, Rapid Static
- Horizontal: 0.005 m + 1 ppm (0.016ft+1ppm)
- Vertical: 0.010 m + 1 ppm (0.033ft + 1ppm)

Post-Processed Kinematic
- Horizontal: 0.010 m + 1 ppm (0.033ft + 1ppm)
- Vertical: 0.020 m + 1 ppm (0.065ft+1ppm)

Real-Time Code Differential Position
- <1 m (3.28 ft)

Real-Time Z Kinematic Position (Fine Mode)
- Horizontal: 0.010 m + 2 ppm (0.033ft + 2 ppm)
- Vertical: 0.020 m + 2 ppm (0.065ft + 2 ppm)
- Azimuth (arc sec): 0.4 + 2.0/baseline (km)

RTK Occupation Time
- 2 seconds (typical - sub-centimeter accuracy with longer occupation time)

Instant-RTK Initialization
- 99.9% reliability
- Typically <2 seconds with 6 or more satellites, PDOP <5, baseline length <7 km (4.35 mi), open sky and low multipath conditions

RTK Operating Range
- Recommended: 10 km (6.21 mi)
- Maximum: 40 km (24.85 mi)

Standard Features

- 16 MB PCMCIA removable memory card
- NMEA 0183 output
- Selectable update rate from 999 sec to 10 Hz
- Event marker
- Point positioning
- 1 PPS timing signal
- Session programming
- Wide array of coordinate transformations
- Removable internal battery
- 8-character alphanumeric LED display with 4-button interface
- 3 function LED display - Radio,Memory, Satellites/Power
- Multi-function audible alarm
- Quick reference card holder
- External mount capabilities
- External power input
- 4 RS-232 ports (115200 baud max, 3 external, 1 internal)
- 1-year warranty
- Free factory technical support

Standard Accessories

- Communications software
- Padded system bag and hard case
- RS-232 data cable
- Receiver operating manual
- Quick reference field card

Technical Data

Environmental

Z-Xtreme Receiver
- Meets MIL-STD 810E for wind driven rain and dust
- Operating temperature: -30° to +55°C (-22° to 131°F)
- Storage temperature: -40° to +85°C (-40° to 185°F)

Geodetic 4 Antenna
- Meets IPX7 specifications for submersion
- Operating temperature: -55 to +75°C (-40° to 149°F)
- Storage temperature: -55° to +75°C (-67° to 167°F)

Physical

Weight
- Receiver: 1.59 kg (3.50 lb)
- Antenna: 0.82 kg (1.81 lb)
- Battery: 0.43 kg (0.95 lb)

Dimensions
- 76.2 H x 196.85 W x 222.25 D mm
- (0.25 H x 0.646 W x 0.729 D ft)

Power
- 10 - 28 VDC, 6.0 W

Internal battery
- Capacity: 6000 mAh
- >9 hours (typical) @ 25°C (77°F)
- Operating temperature: -30° to +55°C (-22° to 131°F)
- Storage temperature: -40 to +60°C (-40° to + 140°F)

PC card
- ATA Type II PCMCIA memory card (16 MB standard)
- Temperature range: -40° to +85°C (-40° to 185°F)
- Data capacity: 4500 epochs per 2 MB*

** Based on one session, eight satellites' data and full measurements. This number can vary significantly depending on the conditions of the session.*

Optional Features

- Real-time kinematic (base and rover modes) for cm-accuracy
- RTCM 2.2 (Types 1, 2, 3, 9, 16, 18, 19, 20, 21, 22)
- Internal UHF or spread spectrum radio for RTK rover operations
- External UHF or spread spectrum radio for RTK base and rover operations
- Geodetic 4 antenna ground plane kit
- Kinematic antenna kit
- Aircraft antenna kit
- AC power cable
- Choke ring antenna
- Long haul backpack kit
- All-on-a-pole kit

Optional Application Software

GPS data processing
- Ashtech Solutions

Land Surveying and Construction
- TDS Survey Pro
- Carlson SurvCE
- Ashtech Survey Control II
- Ashtech GPS Fieldmate

Mining and Land Seismic
- Ashtech Mine Surveyor II
- Ashtech Seismark II

1 *Specifications assume operation follows all the procedures recommended in the product manual utilizing Instant-RTK, post processing with Ashtech Solutions or Ashtech Office Suite for Survey. High-multipath areas, high PDOP values, low satellite visibility, and periods of adverse atmospheric conditions and/or other adverse circumstances will degrade system performance. All accuracy specifications are RMS values.*

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Thales Navigation follows a policy of continuous product improvement; specifications and descriptions are thus subject to change without notice. Please contact Thales Navigation for the latest product information.

THALES NAVIGATION

MAGELLAN®
PROFESSIONAL

Z-Max®.Net
NETWORK GENERATION

Get Free From Operational Constraints

Z-Max.Net:

Liberate Yourself!

Z-Max.Net is the next-generation survey solution from Magellan. The .Net generation offers NTRIP, GPRS and RTCM V3.0 network communication. Z-Max.Net delivers high accuracy and enhanced performance for all your survey needs.

Z-Max.Net is the most flexible GNSS surveying system available, offering multiple operating modes, configurations and communication protocols:

- Survey in NTRIP, VRS or FKP networks.
- Select your communication mode: GSM/GPRS, UHF, unique combined UHF+GSM/GPRS module or external source.
- Switch seamlessly from post-processing to RTK.
- Use Z-Max.Net as a base or rover.

You can perform any GPS survey with Z-Max.Net.

Survey with Added Freedom

The innovative design offers comfort and ease-of-use. Detachable modules make configuration changes and system upgrades simple.

You can use the intuitive keyboard or Bluetooth® wireless field terminal to perform any survey with added freedom. Configure your Z-Max.Net "all-on-the-pole" or in the comfortable backpack for long-duration missions.

Z-Max.Net fits your needs and frees your mind from technology concerns. Simply select the operating mode and you're ready to go!

Get the Max Out of Your GPS

Z-Max.Net delivers the strongest RTK on the market. A combination of unique technologies enables you to optimize your time and maximize your profit. Z-Max.Net offers two-second initialization, extended operation up to 50 km (30 miles) and cuts static data collection time by up to 50%.[1]

Powered by state of the art technologies, Z-Max.Net ensures exceptional RTK coverage and data confidence even in difficult environments.

All-In-One Surveying Solution

Z-Max.Net enhances your surveying capabilities, improves your data quality and upgrades your deliverables with a comprehensive suite of software tools. FAST Survey™ field software simplifies data collection and real-time operation. GNSS Solutions™ office software provides powerful support to a wide range of applications, handling both real-time and post-processing data within the same project.

Z-Max.Net delivers survey-grade positioning on demand, boosts your productivity and sets you free from operational constraints.

Key Features and User Benefits

Survey Your Way

The ultra-flexible Z-Max.Net survey system lets you control your survey your way. It operates in a wide range of data formats including ultimate standards such as NTRIP and RTCM V3.0.

Z-Max.Net features GSM/GPRS modem and offers a unique combined UHF-GSM/GPRS module supporting all operational configurations. Z-Max.Net is available with the Pacific Crest UHF data link, or the unique Magellan Professional UHF for high-performance and superior results when surveying on long baselines.

Z-Max.Net is so flexible that data can even be communicated using an external radio modem like CDMA or EDGE when necessary.

Whichever configuration you chose, Z-Max.Net adapts to your survey environment and delivers the best performance

Strongest RTK on the Market

- Patented **Z-Tracking™** and advanced multipath mitigation technologies ensure the strongest centimeter-level position even in weak signal conditions.
- **Instant-RTK®** technology enhances survey productivity by offering two-second initialization: The fastest on the market.
- Magellan Professional unique **LRK®**, long range kinematic technology, combines fast, real-time centimeter-level positioning up to 50 km (30 miles).
- State-of-the-art **Prism®** technology cuts data collection time by as much as 50% for post-processed surveys.[1]

Plus, Z-Max.Net is ready for tomorrow's RTK networks with features that include **GPRS, NTRIP, RTCM V3.0, VRS and FKP.**

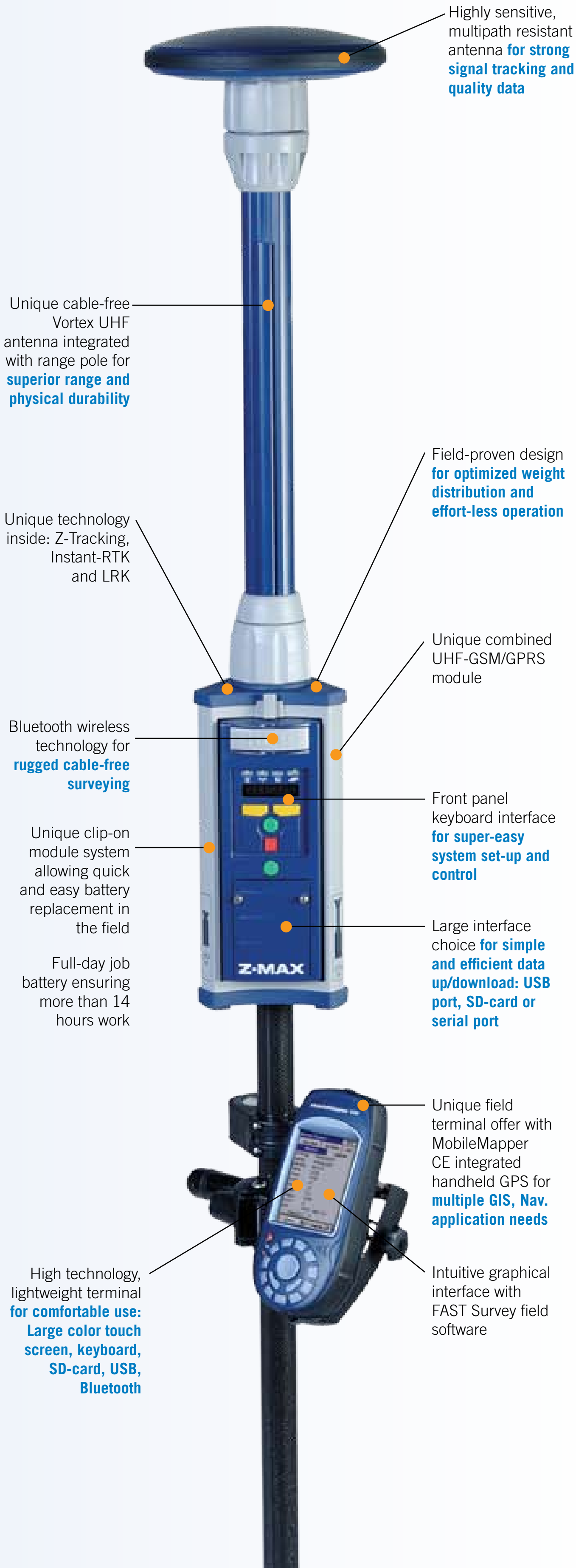
Increased Productivity

Z-Max.Net is designed to increase your productivity with fast initialization, easy modular configuration, superior long-range capability and reliable accuracy. Surveys are faster than ever in both RTK and post-processed mode.

The modular design and flexibility makes upgrades easy and cost-efficient, protecting your investment and ensuring a high return.

Maximum Simplicity

Every aspect of the Z-Max.Net survey system is designed to simplify the job of the surveyor.



Complete Solution in the Field and at the Office

State of the Art Field Terminals

Z-Max.Net offers two high-quality field terminals: the MobileMapper™ CE from Magellan and the classic Allegro CX™ from Juniper Systems Inc.®

Features such as color touch screen, SD-card, USB and Bluetooth wireless technology, are included to ensure a robust, easy-to-use, cable-free RTK rover.

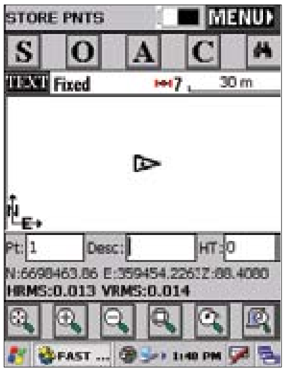
Combined with MobileMapper CE, Z-Max.Net becomes the only survey system on the market to include an additional handheld GPS for multiple application needs (GIS, navigation, and more). Only Z-Max.Net can offer that kind of advantage.

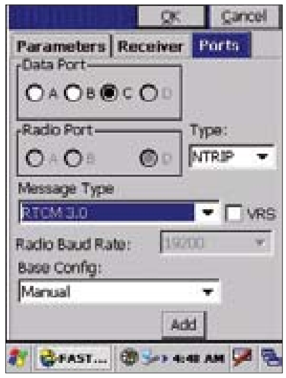
FAST Survey - Field Software

FAST Survey is a graphical field software for topography and construction, designed to optimize the functionality and performance of the Z-Max.Net GNSS system. The ability to collect single coordinate shots, full RTK vectors, raw GNSS data and all data types concurrently, provides a flexible solution for your changing needs.

Power in the Palm of Your Hand

FAST Survey is both powerful and easy to use. Scaleable map-view screen displays points and lines as they are surveyed, offering large-print controls for rapid, reliable data collection. Rich attributing, full editing in the field and export to industry-standard data formats provides true field-to-finish capability, saving time and effort.





GNSS Solutions - Office Software

GNSS Solutions is a comprehensive software package with all of the tools required to successfully process GPS, GLONASS and SBAS survey data. Focusing on simplicity, the software guides you through mission preparation planning, processing, quality control, reporting and data exporting.

Intuitive Handling of Graphical Data

The innovative approach to presenting survey data in graphical and tabular form makes post-processing with GNSS Solutions a simple and enjoyable experience.

Any collection of data can be viewed in different forms through simple drag and drop operations. Importing raster or vector map formats enables you to open background projects and combine them with land survey projects.

Accuracy and Reliability

GNSS Solutions can handle both real-time and post-processing data within the same project. The software includes advanced blunder detection and quality analysis tools to ensure extremely accurate and reliable results. Loop closures, automatic repeat, observation analysis, automatic control analysis, and least-squares adjustments are integral components of GNSS Solutions.

Z-Max.Net: Flexibility in the Field

As a Z-Max.Net surveyor you are prepared for any job condition and ready to meet your customers' needs. Quality, productivity, ease-of-use, cost-efficiency and profitability: **Z-Max.Net delivers it all.**

Network Generation

New communication protocols, such as NTRIP and GPRS, provide higher performance and lower cost access to differential data for RTK surveying. The number of correction service providers is rising and base station networks will expand over the coming years, transforming rover/base surveying to rover only. Z-Max.Net offers the advantage of the latest data communication standards so you are ready to adapt to tomorrow's survey world.

Combined with a MobileMapper CE field terminal, Z-Max. Net is the only survey system on the market to include an additional handheld GPS for multiple application needs (GIS, navigation and more).

Base / Rover Configuration

Z-Max.Net is the most flexible survey system on the market. Thanks to its wide data format compatibility (RTCM V.2.x, CMR/CMR+, DBEN, RTCM V3.0 and other standards). Z-Max.Net easily combines with your equipment and ensures seamless operation within any network.

As a base, Z-Max.Net broadcasts simultaneously through UHF and GSM, providing 100% field coverage for the rover.

Post-Processed Surveys

Z-Max.Net performs all types of post-processed surveys - static, stop-&-go and kinematic - reaching unprecedented accuracy levels.

Base data can come from a CORS station or any GPS receiver. Raw data from Z-Max.Net can also be used with the OPUS processing system. Whatever the source, unique Prism technology cuts survey data collection time by up to 50%[1]

Z-Max.Net Technical Specifications

GNSS Characteristics
- 24 parallel channels all-in-view
- L1 C/A code and carrier
- L1/L2 P-code, full wavelength carrier
- Z-Tracking
- Multipath mitigation
- Integrated real-time WAAS/EGNOS
- Update rate: 10 Hz
- Protocol: NMEA0183

Accuracy Specifications[1-2]
Static Rapid Static
- Horizontal 0.005 m + 0.5 ppm (0.016 ft + 0.5 ppm)
- Vertical 0.010 m + 0.5 ppm (0.033 ft + 0.5 ppm)

Post-Processed Kinematic
- Horizontal 0.010 m + 1.0 ppm (0.033 ft +1.0 ppm)
- Vertical 0.020 m + 1.0 ppm (0.065 ft +1.0 ppm)

Real-Time Performance[1-2]
SBAS (WAAS/EGNOS) (rms)
- Horizontal: <3 m (10 ft)

Real-Time DGPS position
- < 0.8 m (2.62 ft)

Real-Time Kinematic Position (fine mode)
- Horizontal 0.010 m + 1.0 ppm (0.033 ft + 1.0 ppm)
- Vertical 0.020 m + 1.0 ppm (0.065 ft + 1.0 ppm)

Real-Time Kinematic Position (fine mode)
- 99.9% reliability
- Typical 2 second initialization for baselines < 20 km

Datalogging Characteristics
Recording Interval
- 0.1 - 999 seconds

Physical Characteristics
Size
- Unit: 26.9 x 12.5 x 14 cm (10.6x4.9x5.5 inch)
- Antenna: 19 cm dia x 10.1 cm h (7.5 x 4.0 inch)

Weight
- Receiver Module: 1.371 kg (3.02 lb)
- Antenna Module: 0.64 kg (1.17 lb)
- Power Module: 0.52 kg (0.96 lb)

Front Panel
- Eight-character alphanumeric LED display
- 4 tri-color LEDs
- 5-key keyboard

Memory
- 48 hours of 1 sec. raw GPS data with 64 MB Secure digital
- 128 MB SD card available

I/O Interface
- RS232, RS232/422, USB, Bluetooth

Environmental Characteristics
Receiver
- Operating temperature: -30° to +55°C (-22° to +131°F)
- Storage temperature: -40° to +85°C (-40° to +185°F)
- Meets IP54 for moisture
- Shock: 1.5 m (4.92 ft) pole drop
- Vibration: MIL-STD-810F Method 514.4 (I-3.1.1, I-3.4.8, I-3.4.9)

Power Characteristics
- Max-Run battery life > 14 hrs.
- 10-28 VDC input
- Regulated 12 VDC output on serial ports

Controller Language Support
- English, French, German, Spanish

System Components
Standard
- Z-Max.Net GNSS receiver
- GNSS antenna
- Power module, charger included
- System bag
- Hard-shell shipping case

Communication Module[3]
- Magellan UHF
- Pacific Crest
- GSM/GPRS Tri-band
- GSM/GPRS Dual-band (US)
- GSM/GPRS EU + Magellan UHF
- GSM/GPRS EU + PacCrest UHF
- GSM/GPRS US + Magellan UHF
- GSM/GPRS US + PacCrest UHF

Field Terminal kit with FAST Survey[3]
- MobileMapper CE
- Allegro CX from Juniper

Other[3]
- Magellan UHF transmitter kit
- Pacific Crest transmitter kit
- RTK rover backpack kit
- Rechargeable battery kit

[1] Performance values assume minimum of five satellites, following the procedures recommended in the product manual. High-multipath areas, high PDOP values and periods of severe atmospheric conditions may degrade performance.

[2] Accuracy and TTFF specifications based on tests conducted in Nantes, France, and Moscow. Tests in different locations under different conditions may produce different results.

[3] System composition varies depending on the chosen configuration

Office Software Suite - GNSS Solutions
Key software functions include:
- Integrated transformation and grid system computations allow for processing, adjusting, reporting and exporting point positions in user-selected or user-defined systems
- Pre-defined datums along with user-defined capabilities using the 7-parameter method of computing and applying datum transformation parameters
- Survey mission planning
- Automatic vector processing
- Least-squares network adjustment
- Data analysis and quality control tools
- Coordinate transformations
- Reporting
- Exporting
- Geoid 03
- English, Spanish, French, German language support

System Requirement
- Windows 2000 / XP
- Pentium® 133 or higher
- 32 MB RAM
- 90 MB disk space required for installation

Field Software Suite – FAST Survey
Key software functions include:
- Map view
- Geodetic geometry: intersection, azimuth/distance, offsetting, poly-line, curve, area
- Z-Max.Net GPS support : configuration, monitoring and control
- Coordinate system support: predefined grid systems, predefined datums, projections, Geoids, local grid
- Data import/export: DXF, SHP, RW5, LandXML, …
- Survey utilities: calculator, RW5 file viewing
- Compatibility with optical surveying instruments
- Road construction

Supported Hardware
- MobileMapper CE
- Juniper Allegro CX

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Nikon

TOP GUN®

DTM-310

ELECTRONIC TOTAL STATION

Valuable functions, superior cost-performance, longer battery life and enhanced software

Nikon has just taken the world-renowned Top Gun® DTM-300 total station to a whole new level. The new Top Gun® DTM-310's enhanced keyboard and on-board software enable easy code input in both alphabet and numbers, the way you've always wanted. It builds on existing features — such as the large four-line LCD and full numeric key pad — to improve overall convenience. And software upgrades make it easier to search and display data. In fact, the Top Gun® DTM-310 provides customers in any field — from civil construction to cadastral surveying and mapping — with greater ease of operation.

ENHANCED BASIC FUNCTIONS

- Large four-line display with full alphanumeric input on both faces
- Meets basic requirements for distance and angle measurement
- Resume function for quick startup and power management
- Enhanced, powerful built-in programs
- 500-point on-board data storage function
- 7.3 hours continuous measuring with one on-board battery
- Compact and lightweight
- Quick access to the 20 most recently stored codes

CONVENIENT ALPHANUMERIC INPUT

The inclusion of alphabetic input enables you to store codes in a combination of letters and numerals. Codes, target heights (HT) and point numbers are easily input for each new measurement. And codes can also be selected from the most recent 20 codes stored in the memory, eliminating the need to repeatedly input the same codes.

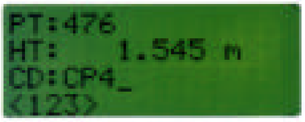
■KEY DESCRIPTIONS

MSR: Distance measurement in normal measurement mode
DSP: Selects display item by scrolling display
TRK: Distance measurement in high-speed measurement mode
ANG: Horizontal angle zero-set, user-defined angle input or hold
XYZ: Coordinate measurement
RDM: Remote distance measurement (continuous or radial)
REM: Remote elevation measurement
STN: Station setup (known point, 2-point resection or 3-point resection)
S-O: Stakeout by inputting angle distance or coordinates
Illumination: Display illumination
REC: Data record to internal memory
ENT: Data entry or sending observation data to communication port in normal observation mode
FNC: Input of temperature and barometric pressure, prism constant, and height of target; simple COGO calculation; settings; view/edit stored data; communication (internal memory); vertical collimation correction

Enhanced, Powerful Built-in Programs

On-board data storage function

The DTM-310 memory stores up to 500 raw or coordinate records. Coordinate data can be manually input, measured or



uploaded from a PC. (Contact your Nikon distributor for download/upload and format conversion software.) Data can be instantly recalled and reviewed for station setup, stakeout and COGO.

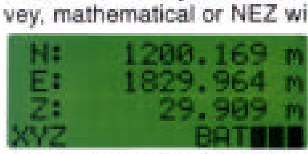
Station setup

For station setups, in addition to the known station setup obtained by inputting the coordinate of backsight or direction angles, a more simplified default station setup is also possible. This can be obtained by setting the station point coordinates at zero

while maintaining the prior orientation intact. Two- and three-point resections are also available. In the case of a three-point resection, it is possible to transfer the elevation from a bench mark.

XYZ coordinate measurement

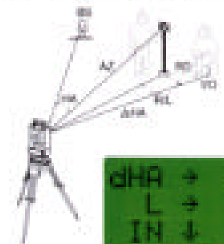
The coordinate system can be set to survey, mathematical or NEZ with indepen-



dent coordinate order settings. Azimuth zero-direction can be set to either north or south. Coordinate calculations are based on these settings. Point name, number, code and coordinate data can be stored in the data file. The target height can be changed at any time by pressing the FNC key.

Stakeout

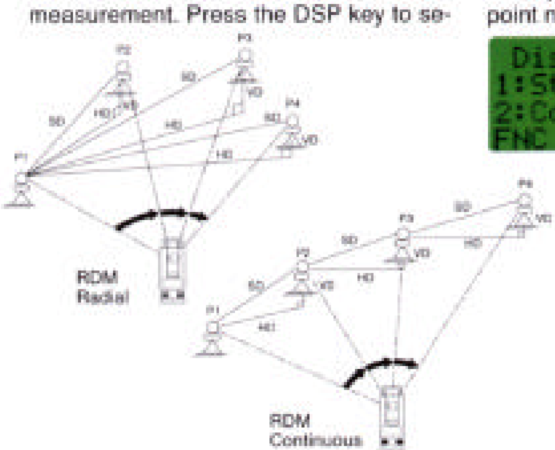
Lets you perform stakeouts by inputting angle and distances, or coordinates. Co-



ordinates can be searched and retrieved from the built-in memory. Zero-direction countdown and delta displays (Left/Right, In/Out, Cut/Fill) make for fast and simple stakeouts. Stakeout data can be also recorded in the internal memory.

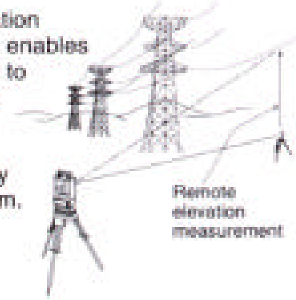
RDM

For continuous or radial remote distance measurement. Press the DSP key to select slope distance, elevation difference, horizontal distance, grade, legal grade ratio between two points, or azimuth from first to second points.



REM

Remote elevation measurement enables measurement to points (e.g., a power pole) where you cannot directly place the prism.

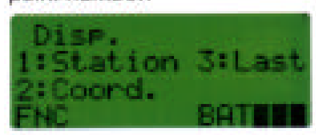


COGO calculation

Enables point-to-point inverse calculations, plus azimuth and distance calculations. Coordinates can be searched and retrieved from the on-board memory, and calculated coordinates can be saved.

Data display

The DTM-310 enables you to search data by tracing back from the most recent record, from specific station points, or from a simple point number.



7.3 Hours Continuous Operating Time

Internal battery BC-60 provides about 7.3 hours (with full charge, at 20°C, for distance/angle measurements) of continuous operation. The remaining battery power is indicated by the LCD. As Ni-MH battery BC-60 contains no harmful substance, recycling is not necessary. Quick recharge can be performed in about 2 hours with standard battery charger Q-70U/Q-70E. The Q-70U/Q-70E's discharging function preserves the batteries' minimum power and protects against deterioration.

Resume Function

This resume function can automatically revert to the orientation prior to power OFF, or automatically display the previous horizontal angle. It guarantees the safety of all previous data settings.

Basic Measurement Functions

- Built-in Automatic Vertical Compensation
- Vertical Angle Zero-Degree Set Handled in Three Modes
- Grade Display
- With Triple Prism, to 1.2km or 3,900 feet (under good conditions)
- ±(5 + 3ppm x D)mm Precision
- Automatic Environmental Compensation
- Selectable Angle Reading of 5/10", 0.5/1mgon, 0.02/0.05MIL
- Angle Measurement Accuracy of 5"/1.6mgon/0.02MIL (standard deviation based on DIN18723)

Standard Package

- DTM-310 main unit
- On-board battery BC-60
- Battery charger Q-70U/Q-70E
- Lens cap
- Plumb bob
- Tool set
- Plastic case
- Vinyl cover
- Instruction manual

Optional Accessories

- Diagonal eyepiece prism
- High-power (32x) and low-power (16x) eyepiece lenses
- Compass (tubular type) and compass adapter
- Zenith prism
- Solar filter
- Solar reticle
- External battery B4

On-board battery BC-60 and battery charger Q-70U/Q-70E

Specifications

Telescope	
Tube length	150mm/5.9 in.
Effective diameter of objective	36mm/1.41 in. (EDM aperture 40mm/1.57 in.)
Magnification	26x (standard)
Field of view	1°30'
Resolving power	3.5"
Minimum focusing distance	1.0m/3.3 ft.
Angle measurement	
Reading system	Incremental encoder
Unit of reading	Degree/Gon/6400MIL
Least count (selectable)	
(360°)	5" or 10"
(400G)	0.5mgon or 1mgon
(6400MIL)	0.02MIL or 0.05MIL
Accuracy (Standard deviation based on DIN 18723)	5"/1.6mgon/0.02MIL
Tilt sensor (Automatic Vertical Compensator)	Liquid type
Working range	±3'
Distance measurement	
Range (with Nikon prism)	
(Normal conditions: ordinary haze, visibility 20km/12.5 miles)	
with mini prism	380m/1,300 ft.
with single prism	800m/2,600 ft.
with triple prism	1,100m/3,700 ft.
(Good conditions: no haze, visibility 40km/25 miles)	
with mini prism	450m/1,500 ft.
with single prism	1,000m/3,300 ft.
with triple prism	1,200m/3,900 ft.
Accuracy	±(5 + 3ppm x D)mm, –10°C to +40°C/+14°F to +104°F ±(5 + 5ppm x D)mm, –20°C to +50°C/–4°F to +122°F
Maximum measurement display	1,230m/4,000 ft.
Least count	
Standard MSR mode	1mm/0.005 ft.
Tracking mode	10mm/0.05 ft.
Measuring intervals	
Standard MSR mode	4 sec.
Tracking mode	1.2 sec.
Measuring mode	Continuous/Single/Average (2 - 99)
Ambient temperature range	–20°C to +50°C (–4°F to +122°F)
Atmospheric correction range	
Temperature range	–40°C to +60°C (–40°F to +140°F)
Pressure range	400 to 999mmHg (1mmHg step) 15.8 to 39.3 in.Hg (0.1 in.Hg step) 533 to 1,332hPa (1hPa step)
Display	Dot-matrix LCD 16 characters x 4 lines
Level vial	
Sensitivity of plate level vial	30"/2mm
Sensitivity of circular level vial	10'/2mm
Leveling base	
Tribrach	Detachable
Optical plummet	
Image	Erect
Magnification	3x
Field of view	5°
Focusing range	0.5m/1.6 ft. to ∞
Power sources	
Type	Ni-MH 7.2V DC
Continuous operating time	7.3 hrs. or 8,760 measurements (for distance/angle measurement) 22 hrs. (for angle measurement only)
Quick battery charger (Q-70U/Q-70E)	
Input voltage	115V for Q-70U, 220/240V for Q-70E
Recharging time	1.5 hrs.
Dimensions (W x D x H)	
Main unit (with carrying handle)	164 x 177 x 335mm/6.5 x 7.0 x 13.2 in.
Weight	
Main unit w/battery	5.5kg/12.1 lbs.
Battery BC-60	0.5kg/1.1 lbs.
Carrying case	2.5kg/5.5 lbs.

These products (DTM-310 and battery charger Q-70U/E) are strategic products subject to Japanese/International export control regime. They should not be exported without authorization from the appropriate governmental authorities.

Specifications and equipment are subject to change without any notice or obligation on the part of the manufacturer. February 1997

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Instruments Division
Yokohama Plant

E

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V. SPECIFICATIONS

1. Main Unit

● Telescope

Image	: Erect/unreversed
Magnification	: 26×
Effective diameter of objective	: 36mm
Field of view	: 1°30′
Minimum focusing distance	: 1.0m
Resolving power	: 3.5″

● Distance Measurement

Distance range of Nikon prisms	: 450m with mini prism 1000m with single prism 1200m or longer with triple prism *With visibility 40km (25miles)
Precision	: ±(5mm + 3ppm × D) *With accurate measurement mode, at −10°C ~ +40°C/+14°F ~ +104°F D is measuring distance, mm unit ±(5mm + 5ppm × D) at −20°C≦t< −10°C/ −4°F≦t< +14°F and +40°C<t≦50°C/ +104°F<t≦ +122°F
Measuring time response	: [MSR] mode: About 4sec. (initial: about 5sec.) [TRK] mode (cm): About 1.2sec (initial: about 2.2sec.)
Least count	: 1mm
Display	: Up to 1230m
Display unit	: m/ft-INT/ft-US

● Angle Measurement

Accuracy	: 5″ (Standard deviation based on DIN 18723)
Reading system	: Photoelectric detection by incremental encoder single-sided reading
Display unit	: Degree/Gon/MIL

● Automatic Vertical Compensator

System	: Liquid-electric detection
Working range	: ±3′

● Optical plummet

Image	: Erect
Magnification	: 3×
Field of view	: 5°
Focusing range	: 0.5m～∞

● Clamps/tangent screws : Coaxial dual speed tangents

● Sensitivity of level vials

Plate level vial	: 30″/2mm
Circular level vial	: 10′/2mm

● Tribrach : Detachable

● Dimensions and weight

Main body	: 5.5kg (12lbs) including BC-6 battery pack
Case	: About 3.5kg (7.6lbs)

● Operating temperature range:

−20°C～50°C/−4°F～+122°F

SURVEYING INSTRUMENTS

SOKKIA

SET5F

Version 01-00

TOTAL STATION

Enhanced software with 3,000-point data memory.

Flexible, Friendly and Featherweight

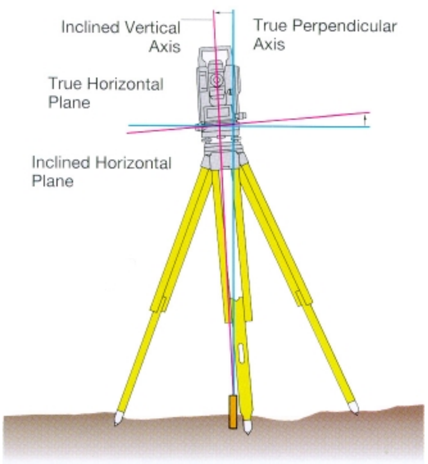
The SET5F's powerful EDM, dependable dual-axis compensator and 3,000-point data memory are conveniently packaged in a compact, lightweight body. Software [Version 01-00) has been enhanced for more effective survey work, and "softkey" assignments can be freely customized to suit all user needs.

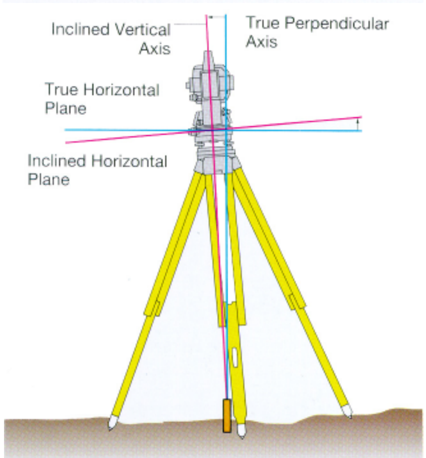
Dependable Hardware

Proven Dual-axis Compensator

•Since its introduction with the Series C total station in 1989, Sokkia's dual-axis compensator has proven its reliability and accuracy at survey sites all over the world.

•The dual-axis tilt sensor monitors deviations of both the X and Y axes and the correct horizontal and vertical angle readings are automatically computed and applied. The result is easier and faster instrument leveling.





The High-performing EDM

•1,500m/4,900ft range with a single prism under good ambient conditions (40km/25miles visibility, with no haze, overcast, no scintillation).

•Outstanding precision; ±(3+2ppmxD)mm. This corresponds to a deviation of a mere ±3.2mm at a distance of 100m and ±5mm at 1,000m.

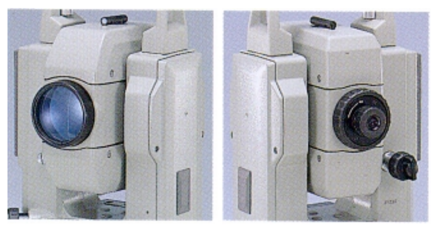
•Supreme speed; only 1.7 seconds initial measuring time in the rapid measurement mode.

	Average Conditions	Good Conditions
CP01 Compact Prism	700 m/2,300 ft.	
One AP01 Prism	1,200 m/3,900 ft.	1,500 m 4,900 ft.
Three AP01 Prisms	1,600 m/5,200 ft.	2,000 m 6,500 ft.

Powerful Telescope

•Highest magnification in its class: 30x

•Easy, accurate sighting of prisms or targets



Outstanding Mobility

•Total carrying weight (including instrument, tribrach, battery and hard case) is a mere 8 kg/18 lbs. The secret lies in the lightest and most compact carrying case of its kind (W390 x D255 x H220mm / W15.3 x D10.0 x H8.6in.), making the SET5F supremely portable.

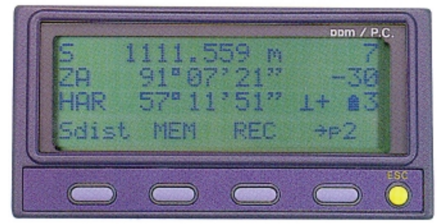
•A convenient shoulder strap is provided as standard. An optional back pack (SC94) is ideal for longer day treks.

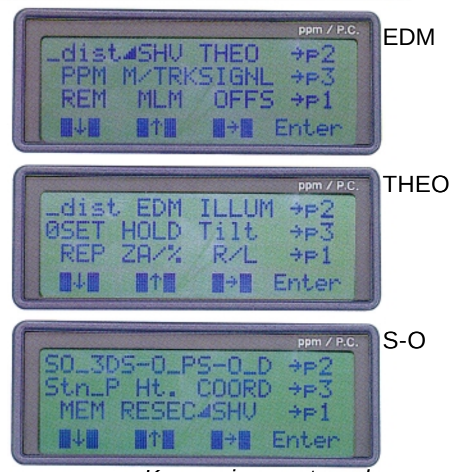
Enhanced Software

The SET5F can be easily customized to your preferred key assignments.

•The SET5F offers optimum keyboard flexibility. Any keyboard layout can be configured. For example, functions can be assigned to any key position on any page, and unused functions can be temporarily deleted.

•A powerful "softkey" feature facilitates input of coordinate values, feature codes, etc.





Key assignment mode

Spacious 3,000-point Internal Memory

•The SET5F's internal memory is large—holding a full 3,000 data points—and secure. For optimum convenience, measurements can be performed and recorded at the touch of a key.

•Up to five (5) job files can be created to efficiently organize multiple survey tasks.

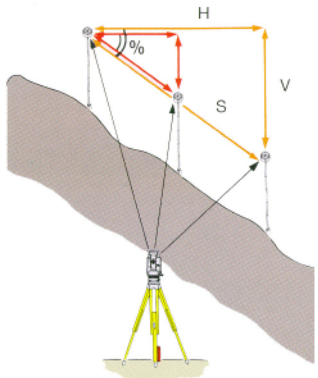
•Forty (40) feature codes (max.13 characters each) can be kept in the memory for easy recall as needed.

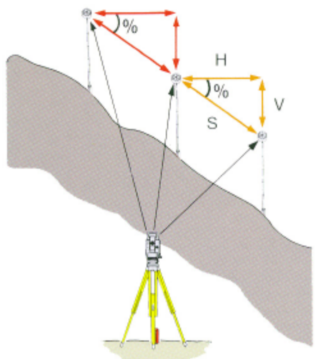
Sophisticated Application Software

Missing Line Measurement (MLM)

•The SET5F measures horizontal distance, slope distance, height difference, and slope in percent (%) between two prisms, all at the touch of a key.

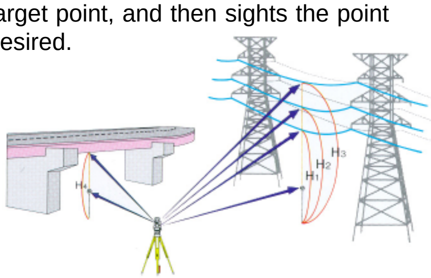
The SET5F brings full freedom to survey work.





Remote Elevation Measurement (REM)

•The SET5F can be used to easily determine the height of a point where a prism cannot be placed. The system sights a prism directly above or below the target point, and then sights the point desired.

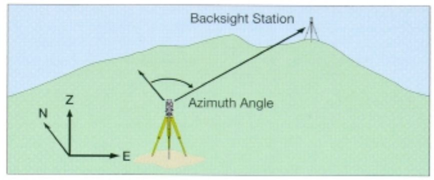


Angle Repetition

•For enhanced accuracy in the horizontal angle measurement, the SET5F can measure in repetition. It then calculates and displays the average of the multiple angle measurements.

Azimuth Angle Setting

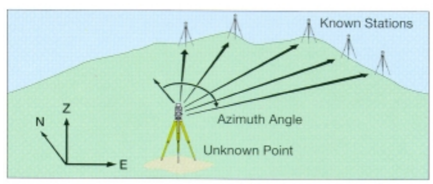
•Using the coordinates of the instrument station and a backlight point, the SET5F can automatically set the horizontal angle to the azimuth of the backlight.



Resection

•With 2 to 5 known points, the SET5F can be used to determine the azimuth and coordinates of the unknown instrument station.

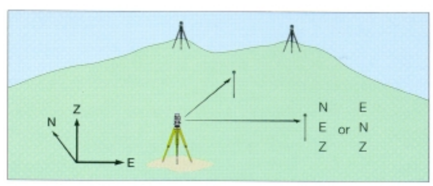
•When using 2 known points, both angles and distances are measured. When using 3 or more points, the distance does not always have to be measured.



3-D Coordinate Measurement

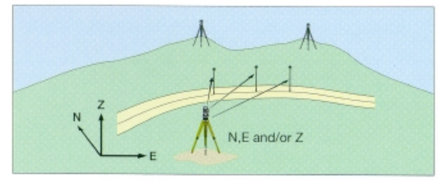
•The SET5F calculates 3-D coordinate values of measuring points.

•The operator may choose display settings either of "N, E, Z" or "E, N, Z."



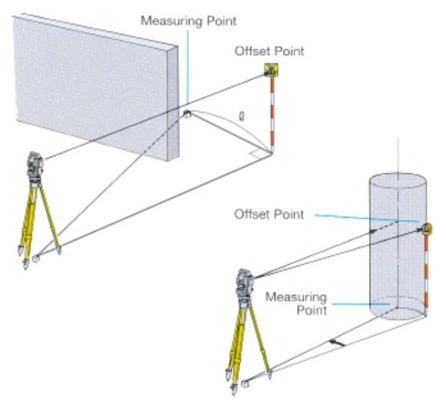
3-D Setting-out

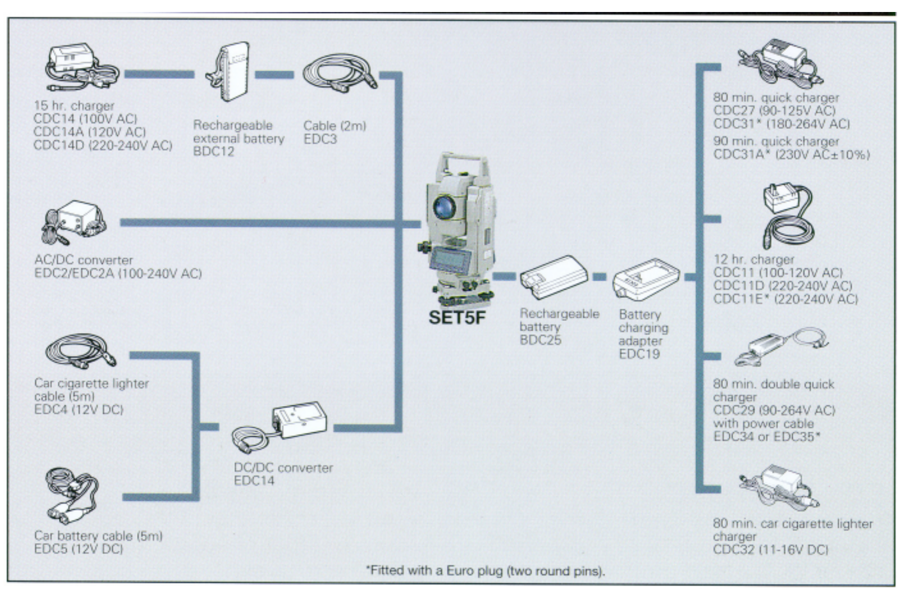
•The SET5F can be used to perform 3-dimensional setting-out with N, E and/or Z coordinates.



Offset Measurements

Two basic offset measurement methods are provided to measure the hidden points. One calls for input of the offset distance and the direction between the measuring point and the prism. The other uses a prism set on the left or right side of the measuring point at the same distance from the SET5F; the angles and distance to the prism are measured, and the measuring point is sighted. In both cases, the SET5F calculates the horizontal and vertical angles and distance, or the N, E, Z coordinates.





Standard Configuration

The SET5F comes with two (2) BDC25 rechargeable batteries EDC19 battery charging adapter CDC27, CDC31 or CDC31A quick charger, CP7 tubular compass, sunshade, lens cap, plumb bob, vinyl cover, tool kit, operator's manual, carrying case and shoulder strap.

Electronic Field Books (SDR33/SDR31)

Thanks to its advanced two-way communications port, the SET5F's functions can all be accessed by external controller. For example, by connecting one of the Sokkia's acclaimed Electronic Field Books (SDR33 or SDR31), complex field operations such as traverse adjustment, intersection, area calculations and roading can be carried out with remarkable ease.

Optional Accessories

DE17A Diagonal Eyepiece
OF1/OF1A Solar Filters
SC94 Back Pack

SET5F Specifications

Telescope		**Fully transiting, coaxial EDM**
Length		165mm (6.5in)
Objective aperture		45mm (1.8in)
Magnification, image		30x, Erect
Resolving power		3.0"
Field of view		1°30'(26m/1,000m)
Minimum focus		1.3m (4.3ft.)
Reticle illumination		Bright or Dim, selectable
Angle measurement		**Incremental encoder, diametrical detection**
Display resolution	H&V	1"/ 0.2 mgon/ 0.005 mil, 5"/1 mgon/ 0.02 mil
Angle unit	H&V	Degree/Gon/Mil
Accuracy	H&V	5" (1.5 mgon/ 0.02 mil) according to DIN18723
Dual-axis compensator		Liquid dual-axis tilt sensor, range: ±3' (±55 mgon)
Display mode	H	Clockwise/ Counterclockwise, Repetition, Oset, Hold available
	V	Zenith 0°/ Horizontal 0°/ Horizontal 0°±90°/ Slope%
Distance measurement		**Electro-optical with modulated infrared LED.**
Measuring range (slope distance)		A: Average conditions; slight haze, visibility about 20km(12 miles), sunny periods, weak scintillation. G: Good conditions; no haze, visibility about 40km (25 miles), overcast, no scintillation. Maximum ranges are achieved with Sokkia CP/AP prisms.
With CP01 compact prism		A: 1.3m (4.3ft.) to 700m (2,300ft.)
With one AP01 prism		A: 1.3m (4.3ft.) to 1,200m (3,900ft.), G: 1,500m (4,900ft.)
With three AP01 prism		A: 1.3m (4.3ft.) to 1,600m (5,200ft.), G: 2,000m (6,500ft.)
Distance unit		Meters or feet, selectable
Accuracy (Fine measurement)		±(3+2ppmxD)mm D=measuring range, unit=mm
Measuring unit and time (slope distance)	Fine	0.001 m Every 3.2 seconds (initial 4.7 seconds)
	Rapid	0.001 m 1.7 seconds
	Tracking	0.01 m Every 0.3 seconds (initial 1.4 seconds)
	Average	0.0001 m (average of 2 to 9 times measurement)
Atmospheric correction		Key-in the temperature and pressure, or -499 to +499ppm.
Prism constant		-99 to 0mm (1 mm steps)
Refraction & Earth-curvature correction		On/off selectable (K=0.142)
General		
Display		LCD dot matrix display (20 characters x 4 lines) on both faces with back light.
Keyboard		5 keys on both faces, free assignment of functions.
Resume function		On/off selectable
Sensitivity of levels		Plate level: 40"/2mm, Circular level: 10'/2mm (in tribrach)
Optical plummet		Image: erect, Magnification: 3x, Minimum focus: 0.5m (1.6ft.)
Interface		Asynchronous serial, RS-232C compatible, baud rate 1200/ 9600bps
2-way communication		Provided
Data storage		3,000-point data memory
Operating temperature		-20°C to +50°C (-4°F to +122°F)
Tilting/Trunnion axis height		236mm (9.3in) from tribrach bottom, 193mm (7.6in) from tribrach dish.
Size with handle and battery		W150 x D165 x H353mm, W5.9 x D6.5 x H13.9in.
Weight with handle and battery		5.4kg (11.9lbs)
Weight of parts		BDC25 battery: 240g (8.5oz.), Handle: 100g (3.5oz.), Tribrach: 740g (1.6 lbs), Case:2.4kg (5.3lbs)
Power supplies		
Battery level display		4 steps with warning message.
Automatic power cut-off		On/off selectable (30 minutes after the last operation)
Power source		BDC25 rechargeable battery, Ni-Cd 6V, 2 supplied as standard.
Working duration at 25°C (77°F) w/one BDC25 battery		Distance & angle measurement: about 5 hours, about 600 points (Fine & single measurement with 30 seconds intervals). Angle measurement only: about 9 hours.
Charging time		CDC27/31: about 80 minutes, CDC31A: about 90 minutes

Designs and specifications are subject to change without notice.

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FIG
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Certificate No. JQA-0557
ISO 9001/BS EN ISO 9001/EN 29001/JIS Z9901
SOKKIA CO.,LTD.

Appendix III

Vessel Reports, Offsets, and Diagrams

Launch 1010

1. Offsets
2. Patch Test
3. DDSSM and Settlement & Squat
4. POS Gams Calibration
5. Wire Diagram

Launch 1018

1. Offsets
2. Patch Test
3. DDSSM and Settlement & Squat
4. POS Gams Calibration
5. Wire Diagram

S220

1. Offsets
2. Patch Test
3. DDSSM and Settlement & Squat
4. POS Gams Calibration
5. Wire Diagram
6. Correspondence

Waterline Measurements - 2007

Measuring Party: Gonsalves, Glazewski, N. Morgan (2007 value used for 2008)

	1010	
	Benchmark A to Waterline	Benchmark B to Waterline
Measure 1	-97.3	-90.4
Measure 2	-94.1	-90.0
Measure 3	-92.1	-88.5
Avg (cm)	-94.50	-89.63
Avg (m)	-0.9450	-0.8963
Stdev	0.02623	0.01002
BM Z-value (m)	-0.02017	-0.05283
BM C to WL (m)	-0.965	-0.949

Date: 3/16/2007
Fuel Level: ~ 1/3 Full
Draft Tube: 15.2 cm

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0327	0.0487	0.0160

BM C to WL Average (m)
-0.957

This spreadsheet is designed to compute the z-values of the phase centers of the new POS M/V antenna.

All offsets are in the Theodolite Coordinate System

BM E	x	1.665536	Port Ant	x	2.316862
	y	-0.892424		y	-0.886431
	z	1.612667		z	Unknown
BM F	x	1.668082	Stbd Ant	x	2.324270
	y	-0.001217		y	0.952574
	z	1.649000		z	Unknown
BM G	x	1.668115			
	y	0.957794			
	z	1.578000			

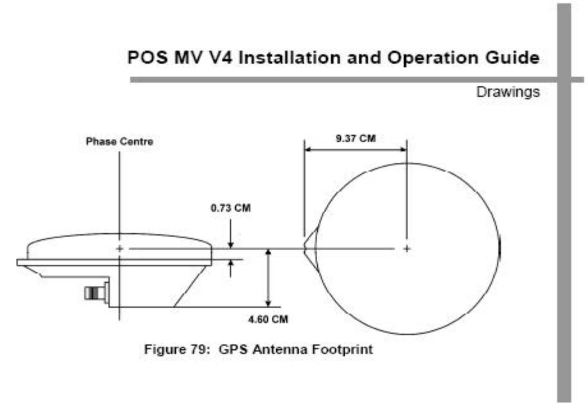


Figure 79: GPS Antenna Footprint

Measuring Party (fill in yellow spaces only):
Breen

Date:
4/15/2008

Distances					z-Values Ant. Base	Phase Center	
Port Ant to BM 'E'	0.691	0.691	0.693	0.70443	1.880922	1.926922	
Port Ant to BM 'F'	1.111	1.108	1.11	1.12243	1.884225	1.930225	
Port Ant to BM 'G'	1.97	1.963	1.968	1.979764	1.890128	1.936128	
					1.882574	1.928574	AVERAGE
						0.0047	STDEV
Stbd Ant to BM 'E'	1.961	1.962	1.963	1.974764	1.861152	1.907152	
Stbd Ant to BM 'F'	1.156	1.166	1.163	1.17443	1.846452	1.892452	
Stbd Ant to BM 'G'	0.702	0.705	0.702	0.715764	1.863920	1.909920	
					1.855186	1.901186	AVERAGE
						0.0094	STDEV

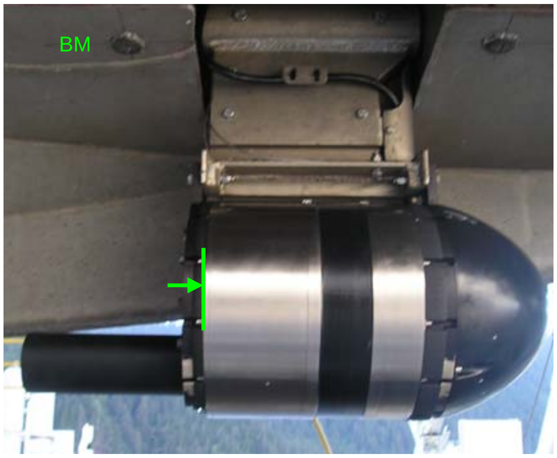
Antenna Post	Diameter	Radius
	0.025527	0.012764

The distances from the antenna post to each benchmark was measured three times and averaged. The post offset to phase center (radius) was then added.

The distance is 0.046m (4.60cm) from the bottom of the antenna to the Phase center, obtained from the POSM/V v4 guide, see image above.

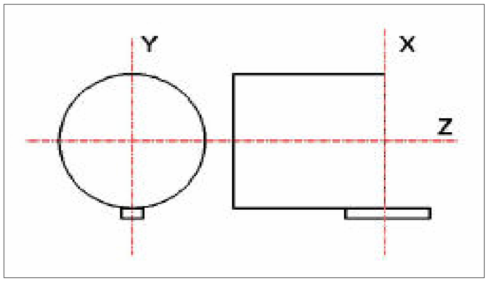
Offsets from Aft Benchmark to Phase Center of Transducer

4/15/2008	106	1010	Breen
Date	DN	Vessel	Personnel



Instructions: The purpose of this measurement is to check for gross movement of the tranducer.

While the boat is in the cradle, gently lower the transducer and lock it in place. Using a metric tape measure, plumb bob and carpenter's level, measure the horizontal and vertical offsets from the aft benchmark (BM H) to the phase center of the transducer. The phase center is measured at the forward edge of the black insulating layer, as shown in the photos. If you have trouble locating the center, borrow a compass from the navigation department.



Notwithstanding a major accident, BM H will be outboard, aft and higher than the phase center; as such, enter all offsets as positive numbers (in cm) and the proper signs will be applied.

Once offsets have been measured, apply a digital level to the IMU to determine any pitch or roll bias in the orientation of the launch. For the purposes of this spreadsheet, a positive angle (measured in degrees) will imply the bow is higher than the stern and the port side is higher than the starboard side.

All measurements should be done in triplicate to aid in the calculation of the uncertainty (needed in the HVF). The *IMU to Phase Center* values will be calculated automatically.

Offset Measurements (positive cm):				**Average**
Bow-Stern	10.1	10.2	10.4	10.2
Port-Stbd	15.1	15.2	15.7	15.3
Up-Down	36.0	36.4	36.5	36.3

Angle Bias (deg):	
Bow Up	-1.4
Port Up	-1.8

The measuring crew should insure there will be no yaw bias.

BM H to Phase Center

(Theodolite Coordinate System)

x 11.105 cm

y -16.466 cm

z -35.540 cm

IMU to Phase Center

(CARIS Coordinate System)

x 0.250 m

y -0.133 m

z 0.549 m

Note: The traditional rotation matrices require a right-handed coordinate system. Thus, behind-the-scenes, all numbers have been converted to the POS M/V Coordinate system.

Rotation about x-axis

1	0	0
0	Cos(x-angle)	-Sin(x-angle)
0	Sin(x-angle)	Cos(x-angle)

Rotation about y-axis

Cos(y-angle)	0	Sin(y-angle)
0	1	0
-Sin(y-angle)	0	Cos(y-angle)

Rotation about z-axis

Cos(z-angle)	-Sin(z-angle)	0
Sin(z-angle)	Cos(z-angle)	0
0	0	1

BM 'H' to Phase Center (POS M/V Coordinate system)

Original vector
10.2
-15.3
36.3

Rotation angles

x-axis	1.8	Note: A positive angle will raise the port-side.
y-axis	1.4	Note: A positive angle will raise the bow.
z-axis	0	Note: The measuring crew should insure there will be no yaw bias.

Rotated about x-axis
10.233
-16.466
35.800

Rotated about y-axis
11.105
-16.466
35.540

Rotated about z-axis
11.105
-16.466
35.540

BM 'H' to Phase Center (POS M/V Coordinate system)

Newly rotated vector
11.10
-16.47
35.54

- Rotation around the *x*-axis is defined as:

$$\mathcal{R}_x(\theta_x) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_x & -\sin\theta_x \\ 0 & \sin\theta_x & \cos\theta_x \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -\theta_x \\ 0 & \theta_x & 0 \end{bmatrix}\right)$$

where θ_x is the *roll angle*.

- Rotation around the *y*-axis is defined as:

$$\mathcal{R}_y(\theta_y) = \begin{bmatrix} \cos\theta_y & 0 & \sin\theta_y \\ 0 & 1 & 0 \\ -\sin\theta_y & 0 & \cos\theta_y \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & 0 & \theta_y \\ 0 & 0 & 0 \\ -\theta_y & 0 & 0 \end{bmatrix}\right)$$

where θ_y is the *pitch angle*.

- Rotation about the *z*-axis is defined as:

$$\mathcal{R}_z(\theta_z) = \begin{bmatrix} \cos\theta_z & -\sin\theta_z & 0 \\ \sin\theta_z & \cos\theta_z & 0 \\ 0 & 0 & 1 \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & -\theta_z & 0 \\ \theta_z & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}\right)$$

where θ_z is the *yaw angle*.

* - Valid for a right-handed (i.e. POS M/V) coordinate system
Angles are rotated clockwise when looking from the origin along the positive axis.

1010

	IMU	BM H	IMU to BM H
x	3.515566	3.271447	-0.244119
y	0.010709	0.425598	0.41489
z	-1.183	-1.376667	-0.193667

Using the XYZ positions of the IMU and BM H from the launch *Offsets & Measurements* form located in the DAPR appendix, the offset from the IMU to BM H could be calculated, as shown above. The measured offsets from BM H to the phase center of the transducer are divided by 100 to convert to meters, then added to the offset from the IMU to BM H. The result is the offset from the IMU to the phase center of the transducer. The values in the X and Y fields are transposed and the inverse of the Z value is used to give the offsets in CARIS coordinates.

IMU to PC = (IMU to BM H) + (BM H to PC/100)

1010 Offsets and Measurements - Summary

Measurement aka Coord. Sys.	IMU to RP* Caris	8101 to RP* Caris	IMU to 8101 (SWATH1 x,y,z & MRU to Trans) Caris	Port Ant to 8101 (Nav to Trans x,y,z) Caris	RP* to Waterline Caris
x	0.000	0.250	0.250	1.147	n/a
y	0.000	-0.133	-0.133	1.066	n/a
z	0.000	0.549	0.549	3.661	-0.243

*IMU is RP (Reference Pt)

Vessel Offsets for 1010_8101 are derived from the Horizontal, Vertical & XYZ worksheets in this spreadsheet. 2008 Measured Values

Calculations

Coord. Sys. Theodolite

8101 to RP*

IMU to 8101

IMU (m)	x	3.516
	y	0.011
	z	-1.183
BM H	x	3.271447
	y	0.425598
	z	-1.37667
IMU to BM H	x	-0.244
	y	0.415
	z	-0.194
BM H to Phase Ctr (cm) measured	x	11.10496
	y	-16.466
	z	-35.540
BM H to Phase Ctr (m)	x	0.11105
	y	-0.16466
	z	-0.3554

Port Ant to 8101

IMU (m)	x	3.516
	y	0.011
	z	-1.183
Port Antenna	x	2.317
	y	-0.886
	z	1.929
IMU to Port Antenna	x	-1.199
	y	-0.897
	z	3.112
IMU to Phase Ctr	x	-0.133
	y	0.250
	z	-0.549

RP to Waterline

IMU (m)	x	3.516
	y	0.011
	z	-1.183
BM C	x	0.000
	y	0.000
	z	0.000
BM C to IMU	x	n/a
	y	n/a
	z	-1.183
BM C to Waterline measured	x	n/a
	y	n/a
	z	-0.940

see

Coord. Sys. Theodolite

IMU to 8101

IMU to 8101

IMU to Phase Ctr	x	-0.133
	y	0.250
	z	-0.549

Coord. Sys. CARIS

x	0.250
y	-0.133
z	0.549

Port Ant to 8101

x	1.066
y	1.147
z	-3.661

Coord. Sys. CARIS

x	1.147
y	1.066
z	3.661

RP to Waterline

x	n/a
y	n/a
z	0.243

Coord. Sys. CARIS

x	n/a
y	n/a
z	-0.243

1010 Offsets and Measurements - Summary

Port Ant to Stbd Ant	
Scalar Distance	1.839

IMU to Port Antenna – Caris	IMU to Port Antenna – Pos/Mv
-0.897	-1.199
-1.199	-0.897
-3.112	-3.112

IMU to Heave – Caris	IMU to Heave – Pos/Mv
-0.011	-1.176
-1.176	-0.011
-0.243	-0.243

2007 Measured Values

Port Ant to Stbd Ant

Port Ant (m)	x	2.317
	y	-0.886
	z	1.929
Stbd Ant (m)	x	2.324
	y	0.953
	z	1.901

IMU to Port Antenna

IMU (m)	x	3.516
	y	0.011
	z	-1.183
Port Ant (m)	x	2.317
	y	-0.886
	z	1.929

IMU to Heave

IMU (m)	y	0.011
x is n/a	z	-1.183
Heave Pt (m) (centerline)	y	0.000
BM C to Waterline (m) measured scalar dist		-0.940
BM C x&y are n/a	z	0.000
BM C to Waterline (m) (Heave Pt)	z	-0.940
IMU to LCG	x	-1.176

See IMU to Heave tab

Port Ant to Stbd Ant

Scalar Distance	1.839

IMU to Port Antenna

x	-1.199
y	-0.897
z	3.112

Coord. Sys. **Pos/Mv**

x	-1.199
y	-0.897
z	-3.112

IMU to Heave

x	-1.176
y	-0.011
z	0.243

Coord. Sys. **Pos/Mv**

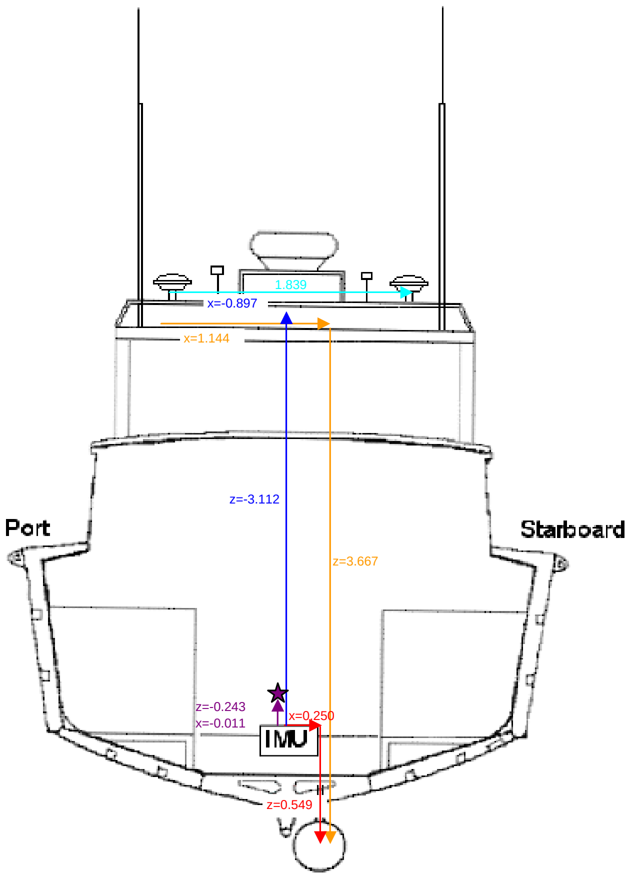
x	-1.176
y	-0.011
z	-0.243

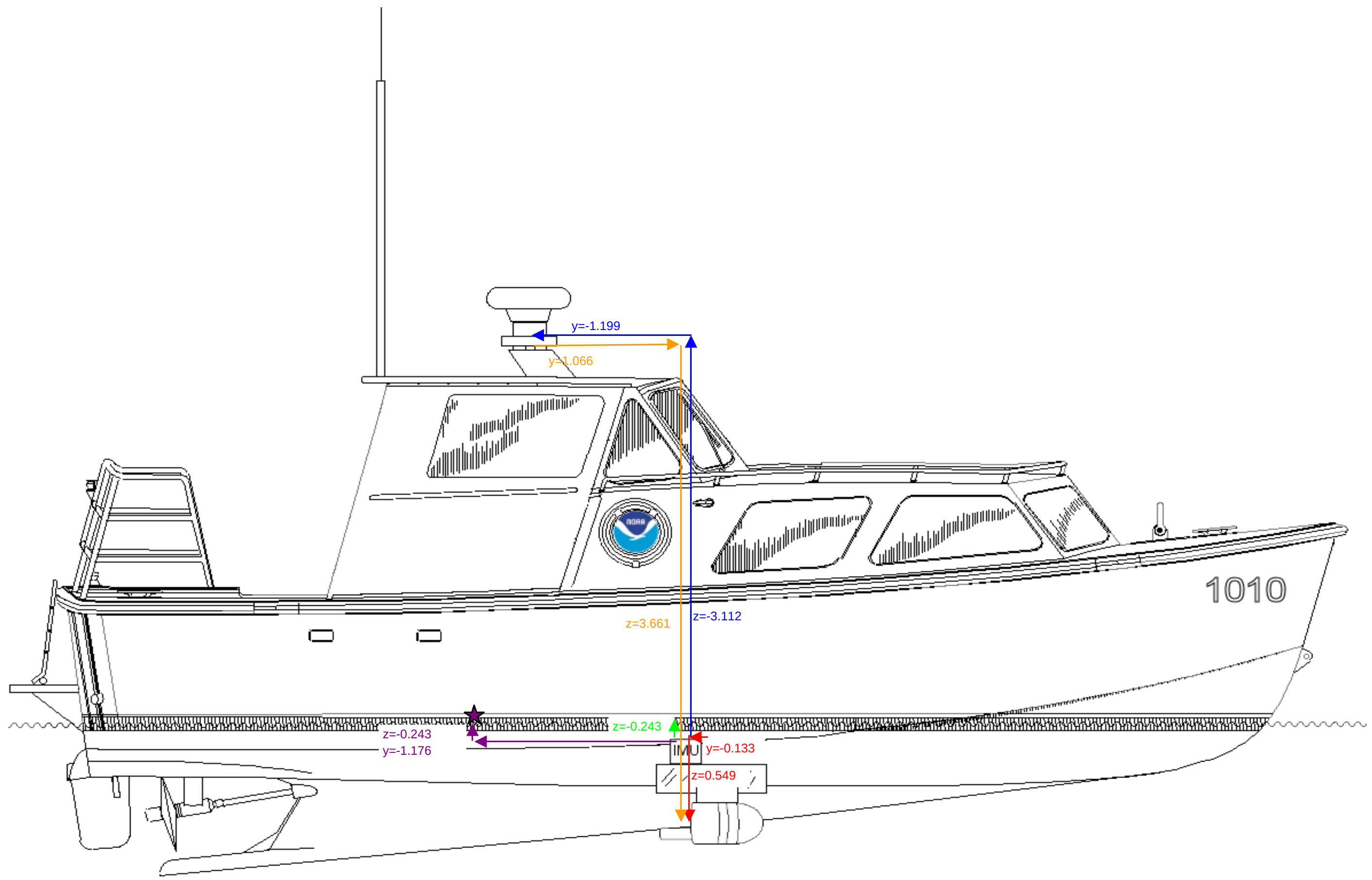
See IMU to Heave tab

Description of Offsets for Launch 1010

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 1010 was based from benchmark (BM) C as the 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 8101		
x	y	z
0.250	-0.133	0.549

The physical positions of the IMU and the phase center of the 8101 with respect to the Ship Reference Frame were measured by NOAA personnel. These physical measurements were used to calculate the xyz offsets from the IMU to BM H. Measurements from BM H to the Phase Center of the 8101 were collected by NOAA personnel while the boat was secured on the pier and thought to be as level as possible. The measured offsets from BM H to the phase center were then added to the offset from the IMU to BM H. The result is the offset from the IMU to the phase center of the transducer. The values in the X and Y fields are transposed and the inverse of the Z value is used to give the offsets in CARIS coordinates.

Port Ant to 8101		
x	y	z
1.147	1.066	3.661

NOAA personnel calculated the distance between the port antenna and the phase center of the port antenna subtracting the IMU to Port Antenna value from the IMU to Phase Center value.

RP to Waterline		
x	y	z
N/A	N/A	-0.243

The average vertical distance from BM A and B to the waterline was measured by FAIRWEATHER personnel using a steel tape and bubble level. These values were used to calculate the BM C to the waterline value. With the knowledge of the BM C height above the IMU, the waterline height above the IMU could be calculated. On launch 1010, the IMU is used as the reference point.

Port Ant to Stbd Ant
Scalar Distance
1.839

The location of the phase center of the port and starboard POS/MV antennas were measured by NOAA personnel with respect to the SRF. The scalar distance between the phase centers was then calculated.

IMU to Port Antenna		
x	y	z
-0.897	-1.199	-3.112

The location of the IMU and the location of the port antenna were measured by NOAA personnel with respect to the Ship Reference Frame (SRF). The xyz offsets from the IMU to the port antenna could be calculated from these physical locations.

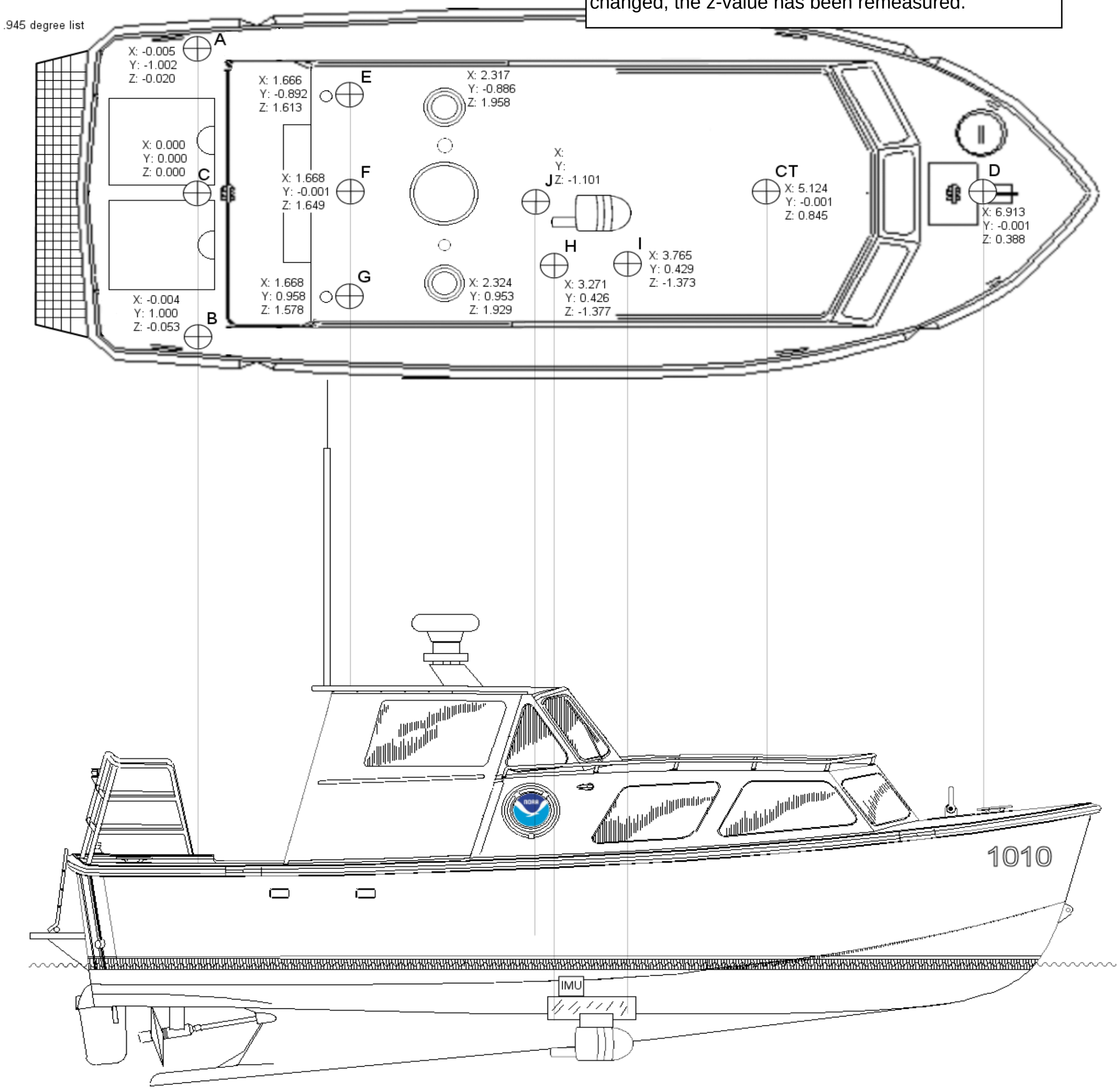
IMU to Heave		
x	y	z
-0.011	-1.176	-0.243

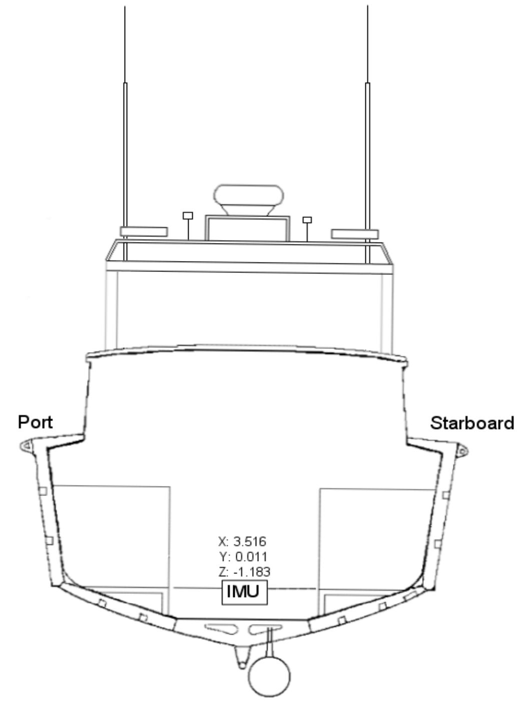
The heave point was positioned differently on each of the axes. The distance for the longitundinal axis was determined as described in the "IMU to Heave" tab in this workbook. The athwart ships axis was the vessel centerline. Lastly, the waterline was used as the height of the heave point, which was calculated earlier in 'RP to Waterline'.

1010 Vessel Diagram

All Values Shown are in Theodolite Coordinates

Note: Both antenna have been replaced for the POS V4. While their x-y values are not thought to have changed, the z-value has been remeasured.





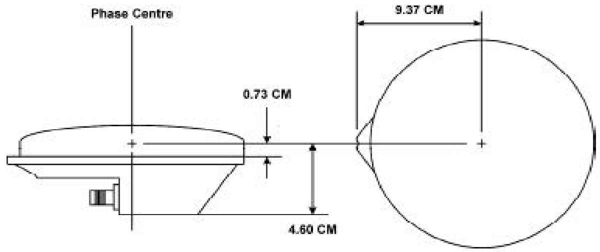


Figure 79: GPS Antenna Footprint

2.4.4 Sonar Head Acoustic Center

Figure 8 provides the acoustic center location (the intersection of lines Y-Z and X-Z) required for Vessel Reference Point (VRP) measurement. This is the point to which the offset measurements (in relation to the VRP) are made for the multi-beam system. Figure 8 illustrates a sonar head with a stick projector installed. For sonar heads equipped with an Extended Range (ER) projector, the acoustic center will be the same as shown in Figure 8 (the slight offset is compensated for in the system's software). See also paragraph 3.10.5.

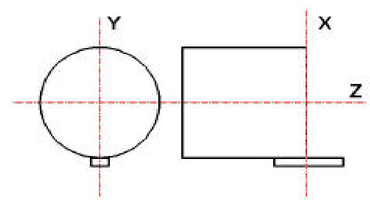


Figure 8, Sonar Head Acoustic Center

1010 Offsets and Measurements - Horizontal

All offsets are in Theodolite Coordinate System

	BM CT	BS	**BM A**	m	S	DD	dA	Hd	Vd	**BM A**	
X	5.123977	HA	11	2	35	191.0431		5.22883	-1.793911	X	-0.0080
Y	-0.000827	VA	108	56	10	108.9361	-18.93611			Y	-1.0024
Z	0.845	SDx	5.528							Z	-0.0229
		HI	1.031								
		HT	0.105								

	BM CT	BS	**BM A**	m	S	DD	dA	Hd	Vd	**BM A**	
X	5.123977	HA	11	2	50	191.0472		5.223191	0.091931	X	-0.0024
Y	-0.000827	VA	88	59	30	88.99167	1.008333			Y	-1.0017
Z	0.845	SDx	5.224							Z	-0.0351
		HI	1.028								
		HT	2								

	BM CT	BS	**BM B**	m	S	DD	dA	Hd	Vd	**BM B**	
X	5.123977	HA	348	57	40	168.9611		5.227332	-1.825751	X	-0.0066
Y	-0.000827	VA	109	15	10	109.2528	-19.25278			Y	1.0001
Z	0.845	SDx	5.537							Z	-0.0548
		HI	1.031								
		HT	0.105								

	BM CT	BS	**BM B**	m	S	DD	dA	Hd	Vd	**BM B**	
X	5.123977	HA	348	57	20	168.9556		5.22166	0.05962	X	-0.0010
Y	-0.000827	VA	89	20	45	89.34583	0.654167			Y	0.9995
Z	0.845	SDx	5.222							Z	-0.0674
		HI	1.028								
		HT	2								

	BM CT	BS	**BM C**	m	S	DD	dA	Hd	Vd	**BM C**	
X	5.12892	HA	180	0	0	180		5.128883	-1.773947	X	0.0000
Y	0	VA	109	4	45	109.0792	-19.07917			Y	0.0000
Z	0.847926	SDx	5.427							Z	0.0000
		HI	1.031								
		HT	0.105								

	BM CT	BS	**BM C**	m	S	DD	dA	Hd	Vd	**BM C**	
X	5.1257	HA	0	0	0	180		5.125747	0.113336	X	0.0000
Y	0	VA	88	44	0	88.73333	1.266667			Y	0.0000
Z	0.8586	SDx	5.127							Z	-0.0001
		HI	1.028								
		HT	2								

	BM F	BS	**BM D**	m	S	DD	dA	Hd	Vd	**BM D**	
X	1.668082	HA	0	0	0	0		5.249724	-1.383634	X	6.9178
Y	-0.001217	VA	104	45	55	104.7653	-14.76528			Y	-0.0012
Z	1.649	SDx	5.429							Z	0.3394
		HI	1.234								
		HT	1.16								

	BM C	BS	**BM D**	m	S	DD	dA	Hd	Vd	**BM D**	
X	0	HA	0	0	0	0		6.906514	0.342484	X	6.9065
Y	0	VA	87	9	40	87.16111	2.838889			Y	0.0000
Z	0	SDx	6.915							Z	0.3805
		HI	1.225								
		HT	1.187								

	BM CT	BS	**BM D**	m	S	DD	dA	Hd	Vd	**BM D**	
X	5.123977	HA	180	1	25	0.023611		1.782119	-1.402809	X	6.9061
Y	-0.000827	VA	128	12	30	128.2083	-38.20833			Y	-0.0001
Z	0.845	SDx	2.268							Z	0.3932
		HI	1.031								
		HT	0.08								

	BM CT	BS	**BM D**	m	S	DD	dA	Hd	Vd	**BM D**	
X	5.123977	HA	180	1	35	0.026389		1.800322	0.049414	X	6.9243
Y	-0.000827	VA	88	25	40	88.42778	1.572222			Y	0.0000
Z	0.845	SDx	1.801							Z	0.3724
		HI	1.028								
		HT	1.55								

	TBM 2	BS	**BM D**	m	S	DD	dA	Hd	Vd	**BM D**	
X	18.8276	HA	2	4	10	182.0694		11.91991	2.88893	X	6.9154
Y	0.4290	VA	76	22	35	76.37639	13.62361			Y	-0.0014
Z	-2.1960	SDx	12.265							Z	0.3759
		HI	1.233								
		HT	1.55								

1010 Offsets and Measurements - Horizontal

	BM CT	BS	**BM E**	m	S	DD	dA	Hd	Vd	**BM E**	
X	5.123977	HA	14	27	40	194.4611		3.568662	-0.176011	X	1.6684
Y	-0.000827	VA	92	49	25	92.82361	-2.823611			Y	-0.8920
Z	0.845	SDx	3.573							Z	1.6200
		HI	1.031								
		HT	0.08								

	BM CT	BS	**BM E**	m	S	DD	dA	Hd	Vd	**BM E**	
X	5.123977	HA	14	27	5	194.4514		3.57438	1.278054	X	1.6627
Y	-0.000827	VA	70	19	30	70.325	19.675			Y	-0.8928
Z	0.845	SDx	3.796							Z	1.6011
		HI	1.028								
		HT	1.55								

	TBM CT	BS	**BM F**	m	S	DD	dA	Hd	Vd	**BM F**	
X	5.123977	HA	180	0	0	180		3.456432	-0.062679	X	1.6675
Y	-0.000827	VA	91	2	20	91.03889	-1.038889			Y	-0.0008
Z	0.845	SDx	3.457							Z	1.6433
		HI	0.941								
		HT	0.08								

	BM CT	BS	**BM F**	m	S	DD	dA	Hd	Vd	**BM F**	
X	5.123977	HA	0	1	10	180.0194		3.448108	-0.141253	X	1.6759
Y	-0.000827	VA	92	20	45	92.34583	-2.345833			Y	-0.0020
Z	0.845	SDx	3.451							Z	1.6547
		HI	1.031								
		HT	0.08								

	BM CT	BS	**BM F**	m	S	DD	dA	Hd	Vd	**BM F**	
X	5.123977	HA	0	0	0	180		3.463146	1.316679	X	1.6608
Y	-0.000827	VA	69	11	0	69.18333	20.81667			Y	-0.0008
Z	0.845	SDx	3.705							Z	1.6397
		HI	1.028								
		HT	1.55								

	BM CT	BS	**BM G**	m	S	DD	dA	Hd	Vd	**BM G**	
X	5.123977	HA	344	29	55	164.4986		3.578828	-0.210271	X	1.6753
Y	-0.000827	VA	93	21	45	93.3625	-3.3625			Y	0.9557
Z	0.845	SDx	3.585							Z	1.5857
		HI	1.031								
		HT	0.08								

	BM CT	BS	**BM G**	m	S	DD	dA	Hd	Vd	**BM G**	
X	5.123977	HA	344	29	40	164.4944		3.593882	1.243713	X	1.6609
Y	-0.000827	VA	70	54	40	70.91111	19.08889			Y	0.9599
Z	0.845	SDx	3.803							Z	1.5667
		HI	1.028								
		HT	1.55								

	TBM2	BS	**BM H**	m	S	DD	dA	Hd	Vd	**BM H**	
X	18.8276	HA	180	0	0	180		15.55637	-0.418679	X	3.2712
Y	0.4290	VA	91	32	30	91.54167	-1.541667			Y	0.4290
Z	-2.1960	SDx	15.562							Z	-1.3537
		HI	1.171								
		HT	-0.09								

	TBM 2	BS	**BM H**	m	S	DD	dA	Hd	Vd	**BM H**	
X	18.8276	HA	0	0	50	180.0139		15.55449	-0.449948	X	3.2731
Y	0.4290	VA	91	39	25	91.65694	-1.656944			Y	0.4252
Z	-2.1960	SDx	15.561							Z	-1.3639
		HI	1.232								
		HT	-0.05								

	TBM 2	BS	**BM H**	m	S	DD	dA	Hd	Vd	**BM H**	
X	18.8276	HA	0	1	25	180.0236		15.5575	-0.449658	X	3.2701
Y	0.4290	VA	91	39	20	91.65556	-1.655556			Y	0.4226
Z	-2.1960	SDx	15.564							Z	-1.3627
		HI	1.233								
		HT	-0.05								

	TBM 2	BS	**BM I**	m	S	DD	dA	Hd	Vd	**BM I**	
X	18.8276	HA	359	59	35	179.9931		15.06194	-0.390392	X	3.7656
Y	0.4290	VA	91	29	5	91.48472	-1.484722			Y	0.4308
Z	-2.1960	SDx	15.067							Z	-1.3504
		HI	1.171								
		HT	-0.065								

	TBM 2	BS	**BM I**	m	S	DD	dA	Hd	Vd	**BM I**	
X	18.8276	HA	0	0	55	180.0153		15.06239	-0.44631	X	3.7652

1010 Offsets and Measurements - Horizontal

Y	0.4290	VA	91	41	50	91.69722	-1.697222			Y	0.4250
Z	-2.1960	SDx	15.069							Z	-1.3593
		HI	1.233								
		HT	-0.05								
	TBM 2	BS	**BM I**	m	S	DD	dA	Hd	Vd	**BM I**	
X	18.8276	HA	359	59	50	179.9972		15.06336	-0.447435	X	3.7642
Y	0.4290	VA	91	42	5	91.70139	-1.701389			Y	0.4297
Z	-2.1960	SDx	15.07							Z	-1.3614
		HI	1.232								
		HT	-0.05								
	TBM CT	BS	**Stbd Ant**	m	S	DD	dA	Hd	Vd	**Stbd Ant**	
X	5.123977	HA	161	13	25	161.2236		2.958503	0.249444	X	2.3229
Y	-0.000827	VA	85	10	50	85.18056	4.819444			Y	0.9514
Z	0.845	SDx	2.969							Z	1.9344
		HI	0.92								
		HT	0.08								
	BM CT	BS	**Stbd Ant**	m	S	DD	dA	Hd	Vd	**Stbd Ant**	
X	5.123977	HA	341	9	55	161.1653		2.956677	0.140223	X	2.3256
Y	-0.000827	VA	87	17	5	87.28472	2.715278			Y	0.9537
Z	0.845	SDx	2.96							Z	1.9362
		HI	1.031								
		HT	0.08								
	TBM CT	BS	**Port Ant**	m	S	DD	dA	Hd	Vd	**Port Ant**	
X	5.123977	HA	197	31	25	197.5236		2.943877	0.278278	X	2.3167
Y	-0.000827	VA	84	36	0	84.6	5.4			Y	-0.8872
Z	0.845	SDx	2.957							Z	1.9633
		HI	0.92								
		HT	0.08								
	BM CT	BS	**Port Ant**	m	S	DD	dA	Hd	Vd	**Port Ant**	
X	5.123977	HA	17	29	45	197.4958		2.943124	0.169485	X	2.3170
Y	-0.000827	VA	86	42	15	86.70417	3.295833			Y	-0.8856
Z	0.845	SDx	2.948							Z	1.9655
		HI	1.031								
		HT	0.08								
	BM C	BS	**IMU**	m	S	DD	dA	Hd	Vd	**IMU**	
X	0.0000	HA	359	35	35	359.5931		3.519377	-0.713627	X	3.5193
Y	0.0000	VA	101	27	45	101.4625	-11.4625			Y	-0.0250
Z	0.0000	SDx	3.591							Z	-1.1936
		HI	1.07								
		HT	1.55								
	BM C	BS	**IMU**	m	S	DD	dA	Hd	Vd	**IMU**	
X	0.0000	HA	359	37	30	359.625		3.519208	-0.709419	X	3.5191
Y	0.0000	VA	101	23	50	101.3972	-11.39722			Y	-0.0230
Z	0.0000	SDx	3.59							Z	-1.1944
		HI	1.065								
		HT	1.55								
	BM C	BS	**IMU**	m	S	DD	dA	Hd	Vd	**IMU**	
X	0.0000	HA	359	44	25	359.7403		3.508314	-0.722813	X	3.5083
Y	0.0000	VA	101	38	30	101.6417	-11.64167			Y	-0.0159
Z	0.0000	SDx	3.582							Z	-1.1748
		HI	1.147								
		HT	1.599								
	BM CT	BS	**TBM 1**	m	S	DD	dA	Hd	Vd	**TBM 1**	
X	5.123977	HA	180	0	10	0.002778		13.70743	-2.535711	X	18.8314
Y	-0.000827	VA	100	28	50	100.4806	-10.48056			Y	-0.0002
Z	0.845	SDx	13.94							Z	-2.2127
		HI	1.028								
		HT	1.55								
	BM CT	BS	**TBM 1**	m	S	DD	dA	Hd	Vd	**TBM 1**	
X	5.123977	HA	179	59	45	359.9958		13.70731	-2.536376	X	18.8313
Y	-0.000827	VA	100	29	0	100.4833	-10.48333			Y	-0.0018
Z	0.845	SDx	13.94							Z	-2.2104
		HI	1.031								
		HT	1.55								
	BM D	BS	**TBM 1**	m	S	DD	dA	Hd	Vd	**TBM 1**	
X	6.9065	HA	0	0	0	0		11.91516	-2.662444	X	18.8217
Y	0.0000	VA	257	24	15	257.4042	-12.59583			Y	0.0000
Z	0.3805	SDx	12.209							Z	-2.2020

1010 Offsets and Measurements - Horizontal

		HI	1.165								
		HT	1.085								

	BM CT	BS	**TBM 2**	m	S	DD	dA	Hd	Vd	**TBM 2**	
X	5.123977	HA	181	47	50	1.797222		13.70934	-2.541907	X	18.8266
Y	-0.000827	VA	100	30	15	100.5042	-10.50417			Y	0.4291
Z	0.845	SDx	13.943							Z	-2.2159
		HI	1.031								
		HT	1.55								
	TBM1 Pier	BS	**TBM 2**	m	S	DD	dA	Hd	Vd	**TBM 2**	
X	18.8281	HA	90	0	0	90		0.43	0	X	18.8281
Y	-0.0007	VA	0	0	0	0	0			Y	0.4293
Z	-2.1960	SDx	0.43							Z	-2.1960
		HI	0								
		HT	0								
	BM CT	BS	**TBM 2**	m	S	DD	dA	Hd	Vd	**TBM 2**	
X	5.123977	HA	181	47	40	1.794444		13.71075	-2.539763	X	18.8280
Y	-0.000827	VA	100	29	40	100.4944	-10.49444			Y	0.4285
Z	0.845	SDx	13.944							Z	-2.2168
		HI	1.028								
		HT	1.55								

	BM C	BS	**TBM CT**	m	S	DD	dA	Hd	Vd	**TBM CT**	
X	0	HA	359	58	20	359.9722		5.117313	0.241326	X	5.1173
Y	0	VA	87	18	0	87.3	2.7			Y	-0.0025
Z	0	SDx	5.123							Z	0.8483
		HI	1.225								
		HT	0.618								

1010 Offsets and Measurements - Vertical

All offsets are in Theodolite Coordinate System

		FR							
SETUP 1									
BS	**BM C**			FS		**BM A**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	2.014		1.988333333	
Mid	1.967		0.025		Mid	1.988	0.026		
Bot	1.943		0.024		Bot	1.963	0.025		
		DTI					DTI		
			1				1		
	BM C	HI		Rod	BM A				
	0		1.967333333	1.988333	-0.021				
SETUP 5									
BS	**BM C**			FS		**BM A**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.908			1.883	Top	1.928		1.902333333	
Mid	1.883		0.025		Mid	1.902	0.026		
Bot	1.858		0.025		Bot	1.877	0.025		
		DTI					DTI		
			0				1		
	BM C	HI		Rod	BM A			**BM A Ave**	**-0.02016667**
	0		1.883	1.902333	-0.019333			mm DIFF	-1.66666667
SETUP 1									
BS	**BM C**			FS		**BM B**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	2.046		2.021	
Mid	1.967		0.025		Mid	2.021	0.025		
Bot	1.943		0.024		Bot	1.996	0.025		
		DTI					DTI		
			1				0		
	BM C	HI		Rod	BM B				
	0		1.967333333	2.021	-0.053667				
SETUP 5									
BS	**BM C**			FS		**BM B**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.908			1.883	Top	1.961		1.935	
Mid	1.883		0.025		Mid	1.935	0.026		
Bot	1.858		0.025		Bot	1.909	0.026		
		DTI					DTI		
			0				0		
	BM C	HI		Rod	BM B			**BM B Ave**	**-0.05283333**
	0		1.883	1.935	-0.052			mm DIFF	-1.66666667
	BM C 0 BY DEFINITION								
SETUP 1									
BS	**BM C**			FS		**BM D**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	1.59		1.580666667	
Mid	1.967		0.025		Mid	1.581	0.009		
Bot	1.943		0.024		Bot	1.571	0.01		
		DTI					DTI		
			1				1		
	BM C	HI		Rod	BM D				
	0		1.967333333	1.580667	0.386667				
SETUP 5									
BS	**BM C**			FS		**BM D**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.908			1.883	Top	1.502		1.494333333	
Mid	1.883		0.025		Mid	1.495	0.007		
Bot	1.858		0.025		Bot	1.486	0.009		
		DTI					DTI		
			0				2		
	BM C	HI		Rod	BM D			**BM D Ave**	**0.387666667**
	0		1.883	1.494333	0.388667			mm DIFF	-2
SETUP 1									
BS	**BM C**			FS		**BM E**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	0.372		0.354666667	
Mid	1.967		0.025		Mid	0.354	0.018		
Bot	1.943		0.024		Bot	0.338	0.016		
		DTI					DTI		
			1				2		
	BM C	HI		Rod	BM E				
	0		1.967333333	0.354667	1.612667				
SETUP 6									
BS	**BM D**			FS		**BM E**			

1010 Offsets and Measurements - Vertical

		TI		Ave (HI)			TI	Ave BM El	
Top	1.697			1.689	Top	0.481		0.463	
Mid	1.689		0.008		Mid	0.463	0.018		
Bot	1.681		0.008		Bot	0.445	0.018		
		DTI					DTI		
			0				5.55E-14		
	BM D	HI		Rod	BM E			**BM E Ave**	**1.612666833**
	0.386667		1.689	0.463	1.612667			mm DIFF	-0.00033333
SETUP 1									
BS	**BM C**			FS		**BM F**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	0.336		0.319666667	
Mid	1.967		0.025		Mid	0.319	0.017		
Bot	1.943		0.024		Bot	0.304	0.015		
		DTI					DTI		
			1				2		
	BM C	HI		Rod	BM F				
	0		1.967333333	0.319667	1.647667				
SETUP 5									
BS	**BM C**			FS		**BM F**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.908			1.883	Top	0.249		0.232666667	
Mid	1.883		0.025		Mid	0.233	0.016		
Bot	1.858		0.025		Bot	0.216	0.017		
		DTI					DTI		
			0				1		
	BM C	HI		Rod	BM F			**BM F Ave**	**1.649**
	0		1.883	0.232667	1.650333			mm DIFF	-2.66666667
SETUP 1									
BS	**BM C**			FS		**BM G**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.992			1.967333	Top	0.406		0.389333333	
Mid	1.967		0.025		Mid	0.389	0.017		
Bot	1.943		0.024		Bot	0.373	0.016		
		DTI					DTI		
			1				1		
	BM C	HI		Rod	BM G				
	0		1.967333333	0.389333	1.578				
SETUP 6									
BS	**BM D**			FS		**BM G**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.697			1.689	Top	0.515		0.497666667	
Mid	1.689		0.008		Mid	0.497	0.018		
Bot	1.681		0.008		Bot	0.481	0.016		
		DTI					DTI		
			0				2		
	BM D	HI		Rod	BM G			**BM G Ave**	**1.578000167**
	0.386667		1.689	0.497667	1.578			mm DIFF	-0.00033333
SETUP 10									
BS	**BM C**			FS		**BM J**			
		TI		Ave (HI)			TI	Ave BM El	
Top	0.667			0.657	Top	1.764		1.755	
Mid	0.657		0.01		Mid	1.755	0.009		
Bot	0.647		0.01		Bot	1.746	0.009		
		DTI					DTI		
			0				2.22E-13		
	BM C	HI		Rod	BM J				
	0		0.657	1.755	-1.098				
SETUP 11									
BS	**BM C**			FS		**BM J**			
		TI		Ave (HI)			TI	Ave BM El	
Top	0.658			0.648333	Top	1.761		1.752	
Mid	0.649		0.009		Mid	1.752	0.009		
Bot	0.638		0.011		Bot	1.743	0.009		
		DTI					DTI		
			2				0		
	BM C	HI		Rod	BM J			**BM J Ave**	**-1.10083333**
	0		0.648333333	1.752	-1.103667			mm DIFF	5.666666667
SETUP 2									
BS	**BM C**			FS		**TBM 2**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.381			1.347333	Top	3.609		3.549666667	
Mid	1.348		0.033		Mid	3.55	0.059		
Bot	1.313		0.035		Bot	3.49	0.06		
		DTI					DTI		

1010 Offsets and Measurements - Vertical

			2				1		
	BM C	HI		Rod	TBM 2				
	0		1.347333333	3.549667	-2.202333				
BS	**BM C**			FS		**TBM 2**			NOTE
		TI		Ave (HI)			TI	Ave BM El	
Top	-			1.188	Top	-		3.395	
Mid	1.188	n/a			Mid	3.395	n/a		
Bot	-	n/a			Bot	-			
		DTI					DTI		
		n/a					n/a		
	BM C	HI		Rod	TBM 2			**TBM 2 Ave**	**-2.20466667**
	0		1.188	3.395	-2.207			mm DIFF	4.666666667
SETUP 2									
BS	**BM C**			FS		**BM CT**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.381			1.347333	Top	0.51		0.502	
Mid	1.348		0.033		Mid	0.502	0.008		
Bot	1.313		0.035		Bot	0.494	0.008		
		DTI					DTI		
			2				0		
	BM C	HI		Rod	BM CT				
	0		1.347333333	0.502	0.845333				
SETUP 7									
BS	**BM C**			FS		**BM CT**			
		TI		Ave (HI)			TI	Ave BM El	
Top	1.563			1.528	Top	0.693		0.683333333	
Mid	1.528		0.035		Mid	0.684	0.009		
Bot	1.493		0.035		Bot	0.673	0.011		
		DTI					DTI		
			0				2		
	BM C	HI		Rod	BM CT			**BM CT Ave**	**0.845**
	0		1.528	0.683333	0.844667			mm DIFF	0.666666667
SETUP 3									
BS	**BM C**			FS		**Stbd Ant**			
		TI		Ave (HI)			TI	Ave BM El	
Top	2.068			2.044333	Top	0.128		0.116	
Mid	2.045		0.023		Mid	0.116	0.012		
Bot	2.02		0.025		Bot	0.104	0.012		
		DTI					DTI		
			2				1.39E-14		
	BM C	HI		Rod	Stbd Ant				
	0		2.044333333	0.116	1.928333				
SETUP 4									
BS	**BM C**			FS		**Stbd Ant**			
		TI		Ave (HI)			TI	Ave BM El	
Top	2.067			2.043333	Top	0.126		0.114333333	
Mid	2.044		0.023		Mid	0.114	0.012		
Bot	2.019		0.025		Bot	0.103	0.011		
		DTI					DTI		
			2				1		
	BM C	HI		Rod	Stbd Ant			**Stbd Ant Ave**	**1.928666667**
	0		2.043333333	0.114333	1.929			mm DIFF	-0.66666667
SETUP 3									
BS	**BM C**			FS		**Port Ant**			
		TI		Ave (HI)			TI	Ave BM El	
Top	2.068			2.044333	Top	0.102		0.086666667	
Mid	2.045		0.023		Mid	0.086	0.016		
Bot	2.02		0.025		Bot	0.072	0.014		
		DTI					DTI		
			2				2		
	BM C	HI		Rod	Port Ant				
	0		2.044333333	0.086667	1.957667				
SETUP 4									
BS	**BM C**			FS		**Port Ant**			
		TI		Ave (HI)			TI	Ave BM El	
Top	2.067			2.043333	Top	0.101		0.085333333	
Mid	2.044		0.023		Mid	0.085	0.016		
Bot	2.019		0.025		Bot	0.07	0.015		
		DTI					DTI		
			2				1		
	BM C	HI		Rod	Port Ant			**Port Ant Ave**	**1.957833333**
	0		2.043333333	0.085333	1.958			mm DIFF	-0.33333333
SETUP 10									
BS	**BM C**			FS		**IMU**			

1010 Offsets and Measurements - Vertical

		TI		Ave (HI)			TI	Ave BM El	
Top	0.667			0.657	Top	1.849		1.841	
Mid	0.657		0.01		Mid	1.841	0.008		
Bot	0.647		0.01		Bot	1.833	0.008		
		DTI					DTI		
			0				0		
	BM C	HI		Rod	IMU				
	0		0.657	1.841	-1.184				
SETUP 11									
BS	**BM C**			FS		**IMU**			
		TI		Ave (HI)			TI	Ave BM El	
Top	0.658			0.648333	Top	1.839		1.830333333	
Mid	0.649		0.009		Mid	1.83	0.009		
Bot	0.638		0.011		Bot	1.822	0.008		
		DTI					DTI		
			2				1		
	BM C	HI		Rod	IMU			**IMU Ave**	**-1.183**
	0		0.648333333	1.830333	-1.182			mm DIFF	-2
SETUP 8									
BS	**TBM 2**			FS		**BM H**			NOTE
		TI		Ave (HI)			TI	Ave BM El	
Top	0.792			0.755667	Top	-0.032		-0.072	
Mid	0.755		0.037		Mid	-0.072	0.04		
Bot	0.72		0.035		Bot	-0.112	0.04		
		DTI					DTI		
			2				1.39E-14		
	TBM 2	HI		Rod	BM H				
	-2.204667		0.755666667	-0.072	-1.377				
SETUP 9									
BS	**TBM 2**			FS		**BM H**			NOTE
		TI		Ave (HI)			TI	Ave BM El	
Top	0.783			0.746333	Top	-0.041		-0.082	
Mid	0.746		0.037		Mid	-0.082	0.041		
Bot	0.71		0.036		Bot	-0.123	0.041		
		DTI					DTI		
			1				6.94E-15		
	TBM 2	HI		Rod	BM H			**BM H Ave**	**-1.37666667**
	-2.204667		0.746333333	-0.082	-1.376333			mm DIFF	-0.66666667
SETUP 8									
BS	**TBM 2**			FS		**BM I**			NOTE
		TI		Ave (HI)			TI	Ave BM El	
Top	0.792			0.755667	Top	-0.036		-0.075	
Mid	0.755		0.037		Mid	-0.075	0.039		
Bot	0.72		0.035		Bot	-0.114	0.039		
		DTI					DTI		
			2				6.94E-15		
	TBM 2	HI		Rod	BM I				
	-2.204667		0.755666667	-0.075	-1.374				
SETUP 9									
BS	**TBM 2**			FS		**BM I**			NOTE
		TI		Ave (HI)			TI	Ave BM El	
Top	0.783			0.746333	Top	-0.047		-0.085666667	
Mid	0.746		0.037		Mid	-0.086	0.039		
Bot	0.71		0.036		Bot	-0.124	0.038		
		DTI					DTI		
			1				1		
	TBM 2	HI		Rod	BM I			**BM I Ave**	**-1.37333333**
	-2.204667		0.746333333	-0.085667	-1.372667			mm DIFF	-1.33333333

1010 Launch Offsets Measurements

Jul-04

All offsets are in Theodolite Coordinate System

The Z plane means were taken using only the vertical level measurements.

BM A	88	165		133						
X	-0.0080	-0.0024						**Mean**	**-0.00523**	
Y	-1.0024	-1.0017							**-1.002038**	
Z	-0.0229	-0.0351	-0.021	-0.019333333					**-0.020167**	
BM B	95	172	13	143						
X	-0.006636	-0.000971						**Mean**	**-0.003804**	
Y	1.000078	0.999488							**0.999783**	
Z	-0.054751	-0.06738	-0.053666667	-0.052					**-0.052833**	
BM C										
X	**0**		**By Definition**							
Y	**0**									
Z	**0**									
BM D	3	39	137	200	235					
X	6.906514	6.917806	6.90609668	6.924299204	6.908486			**Mean**	**6.912961**	0.008066 ⇐ X Std Dev
Y	0	-0.001217	-9.25846E-05	2.19861E-06	-0.003272				**-0.001121**	0.001414 ⇐ Y Std Dev
Z	0.380484	0.339366	0.393190546	0.372414056	0.358922	0.386667	0.3886667		**0.387667**	
BM E	102	179	174	33						
X	1.66838	1.662692						**Mean**	**1.665536**	
Y	-0.892003	-0.892844							**-0.892424**	
Z	1.619989	1.601054	1.612667	1.612666667					**1.612667**	
BM F	18	109	186	43	163					
X	1.667546	1.67587	1.660831138					**Mean**	**1.668082**	0.007534 ⇐ X Std Dev
Y	-0.000827	-0.001997	-0.000826981						**-0.001217**	0.000676 ⇐ Y Std Dev
Z	1.643321	1.654747	1.63967874	1.647666667	1.650333				**1.649**	
BM G	116	193	53	184						
X	1.675333	1.660896						**Mean**	**1.668115**	
Y	0.955657	0.959932							**0.957794**	
Z	1.585729	1.566713	1.578	1.578000333					**1.578**	
BM H	60	221	242							
X	3.271201	3.270066	3.273074882					**Mean**	**3.271447**	0.001519 ⇐ X Std Dev
Y	0.428992	0.422581	0.425221731						**0.425598**	0.003222 ⇐ Y Std Dev
Z	-1.353679	-1.362658	-1.363947954	-1.377	-1.376333				**-1.376667**	
BM I	67	228	249	234	254					
X	3.7656	3.7652	3.764211686					**Mean**	**3.765006**	0.000723 ⇐ X Std Dev
Y	0.4308	0.4250	0.429722538						**0.428505**	0.003105 ⇐ Y Std Dev
Z	-1.3504	-1.3593	-1.361435445	-1.374	-1.372667				**-1.373333**	

BM J	67	228	249	274	294			
X	n/a	n/a	n/a	n/a	n/a	**Mean**		
Y	n/a	n/a	n/a	n/a	n/a			
Z	-1.3504	-1.3593	-1.361435445	-1.098	-1.103667		**-1.100833**	
BM CT	11	81	158					
X	5.117312	5.12892	5.1257			**Mean**	**5.123977**	0.005993 ⇐ X Std Dev
Y	-0.002481	0	0				**-0.000827**	0.001432 ⇐ Y Std Dev
Z	0.848326	0.847926	0.8586	0.845333333	0.844667		**0.845**	
TBM 1	46	144	207					
X	18.82167	18.83129	18.83141214			**Mean**	**18.82813**	0.005587 ⇐ X Std Dev
Y	0	-0.001824	-0.000162426				**-0.000662**	0.001009 ⇐ Y Std Dev
Z	-2.20196	-2.210376	-2.212711485	-2.196	-2.197		**-2.1965**	
TBM 2	53	151	214	63				
X	18.82813	18.82657	18.82800643			**Mean**	**18.82757**	0.000865 ⇐ X Std Dev
Y	0.429338	0.429129	0.428509392				**0.428992**	0.000431 ⇐ Y Std Dev
Z	-2.196	-2.215907	-2.216762747	-2.202333333	-2.207		**-2.204667**	
IMU	74	256	263					
X	3.5083	3.519289	3.519132539			**Mean**	**3.515566**	0.006313 ⇐ X Std Dev
Y	-0.0159	0.024996	0.023032997				**0.010709**	0.023067 ⇐ Y Std Dev
Z	-1.1748	-1.193627	-1.194419237	-1.184	-1.182		**-1.183**	
Port Ant	25	130	103	123				
X	2.316717	2.3170				**Mean**	**2.316862**	
Y	-0.887225	-0.8856					**-0.886431**	
Z	1.963278	1.9655	1.957666667	1.958			**1.957833**	
Stbd Ant	32	123	93	113				
X	2.32292	2.32562				**Mean**	**2.32427**	
Y	0.951443	0.953705					**0.952574**	
Z	1.934444	1.936223	1.928333333	1.929			**1.928667**	
Phase Center of Ducer								
	270	277	284					
X	3.360447	3.364447	3.370447321			**Mean**	**3.365114**	0.005033 ⇐ X Std Dev
Y	0.272598	0.271598	0.275598369				**0.273265**	0.002082 ⇐ Y Std Dev
Z	-1.719	-1.719	-1.722	-1.729166667			**-1.729167**	

1010 Offsets and Measurements
IMU to Heave

IMU to Heave

Measurement	Explanation
BM C to BM D 6.913	From Offsets & Measurements XYZ.
BM D to Center of Pick Point -0.275	Measured with steel tape 11/16/05.
Center of Pick Point to Frame 0 0.5207	From JMC drawing. Converted to meters.
BM C to Frame 0 7.1587	Calculated from cells 4, 7 and 10.
Frame 0 to LCG -4.818888	From JMC Stability Test. Converted to meters.
BM C to LCG 2.339812	Calculated from cells 13 and 16.
BM C to IMU 3.516	From Offsets & Measurements XYZ.
IMU to LCG -1.176188	Calculated from cells 19 and 22.

Notes

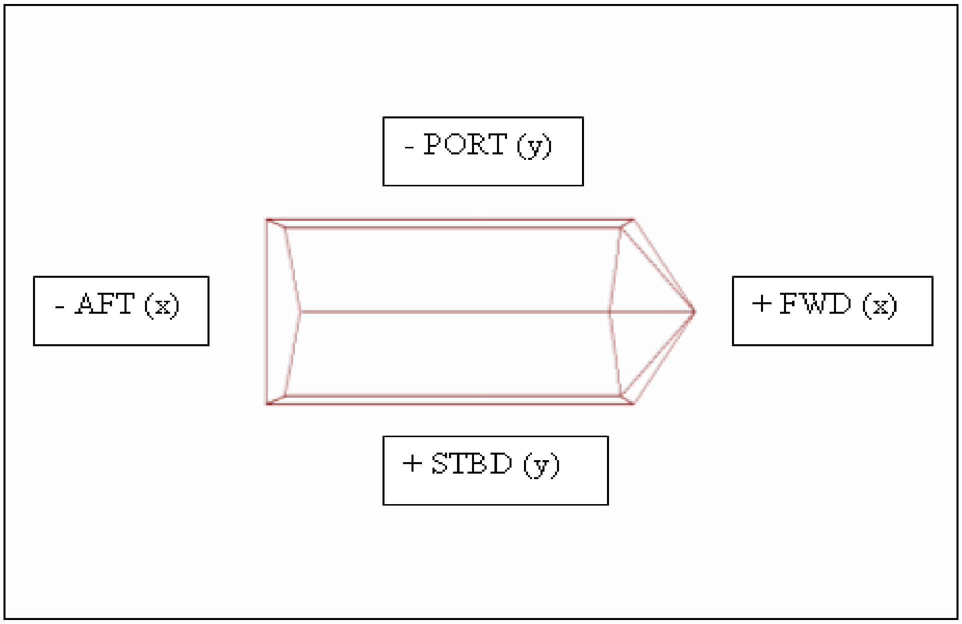
Stability values are not available for Launch 1010 at this time. Values used are from Launch 1018*.

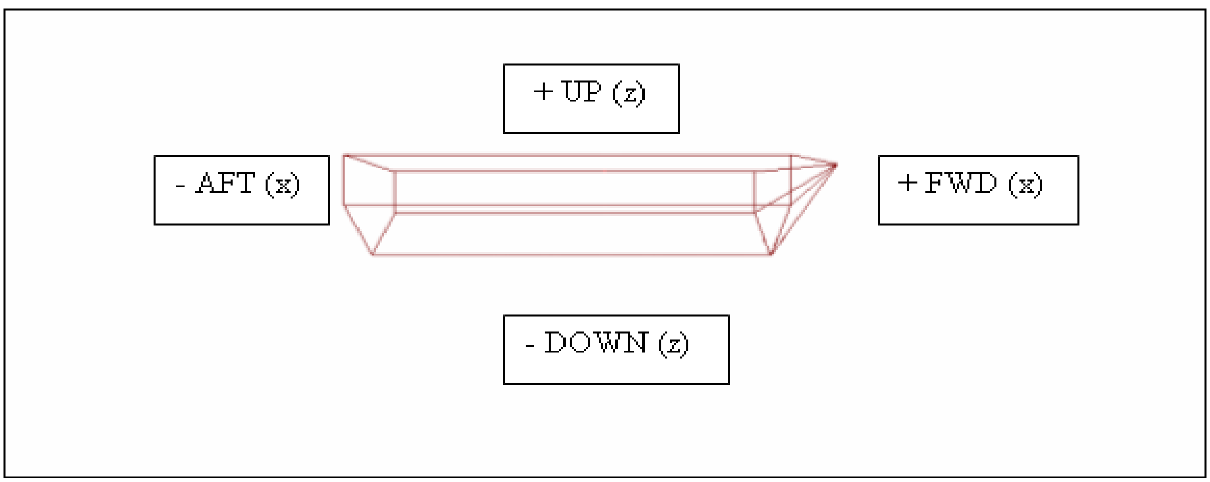
LCG stands for logitudinal center of gravity, which was assumed to be the location of the heave point for the launch.

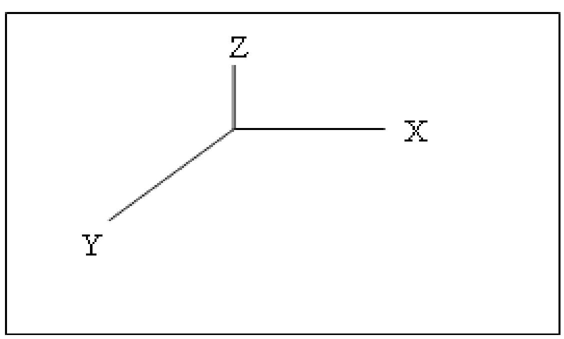
JMC refers to the Jensen Marine Consultants, Inc. report titled, "28' NOAA Survey Launch Stability Information Booklet," dated February 23, 2005*. There were several different values for the LCG in the JMC report, but the value used for these calculations was believed to be the most reasonable.

* There was some confusion as to which boat had the stability testing done to it. This was due to the report listing it as 1010, but the CO (CAPT John Lowell at the time) and Steve Currie both assert that the testing was done to 1018.

Theodolite Coordinate System

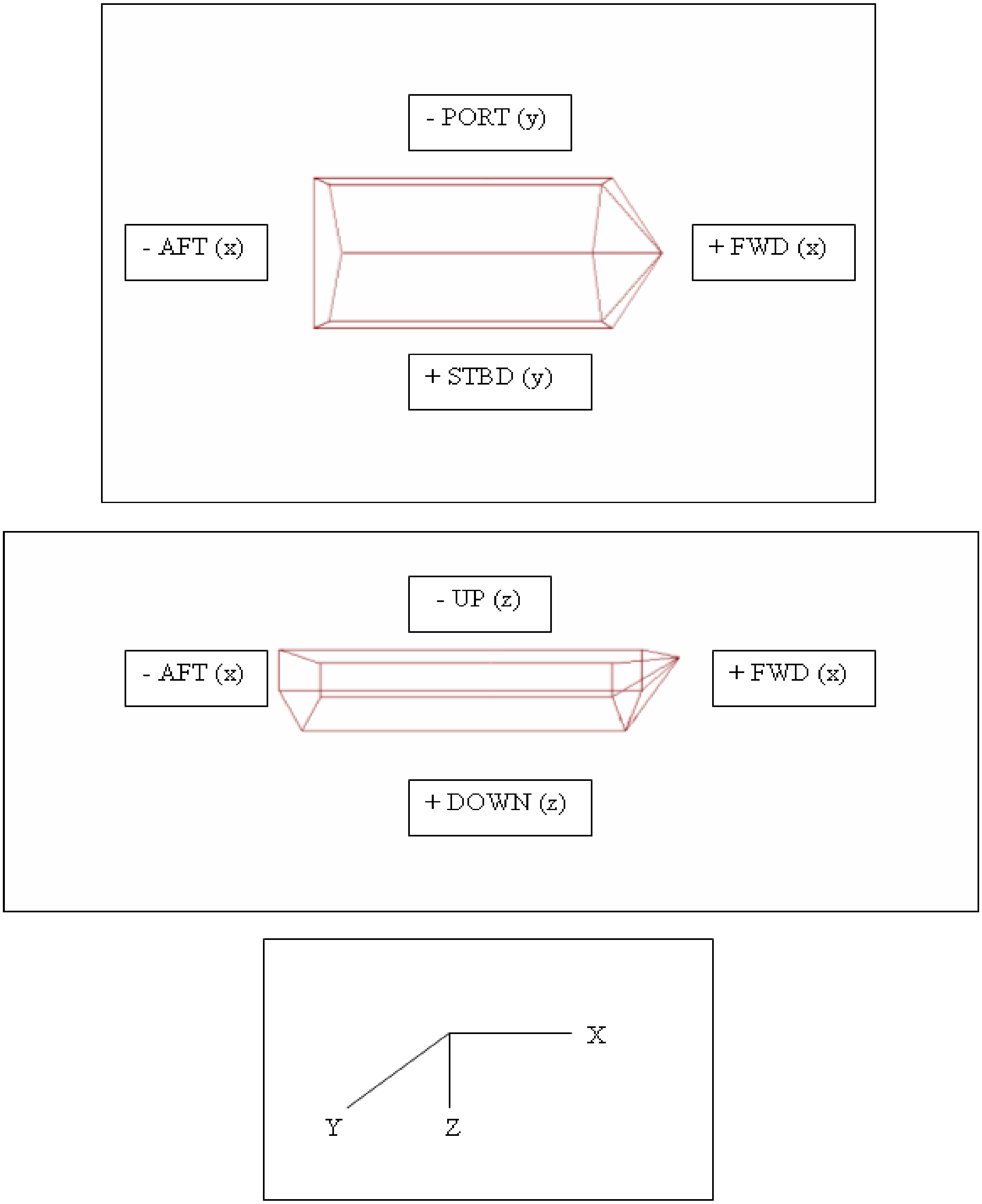






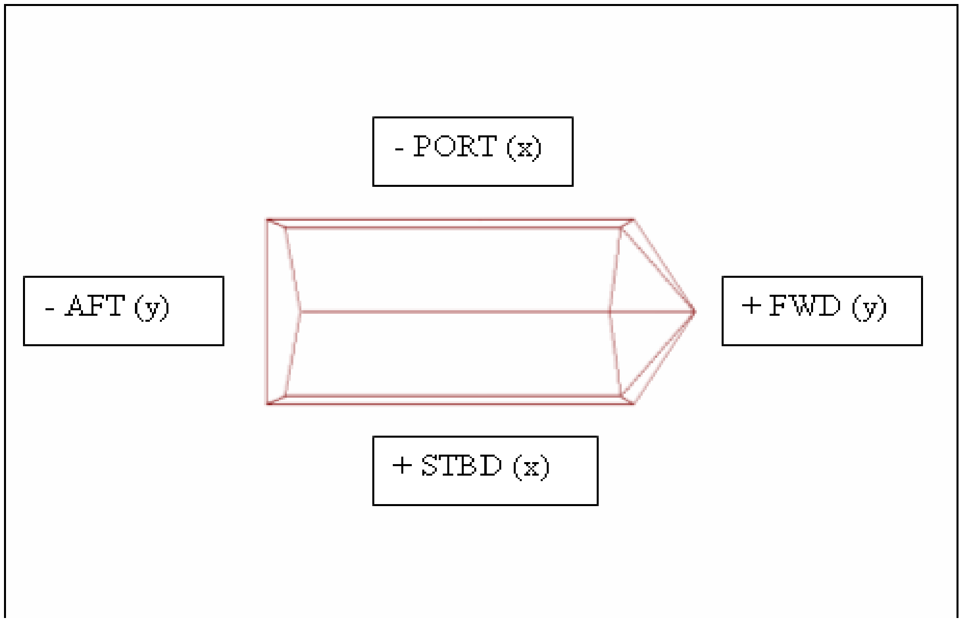
Benchmark C is the origin of the Theodolite Coordinate System

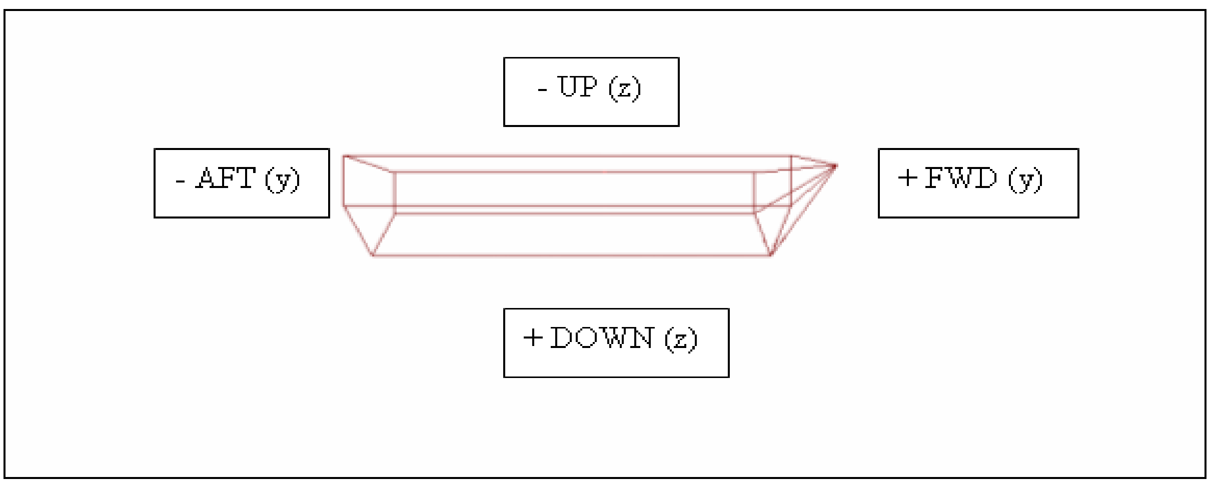
POS/MV Coordinate System

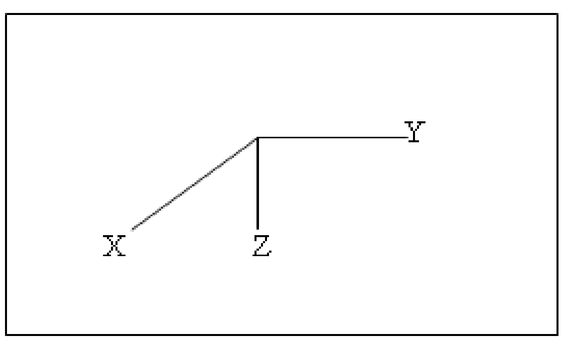


Top Center of IMU is origin of POS/MV Coordinate System

CARIS Coordinate System







Top Center of IMU is origin of CARIS Coordinate System

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 1010
Vessel

6/10/2008	162	Blank Inlet / Tongass Narrows
Date	Dn	Local Area

FA Personnel
Calibrating Hydrographer(s)

8101	Launch 1010	4/10/2006
MBES System	MBES System Location	Date of most recent EED/Factory Check

2701011	34497
Sonar Serial Number	Processing Unit Serial Number
Swing Arm Mount	4/15/2008
Sonar Mounting Configuration	Date of current offset measurement/verification
POSMV v4.0	6/9/2008
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

Date	6/10/2008
Dn	162
Local Area	Blank Inlet / Tongass Narrows
Wx	Sunny, northern wind, small waves
Bottom Type	
Approximate Water Depth	
Personnel on board	Evans, Morgan, Argento, Bucher
Comments	
TrueHeave filename	TH_1010_163.000

	Filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #1	08162131	21:31	55 16 55.85	131 39 14.43	30m	
SV Cast #2	081622344	23:44	55 19 48	131 37 38	35.4	
SV Cast #3						
SV Cast #4						

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
8162131	ROLL1.xtf	100	8.0	brief depth filter cutout at beginning (ncm)
	ROLL2.xtf	280	8.0	

PITCH

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
8162131	PITCH1	311	8.0	
	PITCH2	131	8.0	

HEADING/YAW

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
81622344	HEAD1	309	8.0	
	HEAD2	130	8.0	
	HEAD3	309	8.0	
	HEAD4	130	8.0	

NAV TIME LATENCY

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
81622344	LAT1.xtf	035	5.0	
	LAT2.xtf	035	9.0	

Processing Log

6/10/2008	162	Argento
Date	Dn	Personnel

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

☑ **TrueHeave applied** TH_1010_163.000

☑ **SVP applied** 1010_Patch_Dn162.svp

☑ **Tide applied** 9450460_1010_PatchTest.tid

Zone file ______

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

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

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Argento	0.00	0.10	1.45	0.54
Andrews	0.00	0.10		
Campbell	0.00		1.42	0.82
Johnston	0.00	0.10	1.44	0.49
Renoud	0.00	0.15	1.43	0.77
Averages	0.00	0.11	1.44	0.66
Standard Deviation	0.00	0.02	0.01	0.16
FINAL VALUES				

Final Values based on Argento, Andrews (minus roll and yaw), Campbell (except pitch), Johnston, Renoud

Resulting HVF File Name FA_1010_Reson_8101 (2008-162)

MRU Align StdDev gyro 0.16 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

Did not use Andrews roll value, it was an outlier of -0.33. Did not use Campbell's Pitch value; it was an outlier at -0.1.

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

Name: Bonnie Johnston **Date:** 6/14/2008

LAUNCH DDSSM DATA ACQUISITION FORM

Date 10-Jun-08
Vessel # 1010
Average Depth 26 m

DN 163
Location Blank Inlet/Tongass Narrows
Personnel Evans, Morgan, Aregnto, Bucher

Wind Northern
Seas small waves

RPM	Speed	Az	Isis Line Name	Acquisition Comments
0	5	255	DSSM1	Didn't use. Too far from other nadir beams and Idle line.
0	5.2	75	DSSM2	
0	7	255	DSSM3	
	7.4	75	DSSM4	
	8.8	255	DSSM5	
	8.8	255	DSSM6	
	9.1	75	DSSM7	
	11	255	DSSM8	
	11.5	75	DSSM9	
IDLE	IDLE		DSSM10	NOT A GOOD LINE. DOES NOT INTERSECT WITH OTHER LINES.
IDLE	IDLE		DSSM11	NOT A GOOD LINE. DOES NOT INTERSECT WITH OTHER LINES.
IDLE	IDLE		DSSM12	NOT A GOOD LINE. DOES NOT INTERSECT WITH OTHER LINES.
IDLE	IDLE		DSSM13	NOT A GOOD LINE. DOES NOT INTERSECT WITH OTHER LINES.
IDLE	IDLE		DSSM14	NOT A GOOD LINE. DOES NOT INTERSECT WITH OTHER LINES.

DDSSM DATA PROCESSING AND RESULTS FORM

Date 6/10/2008 DN 163 Wind
Vessel # 1010 Location Blank Inlet/Tongass Narrows Seas
Average Depth 26 m Personnel Argento, Johnston (DDSSM Values)

SVP file loaded 1010_Patch_Dn162.svp

Tide file loaded 9450460_1010_PatchTest.tid

Speed-Rest, values obtained by following FPM May 2008, incorrect

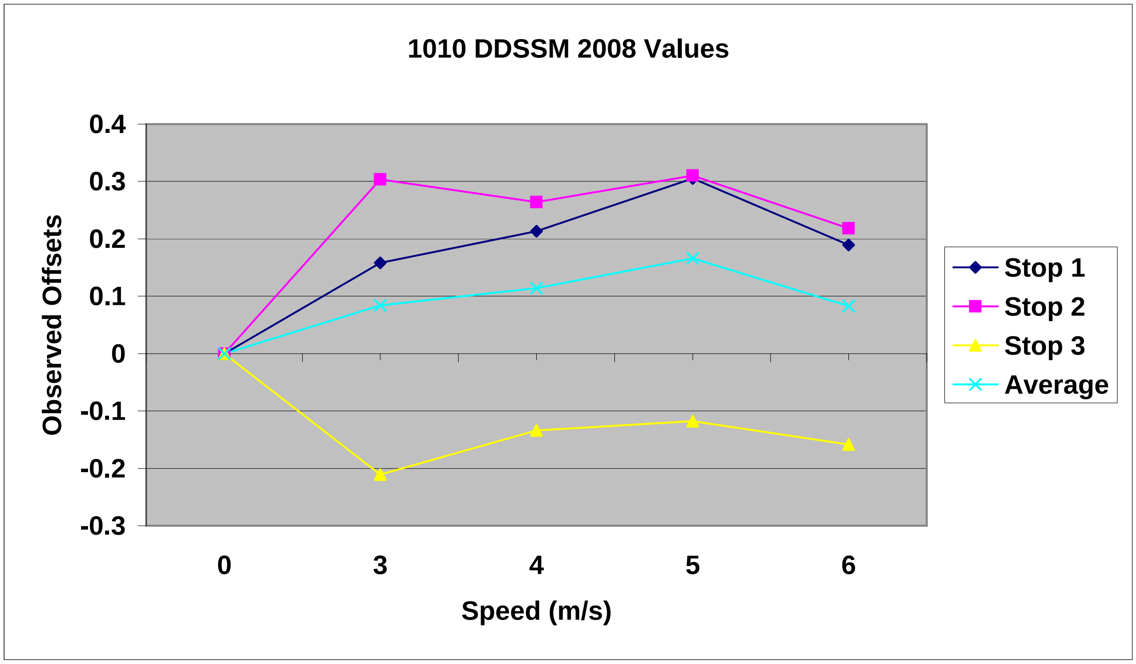
Speed	Isis Line Name	CARIS Line Name	Depth Loc 1	Diff Loc 1	Depth Loc 2	Diff Loc 2	Depth Loc 3	Diff Loc 3	Average
0	DSSM10, 11, 12	DSSM10, 11, 12	28.624125	0	31.6041875	0	21.2503333	0	0
5.2	DSSM2	DSSM2	28.46575	-0.158375	31.300625	-0.3035625	21.461	0.21066667	-0.0837569
7.4	DSSM4	DSSM4	28.411	-0.213125	31.3404	-0.2637875	21.3841818	0.13384848	-0.1143547
9.1	DSSM7	DSSM7	28.3187143	-0.305410714	31.29375	-0.3104375	21.3679231	0.11758974	-0.1660862
11.5	DSSM9	DSSM9	28.435	-0.189125	31.385875	-0.2183125	21.4088889	0.15855556	-0.0829606

Rest-Speed - Values used

Speed	Isis Line Name	CARIS Line Name	Depth Loc 1	Diff Loc 1	Depth Loc 2	Diff Loc 2	Depth Loc 3	Diff Loc 3	Average
0	DSSM10, 11, 12	DSSM10, 11, 12	28.624125	0	31.6041875	0	21.2503333	0	0
5.2	DSSM2	DSSM2	28.46575	0.158375	31.300625	0.3035625	21.461	-0.2106667	0.08375694
7.4	DSSM4	DSSM4	28.411	0.213125	31.3404	0.2637875	21.3841818	-0.1338485	0.11435467
9.1	DSSM7	DSSM7	28.3187143	0.305410714	31.29375	0.3104375	21.3679231	-0.1175897	0.16608616
11.5	DSSM9	DSSM9	28.435	0.189125	31.385875	0.2183125	21.4088889	-0.1585556	0.08296065

2008 1010 DDSSM Values used (Rest-Speed)

Speed (m/s)	Speed (knots)	Stop 1	Stop 2	Stop 3	Std. Dev.	Average
0.00	0	0	0	0	0	0.00
2.68	5.2	0.158	0.304	-0.211	0.265	0.08
3.81	7.4	0.213	0.264	-0.134	0.216	0.11
4.68	9.1	0.305	0.310	-0.118	0.246	0.17
5.92	11.5	0.189	0.218	-0.159	0.210	0.08



NOAA POS/MV Calibration Report

Ship: FAIRWEATHER

Vessel: 1010

Date: 6/9/2008

Dn: 162

Personnel: Argento, Evans, Bucher, Morgan

PCS Serial # 2564

IMU Serial # 294

IP Address: 129.100.1.231

POS controller Version (Use Menu Help > About) 3.4.0.0

POS Version (Use Menu View > Statistics) 320 V4

GPS Receivers

Primary Receiver S/N 60162863

Secondary Receiver S/N 60145247

Calibration area

Location: Tongass Narrows

Approximate Position:

Lat			
Lon			

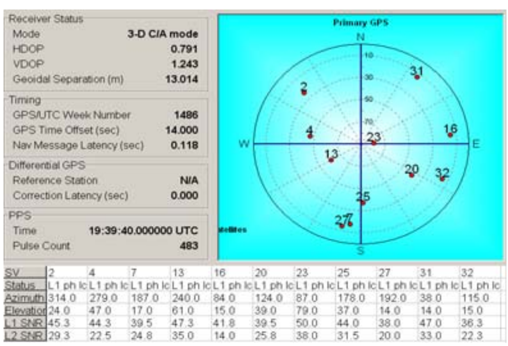
DGPS Beacon Station: Anette Island

Frequency: 323

Satellite Constellation

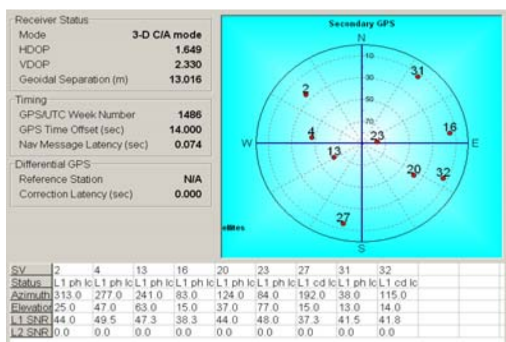
(Use View> GPS Data)

Primary GPS



SV	2	4	7	13	16	20	23	25	27	31	32
Status	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc
Azimuth	314.0	279.0	187.0	240.0	84.0	124.0	87.0	178.0	192.0	38.0	115.0
Elevation	24.0	47.0	17.0	61.0	15.0	39.0	79.0	37.0	14.0	14.0	15.0
L1 SNR	45.3	44.3	39.5	47.3	41.8	39.5	50.0	44.0	38.0	47.0	36.3
L2 SNR	29.3	22.5	24.8	35.0	14.0	25.8	38.0	31.5	20.0	33.0	22.3

Secondary GPS



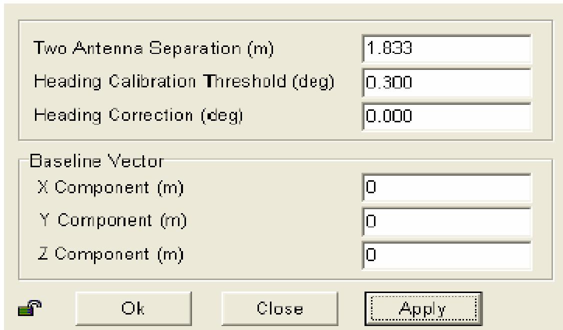
SV	2	4	13	16	20	23	27	31	32
Status	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 ph lc	L1 cd lc	L1 ph lc	L1 cd lc
Azimuth	313.0	277.0	241.0	83.0	124.0	84.0	192.0	38.0	115.0
Elevation	25.0	47.0	63.0	15.0	37.0	77.0	15.0	13.0	14.0
L1 SNR	44.0	49.5	47.3	38.3	44.0	48.0	37.3	41.5	41.8
L2 SNR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PDOP (Use View> GAMS Solution)

POS/MV Configuration

Settings

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



Configuration Notes: ______________________

____

POS/MV Calibration

Calibration Procedure:

(Refer to POS MV V3 Installation and Operation Guide, 4-25)

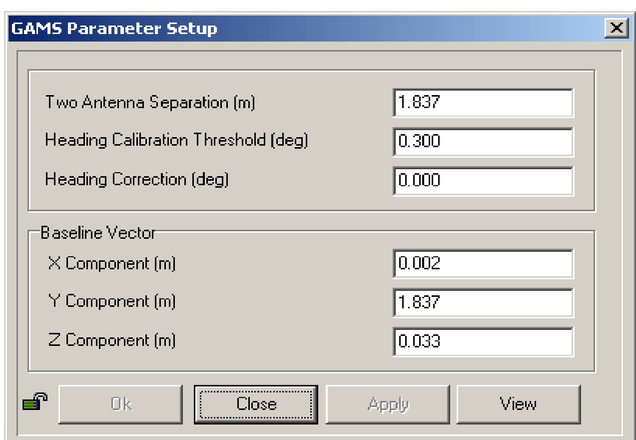
Start time: 9:12 AM

End time: 9:16 AM

Heading accuracy achieved for calibration: 0.295

Calibration Results:

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



Calibration Notes: ______________________

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

File Name: ______________________

General Notes:

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

The right-hand orthogonal system defines the following:

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

The POS/MV uses a Tate-Bryant Rotation Sequence

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

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

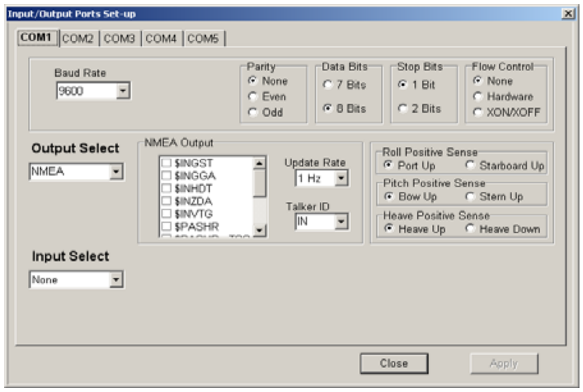
b) Pitch rotation - apply a right-hand screw rotation θy about the once-rotated y-axis to align one frame with the other.

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

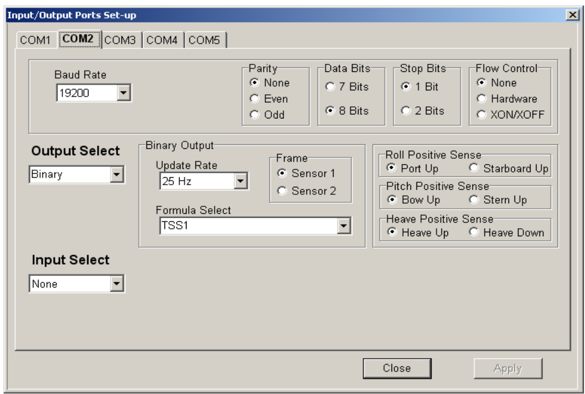
SETTINGS

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

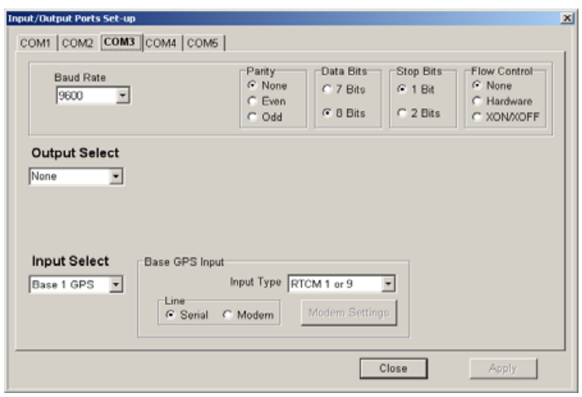
COM1



COM2

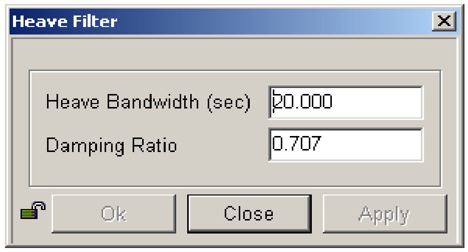


COM3

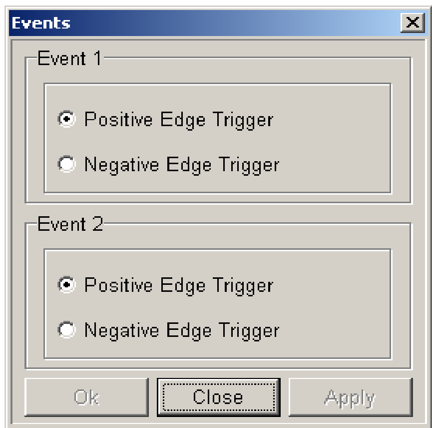


SETTINGS Continued

Heave Filter (Use Settings > Heave)

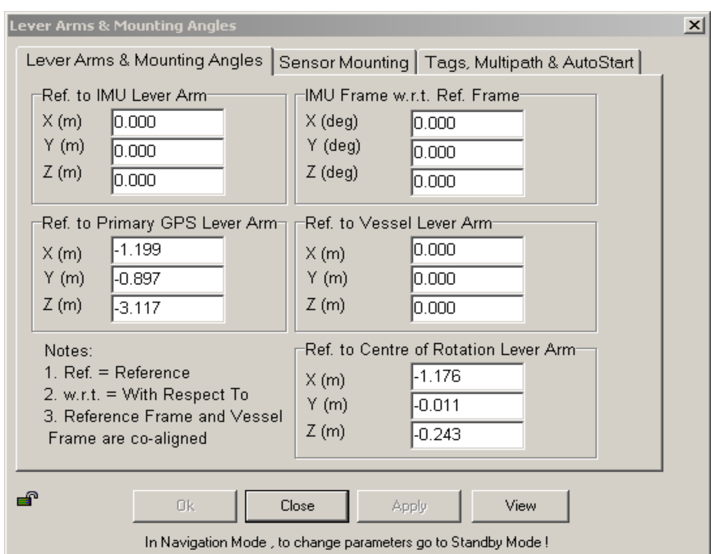


Events Use Settings > Events)

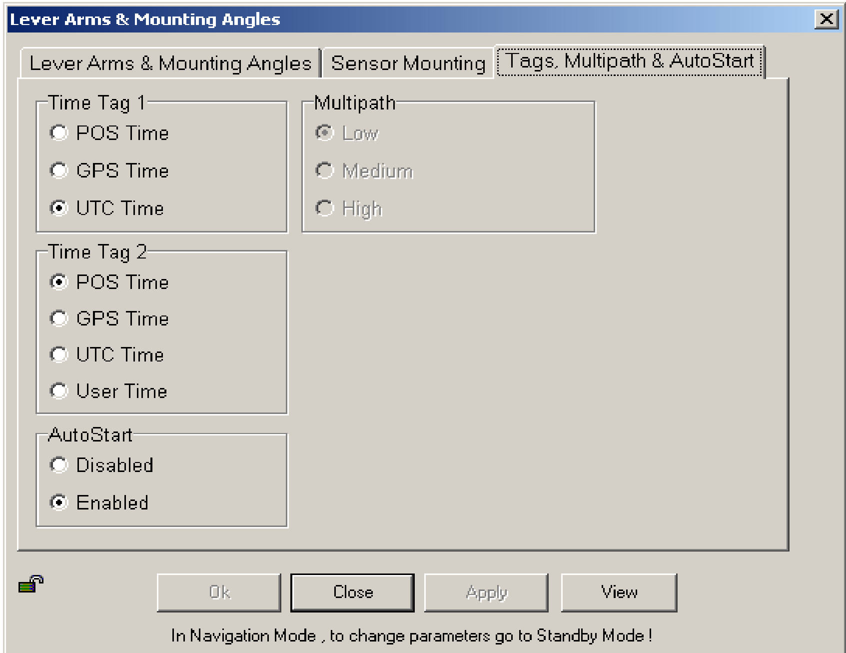


INSTALLATION (Use Settings > Installation)

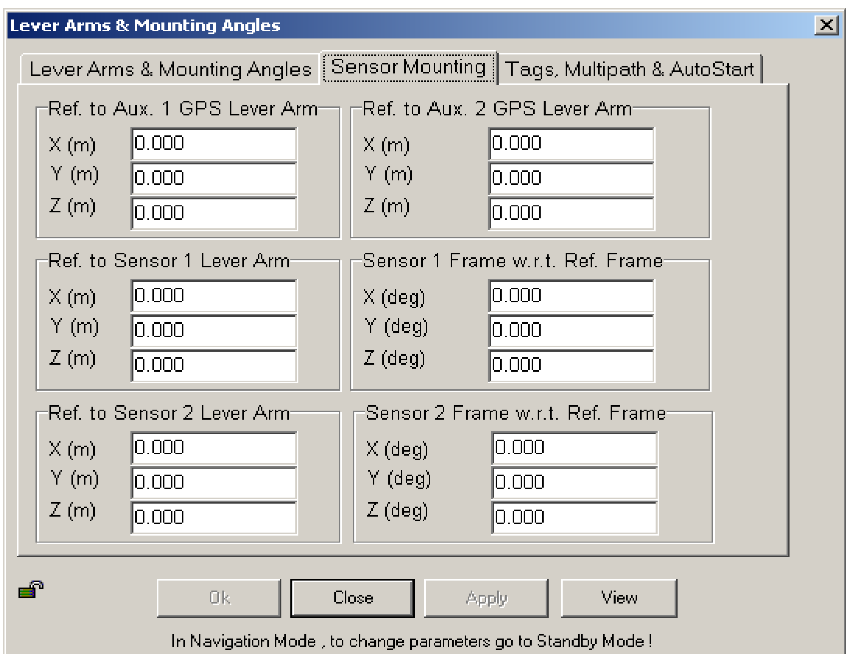
Lever Arms and Mounting Angles (Use Settings > Installation > Lever Arms and Offsets)



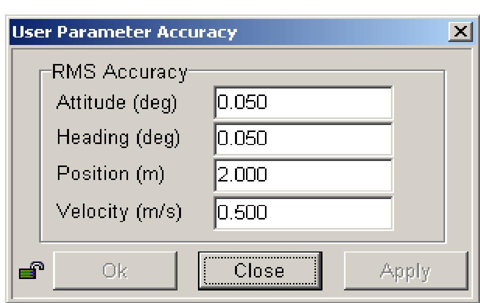
Tags, Multipath and Auto Start (Use Settings > Installation > Tags, Multipath and Auto Start)



Sensor Mounting (Use Settings > Installation > Sensor Mounting)



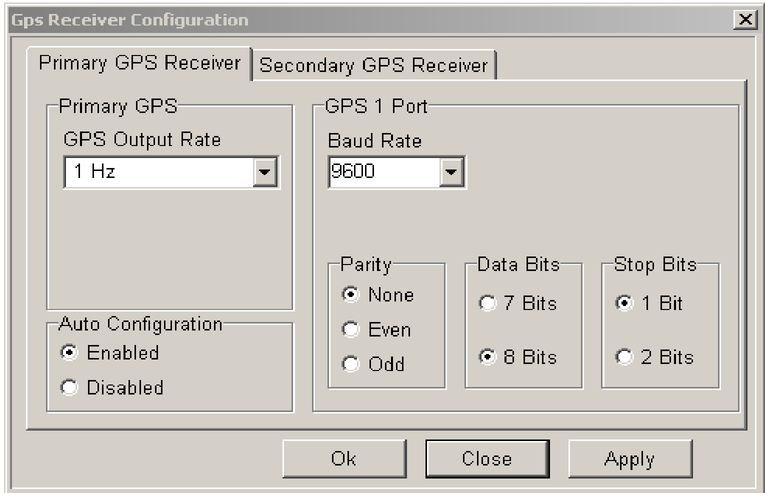
User Parameter Accuracy (Use Settings > Installation > User Accuracy)



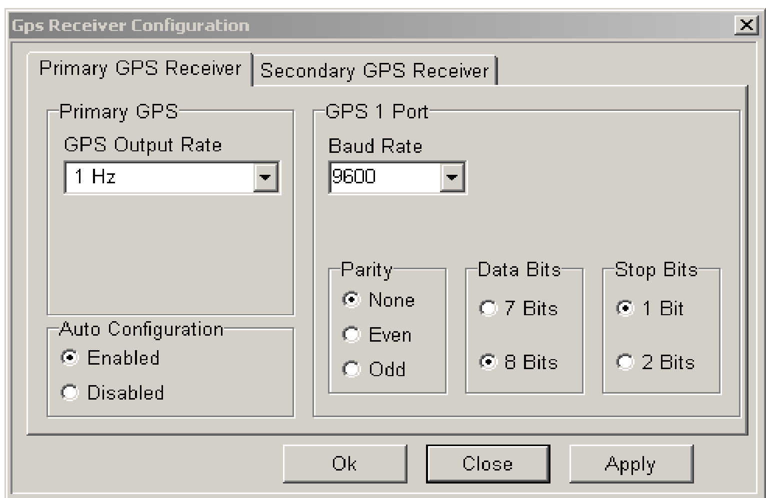
GPS Receiver Configuration

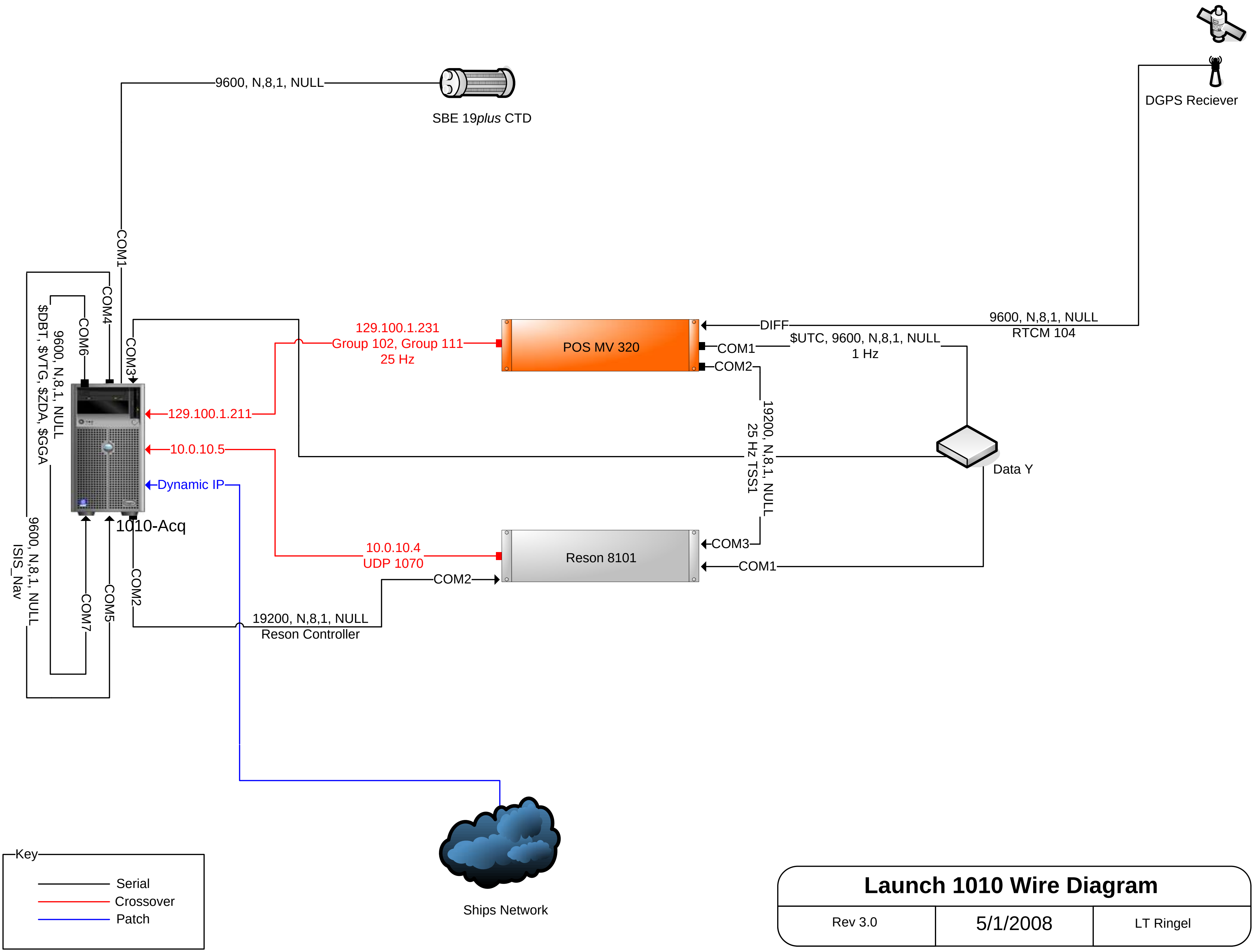
(Use Settings> Installation> GPS Receiver Configuration)

Primary GPS Receiver



Secondary GPS Receiver





9600, N,8,1, NULL
SBE 19*plus* CTD
DGPS Reciever
COM1
COM4
COM6
COM3
$DBT, $VTG, $ZDA, $GGA
9600, N,8,1, NULL
129.100.1.231
Group 102, Group 111
25 Hz
POS MV 320
DIFF
9600, N,8,1, NULL
RTCM 104
COM1
$UTC, 9600, N,8,1, NULL
1 Hz
COM2
129.100.1.211
10.0.10.5
Dynamic IP
19200, N,8,1, NULL
25 Hz TSS1
Data Y
1010-Acq
9600, N,8,1, NULL
ISIS_Nav
COM7
COM5
COM2
10.0.10.4
UDP 1070
Reson 8101
COM3
COM1
COM2
19200, N,8,1, NULL
Reson Controller
Ships Network
Key
Serial
Crossover
Patch
Launch 1010 Wire Diagram
Rev 3.0
5/1/2008
LT Ringel

Waterline Measurements - 2008

Measuring Party: Andrews, Argento, Wozumi

	1018	
	Benchmark A to Waterline	Benchmark B to Waterline
Measure 1	-85.5	-85.0
Measure 2	-84.8	-84.6
Measure 3	-85.0	-85.5
Avg (cm)	-85.10	-85.03
Avg (m)	-0.8510	-0.8503
Stdev	0.00361	0.00451
BM Z-value (m)	0.29933	0.27567
BM C to WL (m)	-0.552	-0.575

Individual measurement	-0.55567	-0.57433
	-0.54867	-0.57033
StDev for TPU xls (of 6 #'s) 0.013116	-0.55067	-0.57933

Date: 4/28/2008

Fuel Level: FULL

Draft Tube: N/A

Port-to-Stbd Z-difference

Theoretical	Actual	Error
0.0237	0.0007	-0.0230

BM C to WL Average (m)

-0.563 (Add this value to 1018_Offsets & Measurements_2008)

utilized in Offsets and Measurements and TPU spreadsheet

This spreadsheet is designed to compute the z-values of the phase centers of the new POS M/V antenna.

All offsets are in the Theodolite Coordinate System

BM E	x	1.825761
	y	-0.861405
	z	2.018667
BM F	x	1.826865
	y	-0.002043
	z	2.054333
BM G	x	1.828354
	y	0.918931
	z	1.998333

Port Ant	x	2.445325
	y	-0.913449
	z	Unknown
Stbd Ant	x	2.444676
	y	0.920569
	z	Unknown

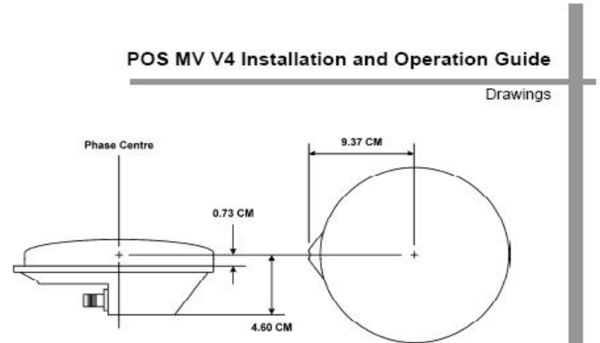


Figure 79: GPS Antenna Footprint

Measuring Party (**fill in yellow spaces only**):
Andrews, Breen, Rice

Date:
4/20/2008

Distances					z-Values Ant. Base	Phase Center	
Port Ant to BM 'E'	0.651	0.651	0.653	0.664417	2.252934	2.298934	
Port Ant to BM 'F'	1.109	1.106	1.108	1.120417	2.259711	2.305711	
Port Ant to BM 'G'	1.946	1.941	1.941	1.955417	2.290537	2.336537	
					2.256322	2.302322	AVERAGE
						0.020	STDEV
Stbd Ant to BM 'E'	1.883	1.882	1.885	1.896083	2.210097	2.256097	
Stbd Ant to BM 'F'	1.108	1.111	1.108	1.12175	2.213769	2.259769	
Stbd Ant to BM 'G'	0.64	0.644	0.648	0.65675	2.225193	2.271193	
					2.219481	2.265481	AVERAGE
						0.008	STDEV

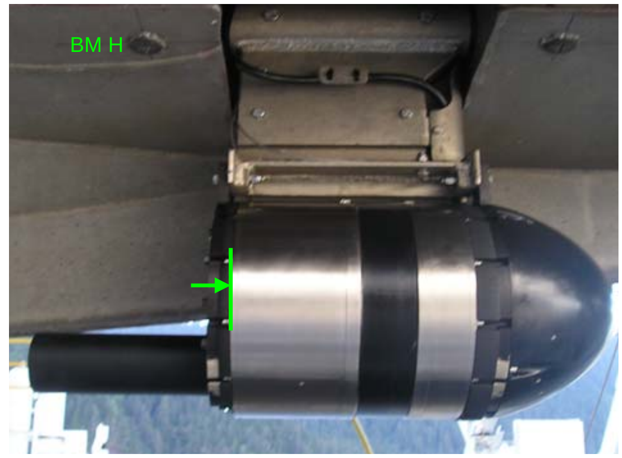
Antenna Post	Diameter	Radius
	0.0255	0.01275

The distances from the antenna post to each benchmark was measured three times and averaged. The post offset to phase center (radius) was then added.

The distance is 0.046m (4.60cm) from the bottom of the antenna to the Phase center, obtained from the POSM/V v4 guide, see image above.

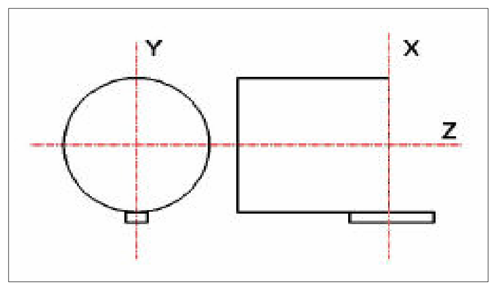
Offsets from Aft Benchmark to Phase Center of Transducer

Date	DN	Vessel	Personnel
4/1/2008	92	1018	Andrews, Breen, Campbell, Rice



Instructions: The purpose of this measurement is to check for gross movement of the tranducer.

While the boat is in the cradle, gently lower the transducer and lock it in place. Using a metric tape measure, plumb bob and carpenter's level, measure the horizontal and vertical offsets from the aft benchmark (BM H) to the phase center of the transducer. The phase center is measured at the forward edge of the black insulating layer, as shown in the photos. If you have trouble locating the center, borrow a compass from the navigation department.



Notwithstanding a major accident, BM H will be outboard, aft and higher than the phase center; as such, enter all offsets as positive numbers (in cm) and the proper signs will be applied.

Once offsets have been measured, apply a digital level to the IMU to determine any pitch or roll bias in the orientation of the launch. For the purposes of this spreadsheet, a positive angle (measured in degrees) will imply the bow is higher than the stern and the port side is higher than the starboard side.

All measurements should be done in triplicate to aid in the calculation of the uncertainty (needed in the HVF). The *IMU to Phase Center* values will be calculated automatically.

Offset Measurements (positive cm):				Average
Bow-Stern	9.6	10.0	10.0	9.9
Port-Stbd	14.3	14.6	14.9	14.6
Up-Down	37.0	36.5	36.4	36.6

Angle Bias (deg):	
Bow Up	0.0
Port Up	-2.8

The measuring crew should insure there will be no yaw bias.

BM H to Phase Center
(Theodolite Coordinate System)

x 9.867 cm

y -16.372 cm

z -35.876 cm

IMU to Phase Center (8101)
(CARIS Coordinate System)

x 0.282 m

y -0.145 m

z 0.548 m

Note: The traditional rotation matrices require a right-handed coordinate system. Thus, behind-the-scenes, all numbers have been converted to the POS M/V Coordinate system.

Rotation about x-axis

1	0	0
0	Cos(x-angle)	-Sin(x-angle)
0	Sin(x-angle)	Cos(x-angle)

Rotation about y-axis

Cos(y-angle)	0	Sin(y-angle)
0	1	0
-Sin(y-angle)	0	Cos(y-angle)

Rotation about z-axis

Cos(z-angle)	-Sin(z-angle)	0
Sin(z-angle)	Cos(z-angle)	0
0	0	1

BM 'H' to Phase Center (POS M/V Coordinate system)

Original vector

9.9
-14.6
36.6

Rotation angles

x-axis	2.8	Note: A positive angle will raise the port-side.
y-axis	0	Note: A positive angle will raise the bow.
z-axis	0	Note: The measuring crew should insure there will be no yaw bias.

Rotated about x-axis

9.867
-16.372
35.876

Rotated about y-axis

9.867
-16.372
35.876

Rotated about z-axis

9.867
-16.372
35.876

BM 'H' to Phase Center (POS M/V Coordinate system)

Newly rotated vector

9.87
-16.37
35.88

- Rotation around the *x*-axis is defined as:

$$\mathcal{R}_x(\theta_x) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_x & -\sin\theta_x \\ 0 & \sin\theta_x & \cos\theta_x \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -\theta_x \\ 0 & \theta_x & 0 \end{bmatrix}\right)$$

where θ_x is the *roll angle*.

- Rotation around the *y*-axis is defined as:

$$\mathcal{R}_y(\theta_y) = \begin{bmatrix} \cos\theta_y & 0 & \sin\theta_y \\ 0 & 1 & 0 \\ -\sin\theta_y & 0 & \cos\theta_y \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & 0 & \theta_y \\ 0 & 0 & 0 \\ -\theta_y & 0 & 0 \end{bmatrix}\right)$$

where θ_y is the *pitch angle*.

- Rotation about the *z*-axis is defined as:

$$\mathcal{R}_z(\theta_z) = \begin{bmatrix} \cos\theta_z & -\sin\theta_z & 0 \\ \sin\theta_z & \cos\theta_z & 0 \\ 0 & 0 & 1 \end{bmatrix} = \exp\left(\begin{bmatrix} 0 & -\theta_z & 0 \\ \theta_z & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}\right)$$

where θ_z is the *yaw angle*.

* - Valid for a right-handed (i.e. POS M/V) coordinate system
Angles are rotated clockwise when looking from the origin along the positive axis.

1018

	IMU	BM H	IMU to BM H
x	3.545867	3.302044	-0.243823
y	-0.01516	0.430807	0.445967
z	-0.85883	-1.0485	-0.18967

Using the XYZ positions of the IMU and BM H from the launch *Offsets & Measurements* form located in the DAPR appendix, the offset from the IMU to BM H could be calculated, as shown above. The measured offsets from BM H to the phase center of the transducer are divided by 100 to convert to meters, then added to the offset from the IMU to BM H. The result is the offset from the IMU to the phase center of the transducer. The values in the X and Y fields are transposed and the inverse of the Z value is used to give the offsets in CARIS coordinates.

IMU to PC = (IMU to BM H) + (BM H to PC/100)

1018 Offsets and Measurements
Summary

Measurement	IMU to RP*	8101 to RP*	IMU to 8101		Port Ant to 8101		RP* to Waterline	
aka			*SWATH1 x,y,z & MRU to Trans*		***Nav to Trans x,y,z***			
Coord. Sys.	Caris	Caris		Caris		Caris		Caris
x	0.000	0.282		0.282		1.181		n/a
y	0.000	-0.145		-0.145		0.955		n/a
z	0.000	0.548		0.548		3.710		-0.296

ghhg

*IMU is Reference Point

Vessel Offsets for 1018_8101 are derived from the Horizontal, Vertical & XYZ worksheets in this spreadsheet.

2008 Measured Value

Calculations

Coord. Sys. **Theodolite**

8101 to RP*	IMU to 8101			Port Ant to 8101			RP to Waterline		
	IMU (m)	x	3.54587	IMU (m)	x	3.545867	IMU (m)	x	3.546
		y	-0.01516		y	-0.01516		y	-0.015
		z	-0.85883		z	-0.85883		z	-0.859
	BM H	x	3.30204	Port Ant (m)	x	2.445	BM C	x	0.000
		y	0.43081		y	-0.913		y	0.000
		z	-1.0485		z	2.302		z	0.000
	IMU	x	-0.244	IMU to	x	-1.101	BM C to IMU		
	to BM H	y	0.446	Port Antenna	y	-0.898		x	n/a
		z	-0.190		z	3.161		y	n/a
								z	-0.859
	BM H to	x	9.867	IMU to	x	-0.145			
	Phase Ctr (cm)	y	-16.372	Phase Ctr	y	0.282	BM C to Waterline (m)		
	measured	z	-35.876		z	-0.548		z	-0.563
	BM H to	x	0.099						
	Phase Ctr (m)	y	-0.164						
		z	-0.359						

see

Coord. Sys. **Theodolite**

IMU to 8101	IMU to 8101			Port Ant to 8101			RP to Waterline		
	IMU to	x	-0.145		x	0.955		x	n/a
	Phase Ctr	y	0.282		y	1.181		y	n/a
		z	-0.548		z	-3.710		z	0.296
	Coord. Sys. CARIS			Coord. Sys. CARIS			Coord. Sys. CARIS		
		x	0.282		x	1.181		x	n/a
		y	-0.145		y	0.955		y	n/a
		z	0.548		z	3.710		z	-0.296

1018 Offsets and Measurements
Summary

Port Ant to Stbd Ant		IMU to Port Ant		IMU to Heave	
		Caris	Pos/Mv	Caris	Pos/Mv
Scaler Distance	1.834	-0.898	-1.101	0.015	-1.114
		-1.101	-0.898	-1.114	0.015
		-3.161	-3.161	-0.296	-0.296

Port Ant to Stbd Ant

Port Ant (m)	x	2.445
	y	-0.913
	z	2.302
Stbd Ant (m)	x	2.445
	y	0.921
	z	2.265

IMU to Port Ant

IMU (m)	x	3.546
	y	-0.015
	z	-0.859
Port Ant(m)	x	2.445
	y	-0.913
	z	2.302

IMU to Heave

IMU (m)	y	-0.015
x is n/a	z	-0.859
Heave Pt (m) (centerline)	y	0.000
BM C to Waterline (m) measured scalar dist		-0.563
BM C x&y are n/a	z	0.000
BM C to Waterline (m) (Heave Pt)	z	-0.563
IMU to Hv	x	-1.114

See IMU to Heave tab.

Port Ant to Stbd Ant

Scalar Distance 1.8344

IMU to Port Ant

x	-1.101
y	-0.898
z	3.161

Coord. Sys. Pos/Mv

x	-1.101
y	-0.898
z	-3.161

IMU to Heave

x	-1.114
y	0.015
z	0.296

Coord. Sys. Pos/Mv

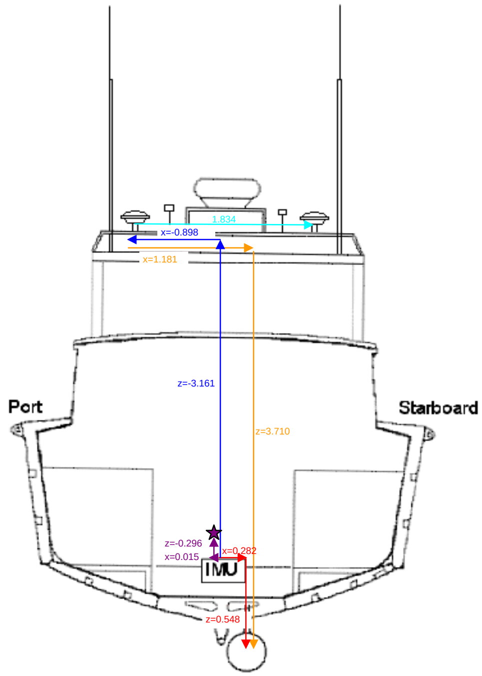
x	-1.114
y	0.015
z	-0.296

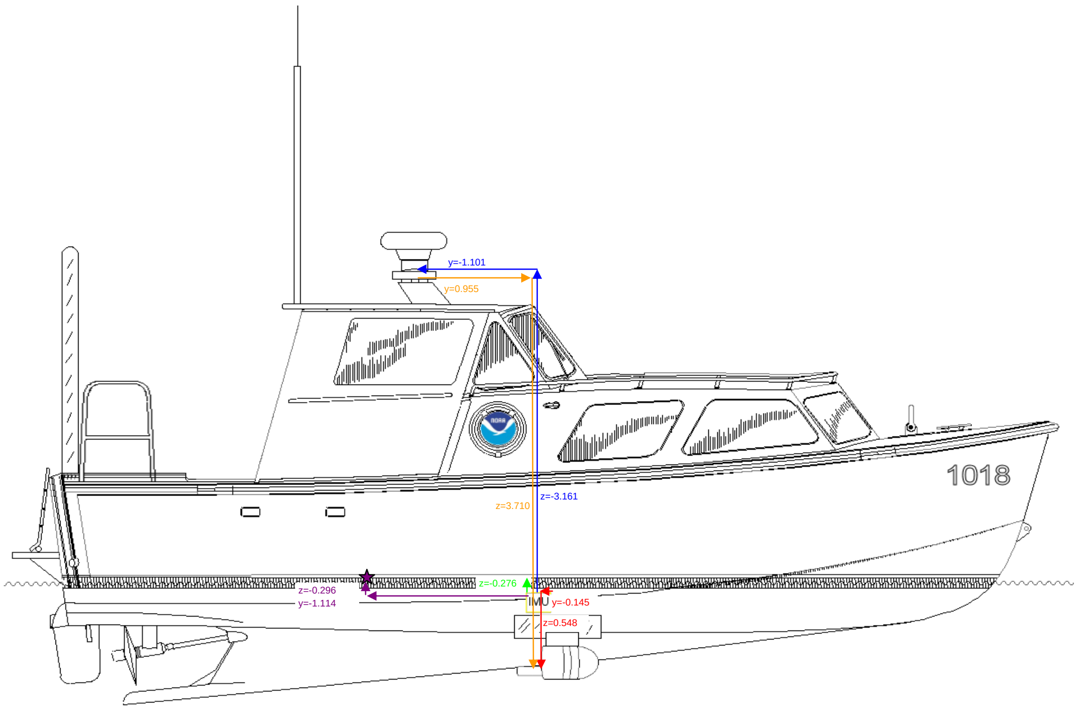
See IMU to Heave tab.

Description of Offsets for Launch 1018

All Values Shown are in CARIS Coordinates

The Ship Reference Frame (SRF) for Launch 1018 was based from benchmark (BM) C as the 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 8101		
x	y	z
0.282	-0.145	0.548

The physical positions of the IMU and the phase center of the 8101 with respect to the Ship Reference Frame were measured by NOAA personnel. These physical measurements were used to calculate the xyz offsets from the IMU to BM H. Measurements from BM H to the Phase Center of the 8101 were collected by NOAA personnel while the boat was secured on the pier and thought to be as level as possible. The measured offsets from BM H to the phase center were then added to the offset from the IMU to BM H. The result is the offset from the IMU to the phase center of the transducer. The values in the X and Y fields are transposed and the inverse of the Z value is used to give the offsets in CARIS coordinates.

Port Ant to 8101		
x	y	z
1.181	0.955	3.710

NOAA personnel calculated the distance between the port antenna and the phase center of the port antenna subtracting the IMU to Port Antenna value from the IMU to Phase Center value.

RP to Waterline		
x	y	z
N/A	N/A	-0.296

The average vertical distance from BM A and B to the waterline was measured by FAIRWEATHER personnel using a steel tape and bubble level. These values were used to calculate the BM C to the waterline value. With the knowledge of the BM C height above the IMU, the waterline height above the IMU could be calculated. On launch 1018, the IMU is used as the reference point.

Port Ant to Stbd Ant
Scalar Distance
1.834

The location of the phase center of the port and starboard POS/MV antennas were measured by NOAA personnel with respect to the SRF. The scalar distance between the phase centers was then calculated.

IMU to Port Antenna		
x	y	z
-0.898	-1.101	-3.161

The location of the IMU and the location of the port antenna were measured by NOAA personnel with respect to the Ship Reference Frame (SRF). The xyz offsets from the IMU to the port antenna could be calculated from these physical locations.

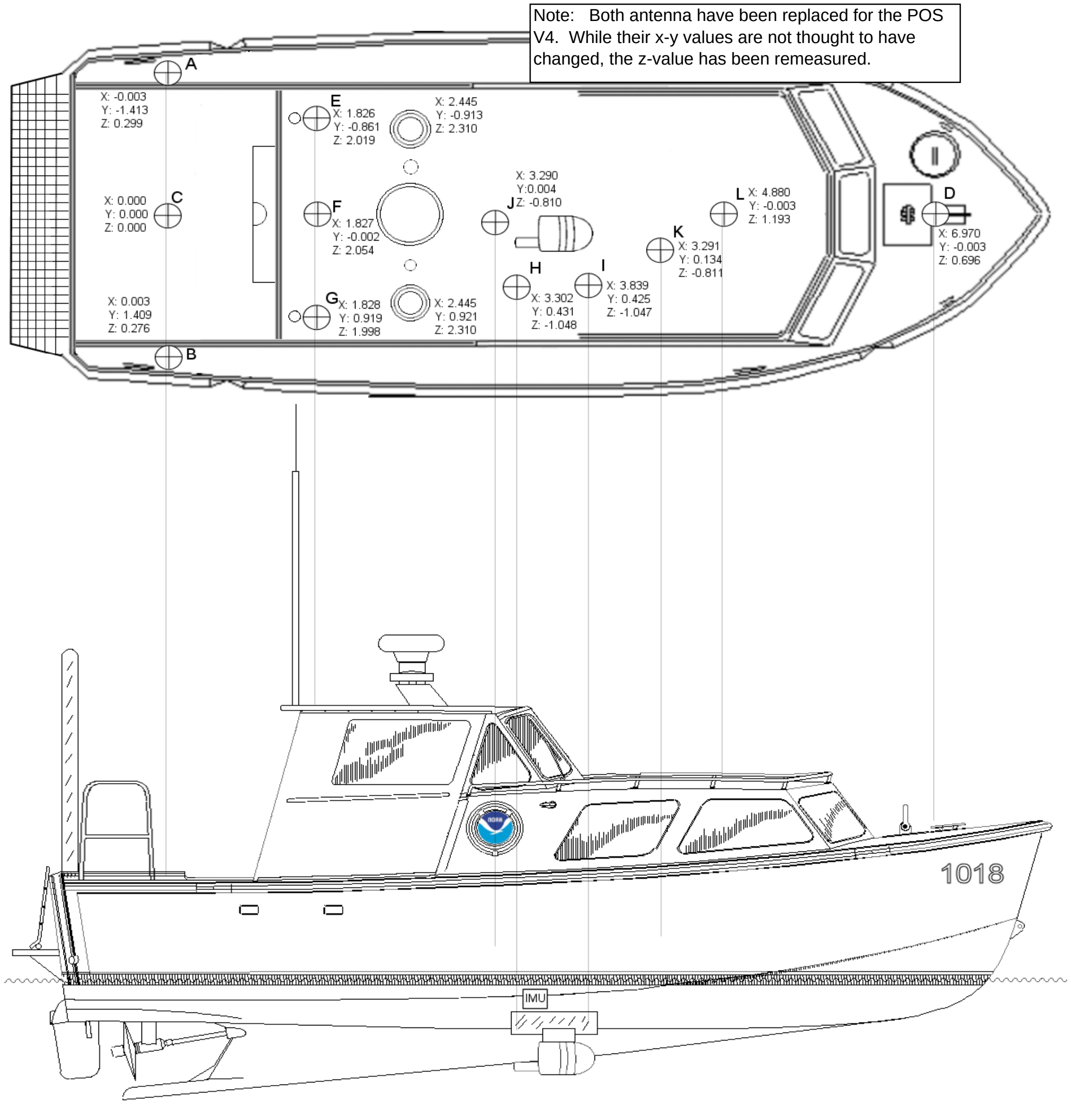
IMU to Heave		
x	y	z
0.015	-1.114	-0.296

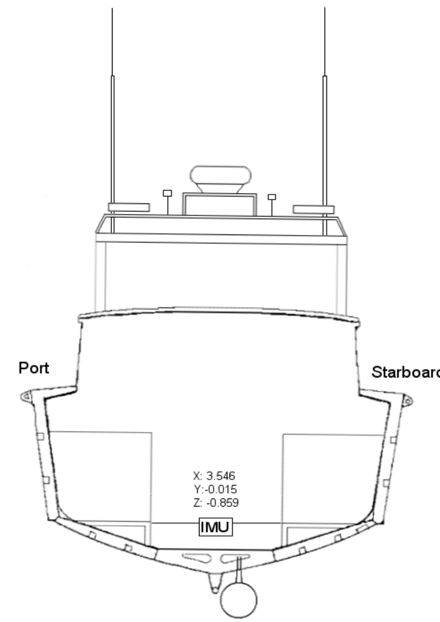
The heave point was positioned differently on each of the axes. The distance for the longitundinal axis was determined as described in the "IMU to Heave" tab in this workbook. The athwart ships axis was the vessel centerline. Lastly, the waterline was used as the height of the heave point, which was calculated earlier in 'RP to Waterline'.

1018 Vessel Diagram

All Values Shown are in Theodolite Coordinates

Note: Both antenna have been replaced for the POS V4. While their x-y values are not thought to have changed, the z-value has been remeasured.





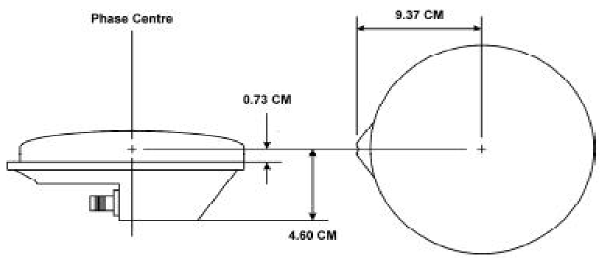


Figure 79: GPS Antenna Footprint

2.4.4 Sonar Head Acoustic Center

Figure 8 provides the acoustic center location (the intersection of lines Y-Z and X-Z) required for Vessel Reference Point (VRP) measurement. This is the point to which the offset measurements (in relation to the VRP) are made for the multi-beam system. Figure 8 illustrates a sonar head with a stick projector installed. For sonar heads equipped with an Extended Range (ER) projector, the acoustic center will be the same as shown in Figure 8 (the slight offset is compensated for in the system's software). See also paragraph 3.10.5.

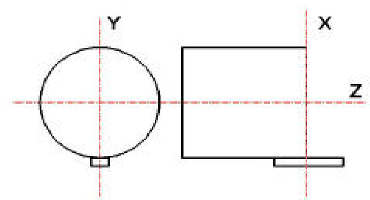


Figure 8, Sonar Head Acoustic Center

All offsets are in Theodolite Coordinate System

	BM C	BS	**BM A**	D	m	S	DD	dA	Hd	Vd	**BM A**	
X	0		HA	269	55	40	269.9278		1.412249	-1.000956	X	-0.0018
Y	0		VA	125	19	40	125.3278	-35.32778			Y	-1.4122
Z	0		SDx	1.731							Z	0.2940
			HI	1.385								
			HT	0.09								

	BM L	BS	**BM A**	D	m	S	DD	dA	Hd	Vd	**BM A**	
X	4.8802		HA	196	5	30	196.0917		5.084436	-0.720982	X	-0.0050
Y	-0.00318		VA	98	4	15	98.07083	-8.070833			Y	-1.4125
Z	1.192667		SDx	5.1353							Z	0.3037
			HI	1.431								
			HT	1.599								

	BM F	BS	**BM A**	D	m	S	DD	dA	Hd	Vd	**BM A**	
X	1.8269		HA	217	38	5	217.6347		2.310529	-1.824927	X	-0.0029
Y	-0.0020		VA	128	18	10	128.3028	-38.30278			Y	-1.4129
Z	2.0543		SDx	2.9443							Z	0.3004
			HI	1.673								
			HT	1.602								

	BM C	BS	**BM B**	D	m	S	DD	dA	Hd	Vd	**BM B**	
X	0		HA	90	6	50	90.11389		1.408507	-1.02162	X	-0.0028
Y	0		VA	125	57	15	125.9542	-35.95417			Y	1.4085
Z	0		SDx	1.74							Z	0.2734
			HI	1.385								
			HT	0.09								

	BM F	BS	**BM B**	D	m	S	DD	dA	Hd	Vd	**BM B**	
X	1.8269		HA	142	17	30	142.2917		2.30385	-1.847291	X	0.0042
Y	-0.0020		VA	128	43	25	128.7236	-38.72361			Y	1.4071
Z	2.0543		SDx	2.953							Z	0.2780
			HI	1.673								
			HT	1.602								

	BM L	BS	**BM B**	D	m	S	DD	dA	Hd	Vd	**BM B**	
X	4.8802		HA	163	48	50	163.8139		5.07525	-0.745425	X	0.0061
Y	-0.00318		VA	98	21	20	98.35556	-8.355556			Y	1.4116
Z	1.192667		SDx	5.1297							Z	0.2792
			HI	1.431								
			HT	1.599								

	BM D	BS	**BM C**	D	m	S	DD	dA	Hd	Vd	**BM C**		
X	6.970125		HA	180	0	0	180		6.971795	-0.940903	X	-0.0017	Modified D so C is 0
Y	-0.002655		VA	97	41	10	97.68611	-7.686111			Y	-0.0027	
Z	0.695667		SDx	7.035							Z	0.0108	
			HI	1.451									
			HT	1.195									

	BM F	BS	**BM C**	D	m	S	DD	dA	Hd	Vd	**BM C**		
X	1.8244		HA	180	4	0	180.0667		1.824376	-2.121032	X	0.0000	Modified F so C is 0
Y	0.0021		VA	139	18	0	139.3	-49.3			Y	0.0000	
Z	2.0500		SDx	2.7977							Z	0.0000	
			HI	1.673									
			HT	1.602									

		BS	**BM C**	D	m	S	DD	dA	Hd	Vd	**BM C**	
X	0		HA	0	0	0	0		0	0	X	0.0000
Y	0		VA	0	0	0	0	90			Y	0.0000
Z	0		SDx	0							Z	0.0000
			HI	0								
J			HT	0								

	BM C	BS	**BM D**	D	m	S	DD	dA	Hd	Vd	**BM D**	
X	0		HA	0	0	0	0		6.971868	0.503147	X	6.9719
Y	0		VA	85	52	20	85.87222	4.127778			Y	0.0000
Z	0		SDx	6.99							Z	0.6901
			HI	1.385								
			HT	1.198								

		BS	**BM D**	D	m	S	DD	dA	Hd	Vd	**BM D**		
X	0		HA	0	0	0	0		0	0	X	6.9718	
Y	0		VA	0	0	0	0	90			Y	0.0000	IN BM D BS BM C
Z	0		SDx	0							Z	0.6849	
			HI	0									
			HT	0									

	BM F	BS	**BM D**	D	m	S	DD	dA	Hd	Vd	**BM D**	
X	1.8269		HA	359	58	20	359.9722		5.142666	-1.428201	X	6.9695
Y	-0.0020		VA	105	31	15	105.5208	-15.52083			Y	-0.0045
Z	2.0543		SDx	5.3373							Z	0.6971
			HI	1.673								
			HT	1.602								

	BM L	BS	**BM D**	D	m	S	DD	dA	Hd	Vd	**BM D**	
X	4.8802		HA	359	59	50	359.9972		2.085613	-1.839614	X	6.9658
Y	-0.00318		VA	131	24	50	131.4139	-41.41389			Y	-0.0033
Z	1.192667		SDx	2.781							Z	0.7021
			HI	1.431								
			HT	0.082								

	BM C	BS	**BM E**	D	m	S	DD	dA	Hd	Vd	**BM E**	
X	0		HA	334	42	5	334.7014		2.016759	1.426038	X	1.8233
Y	0		VA	54	44	10	54.73611	35.26389			Y	-0.8618
Z	0		SDx	2.47							Z	2.0160
			HI	1.385								
			HT	0.795								

	BM D	BS	**BM E**	D	m	S	DD	dA	Hd	Vd	**BM E**	
X	6.970125		HA	189	28	15	189.4708		5.214703	0.66789	X	1.8265
Y	-0.002655		VA	82	42	5	82.70139	7.298611			Y	-0.8607
Z	0.695667		SDx	5.2573							Z	2.0166
			HI	1.451								
			HT	0.798								

	BM L	BS	**BM E**	D	m	S	DD	dA	Hd	Vd	**BM E**	
X	4.8802		HA	195	42	25	195.7069		3.171173	0.192337	X	1.8274
Y	-0.00318		VA	86	31	45	86.52917	3.470833			Y	-0.8617
Z	1.192667		SDx	3.177							Z	2.0220
			HI	1.431								
			HT	0.794								

	BM C	BS	**BM F**	D	m	S	DD	dA	Hd	Vd	**BM F**	
X	0		HA	359	48	40	359.8111		1.823512	1.461634	X	1.8235
Y	0		VA	51	17	10	51.28611	38.71389			Y	-0.0060
Z	0		SDx	2.337							Z	2.0516
			HI	1.385								
			HT	0.795								

	BM D	BS	**BM F**	D	m	S	DD	dA	Hd	Vd	**BM F**	
X	6.970125		HA	180	1	10	180.0194		5.139289	0.704122	X	1.8308
Y	-0.002655		VA	82	11	55	82.19861	7.801389			Y	-0.0044
Z	0.695667		SDx	5.1873							Z	2.0528
			HI	1.451								
			HT	0.798								

	BM L	BS	**BM F**	D	m	S	DD	dA	Hd	Vd	**BM F**	

X	4.8802		HA	179	56	15	179.9375		3.051481	0.228177	X	1.8287
Y	-0.00318		VA	85	43	25	85.72361	4.276389			Y	0.0001
Z	1.192667		SDx	3.06							Z	2.0578
			HI	1.431								
			HT	0.794								
	BM C	BS	**BM G**	D	m	S	DD	dA	Hd	Vd	**BM G**	
X	0		HA	26	44	30	26.74167		2.041987	1.405606	X	1.8236
Y	0		VA	55	27	30	55.45833	34.54167			Y	0.9188
Z	0		SDx	2.479							Z	1.9956
			HI	1.385								
			HT	0.795								
	BM D	BS	**BM G**	D	m	S	DD	dA	Hd	Vd	**BM G**	
X	6.970125		HA	169	49	30	169.825		5.221683	0.647696	X	1.8306
Y	-0.002655		VA	82	55	45	82.92917	7.070833			Y	0.9198
Z	0.695667		SDx	5.2617							Z	1.9964
			HI	1.451								
			HT	0.798								
	BM L	BS	**BM G**	D	m	S	DD	dA	Hd	Vd	**BM G**	
X	4.8802		HA	163	11	15	163.1875		3.185444	0.170427	X	1.8309
Y	-0.00318		VA	86	56	15	86.9375	3.0625			Y	0.9182
Z	1.192667		SDx	3.19							Z	2.0001
			HI	1.431								
			HT	0.794								
	TBM	BS	**BM H**	D	m	S	DD	dA	Hd	Vd	**BM H**	
X	10.0263		HA	179	55	15	179.9208		6.721906	0.035522	X	3.3044
Y	0.4245		VA	89	41	50	89.69722	0.302778			Y	0.4337
Z	-1.8654		SDx	6.722							Z	-1.0239
			HI	0.756								
			HT	-0.05								
	TBM	BS	**BM H**	D	m	S	DD	dA	Hd	Vd	**BM H**	
X	10.0263		HA	179	57	40	179.9611		6.726626	-0.031633	X	3.2996
Y	0.4245		VA	90	16	10	90.26944	-0.269444			Y	0.4290
Z	-1.8654		SDx	6.7267							Z	-1.0231
			HI	0.824								
			HT	-0.05								
	TBM	BS	**BM H**	D	m	S	DD	dA	Hd	Vd	**BM H**	
X	10.0263		HA	179	57	20	179.9556		6.724154	-0.044336	X	3.3021

Y	0.4245		VA	90	22	40	90.37778	-0.377778			Y	0.4297
Z	-1.8654		SDx	6.7243							Z	-1.0098
			HI	0.85								
			HT	-0.05								

	TBM	BS	**BM I**	D	m	S	DD	dA	Hd	Vd	**BM I**	
X	10.0263		HA	179	57	50	179.9639		6.189202	0.034807	X	3.8371
Y	0.4245		VA	89	40	40	89.67778	0.322222			Y	0.4284
Z	-1.8654		SDx	6.1893							Z	-1.0246
			HI	0.756								
			HT	-0.05								

	TBM	BS	**BM I**	D	m	S	DD	dA	Hd	Vd	**BM I**	
X	10.0263		HA	180	1	50	180.0306		6.186227	-0.030142	X	3.8400
Y	0.4245		VA	90	16	45	90.27917	-0.279167			Y	0.4212
Z	-1.8654		SDx	6.1863							Z	-1.0216
			HI	0.824								
			HT	-0.05								

	TBM	BS	**BM I**	D	m	S	DD	dA	Hd	Vd	**BM I**	
X	10.0263		HA	180	0	0	180		6.187145	-0.043795	X	3.8391
Y	0.4245		VA	90	24	20	90.40556	-0.405556			Y	0.4245
Z	-1.8654		SDx	6.1873							Z	-1.0092
			HI	0.85								
			HT	-0.05								

	BM C	BS	**BM J**	D	m	S	DD	dA	Hd	Vd	**BM J**	
X	0		HA	0	5	40	0.094444		3.28806	-0.990463	X	3.2881
Y	0		VA	106	45	50	106.7639	-16.76389			Y	0.0054
Z	0		SDx	3.434							Z	-0.8005
			HI	1.385								
			HT	1.195								

	BM C	BS	**BM J**	D	m	S	DD	dA	Hd	Vd	**BM J**	
X	0		HA	0	3	45	0.0625		3.291776	-0.936134	X	3.2918
Y	0		VA	105	52	30	105.875	-15.875			Y	0.0036
Z	0		SDx	3.4223							Z	-0.7991
			HI	1.372								
			HT	1.235								

	BM C	BS	**BM J**	D	m	S	DD	dA	Hd	Vd	**BM J**	
X	0		HA	0	2	15	0.0375		3.291552	-0.928486	X	3.2916
Y	0		VA	105	45	10	105.7528	-15.75278			Y	0.0022

Z	0		SDx	3.42							Z	-0.8065
			HI	1.36								
			HT	1.238								
	BM C	BS	**BM K**	D	m	S	DD	dA	Hd	Vd	**BM K**	
X	0		HA	2	19	25	2.323611		3.293853	-0.992034	X	3.2911
Y	0		VA	106	45	40	106.7611	-16.76111			Y	0.1335
Z	0		SDx	3.44							Z	-0.8020
			HI	1.385								
			HT	1.195								
	BM C	BS	**BM K**	D	m	S	DD	dA	Hd	Vd	**BM K**	
X	0		HA	2	19	55	2.331944		3.294948	-0.938504	X	3.2922
Y	0		VA	105	53	55	105.8986	-15.89861			Y	0.1341
Z	0		SDx	3.426							Z	-0.8015
			HI	1.372								
			HT	1.235								
	BM C	BS	**BM K**	D	m	S	DD	dA	Hd	Vd	**BM K**	
X	0		HA	2	21	0	2.35		3.293653	-0.92951	X	3.2909
Y	0		VA	105	45	35	105.7597	-15.75972			Y	0.1351
Z	0		SDx	3.4223							Z	-0.8075
			HI	1.36								
			HT	1.238								
	BM C	BS	**BM L**	D	m	S	DD	dA	Hd	Vd	**BM L**	
X	0		HA	359	58	35	359.9764		4.884186	-0.13311	X	4.8842
Y	0		VA	91	33	40	91.56111	-1.561111			Y	-0.0020
Z	0		SDx	4.886							Z	1.1899
			HI	1.385								
			HT	0.062								
	BM D	BS	**BM L**	D	m	S	DD	dA	Hd	Vd	**BM L**	
X	6.970125		HA	180	2	45	180.0458		2.089829	0.115163	X	4.8803
Y	-0.002655		VA	86	50	45	86.84583	3.154167			Y	-0.0043
Z	0.695667		SDx	2.093							Z	1.1938
			HI	1.451								
			HT	1.068								
	BM F	BS	**BM L**	D	m	S	DD	dA	Hd	Vd	**BM L**	
X	1.8269		HA	0	3	10	0.052778		3.052617	-0.926082	X	4.8795
Y	-0.0020		VA	106	52	35	106.8764	-16.87639			Y	0.0008
Z	2.0543		SDx	3.19							Z	1.1993

			HI	1.673								
			HT	1.602								
	BM D	BS	**PORT ANT**	D	m	S	DD	dA	Hd	Vd	**PORT ANT**	
X	0		HA	339	28	10	339.4694		2.610523	1.726867	X	2.4447
Y	0		VA	56	30	55	56.51528	33.48472			Y	-0.9155
Z	0		SDx	3.13							Z	2.3219
			HI	1.385								
			HT	0.79								
	BM D	BS	**PORT ANT**	D	m	S	DD	dA	Hd	Vd	**PORT ANT**	
X	6.970125		HA	191	21	30	191.3583		4.613315	0.970543	X	2.4472
Y	-0.002655		VA	78	7	10	78.11944	11.88056			Y	-0.9112
Z	0.695667		SDx	4.7143							Z	2.3222
			HI	1.451								
			HT	0.795								
	BM L	BS	**PORT ANT**	D	m	S	DD	dA	Hd	Vd	**PORT ANT**	
X	4.8802		HA	200	29	30	200.4917		2.600669	-0.216924	X	2.4441
Y	-0.00318		VA	94	46	5	94.76806	-4.768056			Y	-0.9136
Z	1.192667		SDx	2.6097							Z	2.3247
			HI	1.431								
			HT	0.082								
	BM C	BS	**STBD ANT**	D	m	S	DD	dA	Hd	Vd	**STBD ANT**	
X	0		HA	20	41	20	20.68889		2.60875	1.709557	X	2.4405
Y	0		VA	56	45	45	56.7625	33.2375			Y	0.9217
Z	0		SDx	3.119							Z	2.3046
			HI	1.385								
			HT	0.79								
	BM D	BS	**STBD ANT**	D	m	S	DD	dA	Hd	Vd	**STBD ANT**	
X	6.970125		HA	168	29	0	168.4833		4.617073	0.951015	X	2.4460
Y	-0.002655		VA	78	21	40	78.36111	11.63889			Y	0.9192
Z	0.695667		SDx	4.714							Z	2.3027
			HI	1.451								
			HT	0.795								
	BM L	BS	**STBD ANT**	D	m	S	DD	dA	Hd	Vd	**STBD ANT**	
X	4.884186		HA	159	15	20	159.2556		2.605607	-0.236301	X	2.4475
Y	-0.002013		VA	95	10	55	95.18194	-5.181944			Y	0.9209
Z	1.18989		SDx	2.6163							Z	2.3026
			HI	1.431								

			HT	0.082								
	BM H	BS	**PHASE CENT**	D	m	S	DIRECT MEASUREMENT				**PHASE CENT**	
X	3.302044		HA	N/A	N/A	N/A	0.08				X	3.3820
Y	0.430807		VA	N/A	N/A	N/A	-0.143				Y	0.2878
Z	-1.0485		SDx	N/A			-0.36				Z	-1.4085
			HI	N/A								
			HT	N/A								
	BM H	BS	**PHASE CENT**	D	m	S	DIRECT MEASUREMENT				**PHASE CENT**	
X	3.302044		HA	N/A	N/A	N/A	0.08				X	3.3820
Y	0.430807		VA	N/A	N/A	N/A	-0.145				Y	0.2858
Z	-1.0485		SDx	N/A			-0.36				Z	-1.4085
			HI	N/A								
			HT	N/A								
	BM H	BS	**PHASE CENT**	D	m	S	DIRECT MEASUREMENT				**PHASE CENT**	
X	3.302044		HA	N/A	N/A	N/A	0.08				X	3.3820
Y	0.430807		VA	N/A	N/A	N/A	-0.143				Y	0.2878
Z	-1.0485		SDx	N/A			-0.36				Z	-1.4085
			HI	N/A								
			HT	N/A								
	BM C	BS	**IMU**	D	m	S	DD	dA	Hd	Vd	**IMU**	
X	0		HA	359	45	30	359.7583		3.545118	-1.038158	X	3.5451
Y	0		VA	106	19	20	106.3222	-16.32222			Y	-0.0150
Z	0		SDx	3.694							Z	-0.8482
			HI	1.385								
			HT	1.195								
	BM C	BS	**IMU**	D	m	S	DD	dA	Hd	Vd	**IMU**	
X	0		HA	359	45	55	359.7653		3.5471	-0.98379	X	3.5471
Y	0		VA	105	30	5	105.5014	-15.50139			Y	-0.0145
Z	0		SDx	3.681							Z	-0.8468
			HI	1.372								
			HT	1.235								
	BM C	BS	**IMU**	D	m	S	DD	dA	Hd	Vd	**IMU**	
X	0		HA	359	44	30	359.7417		3.545481	-0.975756	X	3.5454
Y	0		VA	105	23	15	105.3875	-15.3875			Y	-0.0160
Z	0		SDx	3.6773							Z	-0.8538
			HI	1.36								
			HT	1.238								

	BM D	BS	**TBM**	D	m	S	DD	dA	Hd	Vd	**TBM**	
X	6.970125		HA	7	55	30	7.925		3.082642	-2.405777	X	10.0233
Y	-0.002655		VA	127	58	10	127.9694	-37.96944			Y	0.4224
Z	0.695667		SDx	3.9103							Z	-1.8641
			HI	1.451								
			HT	1.605								
	BM L	BS	**TBM**	D	m	S	DD	dA	Hd	Vd	**TBM**	
X	4.8802		HA	4	45	40	4.761111		5.161378	-2.88509	X	10.0238
Y	-0.00318		VA	119	12	15	119.2042	-29.20417			Y	0.4252
Z	1.192667		SDx	5.913							Z	-1.8664
			HI	1.431								
			HT	1.605								
	BM F	BS	**TBM**	D	m	S	DD	dA	Hd	Vd	**TBM**	
X	1.8269		HA	2	59	5	2.984722		8.215994	-4.000061	X	10.0317
Y	-0.0020		VA	115	57	35	115.9597	-25.95972			Y	0.4258
Z	2.0543		SDx	9.138							Z	-1.8657
			HI	1.673								
			HT	1.593								

All offsets are in Theodolite Coordinate System

		FR							
SETUP 1									
BS	**BM C**		FS		**BM A**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.704		2.680667	Top	2.409		2.383		
Mid	2.681	0.023		Mid	2.383	0.026			
Bot	2.657	0.024		Bot	2.357	0.026			
		DTI				DTI			
		1				0			
	BM C	HI	Rod	BM A					
	0	2.680667	2.383	0.297667					
SETUP 2									
BS	**BM C**		FS		**BM A**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.708		2.684667	Top	2.409		2.383667		
Mid	2.685	0.023		Mid	2.384	0.025			
Bot	2.661	0.024		Bot	2.358	0.026			
		DTI				DTI			
		1				1			
	BM C	HI	Rod	BM A			**BM A AVE**	**0.299333**	
	0	2.684667	2.383667	0.301			mm DIFF	-3.33333	
SETUP 1									
BS	**BM C**		FS		**BM B**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.704		2.680667	Top	2.431		2.406333		
Mid	2.681	0.023		Mid	2.406	0.025			
Bot	2.657	0.024		Bot	2.382	0.024			
		DTI				DTI			
		1				1			
	BM C	HI	Rod	BM B					
	0	2.680667	2.406333	0.274333					
SETUP 2									
BS	**BM C**		FS		**BM B**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.708		2.684667	Top	2.432		2.407667		
Mid	2.685	0.023		Mid	2.408	0.024			
Bot	2.661	0.024		Bot	2.383	0.025			
		DTI				DTI			
		1				1			
	BM C	HI	Rod	BM B			**BM B AVE**	**0.275667**	
	0	2.684667	2.407667	0.277			mm DIFF	-2.66667	
SETUP 1									
BS	**BM C**		FS		**BM C**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.704		2.680667	Top	2.409		2.383		
Mid	2.681	0.023		Mid	2.383	0.026			
Bot	2.657	0.024		Bot	2.357	0.026			
		DTI				DTI			
		1				0			
	BM C	HI	Rod	BM C					
	0	2.680667	2.383	0.297667					
SETUP 2									
BS	**BM C**		FS		**BM C**				0 BY DEFINITION
		TI	Ave (HI)			TI	Ave BM El		
Top	2.708		2.684667	Top	2.409		2.383667		

Mid	2.685	0.023		Mid	2.384	0.025		
Bot	2.661	0.024		Bot	2.358	0.026		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	BM C				
	0	2.684667	2.383667	0.301			mm DIFF	-0.00333
SETUP 1								
BS	**BM C**		FS		**BM D**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	1.997		1.986667	
Mid	2.681	0.023		Mid	1.986	0.011		
Bot	2.657	0.024		Bot	1.977	0.009		
		DTI				DTI		
		1				2	??	
	BM C	HI	Rod	BM D				
	0	2.680667	1.986667	0.694				
SETUP 2								
BS	**BM C**		FS		**BM D**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	1.997		1.987333	
Mid	2.685	0.023		Mid	1.987	0.01		
Bot	2.661	0.024		Bot	1.978	0.009		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	BM D			**BM D AVE**	**0.695667**
	0	2.684667	1.987333	0.697333			mm DIFF	-3.33333
SETUP 1								
BS	**BM C**		FS		**BM E**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	0.68		0.664333	
Mid	2.681	0.023		Mid	0.664	0.016		
Bot	2.657	0.024		Bot	0.649	0.015		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	BM E				
	0	2.680667	0.664333	2.016333				
SETUP 2								
BS	**BM C**		FS		**BM E**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	0.679		0.663667	
Mid	2.685	0.023		Mid	0.663	0.016		
Bot	2.661	0.024		Bot	0.649	0.014		
		DTI				DTI		
		1				2		
	BM C	HI	Rod	BM E			**BM E AVE**	**2.018667**
	0	2.684667	0.663667	2.021			mm DIFF	-4.66667
SETUP 1								
BS	**BM C**		FS		**BM F**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	0.643		0.628	
Mid	2.681	0.023		Mid	0.628	0.015		
Bot	2.657	0.024		Bot	0.613	0.015		
		DTI				DTI		
		1				0		
	BM C	HI	Rod	BM F				

	0	2.680667	0.628	2.052667				
SETUP 2								
BS	**BM C**		FS		**BM F**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	0.643		0.628667	
Mid	2.685	0.023		Mid	0.629	0.014		
Bot	2.661	0.024		Bot	0.614	0.015		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	BM F			**BM F AVE**	**2.054333**
	0	2.684667	0.628667	2.056			mm DIFF	-3.33333
SETUP 1								
BS	**BM C**		FS		**BM G**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	0.699		0.684	
Mid	2.681	0.023		Mid	0.684	0.015		
Bot	2.657	0.024		Bot	0.669	0.015		
		DTI				DTI		
		1				1.11E-13		
	BM C	HI	Rod	BM G				
	0	2.680667	0.684	1.996667				
SETUP 2								
BS	**BM C**		FS		**BM G**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	0.699		0.684667	
Mid	2.685	0.023		Mid	0.685	0.014		
Bot	2.661	0.024		Bot	0.67	0.015		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	BM G			**BM G AVE**	**1.998333**
	0	2.684667	0.684667	2			mm DIFF	-3.33333
SETUP 5								
BS	**TBM**		FS		**BM H**			
		TI	Ave (HI)			TI	Ave BM El	
Top	0.506		0.492	Top	-0.058		-0.07233	
Mid	0.492	0.014		Mid	-0.072	0.014		
Bot	0.478	0.014		Bot	-0.087	0.015		
		DTI				DTI		
		0				1		
	TBM	HI	Rod	BM H				
	-1.61267	0.492	-0.07233	-1.04833				
SETUP 6								
BS	**TBM**		FS		**BM H**			
		TI	Ave (HI)			TI	Ave BM El	
Top	0.403		0.418	Top	-0.131		-0.146	
Mid	0.418	-0.015		Mid	-0.146	0.015		
Bot	0.433	-0.015		Bot	-0.161	0.015		
		DTI				DTI		
		5.55E-14				2.78E-14		
	TBM	HI	Rod	BM H			**BM H AVE**	**-1.0485**
	-1.61267	0.418	-0.146	-1.04867			mm DIFF	0.333333
SETUP 5								
BS	**TBM**		FS		**BM I**			
		TI	Ave (HI)			TI	Ave BM El	
Top	0.506		0.492	Top	-0.06		-0.07367	

Mid	0.492	0.014		Mid	-0.074	0.014		
Bot	0.478	0.014		Bot	-0.087	0.013		
		DTI				DTI		
		0				1		
	TBM	HI	Rod	BM I				
	-1.61267	0.492	-0.07367	-1.047				
SETUP 6								
BS	**TBM**		FS		**BM I**			
		TI	Ave (HI)			TI	Ave BM El	
Top	0.403		0.418	Top	-0.134		-0.14733	
Mid	0.418	-0.015		Mid	-0.147	0.013		
Bot	0.433	-0.015		Bot	-0.161	0.014		
		DTI				DTI		
		5.55E-14				1		
	TBM	HI	Rod	BM I			**BM I AVE**	**-1.04717**
	-1.61267	0.418	-0.14733	-1.04733			mm DIFF	0.333333
SETUP 7								
BS	**BM C**		FS		**BM J**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.068		1.06	Top	1.88		1.871	
Mid	1.06	0.008		Mid	1.871	0.009		
Bot	1.052	0.008		Bot	1.862	0.009		
		DTI				DTI		
		0				0		
	BM C	HI	Rod	BM J				
	0	1.06	1.871	-0.811				
SETUP 8								
BS	**BM C**		FS		**BM J**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.058		1.049	Top	1.865		1.857333	
Mid	1.049	0.009		Mid	1.857	0.008		
Bot	1.04	0.009		Bot	1.85	0.007		
		DTI				DTI		
		2.22E-13				1		
	BM C	HI	Rod	BM J			**BM J AVE**	**-0.80967**
	0	1.049	1.857333	-0.80833			mm DIFF	-2.66667
SETUP 7								
BS	**BM C**		FS		**BM K**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.068		1.06	Top	1.88		1.871	
Mid	1.06	0.008		Mid	1.871	0.009		
Bot	1.052	0.008		Bot	1.862	0.009		
		DTI				DTI		
		0				0		
	BM C	HI	Rod	BM K				
	0	1.06	1.871	-0.811				
SETUP 8								
BS	**BM C**		FS		**BM K**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.058		1.049	Top	1.868		1.859667	
Mid	1.049	0.009		Mid	1.86	0.008		
Bot	1.04	0.009		Bot	1.851	0.009		
		DTI				DTI		
		2.22E-13				1		
	BM C	HI	Rod	BM K			**BM K AVE**	**-0.81083**
	0	1.049	1.859667	-0.81067			mm DIFF	-0.33333

SETUP 3								
BS	**BM C**		FS		**BM L**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.852		1.817333	Top	0.633		0.623667	
Mid	1.818	0.034		Mid	0.624	0.009		
Bot	1.782	0.036		Bot	0.614	0.01		
		DTI				DTI		
		2				1		
	BM C	HI	Rod	BM L				
	0	1.817333	0.623667	1.193667				
SETUP 4								
BS	**BM C**		FS		**BM L**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.851		1.817	Top	0.635		0.625333	
Mid	1.817	0.034		Mid	0.625	0.01		
Bot	1.783	0.034		Bot	0.616	0.009		
		DTI				DTI		
		0				1		
	BM C	HI	Rod	BM L			**BM L AVE**	**1.192667**
	0	1.817	0.625333	1.191667			mm DIFF	2
SETUP 1								
BS	**BM C**		FS		**P ANT**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	0.377		0.364	
Mid	2.681	0.023		Mid	0.364	0.013		
Bot	2.657	0.024		Bot	0.351	0.013		
		DTI				DTI		
		1				0		
	BM C	HI	Rod	P ANT				
	0	2.680667	0.364	2.316667				
SETUP 2								
BS	**BM C**		FS		**P ANT**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	0.394		0.382	
Mid	2.685	0.023		Mid	0.382	0.012		
Bot	2.661	0.024		Bot	0.37	0.012		
		DTI				DTI		
		1				0		
	BM C	HI	Rod	P ANT			**P ANT AVI**	**2.309667**
	0	2.684667	0.382	2.302667			mm DIFF	14
SETUP 1								
BS	**BM C**		FS		**S ANT**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.704		2.680667	Top	0.394		0.381667	
Mid	2.681	0.023		Mid	0.382	0.012		
Bot	2.657	0.024		Bot	0.369	0.013		
		DTI				DTI		
		1				1		
	BM C	HI	Rod	S ANT				
	0	2.680667	0.381667	2.299				
SETUP 2								
BS	**BM C**		FS		**S ANT**			
		TI	Ave (HI)			TI	Ave BM El	
Top	2.708		2.684667	Top	0.376		0.363333	
Mid	2.685	0.023		Mid	0.363	0.013		

Bot	2.661	0.024		Bot	0.351	0.012			
		DTI				DTI			
		1				1			
	BM C	HI	Rod	S ANT			**S ANT AVI**	**2.310167**	
	0	2.684667	0.363333	2.321333			mm DIFF	-22.3333	
SETUP 7									
BS	**BM C**		FS		**IMU**				
		TI	Ave (HI)			TI	Ave BM El		
Top	1.068		1.06	Top	1.928		1.918		
Mid	1.06	0.008		Mid	1.918	0.01			
Bot	1.052	0.008		Bot	1.908	0.01			
		DTI				DTI			
		0				0			
	BM C	HI	Rod	IMU					
	0	1.06	1.918	-0.858					
SETUP 8									
BS	**BM C**		FS		**IMU**				
		TI	Ave (HI)			TI	Ave BM El		
Top	1.058		1.049	Top	1.918		1.908667		
Mid	1.049	0.009		Mid	1.909	0.009			
Bot	1.04	0.009		Bot	1.899	0.01			
		DTI				DTI			
		2.22E-13				1			
	BM C	HI	Rod	IMU			**IMU AVE**	**-0.85883**	
	0	1.049	1.908667	-0.85967			mm DIFF	1.666667	
SETUP 1									
BS	**BM C**		FS		**PC**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.704		2.680667	Top	2.409		2.383		
Mid	2.681	0.023		Mid	2.383	0.026			
Bot	2.657	0.024		Bot	2.357	0.026			
		DTI				DTI			
		1				0			
	BM C	HI	Rod	PC					
	0	2.680667	2.383	0.297667					MEASURED
SETUP 2									
BS	**BM C**		FS		**PC**				
		TI	Ave (HI)			TI	Ave BM El		
Top	2.708		2.684667	Top	2.409		2.383667		
Mid	2.685	0.023		Mid	2.384	0.025			
Bot	2.661	0.024		Bot	2.358	0.026			
		DTI				DTI			
		1				1			
	BM C	HI	Rod	PC			**PC AVE**	**0.299333**	
	0	2.684667	2.383667	0.301			mm DIFF	-3.33333	
SETUP 3									
BS	**BM C**		FS		**TEMP BM**				
		TI	Ave (HI)			TI	Ave BM El		
Top	1.852		1.817333	Top	3.448		3.429667		
Mid	1.818	0.034		Mid	3.429	0.019			
Bot	1.782	0.036		Bot	3.412	0.017			
		DTI				DTI			
		2				2			
	BM C	HI	Rod	TEMP BM					
	0	1.817333	3.429667	-1.61233					

SETUP 4								
BS	**BM C**		FS		**TEMP BM**			
		TI	Ave (HI)			TI	Ave BM El	
Top	1.851		1.817	Top	3.449		3.43	
Mid	1.817	0.034		Mid	3.43	0.019		
Bot	1.783	0.034		Bot	3.411	0.019		
		DTI				DTI		
		0				4.44E-13		
	BM C	HI	Rod	TEMP BM			**TEMP BM**	**-1.61267**
	0	1.817	3.43	-1.613			mm DIFF	0.666667

1018 Launch Offset Measurements

Jul-04

All offsets are in Theodolite Coordinate System

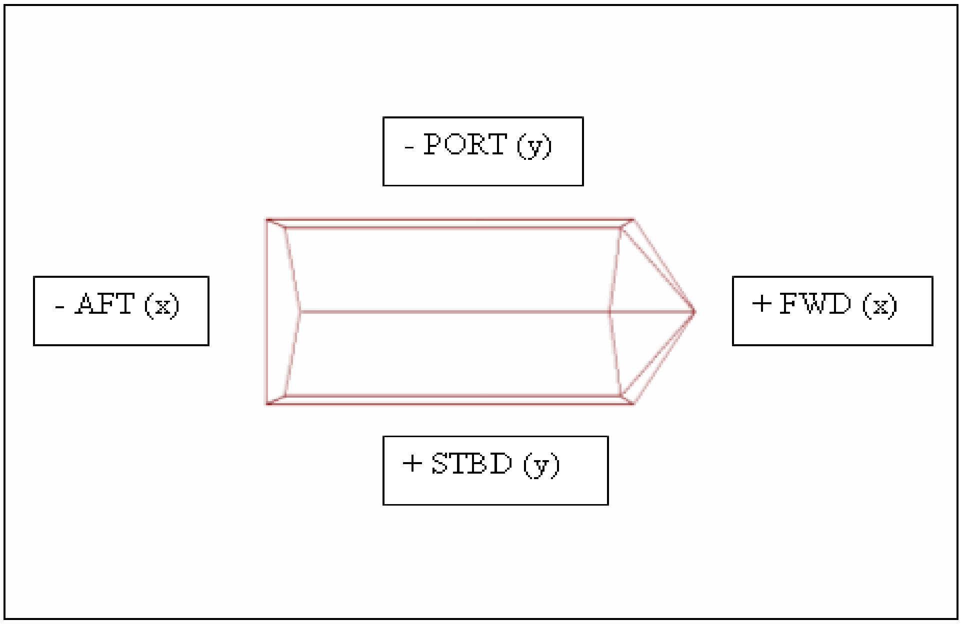
The Z plane means were taken using only the vertical level measurements.

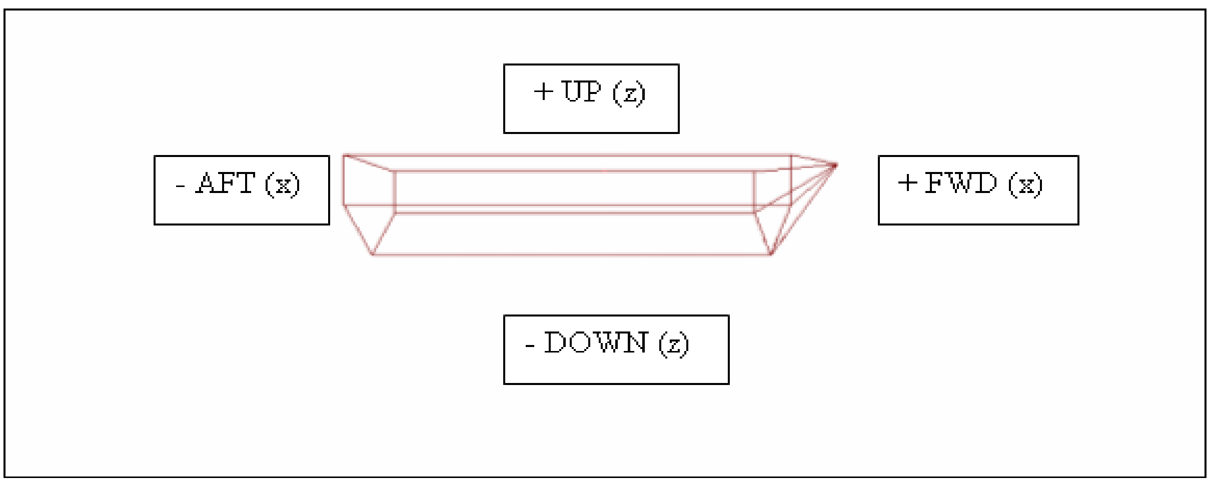
BM A									
X	-0.00178	-0.00503	-0.00289			**Mean**	-0.00323	0.001649	⇐ X Std Dev
Y	-1.41225	-1.41246	-1.41291				-1.41254	0.000338	⇐ Y Std Dev
Z	0.294044	0.303685	0.300406	0.299333			0.299333		
BM B									
X	-0.0028	0.00421	0.006127			**Mean**	0.002512	0.004699	⇐ X Std Dev
Y	1.408504	1.407088	1.411589				1.40906	0.002301	⇐ Y Std Dev
Z	0.27338	0.278042	0.279241	0.275667			0.275667		
BM C									
X	**0**		**By Definition**						
Y	**0**								
Z	**0**								
BM D									
X	6.971868	6.971768	6.9671	6.9698		**Mean**	6.970125	0.002251	⇐ X Std Dev
Y	0	0	-0.0085	-0.0021			-0.00265	0.004025	⇐ Y Std Dev
Z	0.690147	0.684947	0.6944	0.6993	0.695667		0.695667		
BM E									
X	1.823338	1.826502	1.827443			**Mean**	1.825761	0.002151	⇐ X Std Dev
Y	-0.86183	-0.86071	-0.86167				-0.8614	0.000607	⇐ Y Std Dev
Z	2.016038	2.016557	2.022004	2.018667			2.018667		
BM F									
X	1.823502	1.830837	1.828721	1.824402		**Mean**	1.826865	0.003493	⇐ X Std Dev
Y	-0.00601	-0.0044	0.000149	0.002088			-0.00204	0.003794	⇐ Y Std Dev
Z	2.051634	2.052789	2.057844	2.050034	2.054333		2.054333		
BM G									
X	1.823585	1.830565	1.830913			**Mean**	1.828354	0.004134	⇐ X Std Dev
Y	0.91883	0.919783	0.91818				0.918931	0.000806	⇐ Y Std Dev
Z	1.995606	1.996363	2.000093	1.998333			1.998333		
BM H									
X	3.30437	3.299646	3.302118			**Mean**	3.302044	0.002363	⇐ X Std Dev
Y	0.433739	0.429017	0.429667				0.430807	0.002559	⇐ Y Std Dev
Z	-1.0239	-1.02305	-1.00976	-1.0485			-1.0485		
BM I									
X	3.8371	3.840044	3.839125			**Mean**	3.838746	0.001523	⇐ X Std Dev
Y	0.4284	0.421152	0.424451				0.424652	0.003604	⇐ Y Std Dev
Z	-1.0246	-1.02156	-1.00922	-1.04717			-1.04717		
BM J									
X	3.288056	3.291774	3.291551			**Mean**	3.29046	0.002086	⇐ X Std Dev
Y	0.00542	0.003591	0.002154				0.003722	0.001637	⇐ Y Std Dev
Z	-0.80046	-0.79913	-0.80649	-0.80967			-0.80967		
BM K									
X	3.291145	3.29222	3.290883			**Mean**	3.291416	0.000708	⇐ X Std Dev
Y	0.133544	0.134068	0.135052				0.134221	0.000765	⇐ Y Std Dev
Z	-0.80203	-0.8015	-0.80751	-0.81083			-0.81083		
BM L									
X	4.884186	4.880297	4.876118			**Mean**	4.8802	0.004035	⇐ X Std Dev

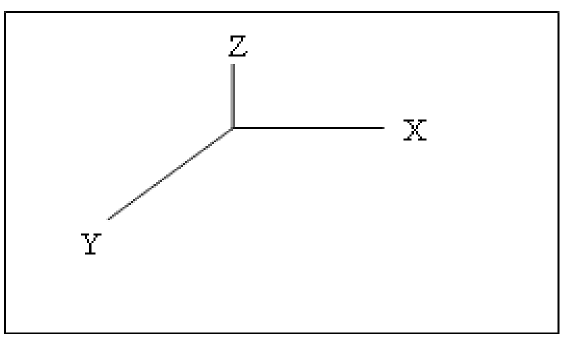
Y	-0.00201	-0.00433	-0.0032			**-0.00318**	0.001157	⇐ Y Std Dev
Z	1.18989	1.193829	1.196552	1.192667		**1.192667**		
S ANT								
X	2.440518	2.446009	2.447502		**Mean**	**2.444676**	0.003678	⇐ X Std Dev
Y	0.921654	0.919158	0.920894			**0.920569**	0.00128	⇐ Y Std Dev
Z	2.304557	2.302682	2.302589	2.310167		**2.310167**		
P ANT								
X	2.444717	2.447164	2.444094		**Mean**	**2.445325**	0.001623	⇐ X Std Dev
Y	-0.91553	-0.91122	-0.9136			**-0.91345**	0.002157	⇐ Y Std Dev
Z	2.321867	2.322209	2.324743	2.309667		**2.309667**		
IMU								
X	3.545087	3.54707	3.545445		**Mean**	**3.545867**	0.001057	⇐ X Std Dev
Y	-0.01495	-0.01453	-0.01599			**-0.01516**	0.000748	⇐ Y Std Dev
Z	-0.84816	-0.84679	-0.85376	-0.85883		**-0.85883**		
TBM Theo								
X	10.02333	10.02377	10.03171		**Mean**	**10.02627**	0.00472	⇐ X Std Dev
Y	0.42237	0.425222	0.425761			**0.424451**	0.001822	⇐ Y Std Dev
Z	-1.86411	-1.86642	-1.86573	-1.86542		**-1.86542**		
Phase Center								
X	3.382044	3.382044	3.382044		**Mean**	**3.382044**	0	⇐ X Std Dev
Y	0.287807	0.285807	0.287807			**0.287141**	0.001155	⇐ Y Std Dev
Z	-1.4085	-1.4085	-1.4085	-1.4085		**-1.4085**		

Measurement	Value	Explanation	Notes
BM C to BM D	6.97	From Offsets & Measurements XYZ.	All calculations are for the X offset from the IMU to the Heave Point in the theodolite coordinate system. Measurements are in meters.
BM D to Center of Pick Point	-0.27	Measured with steel tape 11/16/05.	All calculations are for the X offset from the IMU to the Heave Point in the theodolite coordinate system. Measurements are in meters.
Center of Pick Point to Frame 0	0.5207	From JMC drawing of 1010. Converted to meters.	LCG stands for longitudinal center of gravity, which was assumed to be the location of the heave point for the launch.
BM C to Frame 0	7.2207	Calculated from cells 4, 7 and 10.	
Frame 0 to LCG	-4.818888	From JMC Stability Test for 1010. Converted to meters.	JMC refers to the Jensen Marine Consultants, Inc. report titled, 28' NOAA Survey Launch Stability Information Booklet (1018), dated February 23, 2005. There were several different values for the LCG in the JMC report, but the value used for these calculations was believed to be the most reasonable.
BM C to LCG	2.401812	Calculated from cells 13 and 16.	
BM C to IMU	3.516	From Offsets & Measurements XYZ.	
IMU to LCG	-1.114188	Calculated from cells 19 and 22.	

Theodolite Coordinate System

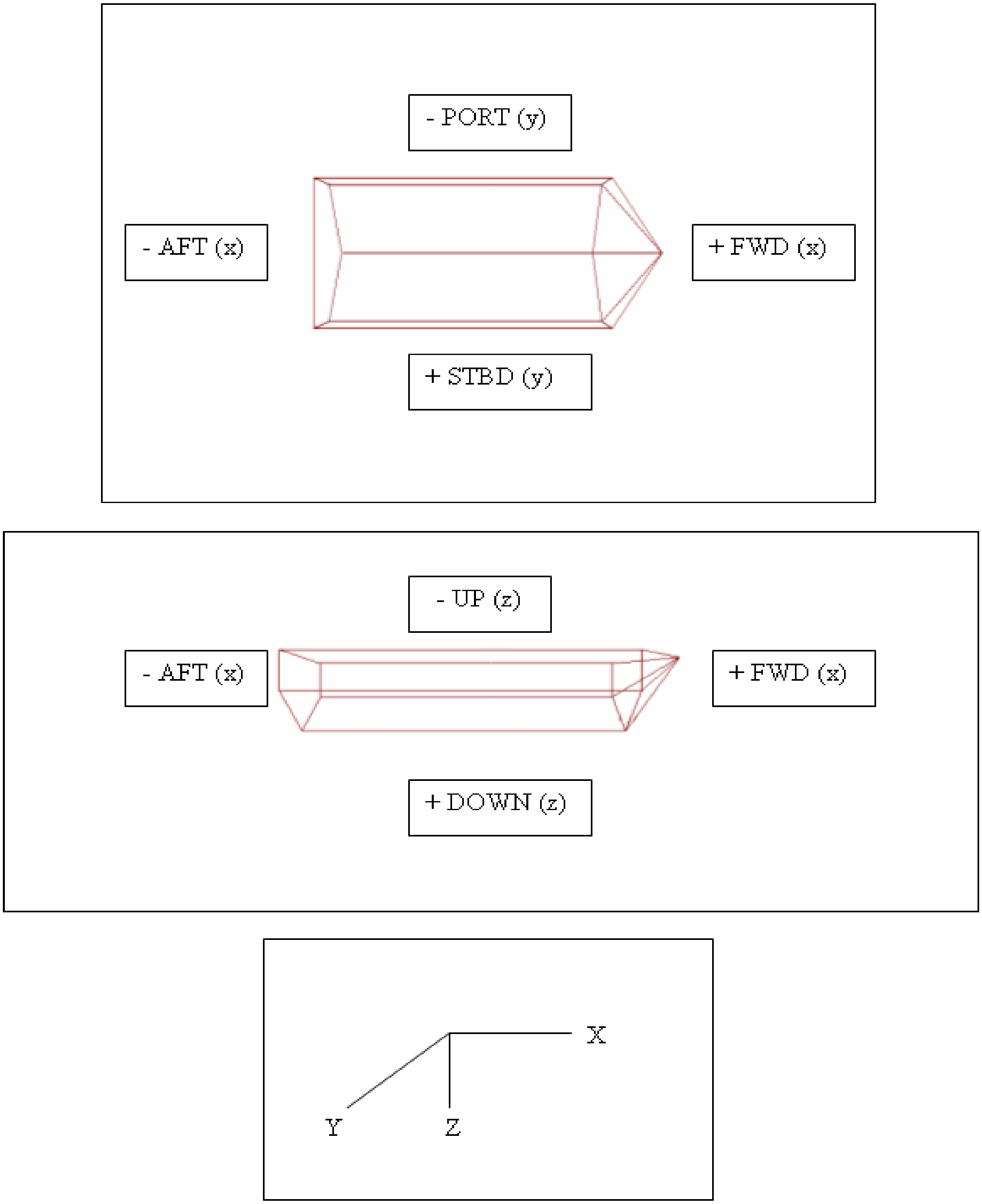






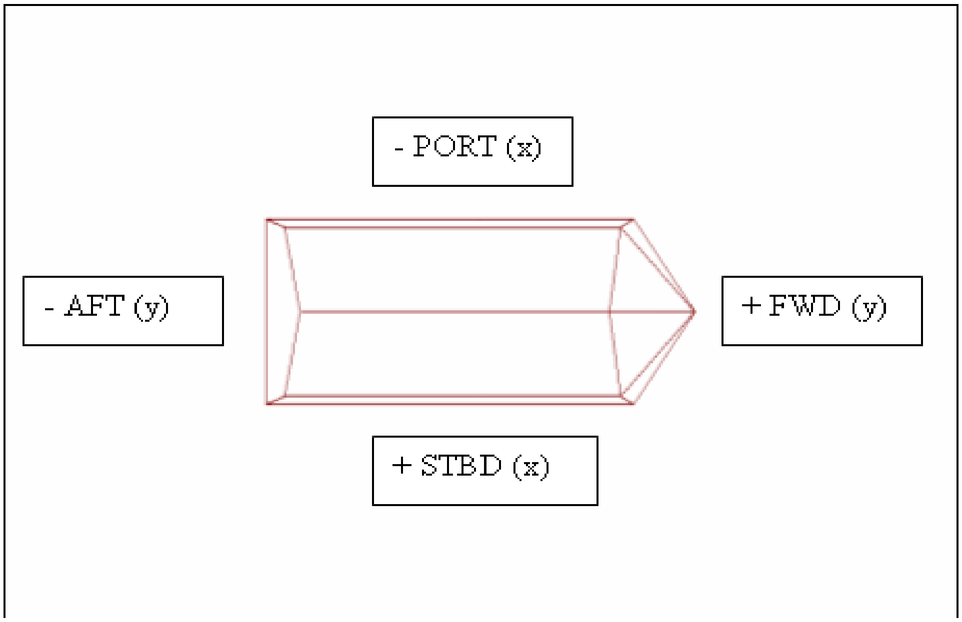
Benchmark C is the origin of the Theodolite Coordinate System

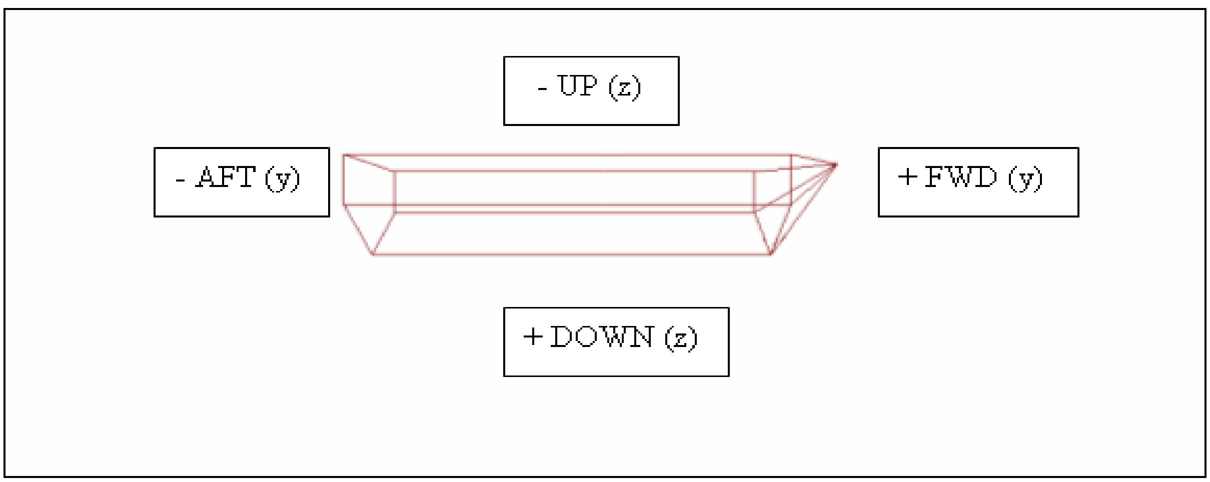
POS/MV Coordinate System

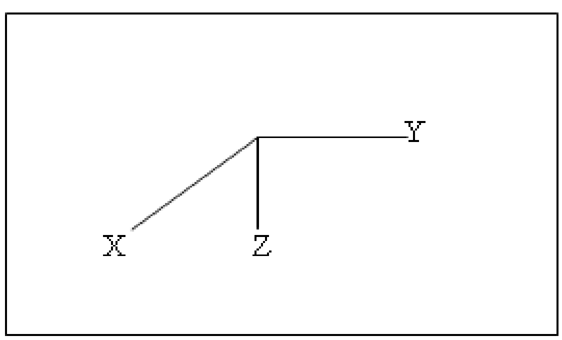


Top Center of IMU is origin of POS/MV Coordinate System

CARIS Coordinate System







Top Center of IMU is origin of CARIS Coordinate System

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 1018
Vessel

6/9/2008	161	Ketchikan Tongass Narrows
Date	Dn	Local Area

Breen, Campbell, Johnston, Argento, Faulkes, Renoud
Calibrating Hydrographer(s)

8101	Drop down hull mount on 1018	not available
MBES System	MBES System Location	Date of most recent EED/Factory Check

3102026	35737
Sonar Serial Number	Processing Unit Serial Number
Swing Arm Mount	4/1/2008
Sonar Mounting Configuration	Date of current offset measurement/verification
POSMV 320 v.4	8/13/2008, re done after configuration switch, earlier date unavailable
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

6/9/2008	161	Ketchikan Tongass Narrows	Clear
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Breen, Campbell, Walker, Faulkes
Personnel on board

Comments

TH_1018_161.000
TrueHeave filename

081611102	11:02	55/19/58.8	131/37/47	42.1	54.4
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
081611119	11:19	55/19/58.4	131/37/46.9	42.4	55.2
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
081611200	12:00	55/19/35.6	131/37/07.2	37.3	48.6
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
081611334	13:34	55/19/58.8	131/37/58.3	45.3	59.9
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
081611459	0:00	55/16/57.5	131/39/54.1	41.1	53.4
SV Cast #3 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
81611200	Roll1	143	5.5	Good line
	Roll2	316	5.2	
	Roll3	146	5.3	
	Roll4	316	5.4	
	Roll5	146	5.8	
	Roll6	316	5.4	Transducer was raised and lowered between each roll lir

PITCH

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
81611119	Pitch1	108	7.5	
	Pitch2	295	7.5	
	Pitch3	110	7.6+	
	Pitch4			abort
	Pitch5	292	7.2	
	Pitch6	111	7.5	

HEADING/YAW

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
81611334	Heading1			abort
	Heading2	298	6.6	good, 2 and 3 same side
	Heading3	117	6.8	good
	Heading4	298	6.6	good,4 and 5 same side
	Heading5	116	6.6	good

NAV TIME LATENCY

SV Cast #	XTF Line Filename	Heading	Speed (knot:	Remarks
81611102	Timing1		6.0	Good line
	Timing2		8.0	Good line
	Timing3		10.0	Good line
	Timing4		12.0	Good line

Processing Log

Date | Dn | Personnel

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

☑ **TrueHeave applied** TH_1018_161.000, TH_1018_161A.000

☑ **SVP applied** Patch_10181_161_GMT.svp

☑ **Tide applied** 9450460_1010_PatchTest.tid

Zone file ______

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**
Do not enter/apply correctors until all evaluations are complete and analyzed.			

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Breen				
Johnston	0.00	0.37	2.57	1.52
Campbell	0.00		2.63	1.62
Argento				
Faulkes	0.00	0.32	2.50	2.10
Renoud	0.00	0.25	2.58	1.42
Averages	0.00	0.31	2.57	1.67
Standard Deviation	0.00	0.06	0.05	0.30
FINAL VALUES				

Final Values based on Johnston, Campbell (except pitch), Faulkes, Renoud

Resulting HVF File Name FA_1018_Reson8101 (2006-161)

MRU Align StdDev gyro 0.30 Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch 0.06 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE
Did not use Breen and Argento values because their Latency was large. Timing latency should be almost indetectable. An incorrect latency would falsely impact the rest of the values, so those were not used.

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

Name: Bonnie Johnston **Date:** 6/14/2008

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 1018	
Vessel	

6/23/2008	175	Kodiak, AK
Date	Dn	Local Area

Argento, Bucher, Renoud
Calibrating Hydrographer(s)

Reson 8101	1018 swing mount	N/A
MBES System	MBES System Location	Date of most recent EED/Factory Check

3102026	35737
Sonar Serial Number	Processing Unit Serial Number

Swing Arm Mount	4/1/2008
Sonar Mounting Configuration	Date of current offset measurement/verification

POSMV v4	8/13/2008, re done after configuration switch, earlier date unavailable
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

6/23/2008	175	NE Cliff Point	clear, sunny, breezy
Date	Dn	Local Area	Wx

Sandy	90 ft
Bottom Type	Approximate Water Depth

Evans, Bucher, Argento, Renoud
Personnel on board

Comments

TH_1018_Dn175
TrueHeave filename

081751905	19:05	57/44/08.5	152/24/26.7		37.1
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	Evans_A_8kts	175	8.0	wavy,don'tuse
1	Evans_B_8kts	355	8.0	good
1	Evans_B_8kts1	175	8.0	short sonar blowout but usable line
1	Evans_C_8kts	359	8.0	good
1	Evans_D_8kts	175	8.0	good
1	Renoud_A_8kts	353	8.0	good
1	Renoud_B_8kts	175	8.0	good
1	Argento_A_8kts	355	8.0	small sonar blowout, otherwise good line
1	Argento_B_8kts	170	8.0	good
1	Bucher_A_8kts	355	8.0	good
1	Bucher_B_8kts	170	8.0	small sonar blowout, otherwise good line
1	4kts	355	4.0	good
1	4kts_B	170	4.0	good
1	10_kts	355	10.0	good
1	10_kts_B	170	10.0	okay, messy data, usable
1	8_kts_A	355	8.0	
1	8_kts_B	170	8.0	data blowout, messy data, still usable

Processing Log

6/23/2008	175	Faulkes
Date	Dn	Personnel

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

☑ **TrueHeave applied** TH_1018_175

☑ **SVP applied**

☑ **Tide applied** 9457292

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

See the following Roll Comparsion section for detailed listing of evaluator values.

	Roll (deg)
Averages	3.065
Standard Deviation	See Roll Comparison section
FINAL VALUES	3.065

Final Values based on average of Johnston, Campbell, Argento, Bucher values

Resulting HVF File Name FA_1018_Reson8101.hvf

MRU Align StdDev Roll/Pitch Value was not adjusted, Dn 161 value was retained.

NARRATIVE

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

Name: FA Personnel **Date:** 6/23/2008

FAIRWEATHER

Multibeam Echosounder Calibration

Launch 1018	
Vessel	

8/16/2008	229	Kodiak, AK
Date	Dn	Local Area

Forney, Argento, Evans
Calibrating Hydrographer(s)

Reson 8101	1018 swing mount	N/A
MBES System	MBES System Location	Date of most recent EED/Factory Check
3102026		35737
Sonar Serial Number		Processing Unit Serial Number
Swing Arm Mount		4/1/2008
Sonar Mounting Configuration		Date of current offset measurement/verification
POSMV v4		8/13/2008
Description of Positioning System		Date of most recent positioning system calibration

Acquisition Log

8/16/2008	229	Kodiak, AK	Cloudy & calm
Date	Dn	Local Area	Wx

Bottom Type	Approximate Water Depth

Forney, Argento, Evans
Personnel on board

Comments

TH_1018_229_2008
TrueHeave filename

08229171.8ex	1718	57/47/50.53	152/21/03.33	60.5	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	ROLL1	066		ABORTED
1	ROLL2	066	8.0	SUCCESSFUL
1	ROLL3	294	8.0	SUCCESSFUL
1	ROLL4	066	8.0	SUCCESSFUL
1	ROLL5	294	8.0	SUCCESSFUL

PITCH

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	PITCH1	133	8.0	SUCCESSFUL
1	PITCH2	317	8.0	SUCCESSFUL
1	PITCH3	133	8.0	SUCCESSFUL
1	PITCH4	317	8.0	SUCCESSFUL

HEADING/YAW

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
1	HEADING_N1	133	8.0	SUCCESSFUL
1	HEADING_S1	317	8.0	SUCCESSFUL
1	HEADING_S2	133	8.0	SUCCESSFUL
1	HEADING_N2	317	8.0	SUCCESSFUL

NAV TIME LATENCY

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

Processing Log

Date | Dn | Personnel

- [x] **Data converted --> HDCS_Data in CARIS**
- [x] **TrueHeave applied** ____________________
- [x] **SVP applied** ____________________
- [ ] **Tide applied** ____________________

Zone file ____________________

Lines merged [x]

Data cleaned to remove gross fliers [x]

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)
Argento	0.00	-0.96	2.99	0.28
PS Raymond	0.00	-0.38	2.88	0.18
Renoud	0.00	-0.50	3.03	0.05
ST Bucher			3.06	
FOO		-0.80	3.00	0.15
Averages	0.00	-0.66	2.99	0.17
Standard Deviation	0.00	0.27	0.07	0.09
FINAL VALUES		-0.66	2.99	0.17

Final Values based on Averages, after outliers were removed.

Resulting HVF File Name FA_1018_Reson8101.hvf

MRU Align StdDev gyro	0.09	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.17	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

Patch Test conducted after it was discovered that the POSMV antenna cables were plugged in backwards (i.e. primary was plugged into secondary and vice versa). Gams calibration performed as well. Patch test values are a fair amount different than previous values. New values supercede old values as old values were based on an incorrect navigation solution.

Values for MRU Align StdDev gyro and Roll/Pitch were not adjusted in the hvf, the values obtained on Dn 161 were retained in the hvf.

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

Name: Matthew Ringel, FOO Fairweather **Date:** 17 August 20(

LAUNCH DDSSM DATA ACQUISITION FORM

Date 6/9/2008
Vessel # 1018
Average Depth 25m

DN 161
Location Blank Inlet
Personnel Breen, Campbell, Faulkes

Wind NW 20
Seas 1-2 ft

RPM	Speed	Az	Isis Line Name	Acquisition Comments
0	6kts	65	DDSSM1	Good Line
0	8kts	65	DDSSM2	Good Line
0	10kts	65	DDSSM3	Good Line
	12kts	65	DDSSM4	Good Line
	0		Stop1	Don't Use. Did not cross other lines.
	0		Stop2	Wind blowing launch to south over lines.
	0		Stop3	Wind blowing launch to south over lines
	0		Stop4	Wind blowing launch to south over lines

Date	6/10/2008	DN	162	Wind	
Vessel #	1018	Location	Blank Islet	Seas	
Average Depth	25 m	Personnel	Breen, Johnston (values)		

SVP file loaded Patch_10181_161_GMT.svp

Tide file loaded 9450460_1010_PatchTest.tid

Speed-Rest, values obtained by following FPM May 2008, incorrect

erroneous formulas/values

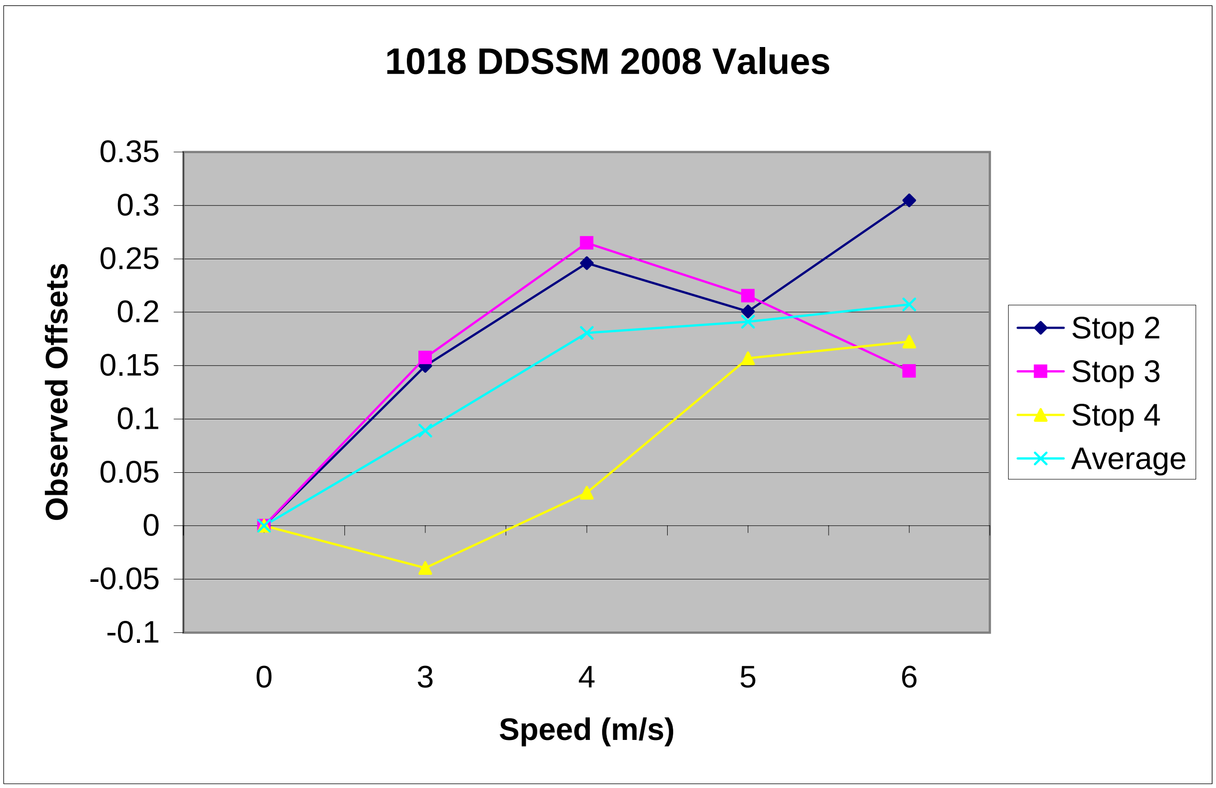
Speed	Isis Line Name	CARIS Line Name	Depth Stop2	Diff Stop 2	Depth Stop 3	Diff Stop 3	Depth Stop 4	Diff Stop 4	Average
0 kts	STOP 2, 3, 4	STOP 2, 3, 4	26.9886933	0	32.2156629	0	22.3035753	0	0
6 kts	DDSSM1	DDSSM1	26.83904	-0.149653333	32.05825	-0.1574129	22.343125	0.03954966	-0.0891722
8 kts	DDSSM2	DDSSM2	26.7426667	-0.246026667	31.950875	-0.2647879	22.2724545	-0.0311208	-0.1806451
10 kts	DDSSM3	DDSSM3	26.7879286	-0.051111429	32.0003333	-0.2153296	22.1465	-0.1570753	-0.1411721
12 kts	DDSSM4	DDSSM4	26.6840909	-0.058575758	32.0708	0.01255	22.1312	-0.211925	-0.0859836

Rest-Speed - Values used

Speed	Isis Line Name	CARIS Line Name	Depth Stop2	Diff Stop 2	Depth Stop 3	Diff Stop 3	Depth Stop 4	Diff Stop 4	Average
0 kts	STOP 2, 3, 4	STOP 2, 3, 4	26.9886933	0	32.2156629	0	22.3035753	0	0
6 kts	DDSSM1	DDSSM1	26.83904	0.149653333	32.05825	0.15741292	22.343125	-0.0395497	0.0891722
8 kts	DDSSM2	DDSSM2	26.7426667	0.246026667	31.950875	0.26478792	22.2724545	0.0311208	0.18064513
10 kts	DDSSM3	DDSSM3	26.7879286	0.200764762	32.0003333	0.21532959	22.1465	0.15707534	0.19105656
12 kts	DDSSM4	DDSSM4	26.6840909	0.304602424	32.0708	0.14486292	22.1312	0.17237534	0.20728023

2008 1018 DDSSM Values used (Rest-Speed)

Speed (m/s)	Speed (knots)	Stop 2	Stop 3	Stop 4	Std. Dev.	Average
0.00	0	0	0	0	0	0.00
3.09	6	0.149653333	0.157412921	-0.039549658	0.111543893	0.09
4.12	8	0.246026667	0.264787921	0.031120797	0.1298312	0.18
5.14	10	0.200764762	0.215329588	0.157075342	0.030316268	0.19
6.17	12	0.304602424	0.144862921	0.172375342	0.085398715	0.21



NOAA POS/MV Calibration Report

Ship: FAIRWEATHER **Vessel:** 1018

Date: 8/13/2008 **Dn:** 226

Personnel: Ringel

PCS Serial # 2560 **IMU Serial #** 007

IP Address:

POS controller Version (Use Menu Help > About) 3.4.0.0

POS Version (Use Menu View > Statistics) 320 v.4

GPS Receivers

Primary Receiver S/N 60145158

Secondary Receiver S/N 60130644

Calibration area

Location: Shumagin Islands, AK

Approximate Position:

Lat	55	5	40.5
Lon	159	54	39.6

DGPS Beacon Station: Cold bay

Frequency: 289

Satellite Constellation

(Use View> GPS Data)

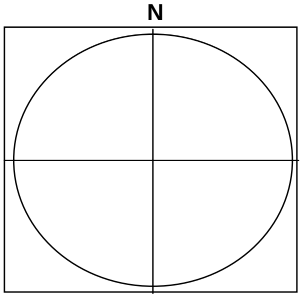
Primary GPS

Sketch general SV configuration or insert screen grabs

HDOP 1.5

VDOP 2.3

N



Sattelites in use: 10

L1 SNR > **30** **35** **40**

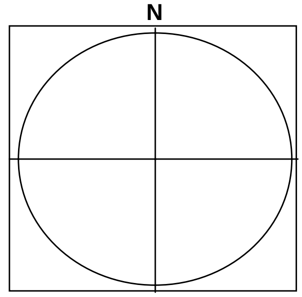
Secondary GPS

Note any differences from Primary GPS Receiver

HDOP 1.4

VDOP 2.4

N



Sattelites in use: 10

L1 SNR : **30** **35** **40**

PDOP 1.8 (Use View> GAMS Solution)

POS/MV Configuration

Settings

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

User Entries, Pre-Calibration

0	Two Antenna Separation (m)
0.4	Heading Calibration Threshold
0	Heading Correction

Baseline Vector

0.052	X Component (m)
-1.831	YComponent (m)
-0.005	Z Component (m)

Configuration Notes:

POS/MV Calibration

Calibration Procedure:

(Refer to POS MV V3 Installation and Operation Guide, 4-25)

Start time: 2130

End time: 2145

Heading accuracy achieved for calibration: 0.2

Calibration Results:

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

POS/MV Post-Calibration Values		Baseline Vector	
1.834	Two Antenna Separation (m)	**0.011**	X Component (m)
n/a	Heading Calibration Threshold	**1.834**	YComponent (m)
0	Heading Correction	**0.035**	Z Component (m)

GAMS Status Online: online

Save Settings: MRR

Calibration Notes:

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

File Name:

General Notes:

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

The right-hand orthogonal system defines the following:

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

The POS/MV uses a Tate-Bryant Rotation Sequence

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

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

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

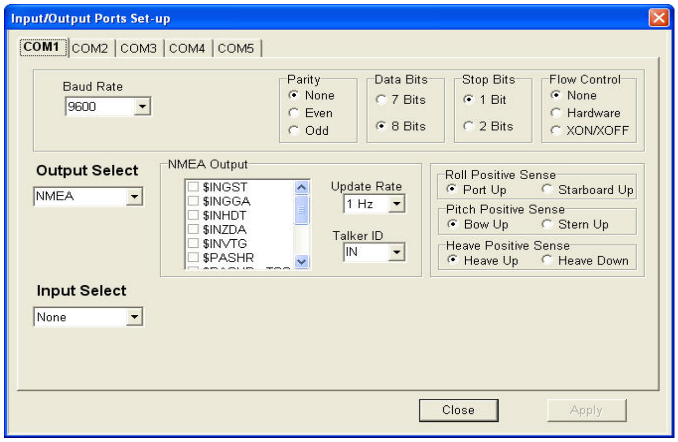
c) Roll rotation - apply a right-hand screw rotation θx about the twice-rotated x-axis to align one frame with the other.

See configuration extractor file for POS Settings.

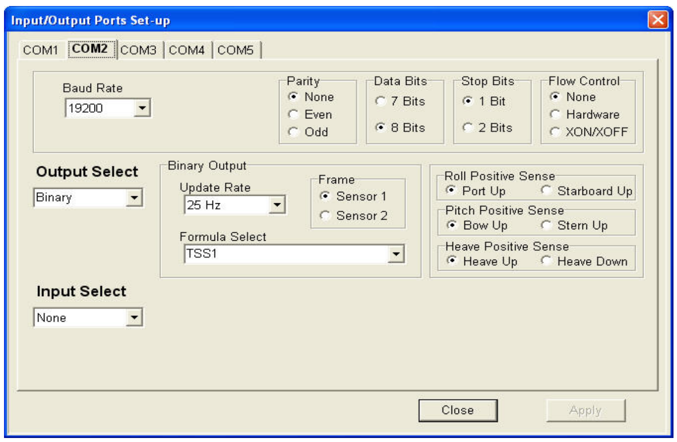
SETTINGS

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

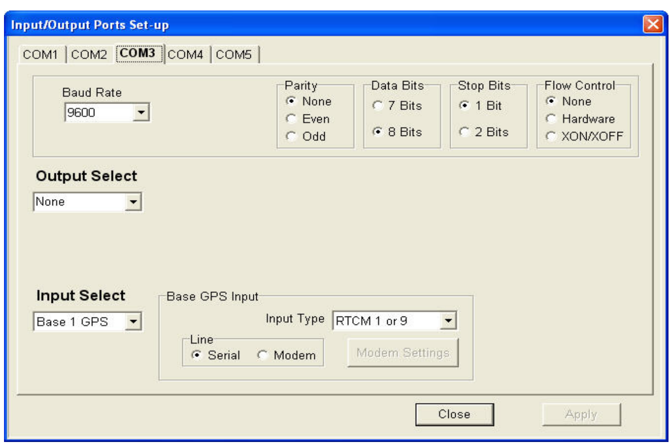
COM1



COM2

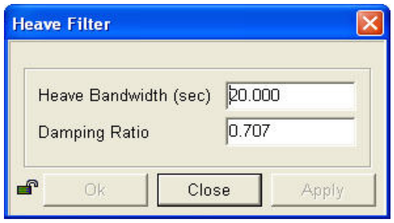


COM3

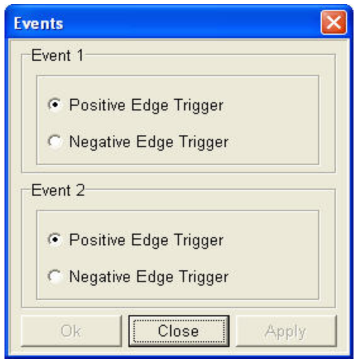


SETTINGS Continued

Heave Filter (Use Settings > Heave)

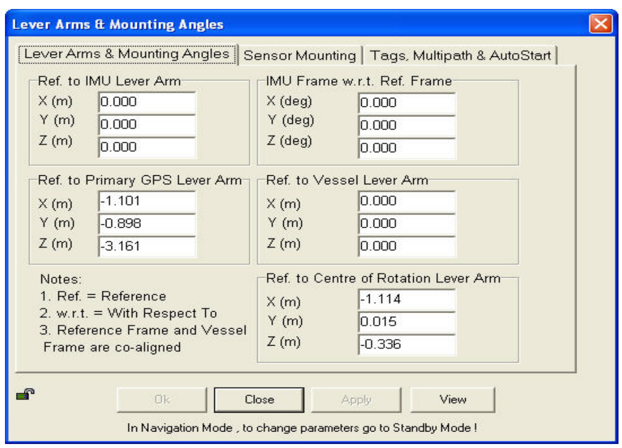


Events Use Settings > Events)

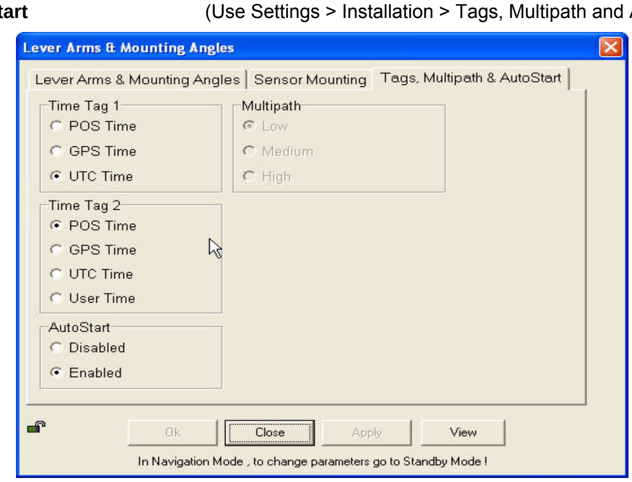


INSTALLATION (Use Settings > Installation)

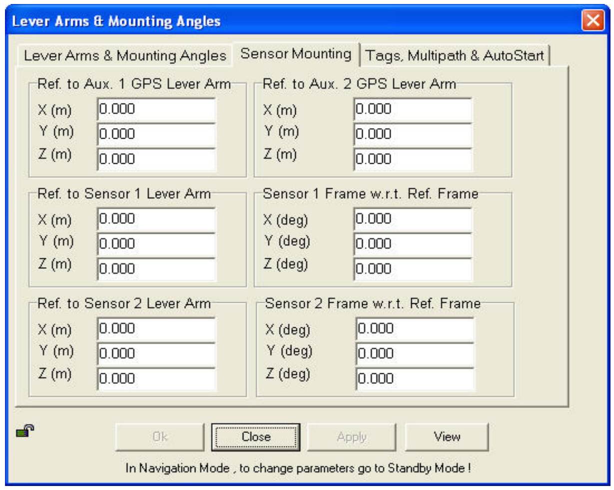
Lever Arms and Mounting Angles (Use Settings > Installation > Lever Arms and Offsets)



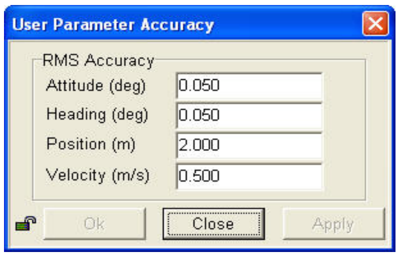
Tags, Multipath and Auto Start (Use Settings > Installation > Tags, Multipath and Auto Start)



Sensor Mounting (Use Settings > Installation > Sensor Mounting)

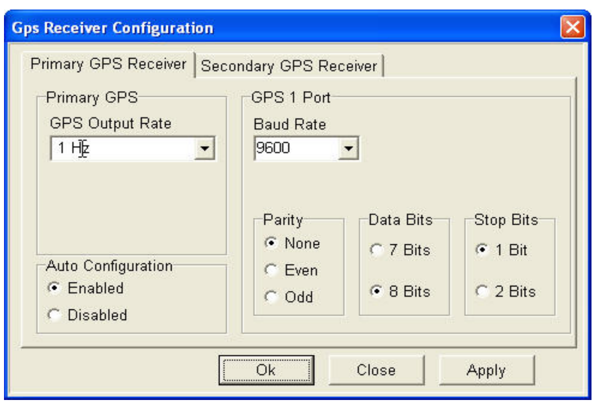


User Parameter Accuracy (Use Settings > Installation > User Accuracy)

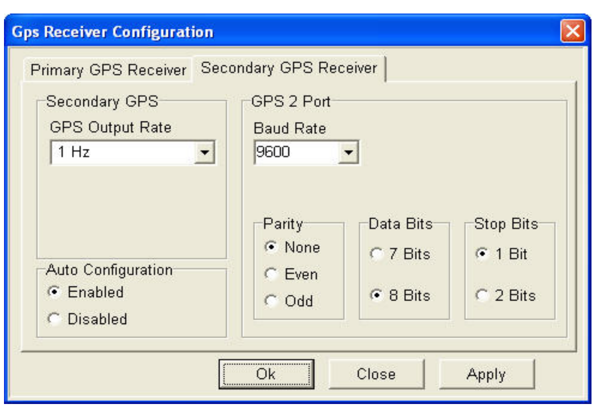


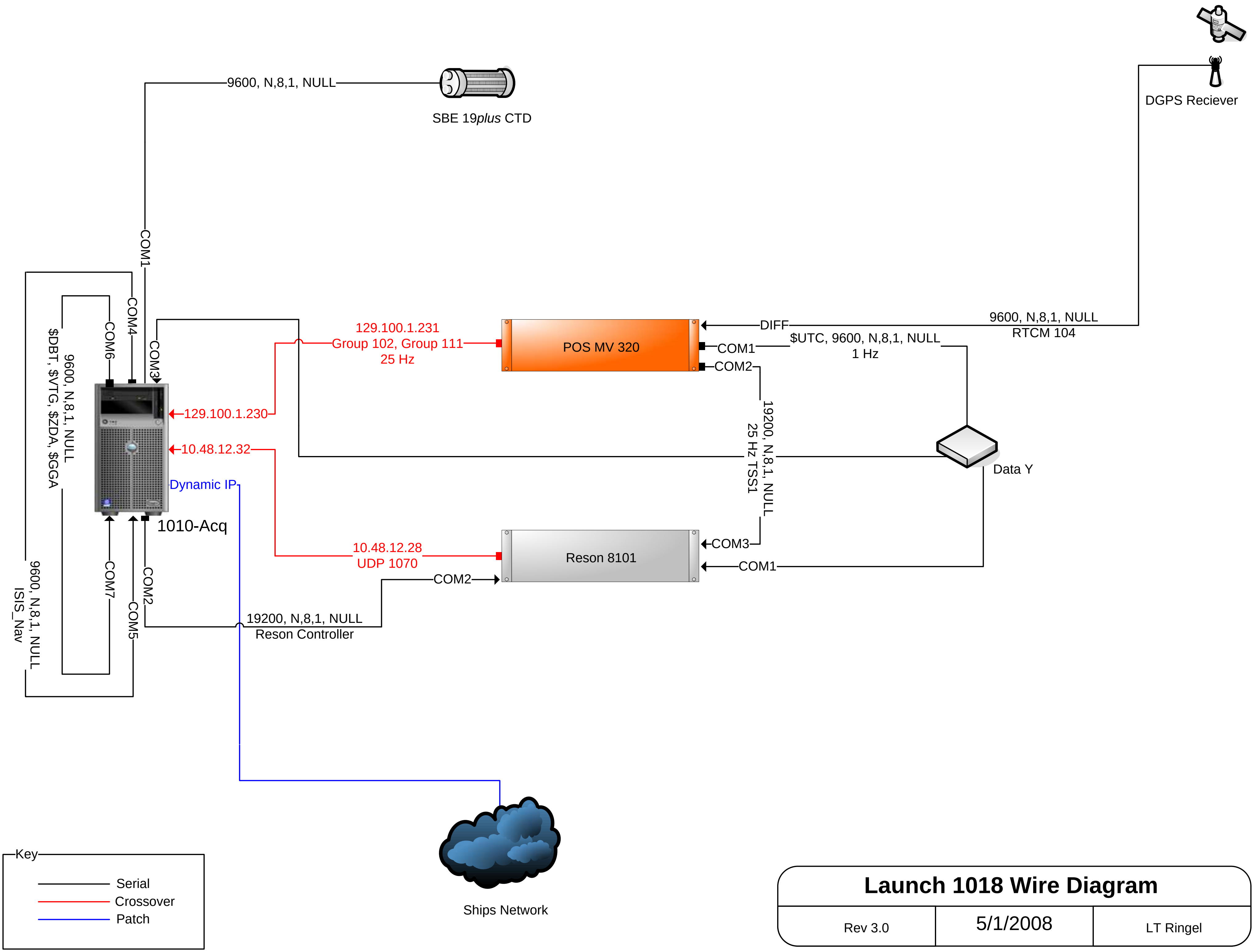
GPS Receiver Configuration (Use Settings> Installation> GPS Receiver Configuration)

Primary GPS Receiver



Secondary GPS Receiver





9600, N,8,1, NULL
SBE 19plus CTD
DGPS Reciever
COM1
COM4
COM6
COM3
9600, N,8,1, NULL
$DBT, $VTG, $ZDA, $GGA
129.100.1.231
Group 102, Group 111
25 Hz
POS MV 320
DIFF
9600, N,8,1, NULL
RTCM 104
COM1
$UTC, 9600, N,8,1, NULL
1 Hz
COM2
129.100.1.230
10.48.12.32
Dynamic IP
19200, N,8,1, NULL
25 Hz TSS1
Data Y
1010-Acq
9600, N,8,1, NULL
ISIS_Nav
COM7
COM2
COM5
10.48.12.28
UDP 1070
Reson 8101
COM3
COM1
COM2
19200, N,8,1, NULL
Reson Controller
Ships Network
Key
Serial
Crossover
Patch
Launch 1018 Wire Diagram
Rev 3.0
5/1/2008
LT Ringel

Measurement Coord. Sys.	IMU to 8111 (MRU to Trans) Caris	Port Ant to 8111 (Nav to Trans) Caris	Waterline to RP* Caris	Port Ant to Stbd Ant	
x	2.868	1.691	n/a	Scaler Distance	1.995
y	8.252	20.172	n/a		
z	4.752	17.756	-0.002		

*Top of IMU is RP (Reference Pt)

Vessel Offsets for S220_8111 are derived from Westlake-Survey-Report-NOAA-Fairweather-09-23-03.pdf and Fairweather_NGS_Report_Feb_2007.doc

2007 Measured Values used for 2008

Calculations

Coord. Sys.

IMU to 8111

Westlake

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

Westlake

8111		easting	27.072
	(ft)	northing	9.410
		elevation	15.042

Westlake

8111		easting	8.252
	(m)	northing	2.868
		elevation	4.585

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

Port Ant to 8111

NGS

Port		easting	-11.920
Ant		northing	1.177
	(m)	elevation	-13.004
	(m)	easting	8.252
Top of IMU		northing	2.868
to 8111		elevation	4.752

Waterline to RP*

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 13.40
Waterline to Keel
(m) elevation 4.084

See Ship's Draft Tab

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

Port		easting	-11.920
Ant		northing	1.177
	(m)	elevation	-13.004

NGS

Stbd		easting	-11.917
Ant		northing	3.171
	(m)	elevation	-12.956

IMU to 8111

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

Coord Sys. CARIS

x	2.868
y	8.252
z	4.752

Port Ant to 8111

(m)	easting	20.172
	northing	1.691
	elevation	17.756

Coord Sys. CARIS

x	1.691
y	20.172
z	17.756

Waterline to RP*

	(m)	easting	N/A
Waterline		northing	N/A
to IMU		elevation	-0.002

Coord. Sys. CARIS

x	N/A
y	N/A
z	-0.002

See Description Tab

Port Ant to Stbd Ant

Scalar Distance (m) 1.995

IMU to Port Ant			IMU to Heave		
Caris		Pos/Mv	Caris		Pos/Mv
1.177		-11.920	1.866		-7.028
-11.920		1.177	-7.028		1.866
-13.004		-13.004	-2.086		-2.086

IMU to Port Ant

NGS

IMU Top (m)		easting	0.000
		northing	0.000
		elevation	0.000

NGS

Port		easting	-11.920
Ant		northing	1.177
	(m)	elevation	-13.004

IMU to Heave

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 Port Ant			
	(m)	easting	-11.920
Top of IMU		northing	1.177
to Port Ant		elevation	-13.004
Coord Sys.	**Pos/Mv**		
		x	-11.920
		y	1.177
		z	-13.004

IMU to Heave			
	(m)	easting	-7.028
Top of IMU		northing	1.866
to Heave Pt*		elevation	-2.086
Coord. Sys.	**Pos/Mv**		
		x	-7.028
		y	1.866
		z	-2.086

see Description Tab

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		-0.684		n/a	Scaler Distance	1.995	1.177	-11.920	1.866	-7.028
y		7.665		19.585		n/a			-11.920	1.177	-7.028	1.866
z		4.726		17.730		-0.002			-13.004	-13.004	-2.086	-2.086

*Top of IMU is RP (Reference Pt)

Vessel Offsets for S220_8111 are derived from Westlake-Survey-Report-NOAA-Fairweather-09-23-03.pdf
and Fairweather_NGS_Report_Feb_2007.doc

Derivations

Coord. Sys.

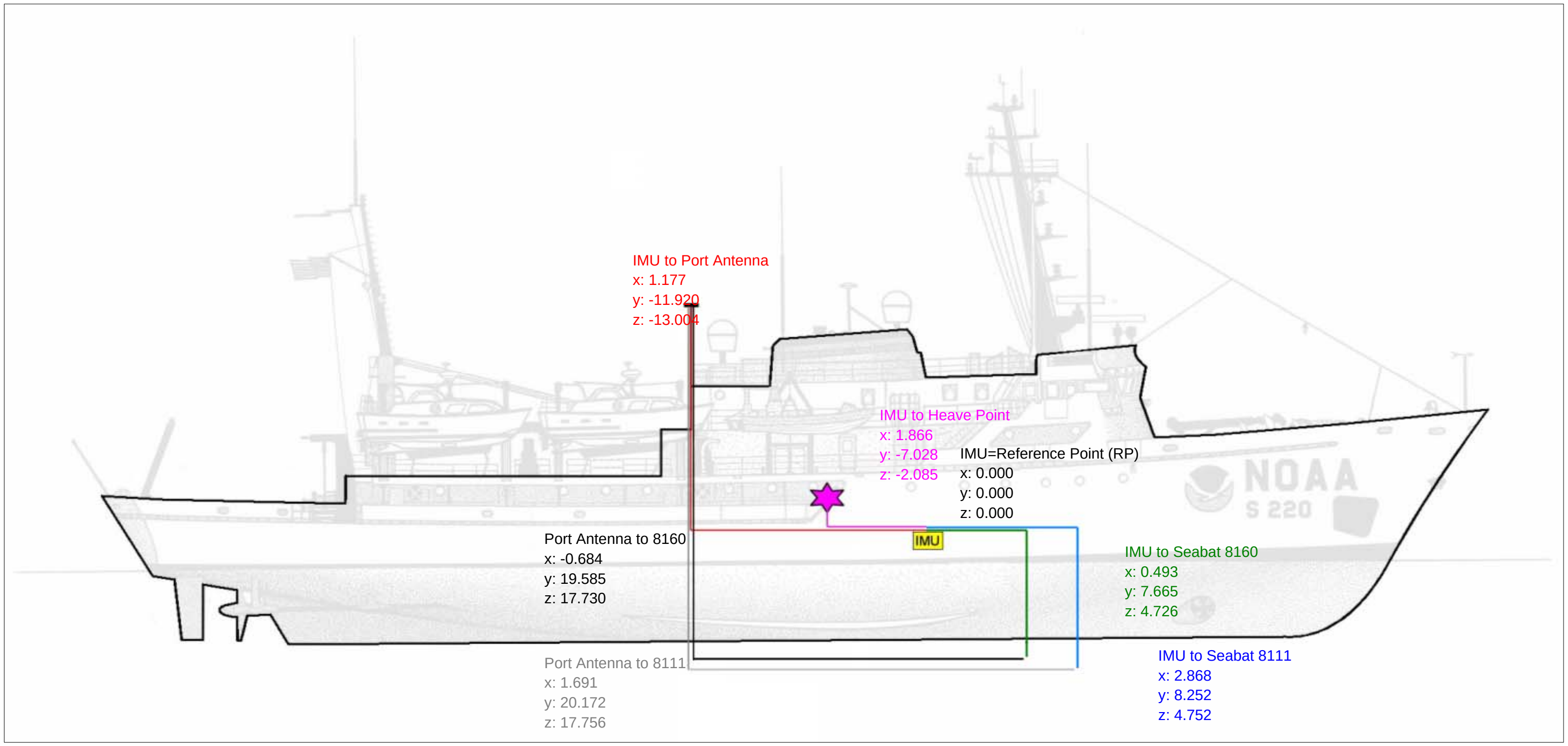
IMU to 8160				Port Ant to 8160			
Westlake				**NGS**			
IMU		easting	0.000	Port		easting	-11.920
Base		northing	0.000	Ant		northing	1.177
	(ft/m)	elevation	0.000		(m)	elevation	-13.004
Westlake							
8160		easting	25.149				
	(ft)	northing	1.619				
		elevation	14.956				
Westlake							
8160		easting	7.665				
	(m)	northing	0.493		(m)	easting	7.665
		elevation	4.559	Top of IMU		northing	0.493
				to 8160		elevation	4.726
Base of IMU to Top of IMU							
	(m)	elevation	-0.168				

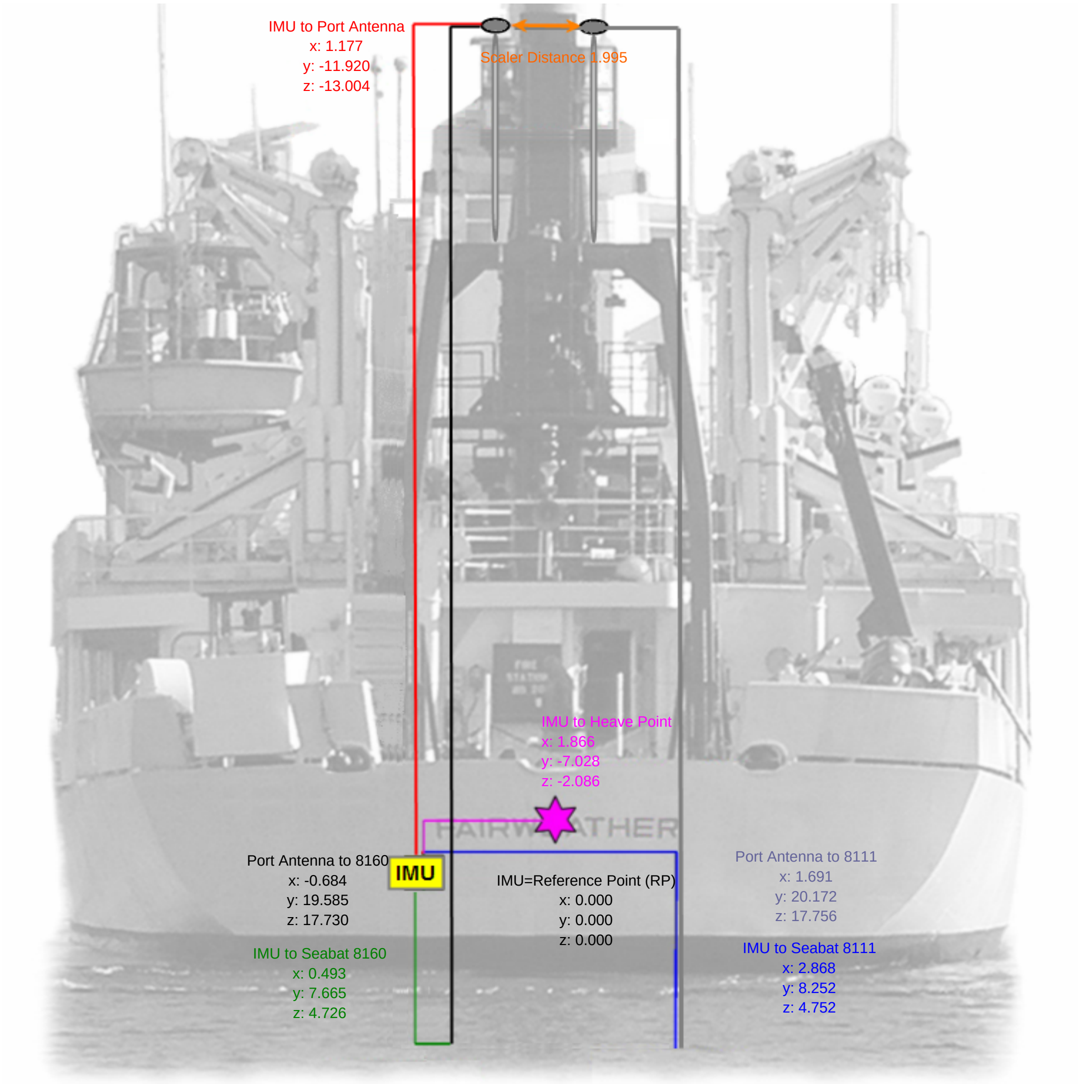
IMU to 8160				Port Ant to 8160			
	(m)	easting	7.665		(m)	easting	19.585
Top of IMU		northing	0.493			northing	-0.684
to 8160		elevation	4.726			elevation	17.730

Coord Sys Caris		Coord Sys Caris	
x	0.493	x	-0.684
y	7.665	y	19.585
z	4.726	z	17.730

Description of Offsets for FAIRWEATHER S-220

All Values Shown are in CARIS Coordinates





IMU to Port Antenna
x: 1.177
y: -11.920
z: -13.004
Scaler Distance 1.995
IMU to Heave Point
x: 1.866
y: -7.028
z: -2.086
FAIRWEATHER
Port Antenna to 8160
x: -0.684
y: 19.585
z: 17.730
IMU
IMU=Reference Point (RP)
x: 0.000
y: 0.000
z: 0.000
Port Antenna to 8111
x: 1.691
y: 20.172
z: 17.756
IMU to Seabat 8160
x: 0.493
y: 7.665
z: 4.726
IMU to Seabat 8111
x: 2.868
y: 8.252
z: 4.752

IMU to 8111 (MRU to Trans)		
x	y	z
2.868	8.252	4.752

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 8160 (MRU to Trans)		
x	y	z
0.493	7.665	4.726

The lever arms between the IMU and phase center of the 8111 transducer are taken from the Westlake report with the addition of the 0.168 m offset included for the height of the IMU.

Port Ant to 8111 (Nav to Trans)		
x	y	z
1.691	20.172	17.756

This information comes from a combination of the Westlake and NGS surveys. Additions for spacing bolt between antenna base and top of pole mount were port antenna elevation adjusted 2.4 cm. Relative positions obtained from Port Ant to 8111 via IMU.

Port Ant to 8160 (Nav to Trans)		
x	y	z
-0.684	19.585	17.730

This information comes from a combination of the Westlake and NGS surveys. Additions for spacing bolt between antenna base and top of pole mount were port antenna elevation adjusted 2.4 cm. Relative positions obtained from Port Ant to 8160 via IMU.

Port Ant to Stbd Ant	
Scaler Distance	1.995

From the NGS survey, it was determined that the vector for antenna separation was 1.995 m. Additions for spacing bolt between antenna base and top of pole mount were port antenna elevation adjusted 2.4 cm, stbd antenna elevation adjusted 2.0 cm.

IMU to Port Ant		
x	y	z
1.177	-11.920	-13.004

This information comes directly from the NGS survey.

Waterline to RP*		
x	y	z
n/a	n/a	-0.002

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 initial observations. 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. Two 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

…and the relocation of the POS M/V antenna forced a partial resurvey in Feb. 2007 by Steven Breidenbach of NGS.

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 TPE, 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.

Draft measurements were taken once the engineers had transferred the fuel in a satisfactory manner. The 2007 measurement for draft was used due to the lack of sufficient draft measurements.

			Fwd			Aft	slope	IMU Depth	IMU Depth (m)	
2008		x1	y1		x2	y2				
16-Apr	before fueling	5.25	13.88		189	12.75	-0.00615	13.42	4.092	
16-Apr	after fueling	5.25	13.88		189	14.42	0.00294	14.10	4.297	
						Draft at IMU (ft)		13.76	4.194	AVE
	The IMU	x-value (ft):	79.36	No boats				0.476	0.145	STDEV
		x-value (m):	24.19	Light Ship						
				Post Fuel						
				Transfer						

Notes:

Fuel level @ ~50%, in forward tanks. Launch 1018 in #4 Davit, 1010 in #5, Ambar in #2, FRB deployed, THIS IS POTENTIALLY NOT A VALID MEASUREMENT AS ALL FUEL WAS LOADED FORWARD WITH THE INTENTION THAT AFT TANKS WERE ABOUT TO BE FILLED.

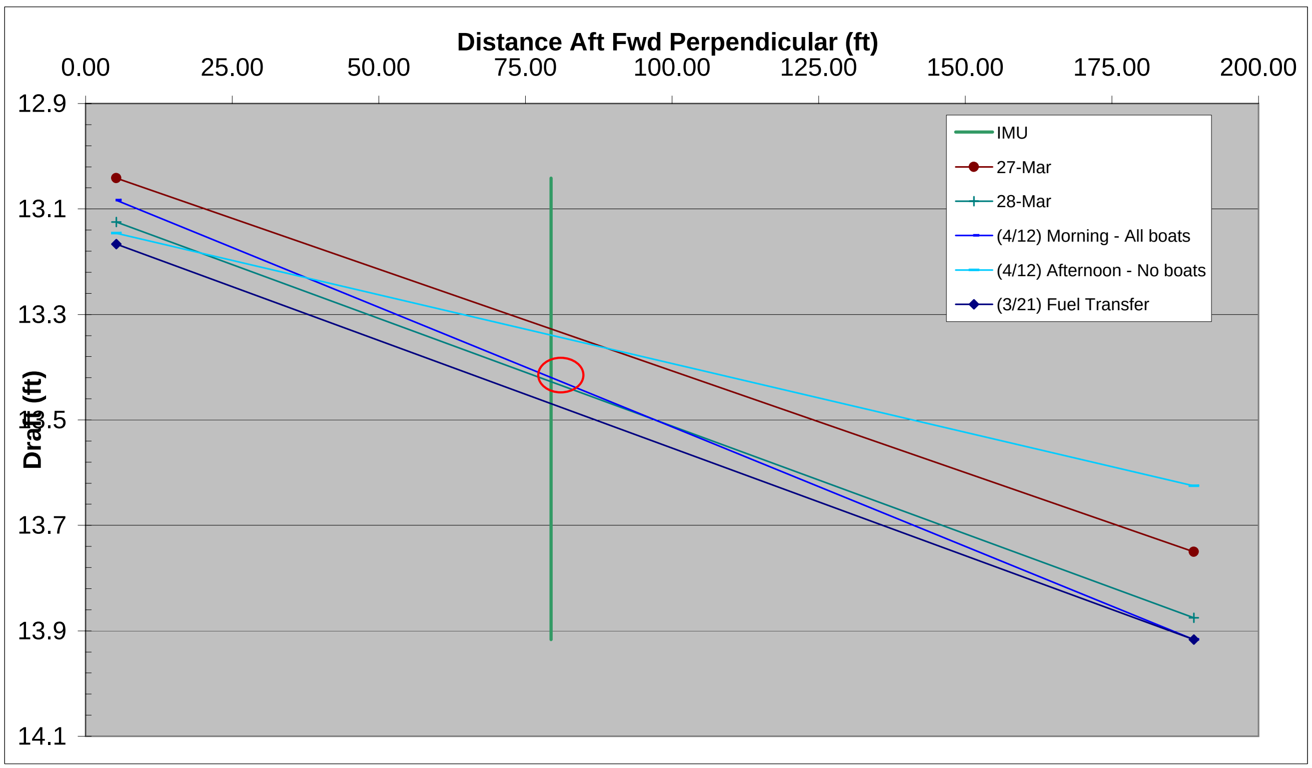
All Fuel tanks pressed up. Launch 1018 in #4 Davit, 1010 in #5, Ambar in #2, FRB in #1.

Fwd Stbd	Fwd Port	Avg	Aft Stbd	Aft Port	Avg
13.75	14.00	13.88	13.00	12.50	12.75
13.75	14.00	13.88	14.33	14.50	14.42

Immediately prior to the FA field season, the draft measurements were taken once the engineers had transferred the fuel in a satisfactory manner. The waterline at the IMU was then calculated based on a linear interpolation.

2007		Fwd		Aft		slope	IMU Depth	IMU Depth (m)
2-Feb								
26-Feb								
27-Feb								
28-Feb		x1	y1	x2	y2			
21-Mar	(3/21) Fuel Transfer	5.25	13.17	189	13.92	0.00408	13.47	4.105
27-Mar	various boats	5.25	13.04	189	13.75	0.00385	13.33	4.062
28-Mar	various boats	5.25	13.13	189	13.88	0.00408	13.43	4.093
12-Apr	(4/12) Morning - All boa	5.25	13.08	189	13.92	0.00454	13.42	4.090
12-Apr	(4/12) Afternoon - No bo	5.25	13.15	189	13.63	0.00261	13.34	4.066

			Draft at IMU (ft)		13.40	4.083	AVE
The IMU	x-value (ft):	79.36	No boats	12.608	0.061	0.019	STDEV
	x-value (m):	24.19	Light Ship	13.100			
			Post Fuel Transfer	13.258			
			Transfer	13.470			



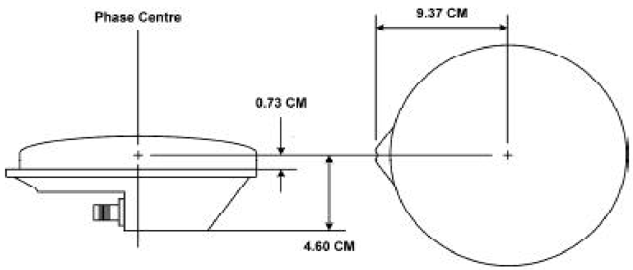


Figure 79: GPS Antenna Footprint

POS MV V4 Installation and Operation Guide
Drawings

Appendix E

Drawings

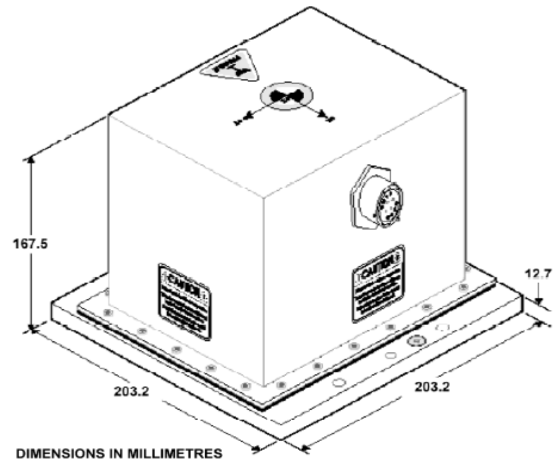
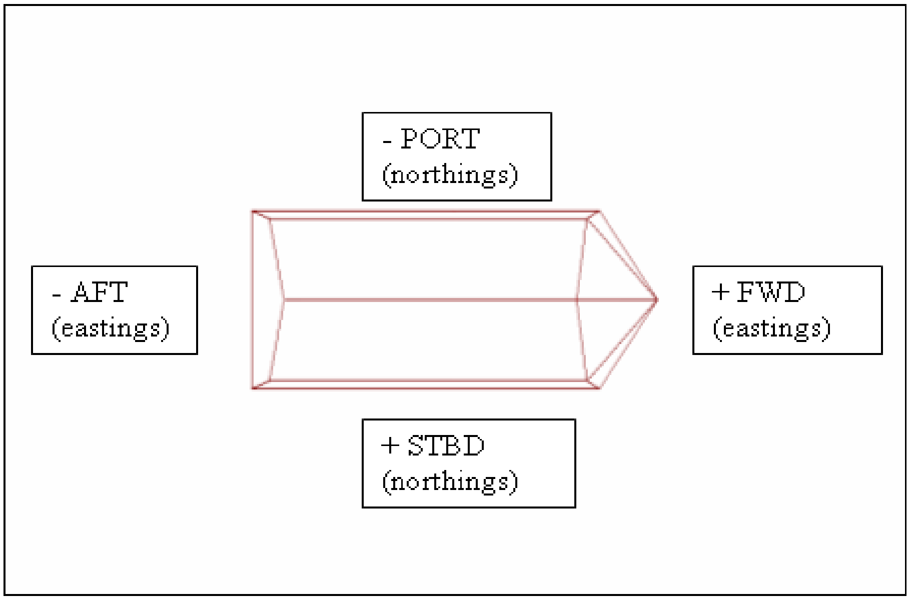
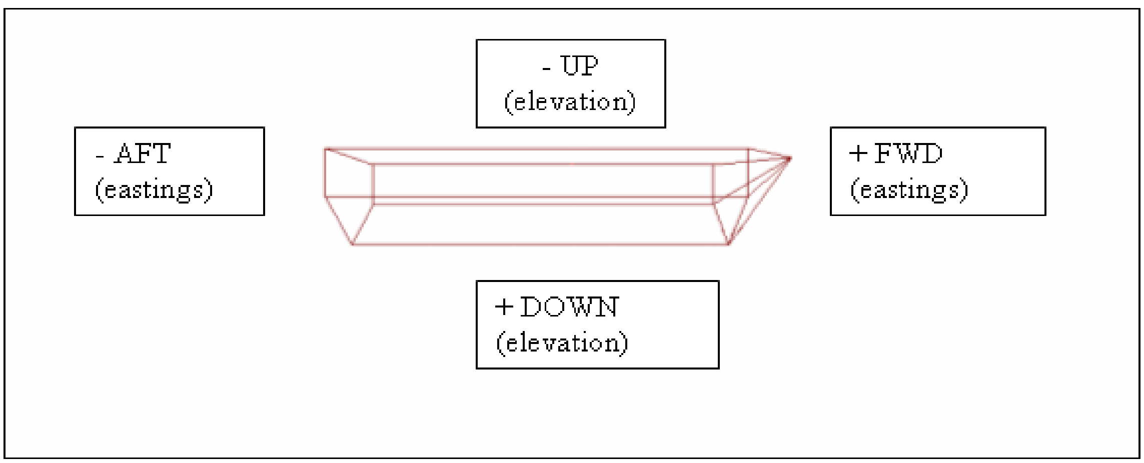
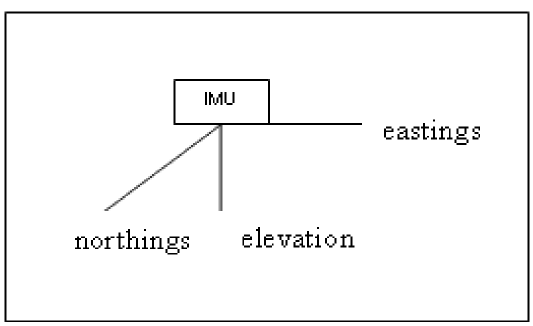


Figure 77: IMU Footprint

WESTLAKE Coordinate System

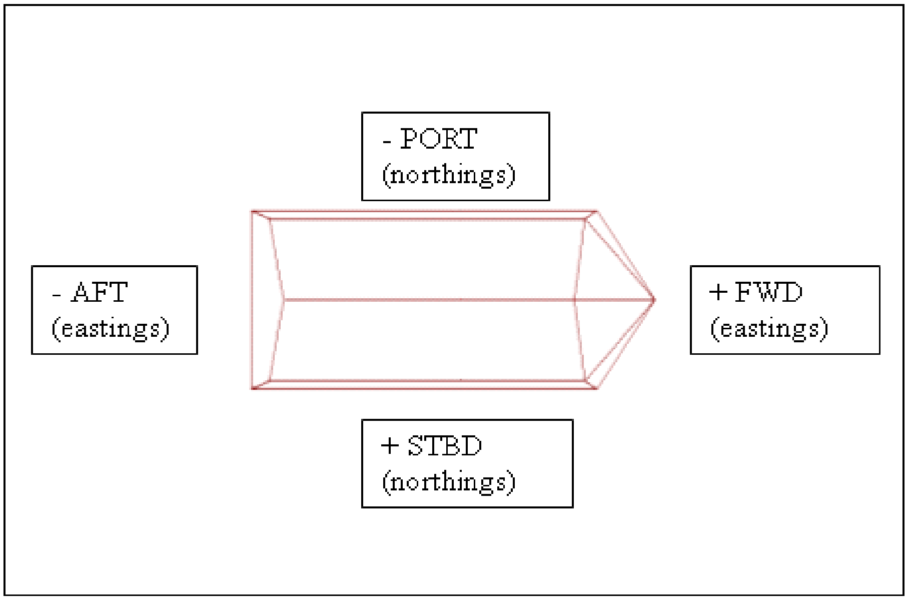


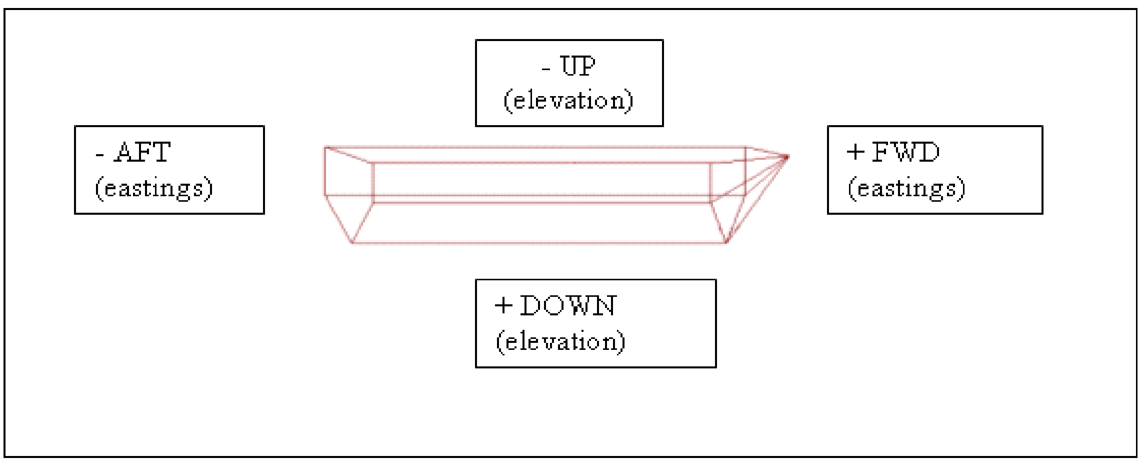


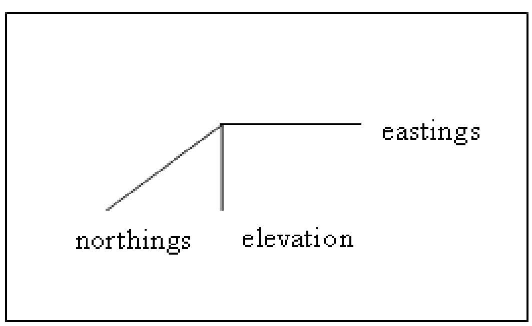


Bottom Center of IMU is origin of Westlake Coordinate System

NGS Coordinate System

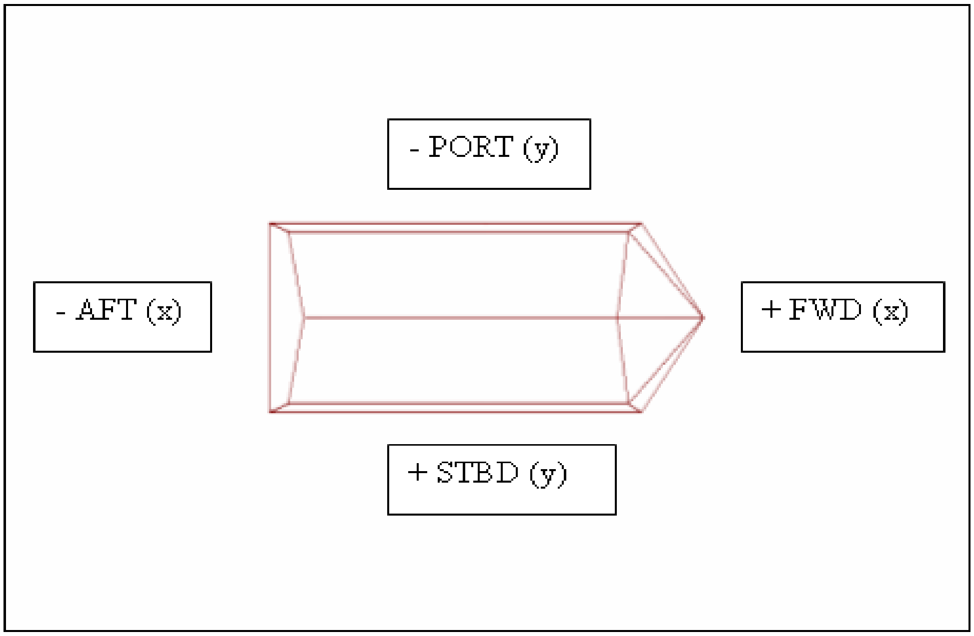


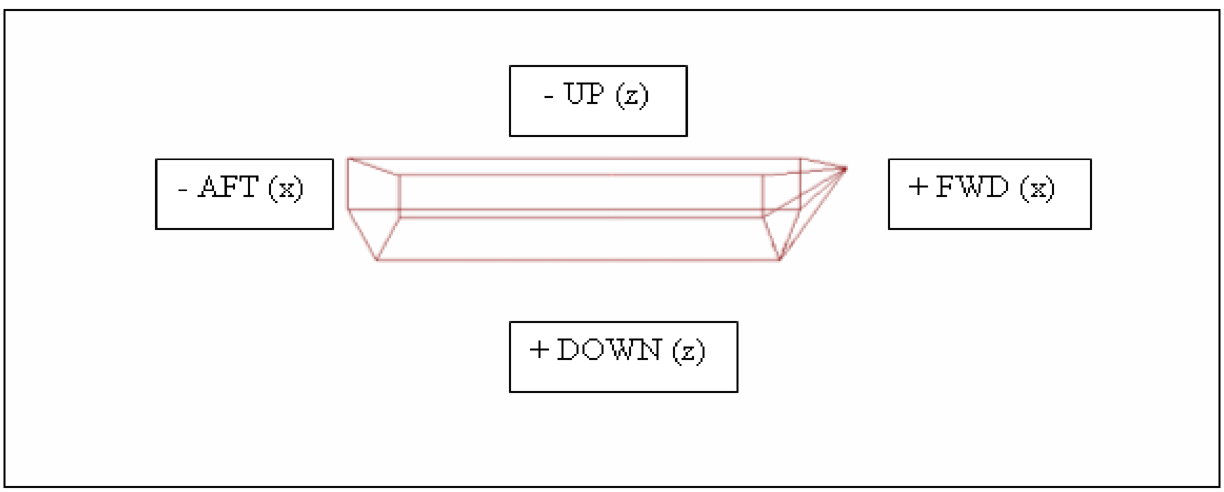


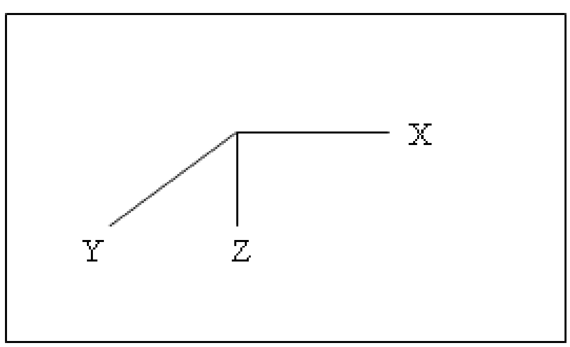


Top Center of IMU is origin of NGS Coordinate System

POS/MV Coordinate System

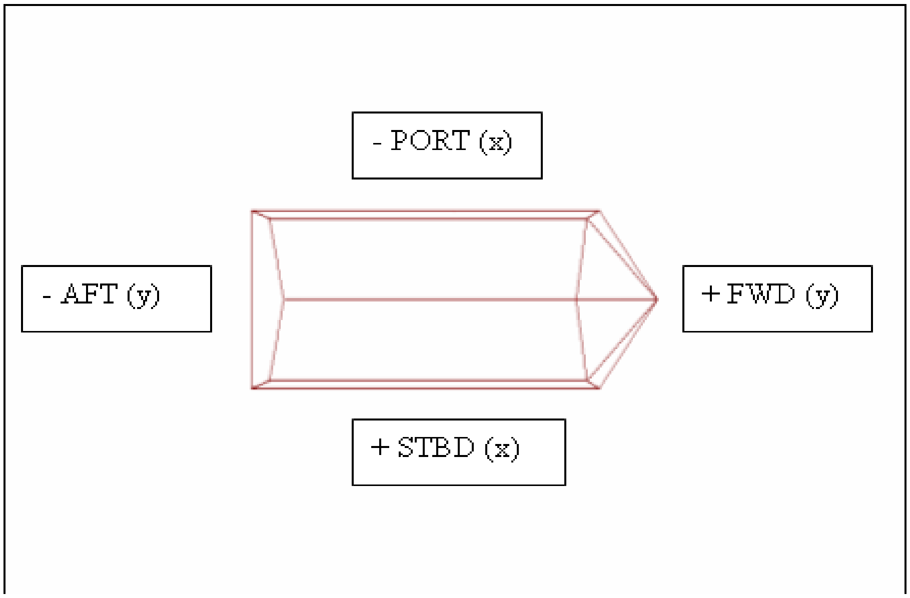


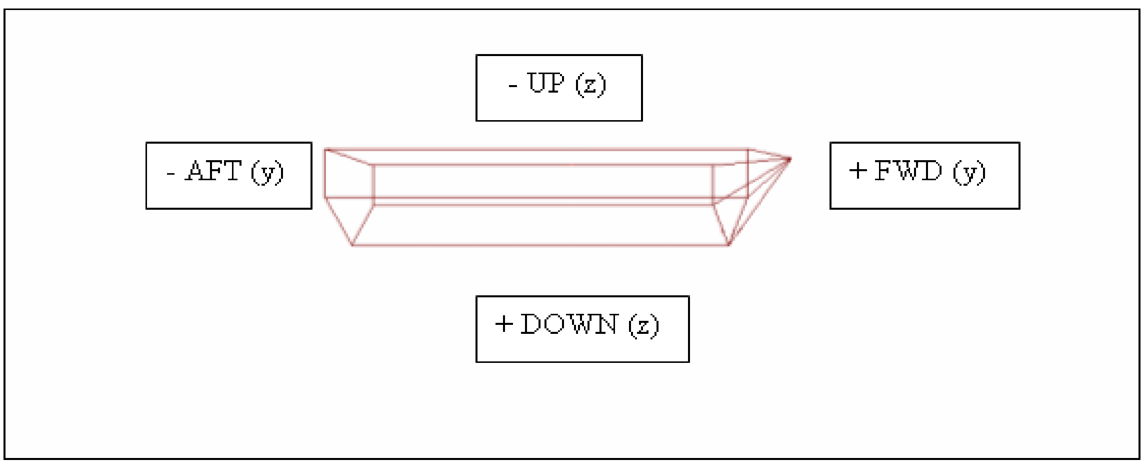


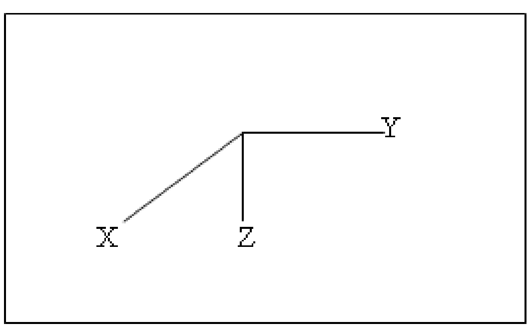


Top Center of IMU is origin of POS/MV Coordinate System

CARIS Coordinate System







Top Center of IMU is origin of CARIS Coordinate System

ENS Rice and CST Morgan
10/23/08

Depth Measurement of *FAIRWEATHER*'s Transducers and Keel with the DLDG and Leadline

Vertical offsets have been observed during the 2008 season between ship collected soundings and launch collected soundings. To check vertical offsets in the Caris HVF depth measurements were taken on the ship's transducers and keel under the IMU. These measurements were taken with the Diver's Least Depth Gauge (DLDG).

Since the DLDG has not been used this season, calibration measurements were also taken to check the accuracy of the DLDG. This was done by hanging a lead line from the ship and taking measurements at the leadline markings with the DLDG. Currents estimated at 0.5 knots were present during these measurements.

Table 1 shows the various measurements and their depth conversions. A comparison of the leadline to the DLDG measured depth shows offsets of approximately 0.16 meters.

Table 1: Measurements from the DLDG

Location	Pressure (psi)	Depth (meters)
2 meters (leadline)	17.60	Not converted
3 meters (leadline)	19.10	3.16
4 meters (leadline)	20.59	Not converted
5 meters (leadline)	22.04	5.18
6 meters (leadline)	23.50	Not converted
7 meters (leadline)	24.90	7.15
8 meters (leadline)	26.41	Not converted
Keel	20.63	4.19
8111	21.48	4.79
8160	21.12	4.55

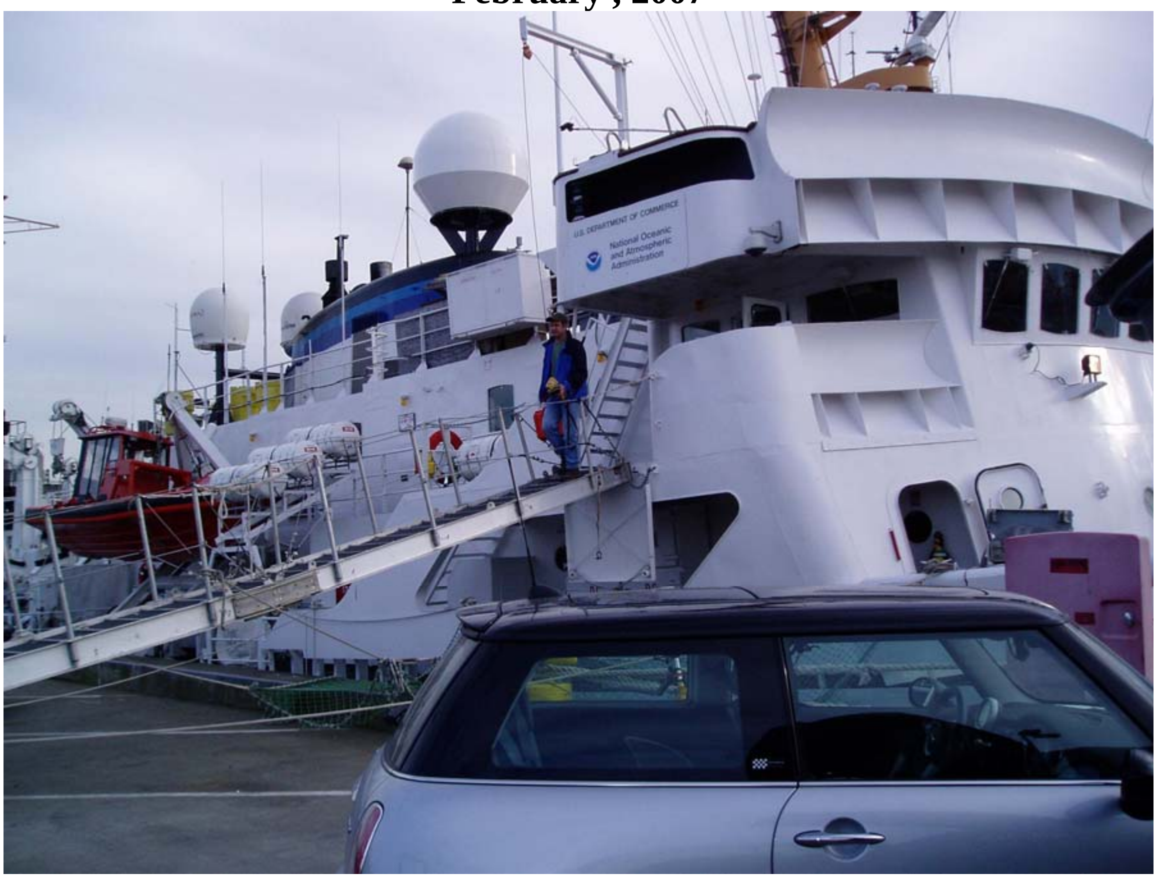
The leadline measurement for the waterline to keel was 4.1m with a difference from the DLDG measurement for the waterline to keel of 0.09m which is a difference that is within the level of accuracy of the measurements themselves.

Based on theses measurements and there agreement with each other and the 2007 waterline to keel measurement, the static draft offset was ruled out as the possible source for the discrepancy between the launches and the ship data.

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

Steven Breidenbach
February , 2007



<u>PRIMARY CONTACTS</u>

LT MARK VAN WAES NOAA (206) 526-6891

NOAA SHIP FAIRWEATHER
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

PURPOSE

The primary purpose of the survey was to accurately determine the spatial relationship of various components of a POS MV navigation system aboard the NOAA ship FAIRWEATHER. Reference points were also established to determine the spatial location of differential GPS antennas, Additionally, various reference points (bench marks) were restablished onboard the vessel to aid in future spatial surveys aboard the boat.

PROJECT DETAILS

This survey was conducted while the ship was docked at the USCG in Seattle, WA . The weather was cool with a steady breeze.

INSTRUMENTATION

The Topcon 3000LW total station was used to make all measurements.

Technical Data:

Angle Measurement

Smallest unit in display	0.1 seconds

Standard Deviation

Horizontal angle	1.0 seconds
Vertical angle	1.0 seconds
Distance measurement	2mm + 2ppm

A standard “peanut” prism was used as a sighting target. This prism was configured to have a zero mm offset.

PERSONNEL

Steve Breidenbach 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

ESTABLISHING THE REFERENCE FRAME

To conduct this survey a local coordinate reference frame was established where the X axis runs along the centerline of the boat and is positive from IMU towards the bow of the boat. The Y axis is perpendicular to the centerline of the boat (X axis) and is positive from IMU towards the right, when looking at the boat from the stern. The Z axis is positive in an upward direction from the IMU. In this reference frame the IMU has the following coordinates;
X = 100.000(m)
Y = 100.000(m)
Z = 100.000(m)

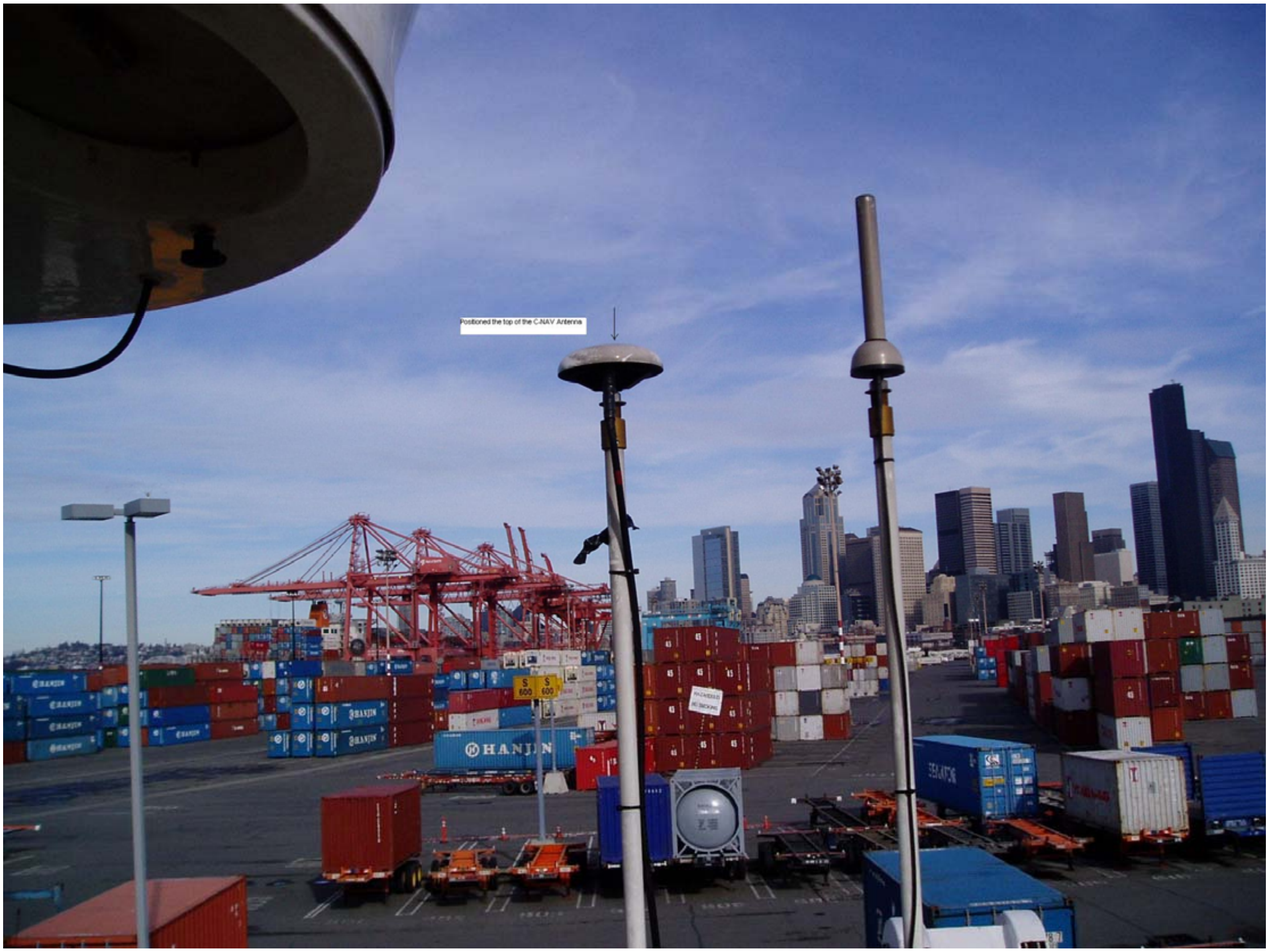
At the end of the survey all the coordinates were rotated to a right-handed coordinate system. The coordinates were translated to the IMU origin and the Granite Block origin.

DISCUSSION

I recommend conducting the survey again, once the ship is put into dry dock. Conducting a survey such as this while the boat is in the water 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 positions given for the IMU GPS antenna are to the bottom of the bolt as depicted on the photo below.

Position of the C-NAV Antenna



Point Summary Report				
Name	Std Dev n (m)	Std Dev e (m)	Std Dev Hz (m)	Std Dev u (m)
10FLOOR	0.003	0.003	0.004	0.002
11FLOOR	0.003	0.004	0.005	0.002
1CLEAT	0.004	0.018	0.019	0.002
1DECK	0.004	0.018	0.018	0.002
1FLOOR	0.000	0.000	0.000	0.000
1LOCKER	0.004	0.004	0.005	0.003
1RAIL	0.004	0.022	0.023	0.002
1WALL	0.003	0.002	0.004	0.001
1WALL3	0.003	0.003	0.004	0.002
2CLEAT	0.003	0.021	0.021	0.002
2CLEAT1	0.004	0.022	0.022	0.003
2FLOOR	0.001	0.001	0.001	0.001
2RAIL	0.004	0.022	0.022	0.002
2WALL	0.002	0.003	0.004	0.002
3ANT	0.003	0.006	0.007	0.003
3FLOOR	0.002	0.002	0.003	0.002
3WALL	0.003	0.003	0.005	0.002
4FLOOR	0.001	0.001	0.002	0.003
5FLOOR	0.002	0.004	0.005	0.001
6FLOOR	0.002	0.002	0.003	0.003
7FLOOR	0.005	0.003	0.006	0.002
8FLOOR	0.004	0.004	0.005	0.002
9FLOOR	0.002	0.013	0.013	0.003
ABOLT	0.003	0.026	0.026	0.003
ANT DECK	0.003	0.006	0.007	0.003

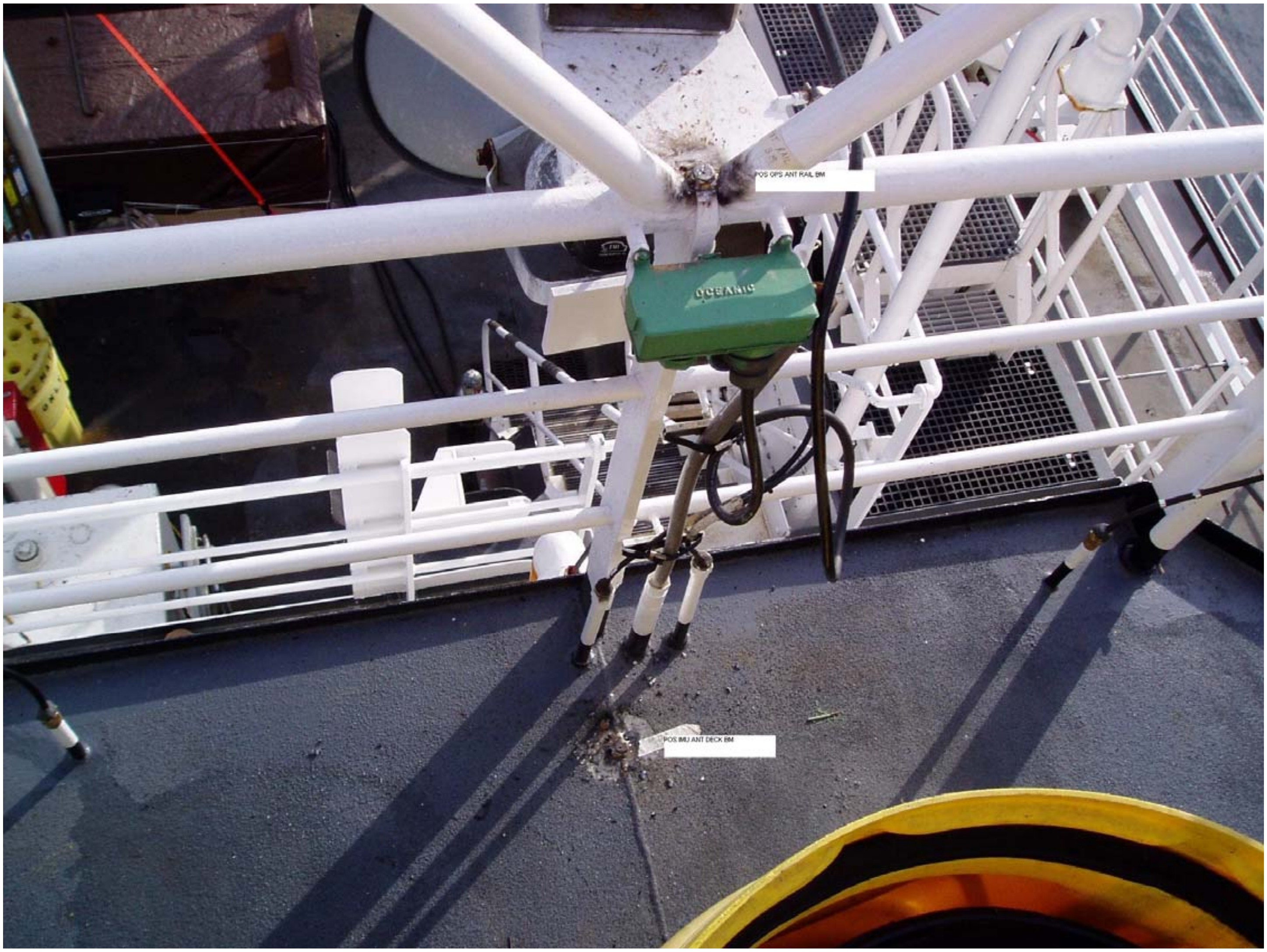
Name	Std Dev n (m)	Std Dev e (m)	Std Dev Hz (m)	Std Dev u (m)
ANT DECK BM	0.004	0.007	0.008	0.003
ANT PORT	0.003	0.007	0.008	0.003
ANT RAIL	0.004	0.006	0.007	0.003
ANT RAIL BM	0.003	0.007	0.007	0.003
ANT STAR	0.004	0.007	0.008	0.003
BOW BM	0.004	0.023	0.024	0.003
BOW BM2	0.004	0.023	0.023	0.003
BRIDGEPORT	0.005	0.011	0.012	0.003
BRIDGESTAR	0.005	0.011	0.012	0.003
BRIDGESTAR2	0.005	0.011	0.012	0.003
DOOR	0.001	0.001	0.002	0.001
GRANITE BOW	0.002	0.001	0.002	0.001
GRANITE CENTER	0.002	0.001	0.002	0.001
GRANITE PORT	0.002	0.001	0.002	0.001
GRANITE STAR	0.003	0.002	0.003	0.001
GRANITE STERN	0.002	0.001	0.002	0.001
IMU BM	0.003	0.001	0.003	0.003
IMU BOW PORT	0.002	0.001	0.002	0.001
IMU BOW STAR	0.002	0.001	0.002	0.001
IMU CENTER	0.000	0.000	0.000	0.000
IMU STERN PORT	0.002	0.001	0.002	0.001
IMU STERN STAR	0.002	0.001	0.002	0.001
LADDER	0.002	0.002	0.002	0.001
MVP BM	0.004	0.023	0.023	0.003
RAIL STAR	0.006	0.015	0.016	0.003
RAIL STAR1	0.004	0.005	0.007	0.003
RAILPORT	0.005	0.015	0.016	0.003

Name	Std Dev n (m)	Std Dev e (m)	Std Dev Hz (m)	Std Dev u (m)
RAILSTAR	0.005	0.015	0.016	0.003
STEARN BM	0.004	0.024	0.024	0.003
STERN BM	0.003	0.024	0.024	0.002

COORDINATES

IMU Origin			
Right-handed Coordinate System			
Name	**Easting (x) meters**	**Northing (y) meters**	**Elevation (z) meters**
IMU CENTER	0	0	0
IMU BOW PORT CORNER	0.073	-0.084	-0.006
IMU BOW STAR CORNER	0.071	0.088	-0.004
IMU STERN STAR CORNER	-0.068	0.089	-0.003
IMU STERN PORT CORNER	-0.065	-0.086	-0.006
GRANITE BOW	0.147	0.48	0.108
GRANITE STAR	-0.002	0.574	0.111
GRANITE STERN	-0.148	0.478	0.109
GRANITE PORT	-0.003	0.382	0.106
GRANITE CENTER	-0.002	0.477	0.108
IMU BM	0.034	-0.263	-0.496
STERN BM	-40.32	1.927	-2.184
MVP BM	-38.721	5.985	-2.018
STEARN BM	-40.313	1.921	-2.181
POS GPS ANT STARBOARD	-11.917	3.171	-12.936
POS GPS ANT PORT	-11.92	1.177	-12.98
A FRAME BOLT	-43.019	1.975	-7.142
POS GPS ANT RAIL BM	-12.037	2.101	-10.376
POS IMU ANT DECK BM	-11.823	2.07	-9.301
C-NAV ANT	-10.075	4.131	-11.377
BOW BM	28.346	2.077	-7.853

Granite Block Origin			
Right-handed Coordinate System			
Name	**Easting (x) meters**	**Northing (y) meters**	**Elevation (z) meters**
IMU CENTER	0.002	-0.477	-0.108
IMU BOW PORT CORNER	0.075	-0.561	-0.114
IMU BOW STARBOARD CORNER	0.073	-0.39	-0.112
IMU STERN STARBOARD CORNER	-0.065	-0.388	-0.111
IMU STERN PORT CORNER	-0.063	-0.563	-0.114
GRANITE BOW	0.149	0.003	0
GRANITE STAR	0	0.097	0.003
GRANITE STERN	-0.145	0.001	0.001
GRANITE PORT	0	-0.095	-0.002
GRANITE CENTER	0	0	0
IMU BM	0.036	-0.74	-0.604
STERN BM	-40.317	1.45	-2.292
MVP BM	-38.719	5.508	-2.126
STEARN BM	-40.31	1.444	-2.289
POS GPS ANT STARBOARD	-11.915	2.694	-13.044
POS GPS ANT PORT	-11.918	0.699	-13.088
A FRAME BOLT	-43.017	1.498	-7.25
POS GPS ANT RAIL BM	-12.034	1.623	-10.484
POS IMU ANT DECK BM	-11.821	1.593	-9.409
C-NAV ANT	-10.073	3.654	-11.485
BOW BM	28.349	1.6	-7.961



POS GPS RAIL BM AND POS GPS DECK BM

IMU BM

TRU-STONE Technologies

ISO 9002 Certified

Certificate of Accuracy

Customer Name: MCMASTER-CARR SUPPLY CO. **Customer PO#:** TA-28173060

Customer Address: 200 AURORA IND. PARKWAY
AURORA,OH 44202

Date of Calibration: 8/23/02
Product Description: GRANITE SURFACE PLATE
Size: 8" X 12" X 2"
Serial Number: 36961
Accuracy: Actual: .000075" Allowed: .0002"
Repeatability: Actual: .000055" Allowed: .00010"
Grade: B
Uncertainty of Measurement: $5.2\sqrt{D}$
M.O.E.: 7.5 x 10 6
Laboratory Conditions: Temperature: 69 °F Humidity: 51%

This product was inspected under environmentally controlled conditions. The electronic and optical gauging equipment used in inspecting this item has been calibrated and is traceable to the National Institute of Standards and Technology (NIST). Our calibration system is in compliance with ISO 10012-1.

Calibration Equipment Used in the Inspection of this Product:

Type of Equipment	*ID Number*	*Instrument Uncertainty*	*NIST Traceability Number*	*Cal. Due Date*
Autocollimator	IP 040	±0.5 arc sec	821/259488-97	6-03
.000020 Mahr Dial I	20990	50 µin	25894-1	6-03

Laboratory Manager Signature: Robert Day

Donald Schirmers, Lapping Manager
Robert Golla, Accessories Supervisor

REWORK / RECALIBRATION *(This section is completed for recertification orders only - accuracies upon receipt)*

Date of Receipt:
Accuracy of Incoming Product:
Repeat Measurement of Incoming Product:

☐ ***Was unable to read upon receipt due to poor condition of product***

The results on this Certificate of Accuracy apply only to the item described above. This report shall not be reproduced except in full and with the written authorization of our laboratory.

Measurement Uncertainty is expressed at a confidence level of 95% (coverage factor k=2)

Procedure Number: QP 4.10.1

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FINAL INSPECTION REPORT

Laboratory Name

TRU-STONE Technologies
1101 Prosper Drive • Box 430
Waite Park, MN 56387
PH: 320-251-7171 • FAX: 320-259-5073

Final Inspection

(1) Inspection Number: 0200851

(2) Inspection Date: 8-23-02

(3) Date of Receipt (rework items): ______

(4) Repeat Reading of Received Item: ______

(5) Accuracy of Received (rework) Item: ______

☐ Unable to Inspect – product in too poor of condition

(6) Customer Name: Menasha Corp

(7) Serial Number: 36961

(8) P.O. Number: IA-2617360

(9) Print/Part Number: ______

(10) Description of Item: 8x12x2 CB

(11) Granite Type: Impala

(12) Conditions at Time of Inspection: Temperature: 69 °F Humidity: 51

(13) Test Equipment:

Autocollimator Mirror Size: 3"

Type of Equipment	Serial Number	Calibration Due Date	Uncertainty of IMTE
Autocollimator ☑ Repeat-o-meter ☑	IP040	6-03	± 0.5 arc sec
Electronic Level ☐ Height Check ☐	2990	6-03	50 μin
Amp & Gauge Head ☐ Surfometer ☐			
Penta Prism ☐ Mikrokator ☐			
Other ______			

(14) Grade: (B) A AA N/A

(15) Overall Accuracy / Flatness (actual): .000075 (allowed): .0002

(16) Repeat Measurement (actual): .000055 (allowed): (.00010") B .000050" A .000025" AA N/A

(FIM: Full Indicator Movement)

(17) Final Inspector Signature: [signature]

(18) Opinion / Interpretation (if applicable): ______

(21) Thread Size, Quantity & Location to Print: Yes ______ No ______

(22) Insert / Hole / Slot Size, Quantity & Location to Print: Yes ______ No ______

19-23 Are Not Applicable – No Inserts ☑

(23) Inspector Signature: ______

Existing inserts are not inspected on reworks and/or calibration items.

The results of this inspection apply only to the item described above. This report shall not be reproduced, except in full, with the written approval of our laboratory. Measurement uncertainty is expressed at a confidence level of 95% (coverage factor k=2).

Shipping

(19) Threaded Inserts: Yes ______ No ______ (20) Clean: Yes ✓ No ______

Packaging Conforms to Company and Customer Requirements: Yes ✓ No ______

TRU-STONE Technologies

Save IMPORTANT DOCUMENT Save

Tru-Stone Technologies
Instructions for Care of Granite Surface Plates

1. **Cleaning and Moisture:** Plates shall be cleaned thoroughly and given adequate time to dry before testing for tolerance. Water based cleansers that have not dried will cause iron parts to rust if they are left in contact with the wet surface for an extended period of time. It is recommended that plates undergo drying time in a room with less than 50 percent relative humidity. Temperature and dirt have a direct correlation with measurement accuracy. Personal cleanliness will aid in eliminating one source of contamination.
2. **Temperature Soaking Time:** Before granite surface plates are measured for work surface flatness, the granite should remain in the calibration area until it has reached room temperature, which may require 2 to 3 days. Large plates require more soak-out time than smaller ones.
3. **Scratches and Nicks**: Whenever scratches and nicks appear on granite plates, the resulting rough edges should be removed with a flat granite dressing plate. Any bump that shatters the surface raises fractured material at the rim of the crater.
4. **Rotation of Plates:** When a specific work surface area receives prolonged usage, it is suggested that the plate and stand be rotated 180 degrees on a periodic basis to increase the wear life of the plate. The production of a contour map during calibration is particularly helpful in locating the parts of the plate that should be given the most use. This can be accomplished by requesting a long form certification when ordering the new surface plate or when the plate is being sent in for recalibration.
5. **Periodic Recalibration:** Periodic recalibration of granite surface plates is recommended to determine resurfacing or replacement needs. The interval between calibrations will vary with the grade of plate and the wear resistance of the granite. TRU-STONE CONFORMS TO ISO 9000 CERTIFICATION REQUIREMENTS FOR VENDORS. Frequent monitoring of the work surface by scanning it with the repeat gage is desirable. When these results differ from those marked on the replaceable sticker, you should recalibrate the plate. In addition to measuring the overall accuracy of a surface, smaller areas can be checked for localized variations often missed by the calibrating methods. Remember precision measurements are only as accurate as the measuring tools used.
6. **Torque on THREADED Inserts:** Do not exceed the following maximum torque values when using a torque wrench to limit distorting the work surface and pulling the insert. The following torque values are the maximum level permissible by the Federal Specification GGG-P-463c.

PERMISSIBLE TORQUE CLAMPING ON THREDED INSERTS

Thread Size	*Torque*
.250 inch	7 ft. lbs.
.3125 inch	15 ft. lbs.
.375 inch	20 ft. lbs.
.500 inch	25 ft. lbs.

7. **Clamping Ledges on Grade AA Surface Plates:** There is danger of distorting the work surface flatness beyond tolerance when a heavy item rests on the ledge or an item is clamped to the ledge. Ledges are not only expensive, but a great cause of inaccuracy. Experimentation and research reveal that no-ledge plates retain their accuracy better than ledged plates.
8. **Supports:** There are working and loading conditions where the standard three point supports are not satisfactory. These cases should be individually engineered. When four or more supports are used, shims or adjusting screws are necessary for proper support. The supports could be spotted under the loading points and set to approximately equal the loading. Sometimes the work surface flatness can be improved by shifting support positions. Fulcrum, air and hydraulic supports are available. Whenever nonstandard supports are used, the surface plate shall be calibrated at the site for compliance to the flatness tolerance.

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9. **Care:**
   - Utilize the full surface of a plate so the wear is distributed and not concentrated in one area.
   - The surface plate should not be overloaded.
   - Use extreme care in moving the item being measured and the gages being used.
   - Place on the surface ONLY what is required.
   - Particularly avoid heavy contact with the edges.
   - Don't leave metal objects on the surface longer than necessary.
   - Clean the surface before and after use.

Remember that the condition of this accurate plane is an integral factor in the measurement being made.

NOTE:

Surface plate cleaner can be purchased through your local Tru-Stone distributor or directly from Tru-Stone Technologies. Call for pricing and delivery information.

When the need for recalibration or rework of your surface plates and precision granite accessories arises, contact a Tru-Stone representative or call us directly for more details on restoring your inspection item to a "like new" condition. This service comes with new certification and plate labels.

One advantage of having your granite inspection equipment recalibrated by a manufacturer is the manufacturer's ability to take the time required to ensure the proper repeatability and overall shape of the inspection surface. Tru-Stone allows the item to normalize overnight prior to taking the final readings to indicate whether it is a good enough quality to certify and return to you.

Should you have any questions, please contact our customer service representatives at 320/251-7171 or fax us at 320/259-5073.

Important Notice

Any streaks of color in the granite are not defects. These are created by the molten lava mixing with minerals prior to evolving into the granite you see today. Black streaks or spots are the result of a magnetite (black iron oxide) concentration. White streaks or spots are areas where the granite is lacking magnetite. The levels of magnetite in granite vary considerably, however the color of the granite in no way affects the functionality or quality of it.

Our products are UNCONDITIONALLY Guaranteed

Please refer to the Federal Specification GGG-P-463c, which is followed by NIST (National Institute of Standards & Technology) for Granite Surface Plates.

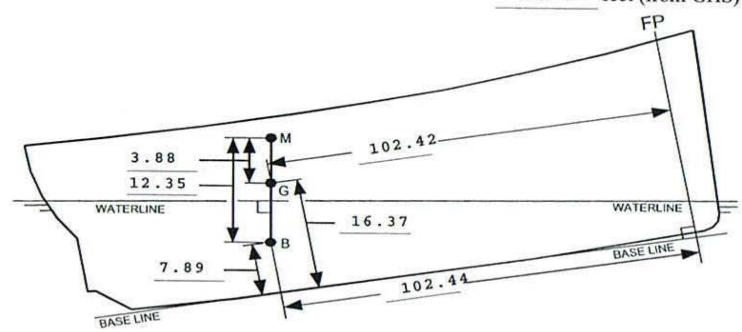
- "3.7 Seams or Color Streaks: *Seams are cause for rejection. Color streaks have no affect on the serviceability of the granite."*
- "4.5.8 Seams or Color Streaks: *Test for a seam is to wet the smooth surface of the granite where the color streak appears; then dry it off. If the streak remains wet or damp, it is a seam."*

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	$C = \frac{T\,GM}{B}$	______	



7/25/2004 6:05 AM

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 that created 10 mm offset =.03281 feet*			**0.001**
			-0.001
			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 from level
Elevation checks near four corners of granite block				
** elevation check adjusted for target that created 10 mm offset = 0.03281 feet*			**-0.217**	-0.001
			-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
Horizontal alignment *measured* on fixture plate scribe -				*parallel*
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			
				deviation from
Elevation checks near four corners of array foundation "fixture plate"				*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'

	ELEVATION
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 to calculated array centerline		***1.624***		
				deviation from level
Elevation checks near four corners of array foundation				
			14.679	0.002
0.861 feet below baseline with 0.965 foot offset = 98.180 feet average elevation			**14.675**	-0.001
			14.675	-0.001
			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 8111
Vessel

4\24\2008	115	Moira Sound
Date	Dn	Local Area

Ringel, Campbell, Morgan, Argento, Wozumi
Calibrating Hydrographer(s)

Reson 8111	Fairweather	N/A
MBES System	MBES System Location	Date of most recent EED/Factory Check

N/A	35652
Sonar Serial Number	Processing Unit Serial Number
Hull	Spring 2007
Sonar Mounting Configuration	Date of current offset measurement/verification
POSMV 320 v.4	4/24/2008
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

4/24/2008	115	Moira Sound	Clear, cool, calm
Date	Dn	Local Area	Wx

rocky	
Bottom Type	Approximate Water Depth

Uozumi, Argento
Personnel on board

Comments

TH_S220_115, S220_115_TH(?)
TrueHeave filename

115.001	4:58	55/04/31	131/57/47	132.8	172.64
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
115.003	15:47	55/04/47	131/58/54	84.1	109.3
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
115.004	11:13	55/04/58	131/58/12	65.3	84.9
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

RESON Error at about 5:45 local time, Reson Power LED dim, and readings went wonky. HeadTemp value fluctuates between
Attempted cast after roll lines but unable to retrieve fish. Pulled by hand.

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	Roll_SE_A	137	4Kt	off line ~15 meters
	Roll_NW_A	317	4kt	off line ~15 meters
	Roll_SE_B	137	4kt	right on line
	Roll_NW_B	317	4Kt	right on line

PITCH

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	Pitch_NW_B	045	7.0	
	Pitch_SW_B	225		
	HeadingB_SW_C	225		Run as heading line
	HeadingB_SW_B	225		Run as heading line
	Pitch_NE_			

HEADING/YAW

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	HeadingA_NE_A			Shoalest point not acquired
	HeadingB_SW_A	225	8.5	good data, set 2
	HeadingA_NE_B			good data, set 2
	HeadingB_SW_B	225	8.7	no good, ran over shoalest point, not pararell to other lin
	HeadingC_NE_C	045		
	HeadingB_SW_C			no good, ran over shoalest point, good for pitch
	HeadingD_NE_A	045		good data, set 1
115.003	HeadingC_SW_B	225		good data, set 1

NAV TIME LATENCY

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
115.003	Latency_NE_3kt	045	3Kt	
	Latency_SW_3kt	225	3Kt	
	Latency_NE_12kt	045	12Kt	
	Latency_SW_12kt	225	12Kt	

Processing Log

4/25/2007	116	Campbell
Date	Dn	Personnel

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

☑ **TrueHeave applied** bcc

☑ **SVP applied** bcc

☑ **Tide applied** bcc

Zone file Patch_Test.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)
Argento	0.00	-0.28	0.02	-0.20
Campbell	-0.04	-0.20	0.03	-0.30
CST	0.00	-0.60	0.02	-0.70
Wozumi	0.00	-0.34	0.04	-0.25
FOO	0.00	-0.62	0.03	-0.30
Averages	-0.01	-0.41	0.03	-0.35
Standard Deviation	0.02	0.19	0.01	0.20
FINAL VALUES	0.00	-0.41	0.03	-0.35
Final Values based on	Concensus	Average	Average	Average

Resulting HVF File Name FA_S220_Reson8111.hvf

MRU Align StdDev gyro 0.20 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.10 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

Patch test lines for the Reson 8111 were run on April 24th and 25th, 2008. Procedures for the test followed those outlined in the Patch Test Procedures SOP and the 2008 FPM. Lines for Pitch, Heading/Yaw, Roll and Nav Time Latency were run over appropriate features in the entrance to Moira Sound, along the SE portion of Prince of Wales Island, in SE Alaska. Following acquisition the data were converted in CARIS, True heave, Sound Velocity and Tides were applied, and the data was merged. Gross flyers were removed using Swath Editor. The data were then analyzed by 5 independant evaluators using the CARIS HIPS Calibration Utility. Based on the results of the evaluations the final values for use in updating the Hydrographic Vessel File were approved by the FOO, the Chief Survey Tech and Toshi Wozumi from PHB.

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

Name: Matthew Ringel LT/NOAA **Date:** 21 May 2008

FAIRWEATHER

Multibeam Echosounder Calibration

S220 8160	Vessel

6/1/2008 and 6/13/2008	153/165	Moira Sound, Clarence Strait
Date	Dn	Local Area

Johnston
Calibrating Hydrographer(s)

Reson 8160	Fairweather	N/A
MBES System	MBES System Location	Date of most recent EED/Factory Check

N/A	35385
Sonar Serial Number	Processing Unit Serial Number
Hull	Spring 2007
Sonar Mounting Configuration	Date of current offset measurement/verification
POSMV 320 v.4	4/24/2008
Description of Positioning System	Date of most recent positioning system calibration

Acquisition Log

6/1/2008	153	Moira Sound, Clarence Strait			
Date	Dn	Local Area	Wx		

Rocky	18 to 150 meters
Bottom Type	Approximate Water Depth

Campbell, Johnston, Argento, Bucher
Personnel on board

SV casts done with MVP.
Comments

TH_8160_Patch_154
TrueHeave filename

153_001					
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
153_002					
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

ROLL

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
153_001	Roll1, roll2	292	6.0	roll 1 is small. Roll 2 is most of line. DO NOT USE
	roll3			do not use. Aborted line. DO NOT USE
	Roll4	150	4.9	good line, a little off on NW end. DO NOT USE
	Roll5	294	6.0	Good line.
	Roll6			do not use. Aborted line.
	Roll7	148	5.1	good but off about 20m to the NW end.
8160_Roll_Patch_DN165	ROLL1			GOOD LINE, SOME SLOPING IN OUTERBEAMS
	ROLL2			GOOD LINE, SOME SLOPING IN OUTERBEAMS

PITCH

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
153_001	PITCH1	044	5.7	Was supposed to be heading but can be used for pitch i
153_002	PITCH2	043	6.6	no good for pitch. May work as a heading line if needed
	PITCH3	223	4.4	Good line
	PITCH4	046	5.5	Should be good over the feature. Off on the ends.
	PITCH5	224	4.3	Good line.

HEADING/YAW

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
153_001	Heading1			Line no good. Aborted.
	Heading2	052	6.1	Probably not good. Do not use.
	Heading3			The feature was captured in the outerbeam, but the trac
	Heading4	052		Looked good
	Heading5	222		Run to starbord next time. Appeared to be directly over
	Heading6	222	4.8	Data looks good. Some features detected. Not sure ab
	Heading7	052	5.5	Good outer beam feature
	Heading8	228	5.0	Pretty good outer beam feature as above.

NAV TIME LATENCY

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
153_002	LATENCY.XTF	040	4.0	good line
	LATENCY1.XTF	220	4.0	good line
	LATENCY2.XTF	040	11.0	bad line
	LATENCY3.XTF	220	11.0	33m starbird of line over feature
	LATENCY4.XTF	040	11.0	good line
	LATENCY5.XTF	220	11.0	good line

Processing Log

6/3/2008	156	Argento
Date	Dn	Personnel

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

☑ **TrueHeave applied** H:\2008_Data\Testing_2008\S220_Patch_Test\Dn 153\TH_8160_Patch_154.000
H:\2008_Data\Testing_2008\S220_Patch_Test\DN 165_Roll_Lines\TH_220_165.000

☑ **SVP applied** I:\2008_Processed_Data\SVP\Testing_2008\8160_Patch_Test_153\8160_PATCH_Concat.svp
I:\2008_Processed_Data\SVP\Testing_2008\8160_Patch_Test_153\8160_Roll_Patch_DN165.svp

☑ **Tide applied** I:\2008_Processed_Data\Tide\Testing_2008\Predicted\9450460_8160.tid (Dn153)

Zone file O322FA2008_CORP.zdf (Dn 165 ROLL1 and ROLL2)

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)
Argento	-0.01	-0.80		0.30
Bucher		-0.50		0.30
Johnston	0.00	-0.35	-0.37	0.14
Campbell	-0.01		-0.27	0.08
Ringel	0.00	-0.28		0.30
Rice	0.00	-0.50		
Renoud			-0.07	
Outlier values removed:	-0.03	0.00	1.00	-0.30
Averages	0.00	-0.49	-0.24	0.22
Standard Deviation	0.01	0.20	0.15	0.11
FINAL VALUES				

Final Values based on Argento (L/P/Y), Bucher (P), Johnston (L/P/R/Y), Campbell (L/R/Y), Ringel (L/P/Y), Rice (L/P), Reno

Resulting HVF File Name FA_S220_Reson8160_5to750.hvf (2008-153)

MRU Align StdDev gyro 0.11 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

Roll Values from the first patch test were way too high and were causing large offsets and artifacts in the data. 2 additional roll lines were run on the 8160 near the Chatham Strait Project on DN 165. Running the roll lines in deeper water yielded more accurate calibration numbers. See the next tab for Roll values from DN 165. Roll lines from DN153 were not used to calculate the roll bias. Lines ROLL1 and ROLL2 from DN165 near Chatham Sound Project were used to calibrate roll.

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

Name: Bonnie Johnston **Date:** 6/14/2008

FAIRWEATHER S220 Settlement & Squat (DDSSM method)

SHIP DDSSM DATA ACQUISITION FORM

Wind s 15knts
Seas 1-2 ft

Date 4/14/2006
Vessel # S220
Average Depth 25m

DN 104
Location Bellingham, WA
Personnel Froelich, Castle, VanWaes

RPM	Speed	Az	Isis Line Name	Acquisiton Comments
0	0	0	STOP1/STOP2	Fat finger logged two lines
0	0	180	STOP5	
0	0	180	STOP6	
132	4.7	180	DDSSM1	
135	6.1	180	DDSSM2	
135	7.2	180	DDSSM3	
135	8.1	180	DDSSM4	
135	9.1	180	DDSSM5	
135	10.3	180	DDSSM6	Corrupted file
155	11.6	180	DDSSM7	
175	12.9	180	DDSSM13	

DDSSM Processing Log

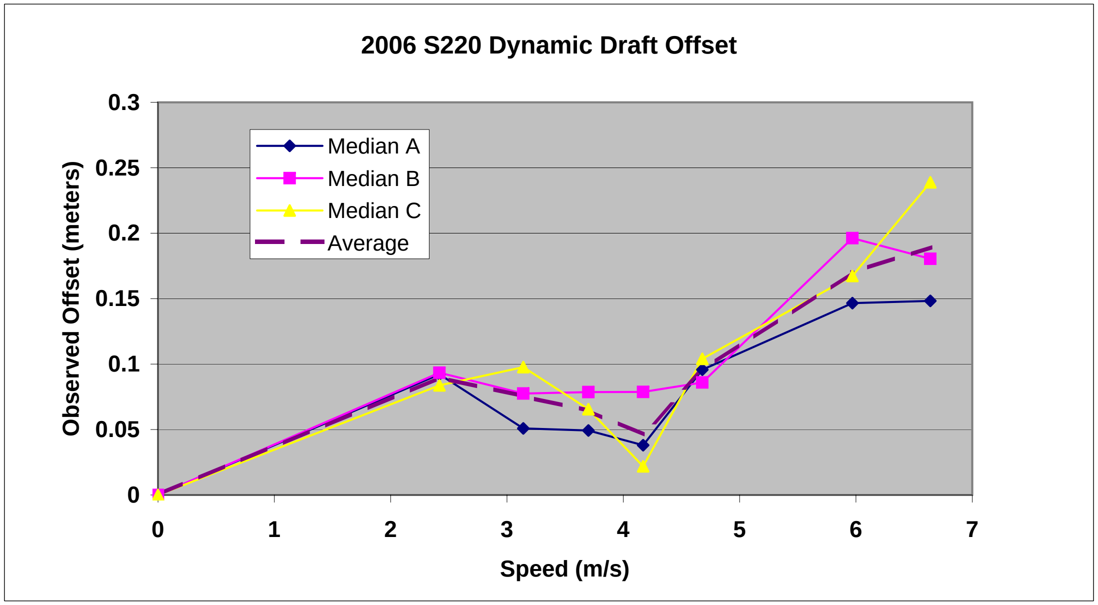
S220-8111
Vessel

4/14/2006	104
Date	Dn

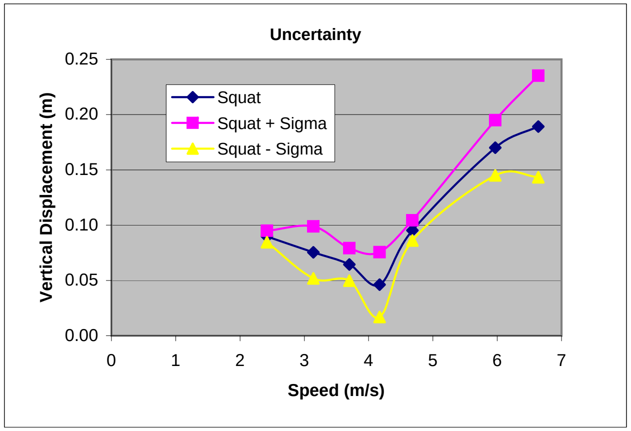
- [x] **Data converted --> HDCS_Data in CARIS**
- [x] **TrueHeave applied** TH_S220_104
- [x] **SVP applied** 06104212.svp
- [x] **Tide applied** 9449424.tid, 9449880.tid
  - [x] **Zoned** N161RA2005CORP.zdf
- [x] **Lines merged**
  - [x] **Data cleaned to remove gross fliers**
  - [ ] **Filtered 40/40**

2006 FAIRWEATHER S220 Settlement & Squat (DDSSM method)

RPM	Speed (m/s)	Speed (knots)	MedianA	MedianB	MedianC	Std. Dev.	Squat	Squat + Sigma	Squat - Sigma
	0.00	0	0	0	0	0	**0.00**		
132	**2.42**	4.7	0.092	0.093	0.084	0.005	**0.09**	0.095	0.085
135	**3.14**	6.1	0.051	0.077	0.098	0.023	**0.08**	0.099	0.052
135	**3.7**	7.2	0.049	0.079	0.066	0.015	**0.06**	0.079	0.050
135	**4.17**	8.1	0.038	0.079	0.022	0.029	**0.05**	0.076	0.017
135	**4.68**	9.1	0.096	0.086	0.104	0.009	**0.10**	0.104	0.086
155	**5.97**	11.6	0.147	0.196	0.167	0.025	**0.17**	0.195	0.145
175	**6.64**	12.9	0.148	0.180	0.239	0.046	**0.19**	0.235	0.143



Values used for 2008



SHIP DDSSM DATA ACQUISITION FORM

Date 4/24/2008
Vessel # S220
Average Depth 69F

DN 115
Location Moira
Personnel Campbell,FOO (8-12), CST, Bucher (12-4), Argento,Uozumi (4-8

Wind calm
Seas flat

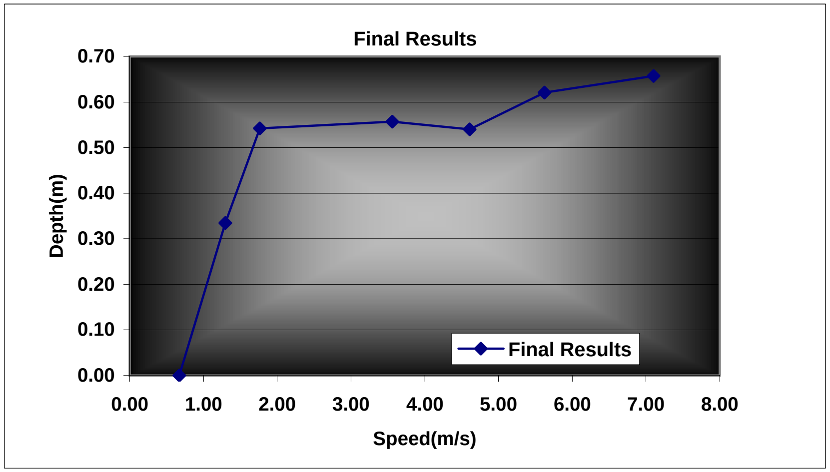
RPM	Speed	Az	Isis Line Name	Acquisition Comments
120/10	2	NW	DDSSM_NW_2kt_1	115-0605 (renamed), deleted small mistake line 115-0617
120/10	2	SE	DDSSM_SE_2kt_2	
180/100	13	NW	DDSSM_NW_13kt_3	
120/20	4	SE	DDSSM_SE_4kt_4	mis-named NW, renamed
120/20	4	NW	DDSSM_NW_4kt_5	
160/80	10	SE	DDSSM_SE_10kt_6	re-run, offline at southern end
140/50	6	NW	DDSSM_NW_6kt_7	
140/50	6	SE	DDSSM_SE_6kt_8	
160/80	10	NW	DDSSM_NW_10kt_9	
180/100	13	SE	DDSSM_SE_13kt_10	2 lines created by mistake (SE_13KT_11,12), delete
150/60	8	NW	DDSSM_NW_8kt_11	
150/60	8	SE	DDSSM_SE_8kt_12	
		STOP1	DDSSM_STOP1_A	NE, initially NW logged perpendicular to main scheme
		STOP2	DDSSM_STOP2_A	Midpoint
		STOP3	DDSSM_STOP3_A	SE Point
160/80	10	SE STOP4	DDSSM_SE_10kt_13 DDSSM_STOP3_B	rerun of line 6

DDSSM Processing Log

S220-8111		
Vessel		
Date:5/1/2008	DN:122	Processors: Campbell

- [x] **Data converted --> HDCS_Data in CARIS**
- [x] **TrueHeave applied** — TH_S220_115; S220_115_TH
- [x] **SVP applied** — Patch_S220_115_SV
- [x] **Tide applied** — 9450460 (preliminary)
  - [x] **Zoned** — Patch_Test.zdf
- [x] **Lines merged**
  - [x] **Data cleaned to remove gross fliers**
  - [ ] **Filtered 40/40**

Graph of Final Results (A,C)   (*Note* B included in chart and table to right)



Final Results S220 2008 Dn 115 testing
(average of A andC combined medians)

Speed (knots)	Speed (m/s)	Depth Difference	Std. Dev.
1.30	0.67	0.00	0
2.52	1.30	0.33	0.095
3.43	1.76	0.54	0.128
6.92	3.56	0.56	0.103
8.96	4.61	0.54	0.101
10.93	5.62	0.62	0.091
13.81	7.10	0.66	0.129
		Avg:	0.1104

SHIP DDSSM DATA ACQUISITION FORM

Date 10/25/2008
Vessel # S220
Average Depth

DN 299
Location NW Union Bay, Ernest Sd
Personnel Argento, Beduhn, Bucher, Campbell

Wind 12kts
Seas c, 1ft

RPM	Speed	Az	Isis Line Name	Acquisition Comments
120/10	1.5	SE	2kts_SE.xtf	Good Run
120/10	2	NW	2kts_NW.xtf	Good run
120/30	3.3	SE	4kts_SE.xtf	Good Run
120/30	3.67	NW	4kts_NW.xtf	A little to port ~10m, wide at NW end. okay
140/50	6	SE	6kts_SE.xtf	Good run
140/50	6	NW	6kts_NW.xtf	wide at SE start. okay
150/60	8	SE	8kts_SE.xtf	A little to port and starboard ~10m, wide each way at NW end
150/60	8	NW	8kts_NW.xtf	A little to port at NW corner of line, ~8m
160/80	10	SE	10kts_SE.xtf	Good Run
160/80	10.8	NW	10kts_NW.xtf	Good Run
180/94	13.6	SE	14kts_SE.xtf	
180/94	14	NW	14kts_NW.xtf	
		STOP1		
		STOP2		
		STOP3		
		STOP4		

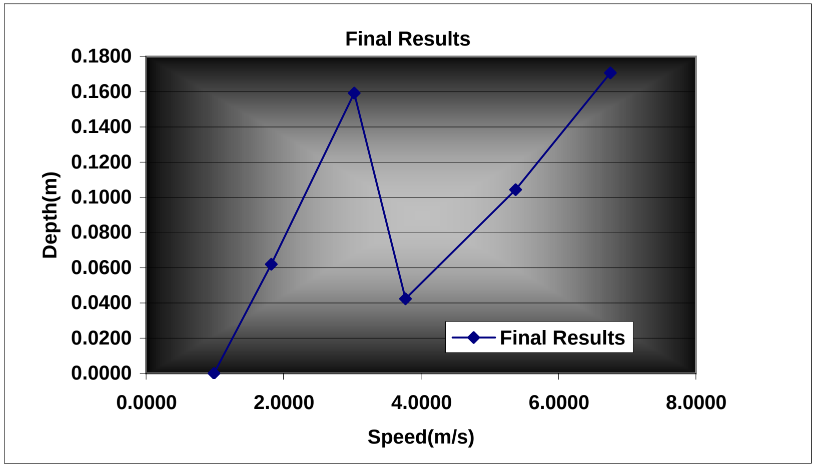
DDSSM Processing Log

S220-8111	Vessel

Date:10/25/08	DN: 299	Processors: Argento

- ☑ **Data converted --> HDCS_Data in CARIS**
- ☑ **TrueHeave applied** POS_TH_S220_2008_299.000
- ☑ **SVP applied** DDSSM_S220_Dn299.svp
- ☑ **Tide applied** Preliminary
  - ☑ **Zoned** O119FA2008CORP.zdf
- ☑ **Lines merged**
  - ☑ **Data cleaned to remove gross fliers**
  - ☑ **Filtered 40/40**

Graph of Final Results (A,2A,B,C)



Final Results S220 2008 Dn 299 testing
(average of A,2A,B, and C combined medians)

Speed (m/s)	Depth Difference	Std. Dev.
0.9880	0.0000	0.0000
1.8212	0.0619	0.0320
3.0297	0.1593	0.0290
3.7733	0.0423	0.0300
5.3779	0.1044	0.0410
6.7578	0.1708	0.0460
	Avg:	0.0356

NOAA POS/MV Calibration Report

Ship: FAIRWEATHER **Vessel:** S220

Date: 4/24/2008 **Dn:** 115

Personnel: Campbell

PCS Serial # 2411 **IMU Serial #** 292

IP Address: 129.100.1.231

POS controller Version (Use Menu Help > About) 3.3.2.2

POS Version (Use Menu View > Statistics) Version 4

GPS Receivers

Primary Receiver: BD950 SN:4611A66708 v.00211

Secondary Receiver: BD950 SN:4602A62806 v.00211

Calibration area

Location: Moria Sound, SE Alaska

Approximate Position:

Lat	55	4	50
Lon	131	58	34.2

DGPS Beacon Station: Annette

Frequency: 323

Satellite Constellation

(Use View> GPS Data)

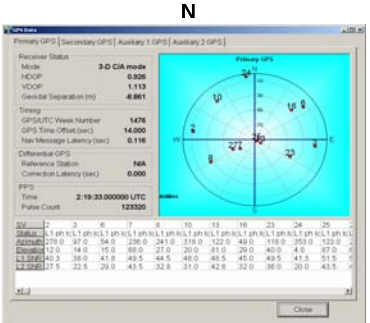
Primary GPS

Sketch general SV configuration or insert screen grabs

N

HDOP 0.926

VDOP 1.113



Sattelites in use: 12

L1 SNR > 30 35 40

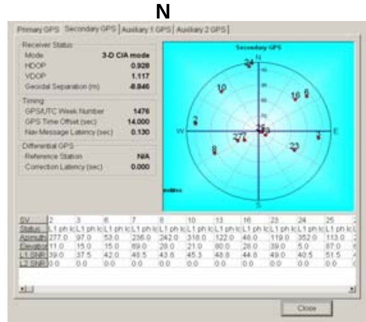
Secondary GPS

Note any differences from Primary GPS Receiver

N

HDOP 0.928

VDOP 1.117



Sattelites in use: 12

L1 SNR > 30 35 40

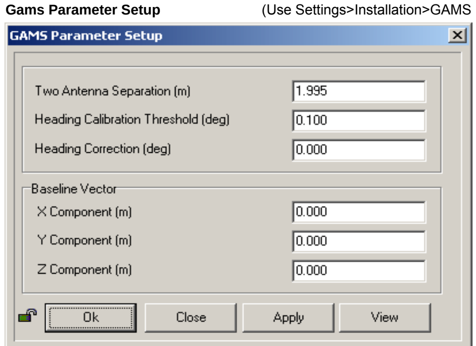
PDOP ______

(Use View> GAMS Solution)

POS/MV Configuration

Settings

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



Configuration Notes: Antenna separation based on 2007 survey.

POS/MV Calibration

Calibration Procedure:

(Refer to POS MV V3 Installation and Operation Guide, 4-25)

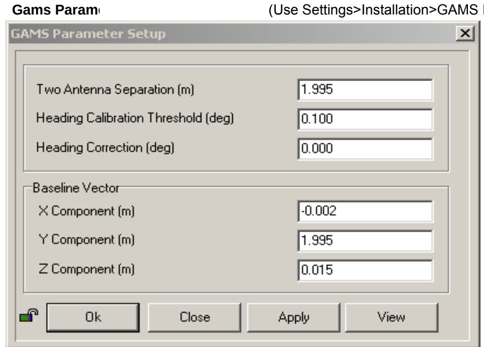
Start time: 2:16

End time: 2:41

Heading accuracy achieved for calibration: 0.398

Calibration Results:

Gams Param (Use Settings>Installation>GAMS Installation)



GAMS Status Online Yes

Save Settings Yes

Calibration Notes:

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

File Name:

General Notes:

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

The right-hand orthogonal system defines the following:

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

The POS/MV uses a Tate-Bryant Rotation Sequence

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

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

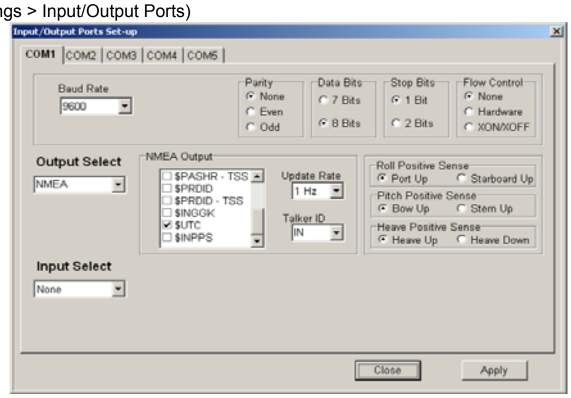
b) Pitch rotation - apply a right-hand screw rotation θy about the once-rotated y-axis to align one frame with the other.

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

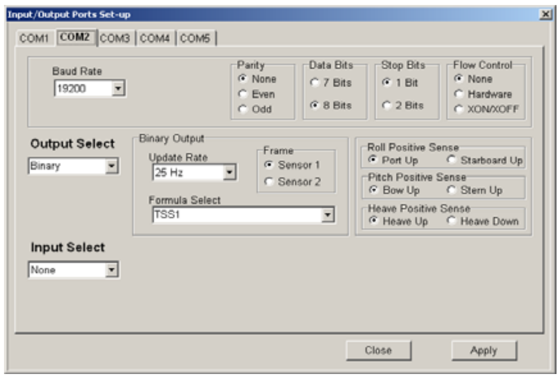
SETTINGS

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

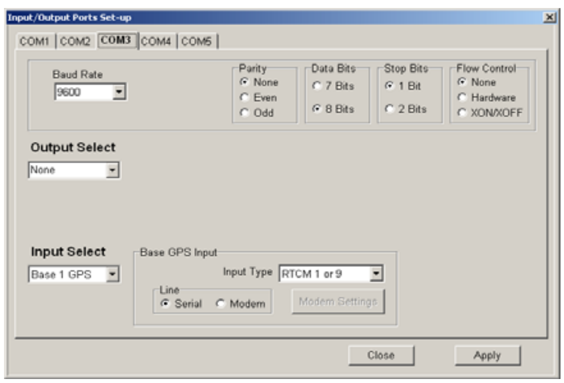
COM1



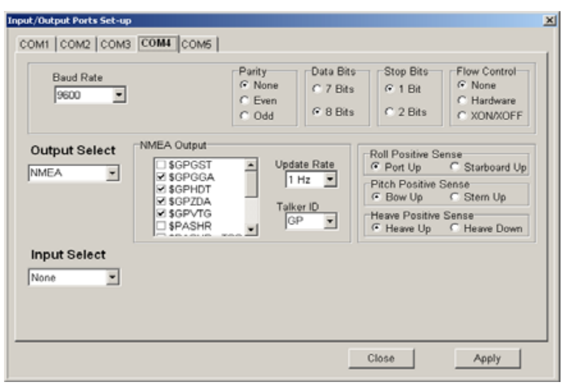
COM2



COM3

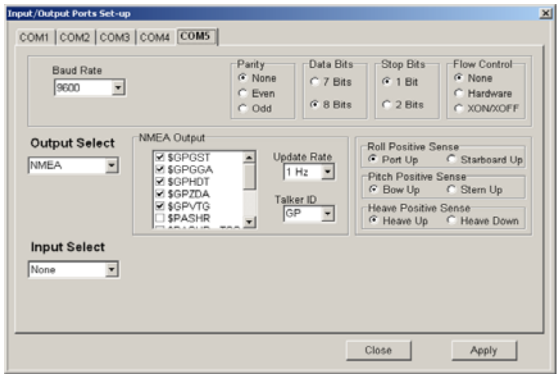


COM4

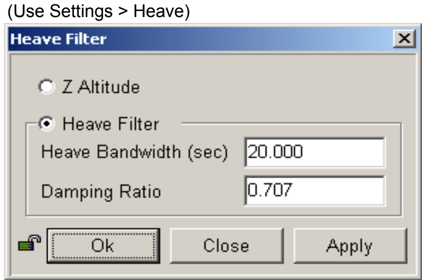


SETTINGS Continued

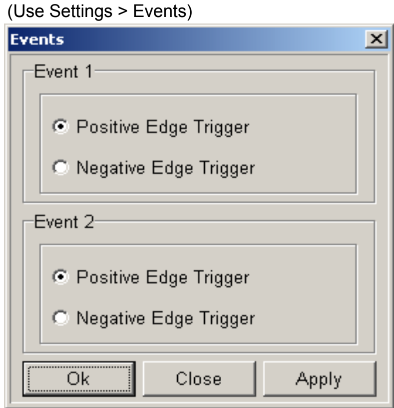
COM5



Heave Filter (Use Settings > Heave)



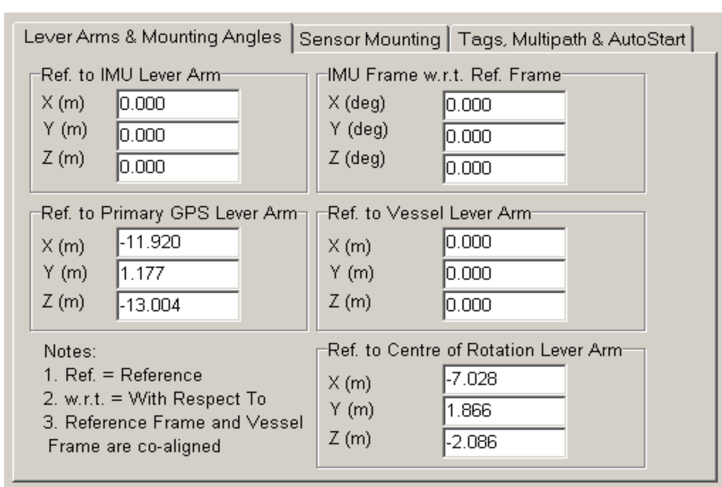
Events (Use Settings > Events)



INSTALLATION

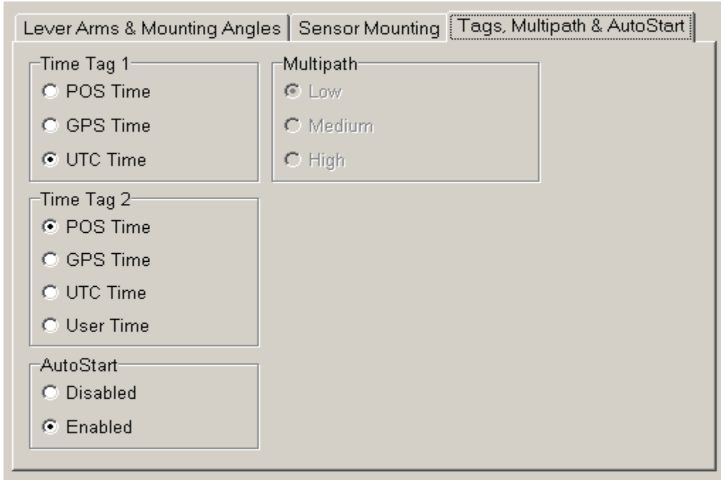
(Use Settings > Installation)

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

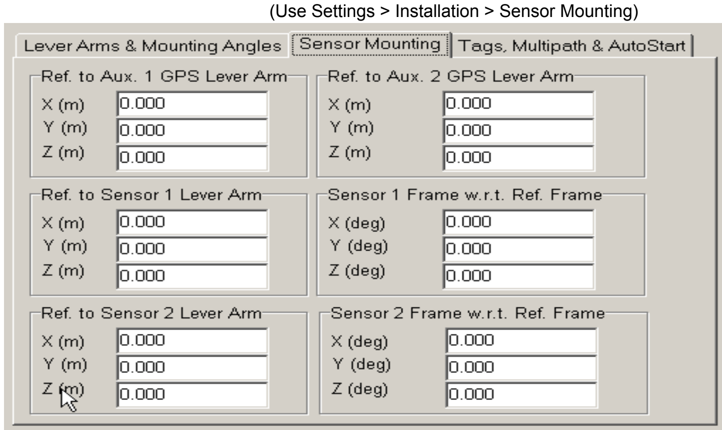


INSTALLATION Continued

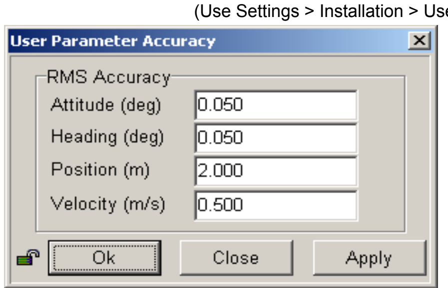
Tags, Multipath and Auto Start (Use Settings > Installation > Tags, Multipath and Auto Start)



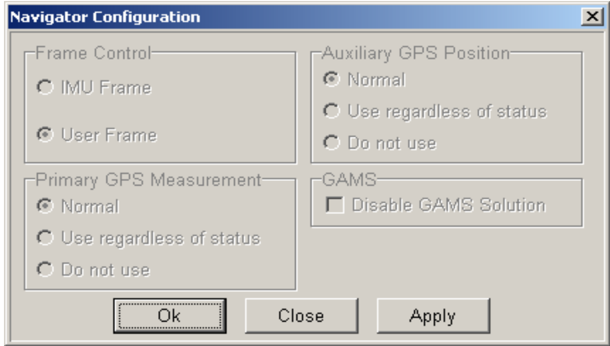
Sensor Mounting (Use Settings > Installation > Sensor Mounting)



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



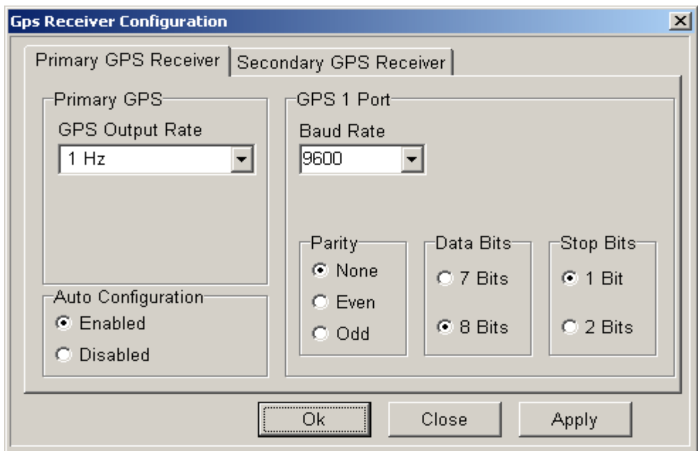
Frame Control (Use Tools > Config)



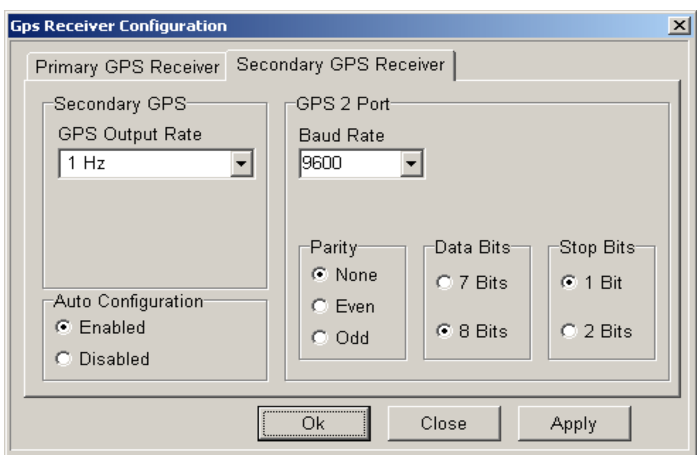
(Use Settings> Installation> GPS Receiver Configuration)

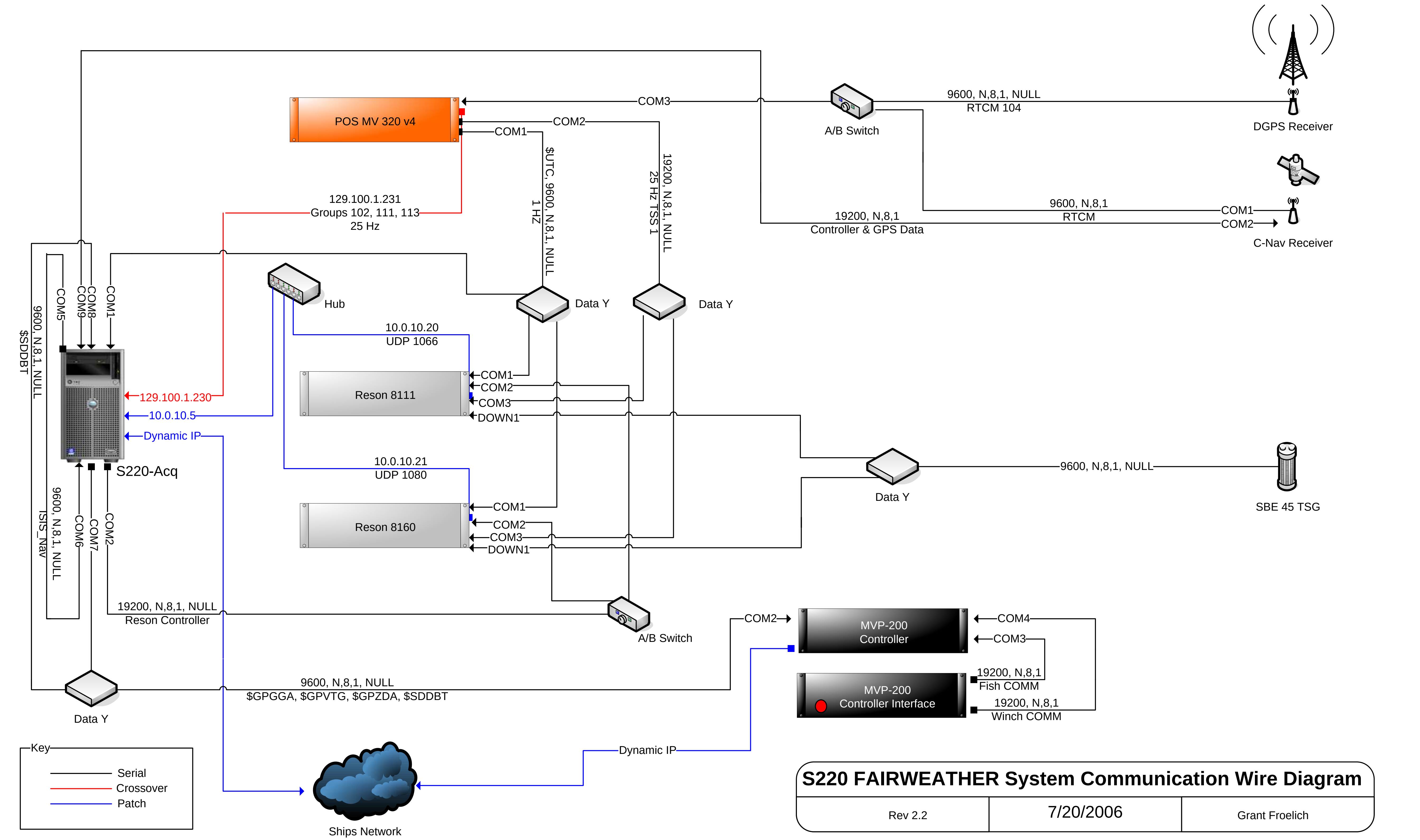
GPS Receiver Configuration

Primary GPS Receiver

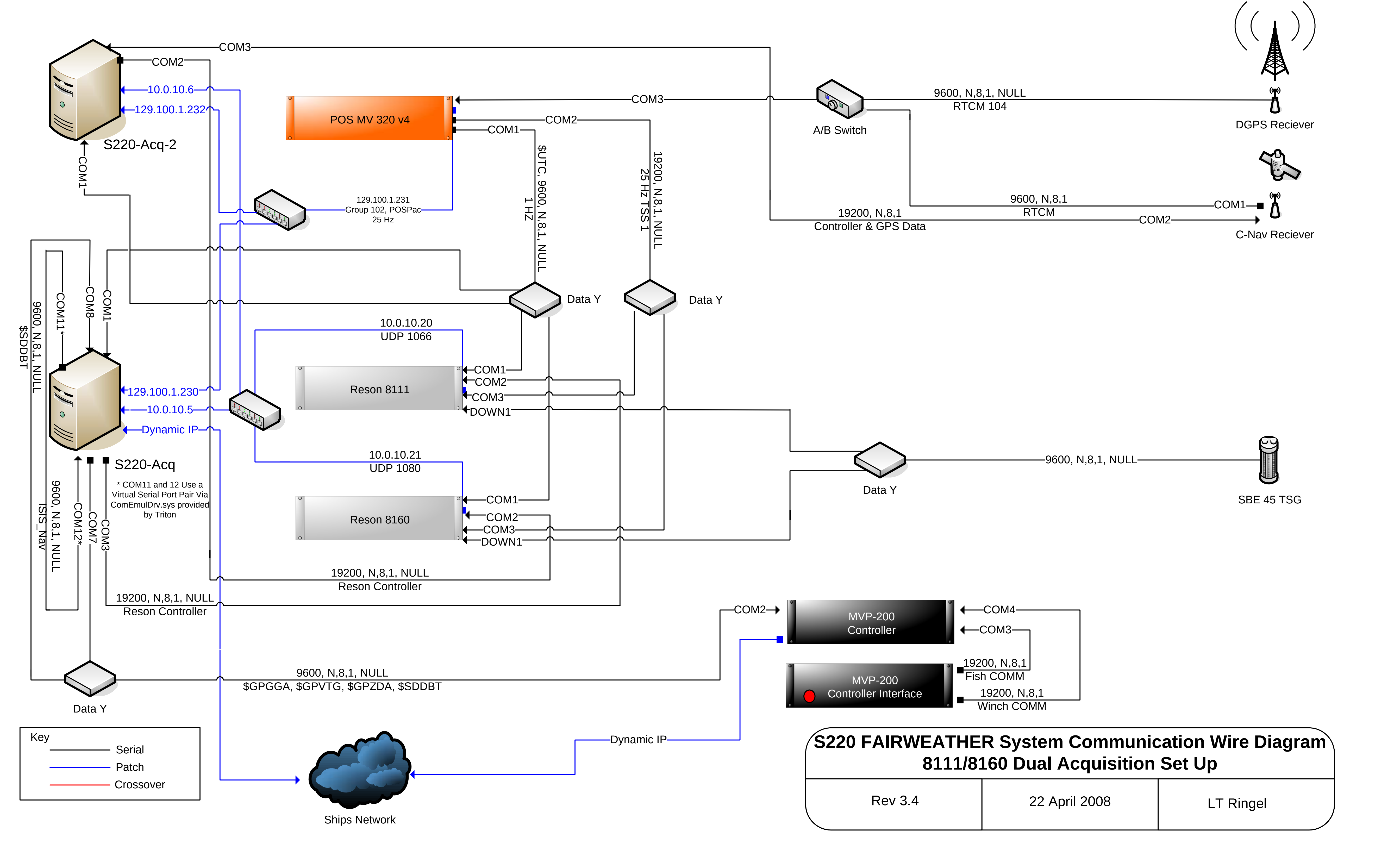


Secondary GPS Receiver





S220 FAIRWEATHER System Communication Wire Diagram		
Rev 2.2	7/20/2006	Grant Froelich


S220 FAIRWEATHER System Communication Wire Diagram
8111/8160 Dual Acquisition Set Up
Rev 3.4
22 April 2008
LT Ringel
S220-Acq-2
S220-Acq
COM3
COM2
10.0.10.6
129.100.1.232
COM1
POS MV 320 v4
COM3
COM2
COM1
129.100.1.231
Group 102, POSPac
25 Hz
$UTC, 9600, N,8,1, NULL
1 HZ
19200, N,8,1, NULL
25 Hz TSS 1
A/B Switch
9600, N,8,1, NULL
RTCM 104
DGPS Reciever
9600, N,8,1
RTCM
COM1
19200, N,8,1
Controller & GPS Data
COM2
C-Nav Reciever
Data Y
Data Y
COM11*
COM8
COM1
9600, N,8,1, NULL
$SDDBT
10.0.10.20
UDP 1066
Reson 8111
COM1
COM2
COM3
DOWN1
129.100.1.230
10.0.10.5
Dynamic IP
10.0.10.21
UDP 1080
Reson 8160
COM1
COM2
COM3
DOWN1
Data Y
9600, N,8,1, NULL
SBE 45 TSG
* COM11 and 12 Use a Virtual Serial Port Pair Via ComEmulDrv.sys provided by Triton
9600, N,8,1, NULL
ISIS_Nav
COM12*
COM7
COM3
19200, N,8,1, NULL
Reson Controller
19200, N,8,1, NULL
Reson Controller
COM2
MVP-200
Controller
COM4
COM3
MVP-200
Controller Interface
19200, N,8,1
Fish COMM
19200, N,8,1
Winch COMM
Data Y
9600, N,8,1, NULL
$GPGGA, $GPVTG, $GPZDA, $SDDBT
Dynamic IP
Ships Network
Key
Serial
Patch
Crossover

RESON

SeaBat 8160 Noise Analysis

1.0 Overview

For mid and deep water sonar systems, noise emanating from the vessel on which the sonar is mounted is a major determinant in the performance of the sonar. In addition to sources such as echosounders and other acoustic devices, such as doppler logs, mechanical noise from the engines and drive trains, and flow noise will also affect performance, with the magnitude of the noise varying with vessel speed.

This document describes the noise analysis test done on the RESON SeaBat 8160 installed on the NOAA S/V Fairweather, on 10 October 2004.

2.0 Test Conduct

The following is a description of the system setup and test protocol used to test the SeaBat 8160 multibeam sonar.

2.1 Sonar Setup

To determine the amount of in-band noise seen by the sonar, the system was configured as follows:

Setting	Value
Power	Off
Gain	Manual Fixed 20
Range	100 meters

Data collection was done using a RESON engineering utility, which collects the full amplitude and phase time series data from the sonar. Figure 1 shows a sample screen capture, in this case one of the data sets taken at six knots, with a shaft speed of 140 RPM. At least ten (10) collections were done for each test case, and the results for first 10 measurements each test case were averaged for the report.

2.2 Vessel Operation

Normal survey speed for the vessel is approximately 10 knots. To bracket this range, and to check at possible lower survey speeds, the test was defined to cover the range of 2 to 12 knots, in 2 knot steps. The initial tests were at a shaft speed of 130 RPM, with the speed adjusted by changing the pitch on the propellers. Additional tests were run at shaft speeds of 140 and 150 RPM, with the pitch adjusted to achieve speeds of 6, 8 and 10 knots. A log of data collections for the tests is provided in Appendix A.

All the underway data collections were done in water depths of 200 to 300 meters. The zero speed data collections were done at anchor, in water depths of about 30 meters.

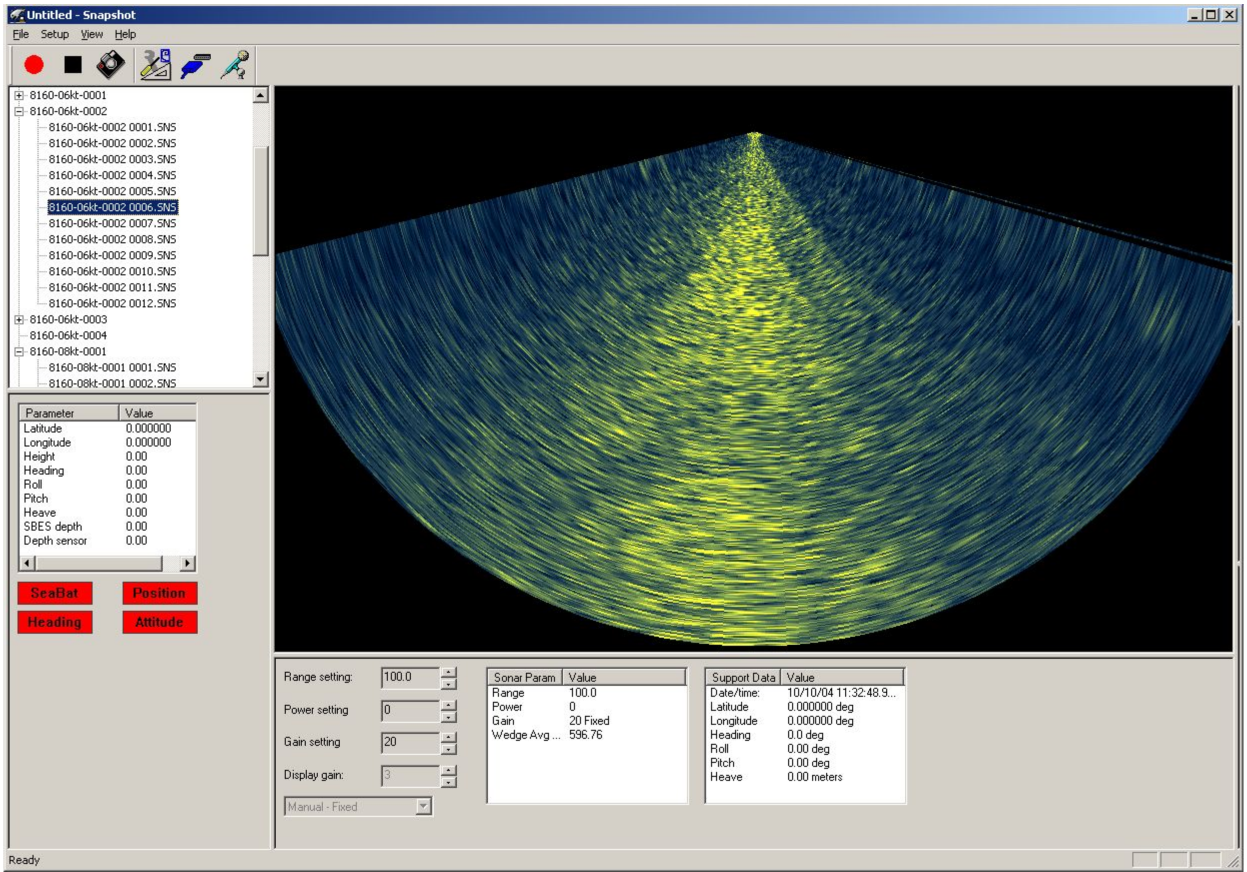


Figure 1 - Snapshot Utility Screen Capture

2.3 Data Analysis

The data from each of the test cases were collated in an Excel spreadsheet, shown in Appendix B. A graph of the measured noise levels, as a function of vessel speed and shaft RPM is shown in Figure 2. The noise level is a unitless value that represents the average of all the amplitude samples, from all the beams for the sampled sonar ping. This value represents a combination of the electrical noise in the sonar, and the response to all acoustic energy, within the bandwidth of the sonar, impinging on the receive array.

For each the 130, 140 and 150 RPM tests, the plot shows the noise level as a function of vessel speed. Only one sample was taken at 160 RPM, since to achieve the 12 knot speed, it was necessary to run at that RPM, with the pitch set to maximum test value of 10 feet.

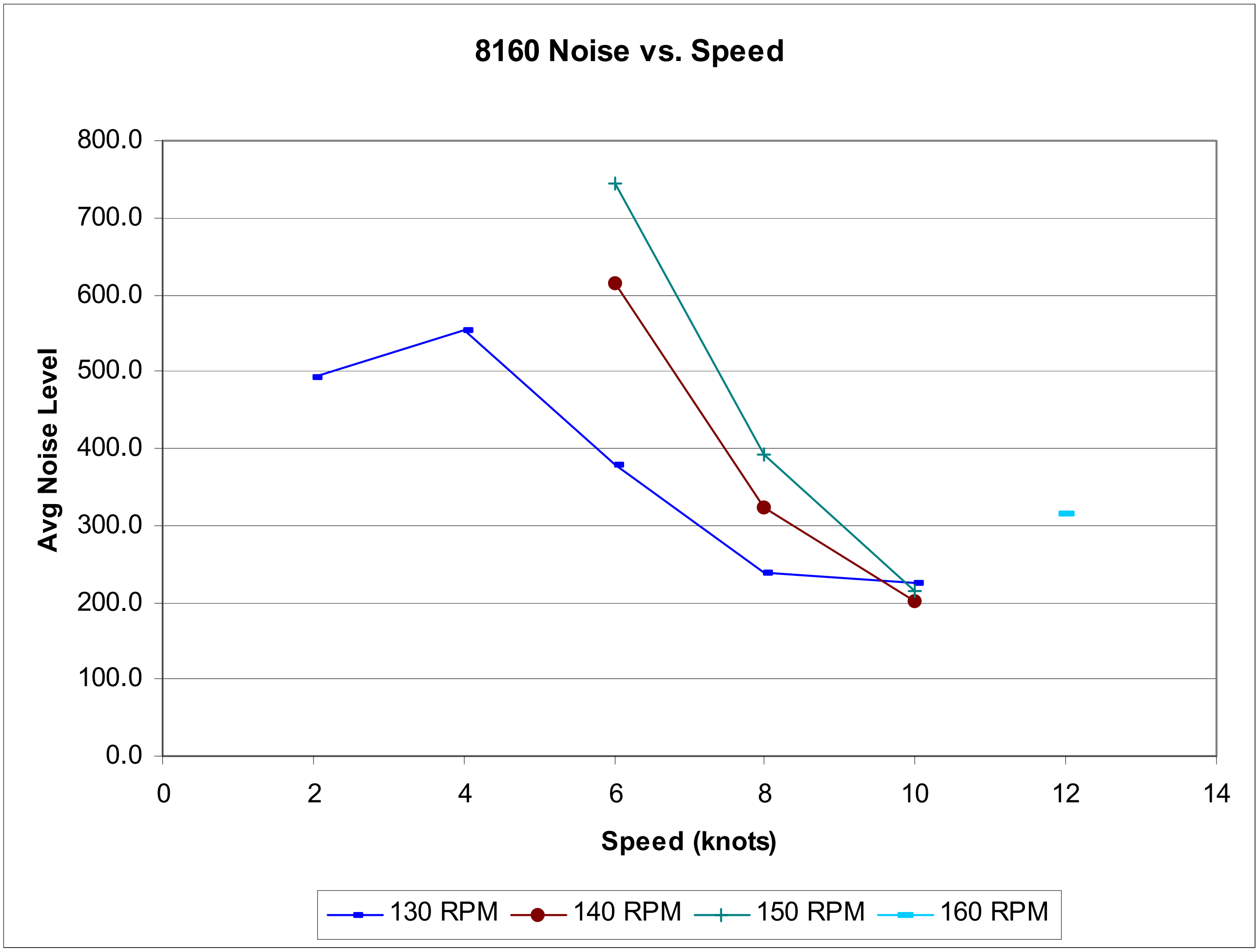


Figure 2 - Noise Plot

3.0 Conclusions

a. It appears that the best survey speed, from a noise perspective, is at approximately 10 knots. Both lower and higher speeds correlate with higher noise levels.
b. For lower survey speeds, it would be desirable to use a lower shaft RPM, combined with a higher pitch setting, to minimize the noise level seen by the sonar.
c. The reason for the higher noise levels seen in the zero speed, at anchor collections is undetermined, by may be a result of the much shallower operating depth, and increased reverberation of vessel mechanical noise reflected off the bottom.

RESON

Appendix A – Test Log

RESON Inc.					
Date:	10/10/2004	**Survey Area:**	Rudyerd Bay, AK	**Page / Pages:**	
Survey Name:	8160 Noise Test	**Surveyors:**	B Bridge	**TimeZone:**	-9
Survey Vessel:	NOAA Fairweather	**Client:**	NOAA		

Offset Information

	X	Y	Z	Latency	Roll	Pitch	Yaw
Sounder							
DGPS							
Motion Sensor							
Other							

SVP File:
Tide File

Date of Patch Test

Total Pole
minus Dry Pole
Draft (Z)

Start	Stop	Line	Dir.	Speed	COMMENTS
		8160-00kt-0002		0	At anchor, engines off - Gain Fixed 20, Pwr Off Rng100
		8160-00kt-eng_on0001		0	Engines turned on
		8160-02kt-0001		2	sog 2.5 stw 1.7 rpm 130@1.5 feet pitch
		8160-04kt-0001		4	sog 4.0 stw 3.0 rpm 130@4.0 feet pitch
		8160-06kt-0001		6	sog 6.0 stw 5.0 rpm 130@6.0 feet pitch
		8160-08kt-0001		8	sog 8.0 stw 7.0 rpm 130@8.0 feet pitch
		8160-10kt-0001		10	sog 10.0 stw 8.5 rpm 130@10.0 feet pitch
		8160-12kt-0001		12	sog 12.0 stw 10.5 rpm 160@10.0 feet pitch
		8160-06kt-0002		6.5	sog 6.0 stw 5.0 rpm 140@5.0 feet pitch
		8160-08kt-0002		8	sog 8.0 stw 7.0 rpm 140@7.0 feet pitch
		8160-10kt-0002		10	sog 10.0 stw 8.5 rpm 140@9.5 feet pitch
		8160-10kt-0003		10	sog 10.0 stw 8.5 rpm 150@9.0 feet pitch
		8160-08kt-0003		8	sog 8.0 stw 7.0 rpm 150@6.5 feet pitch
		8160-06kt-0003		6	sog 6.0 stw 5.0 rpm 150@4.5 feet pitch

Survey Manager:		Client Representative:	
Signature:		Signature:	

Appendix B – Noise Analysis Spreadsheet

8160 Noise Test Results.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	8160 Noise Test Results												
2													
3	Speed	Pitch (ft)	1	2	3	4	5	6	7	8	9	10	Average
4	Eng Off												
5	0		407.4	409.7	406.2	414.0	414.5	416.3	417.4	418.6	417.4	417.8	413.9
6	Eng On												
7	0		1449.6	1363.7	1373.6	1393.3	1495.8	1656.9	1714.9	1597.3	1606.3	1829.4	1548.1
8													
9	130 RPM												
10	2	1.5	500.6	519.0	486.3	540.0	490.3	459.0	482.3	456.7	531.7	473.2	493.9
11	4	4	594.5	648.2	624.9	552.5	633.4	623.7	624.4	577.4	612.2	58.2	554.9
12	6	6	395.0	407.6	355.7	385.4	357.1	386.7	381.0	354.0	404.2	361.1	378.8
13	8	8	231.2	233.3	230.2	233.2	240.3	233.7	241.2	240.3	238.6	262.9	238.5
14	10	10	233.8	221.1	223.3	222.0	222.8	225.6	224.1	223.4	225.5	237.3	225.9
16													
17	RPM 140												
18	6	5	650.8	686.4	648.0	628.3	608.1	596.8	614.1	589.9	572.8	560.5	615.6
19	8	7	330.4	334.9	309.92	330.7	338.5	308.9	308.3	314.5	350.2	312.5	323.9
20	10	9.5	211.0	202.0	201.4	201.0	198.3	196.9	202.3	199.9	198.1	197.1	200.8
21													
22	RPM 150												
23	6	4.5	729.8	638.1	769.8	898.7	740.0	782.7	787.7	687.2	657.8	747.0	743.9
24	8	6.5	428.7	396.0	396.3	391.6	473.6	380.3	432.0	309.7	375.5	336.3	392.0
25	10	9	212.1	214.0	216.5	213.6	217.5	214.2	216.6	216.9	210.3	207.2	213.9
26													
27	160 RPM	10											
28	12	10	324.8	317.1	324.5	308.2	313.3	346.6	315.8	304.7	301.4	303.5	316.0
29													

Sheet1 / Sheet2 / Sheet3

RESON

SeaBat 8111 Noise Analysis

1.0 Overview

For mid and deep water sonar systems, noise emanating from the vessel on which the sonar is mounted is a major determinant in the performance of the sonar. In addition to sources such as echosounders and other acoustic devices, such as doppler logs, mechanical noise from the engines and drive trains, and flow noise will also affect performance, with the magnitude of the noise varying with vessel speed.

This document describes the noise analysis test done on the RESON SeaBat 8111 installed on the NOAA S/V Fairweather, on 11 October 2004.

2.0 Test Conduct

The following is a description of the system setup and test protocol used to test the SeaBat 8111 multibeam sonar.

2.1 Sonar Setup

To determine the amount of in-band noise seen by the sonar, the system was configured as follows:

Setting	Value
Power	Off
Gain	Manual Fixed 20
Range	100 meters

Data collection was done using a RESON engineering utility, which collects the full amplitude and phase time series data from the sonar. Figure 1 shows a sample screen capture, in this case one of the data sets taken at six knots, with a shaft speed of 140 RPM. At least ten (10) collections were done for each test case, and the results for first 10 measurements each test case were averaged for the report.

2.2 Vessel Operation

Normal survey speed for the vessel is approximately 10 knots. To bracket this range, and to check at possible lower survey speeds, the test protocol was defined to cover the range of 2 to 12 knots, in 2 knot steps. The tests were conducted at shaft speeds of 120 to 170 RPM, in 10 RPM steps, with the speed adjusted by changing the pitch on the propellers. For each RPM value, the speeds that could be achieved at that shaft speed were tested. A log of data collections for the tests is provided in Appendix A.

All the underway data collections were done in water depths of 120 to 160 fathoms. The zero speed data collections, with the engines on, were done at anchor in about 30 meters of water, and out in the bay, at water depths of about 130 fathoms.

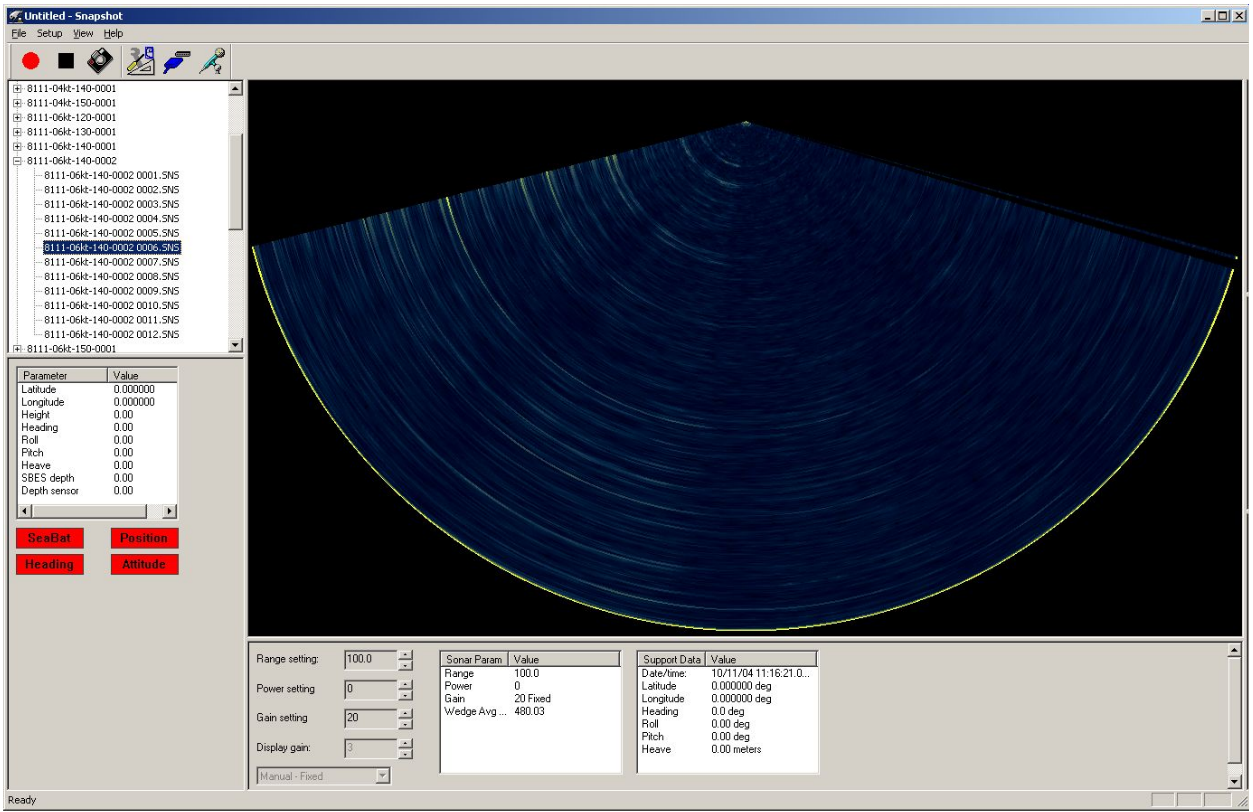


Figure 1 - Snapshot Utility Screen Capture

2.3 Data Analysis

The data from each of the test cases were collated in an Excel spreadsheet, shown in Appendix B. A graph of the measured noise levels, as a function of vessel speed and shaft RPM is shown in Figure 2. The noise level is a unitless value that represents the average of all the amplitude samples, from all the beams for the sampled sonar ping. This value represents a combination of the electrical noise in the sonar, and the response to all acoustic energy, within the bandwidth of the sonar, impinging on the receive array.

For each the tests, the plot shows the noise level as a function of vessel speed. Again, the tests were run at the speeds that could be achieved at the selected shaft RPM.

In an effort to resolve the cause of the high noise levels at anchor seen in the 8160 tests, noise tests with the engines at idle (110 shaft RPM, 0 pitch) in both shallow and deep water. In deeper water, much lower noise levels were observed, apparently due to the greater attenuation of the noise from the various acoustic sources on the ship over the greater range.

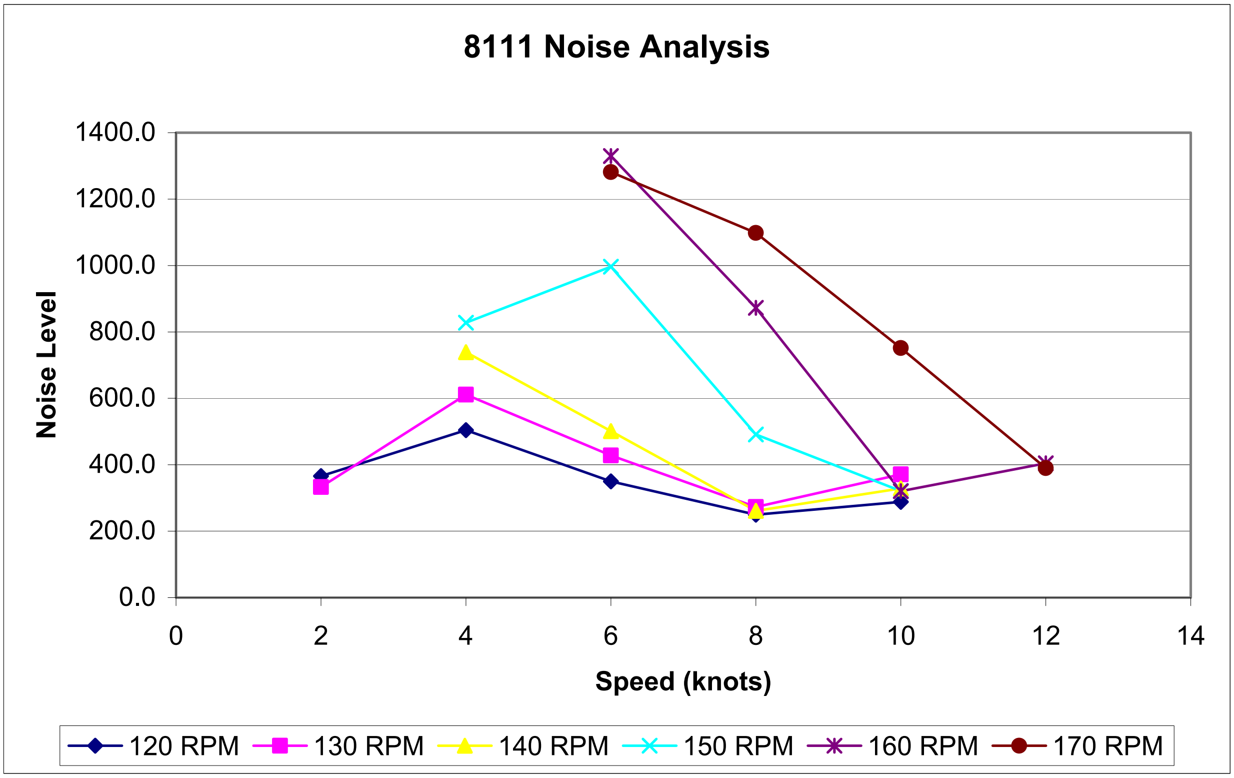


Figure 2 - Noise Plot

3.0 Conclusions

a. It appears that the best survey speed for the 8111, from a noise perspective, is in the range of 8 to 10 knots. Both lower and higher speeds correlate with higher noise levels.
b. It would be desirable to use shaft speeds of 140 RPM, or lower, to minimize the noise level seen by the sonar.
c. Significantly increased levels of reverberation from acoustic sources on the vessel are seen in shallower water. If this causes any degradation in the quality of the soundings in the 8111, increased power levels, higher than those recommended in the sonar settings guide, should be used to compensate.

Appendix A – Test Logs

Survey Log - 8111 Noise Test.xls

RESON Inc.

Date:	10/11/2004	**Survey Area:**	Rudyerd Bay, AK	**Page / Pages:**	1 of 2
Survey Name:	8111 Noise Test	**Surveyors:**	B Bridge	**TimeZone:**	-9
Survey Vessel:	NOAA Fairweather	**Client:**	NOAA		

Offset Information

	X	Y	Z	Latency	Roll	Pitch	Yaw
Sounder							
DGPS							
Motion Sensor							
Other							

SVP File:

Tide File:

Date of Patch Test

Total Pole minus Dry Pole

Draft (Z)

Start	Stop	Line	Dir.	Speed	COMMENTS
		8111-00kt-EngOn-0001		0	Gain MF20, Power 0, Range 100, at anchor, 110 RPM
		8111-00kt-0001		0	110 RPM 0 Pitch
		8111-02kt-120-0001		2	120 RPM 1.0 Pitch 0.4 Doppler
		8111-04kt-120-0001		4	120 RPM 3.0 Pitch 2.8 Doppler
		8111-06kt-120-0001		6	120 RPM 6.0 Pitch 4.6 Doppler
		8111-08kt-120-0001		8	120 RPM 8.5 Pitch 6.7 Doppler
		8111-10kt-120-0001		9	120 RPM 10.0 Pitch 7.2 Doppler
		8111-10kt-130-0001		10	130 RPM 10.0 Pitch 8.2 Doppler
		8111-08kt-130-0001		8	130 RPM 7.0 Pitch 6.2 Doppler
		8111-06kt-130-0001		6	130 RPM 5.0 Pitch 4.5 Doppler
		8111-04kt-130-0001		4	130 RPM 3.0 Pitch 2.2 Doppler
		8111-02kt-130-0001		2	130 RPM 1.5 Pitch 0.5 Doppler
		8111-04kt-140-0001		4	140 RPM 2.5 Pitch 2.5 Doppler
		8111-06kt-140-0001		6	140 RPM 4.75 Pitch 4.3 Doppler Too Shallow
		8111-06kt-140-0002		6	140 RPM 5.3 Pitch 5.2 Doppler
		8111-08kt-140-0001		8	140 RPM 7.4 Pitch 6.5 Doppler
		8111-10kt-140-0001		10	140 RPM 9.0 Pitch 8.5 Doppler

Survey Manager: Client Representative:

Signature: Signature:

Sheet1 / Sheet2 / Sheet3

Survey Log - 8111 Noise Test Pg2.xls

RESON Inc.

Date: 10/11/2004	**Survey Area:** Rudyerd Bay, AK	**Page / Pages:** 2 of 2	
Survey Name: 8111 Noise Test	**Surveyors:** B Bridge	**TimeZone:** -9	
Survey Vessel: NOAA Fairweather	**Client:** NOAA		

Offset Information

	X	Y	Z	Latency	Roll	Pitch	Yaw
Sounder							
DGPS							
Motion Sensor							
Other							

Date of Patch Test

SVP File:

Tide File

Total Pole
minus Dry Pole
Draft (Z)

Start	Stop	Line	Dir.	Speed	COMMENTS
		8111-10kt-150-0001		10	Gain MF20, Power 0, Range 100, 150, 8.2, 7.4
		8111-08kt-150-0002		8	150 RPM 6.1 Pitch 6.3 Doppler
		8111-06kt-150-0001		6	150 RPM 4.3 Pitch 4.4 Doppler
		8111-04kt-150-0001		4	150 RPM 3.0 Pitch 2.8 Doppler
		8111-06kt-160-0001		6	160 RPM 4.0 Pitch 5.2 Doppler
		8111-08kt-160-0001		8	160 RPM 6.1 Pitch 6.5 Doppler
		8111-10kt-160-0001		10	160 RPM 8.2 Pitch 8.8 Doppler
		8111-12kt-160-0001		11.7	160 RPM 10. Pitch 9.9 Doppler
		8111-12kt-170-0001		12	170 RPM 9.0 Pitch 10.4 Doppler
		8111-06kt-170-0001		6	170 RPM 4.0 Pitch 4.8 Doppler
		8111-08kt-170-0001		8	170 RPM 5.9 Pitch 6.8 Doppler
		8111-10kt-170-0001		10	170 RPM 7.0 Pitch 8.3 Doppler

Survey Manager: | Client Representative:
Signature: | Signature:

Sheet1 / Sheet2 / Sheet3

Appendix B – Noise Analysis Spreadsheet

8111 Noise Test Results

Test Condition	Speed	Pitch (ft)	Test Case										Average
			1	2	3	4	5	6	7	8	9	10	
Eng On Shallow	0	0	707.5	740.2	754.1	711.4	728.1	710.6	691.5	747.9	813.7	722.1	732.7
Eng On Deep	0	0	209.0	208.4	208.6	207.2	205.6	211.2	206.3	208.8	210.9	210.0	208.6
120 RPM	2.0	1.0	382.8	363.0	363.6	330.6	447.5	315.2	389.0	322.1	371.9	371.1	365.7
	4.0	3.0	552.7	431.0	555.9	480.0	517.9	448.0	472.8	500.7	583.6	499.2	504.2
	6.0	6.0	325.5	332.9	302.5	322.9	324.8	364.2	325.8	384.3	409.1	407.4	349.9
	8.0	8.5	253.8	244.0	250.3	253.0	248.4	241.0	241.7	252.4	253.5	259.1	249.7
	9.0	10.0	298.8	296.8	277.4	306.1	284.1	274.0	274.1	290.1	287.5	291.9	288.1
130 RPM	2.0	1.5	316.9	363.0	366.1	429.6	317.1	313.9	303.7	315.5	315.5	289.4	333.1
	4.0	3.0	671.0	657.4	700.4	632.7	602.6	631.0	552.5	605.8	537.9	523.7	611.5
	6.0	5.0	488.2	471.1	410.9	497.2	387.7	390.9	431.0	448.9	361.3	393.5	428.1
	8.0	7.0	285.2	279.1	276.7	266.2	287.8	268.3	271.0	262.5	283.4	249.9	273.0
	10.0	10.0	362.8	396.1	378.8	378.2	370.2	391.7	354.6	369.9	334.3	374.0	371.1
RPM 140	4	2.5	763.9	725.6	669.0	723.3	759.5	751.5	773.5	750.6	689.0	785.7	739.2
	6	5.3	487.1	551.5	605.3	596.4	444.3	480.0	416.2	500.0	452.6	478.9	501.2
	8	7.4	261.5	257.6	260.7	273.1	259.8	274.8	255.0	252.1	248.7	270.6	261.4
	10	9.0	301.5	365.3	328.4	360.1	359.9	328.4	326.2	315.0	302.7	300.4	328.8
RPM 150	4	3.0	775.2	766.3	916.9	809.7	815.4	860.6	710.5	801.1	892.1	928.6	827.6
	6	4.3	1058.7	926.7	737.5	1015.6	1028.1	1086.3	1048.8	1133.8	997.3	931.8	996.5
	8	6.1	507.8	567.2	535.4	486.4	507.3	443.4	460.9	537.6	461.0	406.4	491.3
	10	8.2	299.2	294.1	315.8	306.5	308.4	323.2	348.8	336.8	332.8	344.5	321.0
160 RPM	6	4.0	1488.4	1551.6	1328.3	1454.8	1456.9	1518.9	1256.4	1146.3	1089.5	1005.8	1329.7
	8	6.1	740.7	777.4	926.5	904.7	851.6	817.7	886.5	801.0	1005.7	1015.9	872.8
	10	8.2	339.9	330.9	335.0	329.4	300.6	326.7	316.9	311.6	313.7	300.9	320.6
	12	10.0	581.4	396.6	351.5	360.6	344.6	410.5	466.2	357.1	389.6	386.4	404.5
170 RPM	6	4.0	1240.1	1173.3	1016.2	1346.1	1301.8	1391.5	1520.2	1327.6	1320.2	1176.3	1281.3
	8	5.9	961.9	1096.9	1229.4	1017.2	1041.2	1168.9	1176.6	1060.5	1117.9	1112.2	1098.3
	10	7.0	756.2	751.3	747.9	640.1	769.5	844.8	714.6	795.6	787.4	709.4	751.7
	12	9.0	396.2	360.1	552.7	339.9	348.5	339.3	352.6	356.5	502.1	351.7	390.0

Appendix IV

Total Propagated Error (TPE)

- **Fairweather TPE Values**
- **Tide TPE Values**

	FAIRWEATHER SURVEY		Appendix IV	Process Owner Survey
	Documents Title **FA_TPE_Values_2008**	*Last update* October 27, 2008	*Version* *2008.2*	*Approval Date* *October 27, 2008*

Offsets

	Vessel	FAIRWEATHER-S220	FAIRWEATHER-S220	1010	1018
	Sonar System	Reson 8111	Reson 8160	Reson 8101	Reson 8101
	Positioning System	POS/MV Model 320	POS/MV Model 320	POS/MV Model 320	POS/MV Model 320
Offsets	MRU to Trans X	2.868	0.493	0.250	0.282
	MRU to Trans Y	8.252	7.665	-0.133	-0.145
	MRU to Trans Z	4.752	4.726	0.549	0.548
	Nav to Trans X	1.691	-0.684	1.147	1.181
	Nav to Trans Y	20.172	19.585	1.066	0.955
	Nav to Trans Z	17.756	17.730	3.661	3.71
	Trans Roll	0.00	0.00	0.000	0.00

Standard Deviation

	Vessel	FAIRWEATHER-S220	FAIRWEATHER-S220	1010	1018		
	Sonar System	Reson 8111	Reson 8160	Reson 8101	Reson 8101		
	Positioning System	POS/MV Model 320 V4	POS/MV Model 320 V4	POS/MV Model 320 V3	POS/MV Model 320 V3		Status
Motion Sensor	Motion Gyro (deg)	0.02	0.02	0.02	0.02	Vessel Configuration File	Finalized
	Heave% Amp	5	5	5	5		Finalized
	Heave (m)	0.05	0.05	0.05	0.05		Finalized
	Roll (deg)	0.02	0.02	0.02	0.02		Finalized
	Pitch (deg)	0.02	0.02	0.02	0.02		Finalized
	Position Nav (m)	0.5*	0.5	0.5	0.5		Finalized
	Vessel Speed (m/s)	0.03	0.03	0.03	0.03		Finalized
Latency	Timing Trans (s)	0.005	0.005	0.005	0.005		Finalized
	Nav Timing (s)	0.005	0.005	0.005	0.005		Finalized
	Gyro Timing (s)	0.005	0.005	0.005	0.005		Finalized
	Heave Timing (s)	0.005	0.005	0.005	0.005		Finalized
	Pitch Timing (s)	0.005	0.005	0.005	0.005		Finalized
	Roll Timing (s)	0.005	0.005	0.005	0.005		Finalized
Vessel Offsets	Offset X (m)	0.007	0.007	0.007	0.007		Finalized
	Offset Y (m)	0.007	0.007	0.007	0.007		Finalized
	Offset Z (m)	0.008	0.008	0.007	0.007		Finalized
Waterline	Loading	0.02	0.02	0.000	0.010		Finalized
	Draft (m)	0.022	0.022	0.050	0.016		Finalized
	DeltaDraft (m)	0.110	0.110	0.020	0.05		Finalized
MRU Alignment	MRU alignStdev gyro	0.2	0.11	0.16	0.3		Finalized
	MRU align roll/pitch	0.1	0.18	0.02	0.06		Finalized
Tides	Tide Meas (m)	0.02	0.02	0.02	0.02	Compute TPE Dialog Box	Project Dependent**
	Tide Zoning (m)	0.1	0.1	0.1	0.1		Project Dependent**
Sound Velocity	SV Meas (m/s)	0.5	0.5	1.0	1.0		Finalized
	Surface SV (m/s)	0.5	0.5	1.0	1.0		Finalized

*Position Nav adjusted in 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.

	Tide Measurement	Tide Zoning 95% (Provided by CO-OPS)	Tide Zoning 1-sigma (Use in Caris)
OPR-O322-FA-08 Chatham Strait	0.02	0.26	0.13
OPR-P183-FA-08 Shumagin Islands and Vicinity	0.02	0.19	0.095
OPR-P357-FA-08 Kachemak bay	0 (TCARI is a special case, see FOO for more info)	0	0
OPR-P132-FA-08 PWS	0.02	0.31	0.155
OPR-O309-FA-08 Icy Bay, AK	0.02	0.17	0.085
OPR-O168-FA-08 Endicott Arm	0.02	0.1	0.05
OPR-O119-FA-08 Ernest Sound	0.02	0.14	0.07

Appendix V

Additional Calibration Reports

- **Control**
- **Diver Least Depth Gauge**
- **Laser Level**
- **Leadlines**
- **Sound Velocity**
- **Total Stations**

2008 DGPS Beacon Quality Test

Date:
May 2-3, 2008

People involved:
Llian Breen, ENS
Brenna Campbell, SST
Matt Ringel, LT

Location:
USCG ISC Ketchikan BM No. 37 (see appendix A)

Weather:
~46 deg. Fahrenheit, light-moderate rain, gusty winds, 100% cloud cover

Equipment Used:
Trimble DSM 232 Firmware v3.57 (DGPS beacon)
Trimble Zephyr Geodetic Model 2 (DGPS beacon atenna)
Trimble DSM 232 Firmware v3.57 (DGPS receiver)
Trimble Combined receiver
Pacific Crest Position Data Link Base (in low power operation)

Pacific Crest Broadcast antenna
Pacific Crest Position Data Link Rover
Panasonic CF-18 Toughbook
Ashtech Evaluate Software (for data acquisition)
4 12v Marine batteries

Method:
Followed the Fly_Away_SOP.doc as edited by Llian Breen

Results:
95% of all horizontal positions were within 0.8496 meters, which meets the horizontal control standards as defined in the HSSD for the use of a DGPS flyaway station.

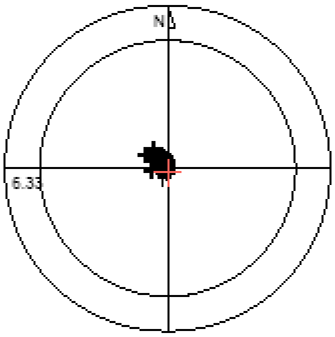
Appendix

A.


USCG ISC
Ketchikan BM
No. 37

B.

Ashtech Evaluate - Analysis Active - GPS Receiver type: Unknown **Position information** **04 May 2008 01:25**



Scatter Plot Units: m

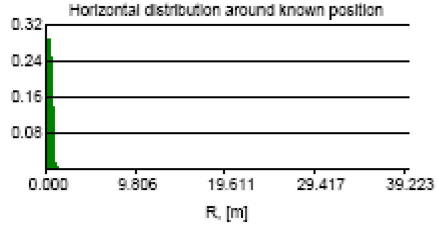
Ring1 = 0.006 Ring2 = 0.012

Outlier Ring = 5.00

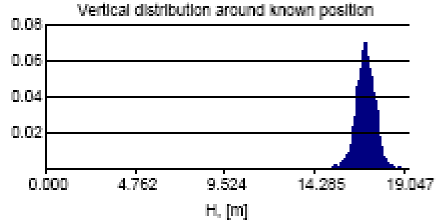
Position Accuracy Measures

Number of used points	97897
CEP	0.4544 m
Horizontal rms	0.5412 m
East rms	0.2733 m
North rms	0.4671 m
Horizontal 95%	0.8496 m
Vertical rms	16.9095 m
Vertical 95%	17.6863 m
Mean East error	-0.1950 m
Mean North error	0.3401 m
Mean Altitude error	-16.9013 m
Mean Latitude	55° 19.9778486' N
Mean Longitude	131° 37.5305271' W
Mean Altitude	-12.0823 m
Outlier limit	5.0000 m
Outliers number	5 points
Outliers percent	0.01 %
Heading standard deviation	0.0000 °
Pitch standard deviation	0.0000 °
Roll standard deviation	0.0000 °
Mean Heading	0.000 °
Mean Pitch	0.000 °
Mean Roll	0.000 °
Mean BRMS	0.00 mm
Mean MRMS	0.00 mm
Number of bad attitude measurements	0
Percentage good attitude availability	100.00 %

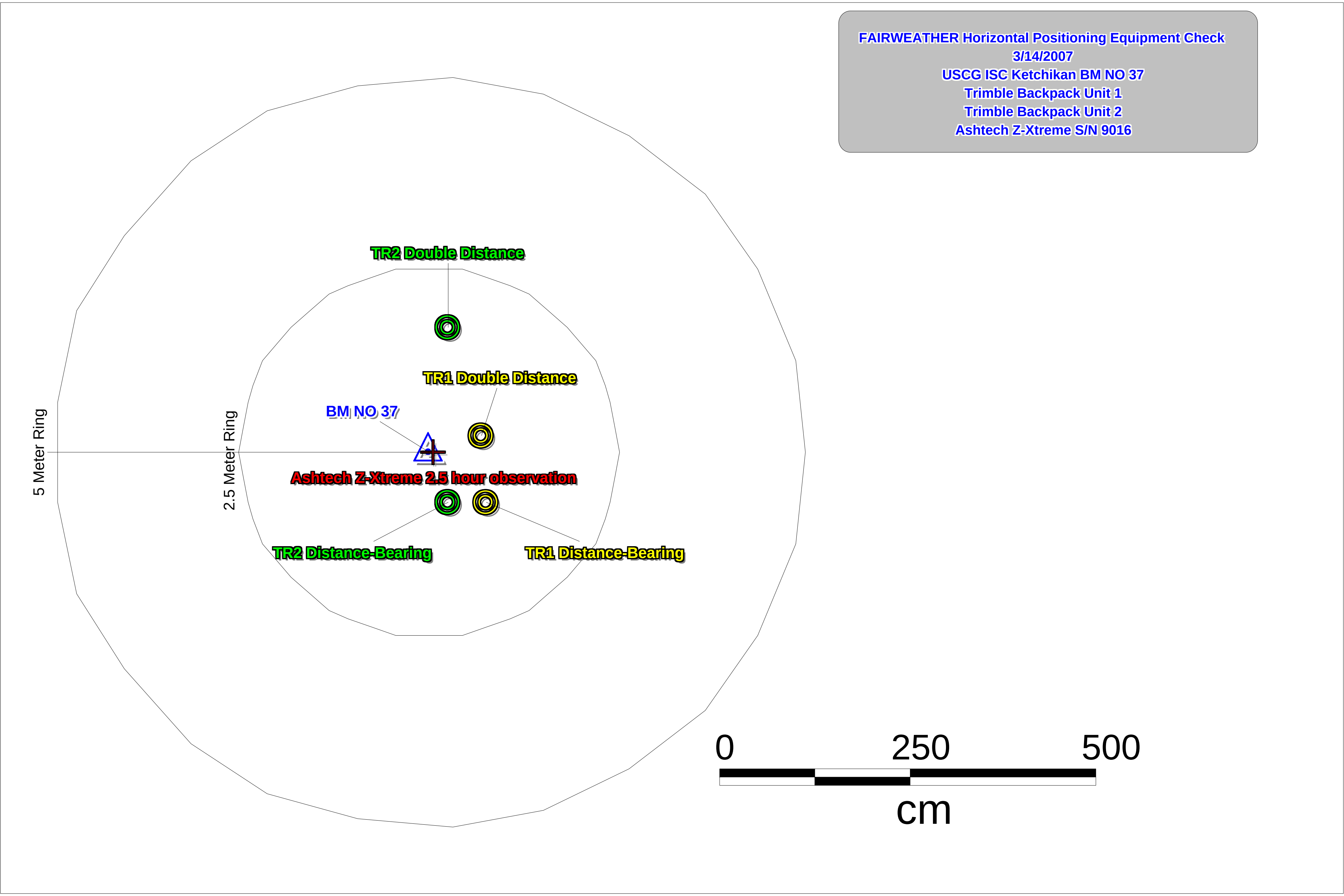
Horizontal distribution around known position



Vertical distribution around known position



Differential GPS position Used SVs: 9 UTC Time: 01 : 27 : 25.00
Lat: 55° 19.9775539' N Lon: 131° 37.5302968' W Altitude above WGS-84: -13.55 m
PDOP: 0.0 HDOP: 1.3 VDOP: 0.0 TDOP: N/A
ADU Double Differences: V1-2: 0 V1-3: 0 V1-4: 0 BRMS: 0.0 mm MRMS: 0.0 mm


FAIRWEATHER Horizontal Positioning Equipment Check
3/14/2007
USCG ISC Ketchikan BM NO 37
Trimble Backpack Unit 1
Trimble Backpack Unit 2
Ashtech Z-Xtreme S/N 9016
TR2 Double Distance
TR1 Double Distance
BM NO 37
Ashtech Z-Xtreme 2.5 hour observation
TR2 Distance-Bearing
TR1 Distance-Bearing
5 Meter Ring
2.5 Meter Ring
0
250
500
cm

Subject:
OPUS solution : USCG0732.07O 000106232
From:
opus@ngs.noaa.gov
Date:
Mon, 02 Apr 2007 12:07:31 -0400 (EDT)
To:
horcon.fairweather@noaa.gov

```
 FILE: USCG0732.07O 000106232

                              NGS OPUS SOLUTION REPORT
                              ========================

      USER: horcon.fairweather@noaa.gov            DATE: April 02, 2007
RINEX FILE: uscg073s.07o                           TIME: 16:07:30 UTC


  SOFTWARE: page5  0612.06 master29.pl            START: 2007/03/14  18:06:00
 EPHEMERIS: igs14183.eph [precise]                 STOP: 2007/03/14  20:36:00
  NAV FILE: brdc0730.07n                       OBS USED:  6385 /  6511   :  98%
  ANT NAME: ASH701975.01AGP NONE             # FIXED AMB:    30 /    32   :  94%
ARP HEIGHT: 2.0                              OVERALL RMS: 0.018(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2003.0000)           ITRF00 (EPOCH:2007.1995)

         X:     -2415358.884(m)   0.013(m)          -2415359.692(m)   0.013(m)
         Y:     -2718046.175(m)   0.012(m)          -2718045.070(m)   0.012(m)
         Z:      5222559.312(m)   0.016(m)           5222559.510(m)   0.016(m)

       LAT:   55 19 58.66133      0.010(m)        55 19 58.67266      0.010(m)
     E LON:  228 22 28.18023      0.007(m)       228 22 28.10433      0.007(m)
     W LON:  131 37 31.81977      0.007(m)       131 37 31.89567      0.007(m)
    EL HGT:            3.781(m)   0.023(m)                 3.780(m)   0.023(m)
 ORTHO HGT:            9.656(m)   0.034(m) [Geoid06 NAVD88]

                        UTM COORDINATES    STATE PLANE COORDINATES
                         UTM (Zone 09)        SPC (5001 AK 1)
Northing (Y) [meters]     6134983.221             0.000
Easting (X)  [meters]      333464.469             0.000
Convergence  [degrees]    -2.15989540           0.00000000
Point Scale                0.99994023           0.00000000
Combined Factor            0.99993963           0.00000000

US NATIONAL GRID DESIGNATOR:  9UUB3346434983(NAD 83)



                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
AI5022 BIS1 BIORKA ISLAND 1 CORS ARP       N565116.162 W1353221.387  296620.8
AJ4430 LEV1 LEVEL ISLAND 1 CORS ARP        N562756.438 W1330533.935  155968.5
AF9530 AIS1 ANNETTE ISLAND 1 CORS ARP      N550408.647 W1313558.255   29425.1

                 NEAREST NGS PUBLISHED CONTROL POINT
AI4914      BM NO 37                       N551958.659 W1313731.820       0.0
```

BASE STATION INFORMATION

```
STATION NAME: bis1  a    5 (BIORKA ISLAND 1; Biorka Island, Alaska, U.S.A.)
 ANTENNA: ASH700829.3     SNOW                                 S/N=xxxx
XYZ  -2494921.0213  -2448390.9324   5317113.5289  MON @ 1997.0000 (M)
XYZ        -0.0164         0.0037         0.0005  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0877  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0598  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1673         0.0377         0.0051  VEL TIMES 10.1982 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0342        -0.0336         0.0734  ARP TO L1 PHASE CENTER
XYZ  -2494921.2228  -2448390.9283   5317113.6074  L1 PHS CEN @ 2007.1995
XYZ        -0.0001         0.0014         0.0005  + XYZ ADJUSTMENTS
XYZ  -2494921.2228  -2448390.9269   5317113.6080  NEW L1 PHS CEN @ 2007.1995
XYZ  -2494921.1886  -2448390.8933   5317113.5345  NEW ARP @ 2007.1995
XYZ  -2494921.1886  -2448390.8933   5317113.5345  NEW MON @ 2007.1995
LLH  56 51 16.17228  224 27 38.53267     66.6787  NEW L1 PHS CEN @ 2007.1995
LLH  56 51 16.17228  224 27 38.53267     66.5910  NEW ARP @ 2007.1995
LLH  56 51 16.17228  224 27 38.53267     66.5910  NEW MON @ 2007.1995

STATION NAME: lev1  a    8 (Level Island 1; Level Island, Alaska  USA)
 ANTENNA: ASH700829.3     SNOW                                 S/N=CG11936
XYZ  -2412828.4670  -2579056.1235   5293283.3535  MON @ 1997.0000 (M)
XYZ        -0.0190         0.0003        -0.0044  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0877  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0598  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1938         0.0031        -0.0449  VEL TIMES 10.1982 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0331        -0.0354         0.0731  ARP TO L1 PHASE CENTER
XYZ  -2412828.6939  -2579056.1558   5293283.3817  L1 PHS CEN @ 2007.1995
XYZ        -0.0002         0.0006         0.0002  + XYZ ADJUSTMENTS
XYZ  -2412828.6941  -2579056.1552   5293283.3819  NEW L1 PHS CEN @ 2007.1995
XYZ  -2412828.6610  -2579056.1198   5293283.3088  NEW ARP @ 2007.1995
XYZ  -2412828.6610  -2579056.1198   5293283.3088  NEW MON @ 2007.1995
LLH  56 27 56.44916  226 54 25.98578     25.2831  NEW L1 PHS CEN @ 2007.1995
LLH  56 27 56.44916  226 54 25.98578     25.1954  NEW ARP @ 2007.1995
LLH  56 27 56.44916  226 54 25.98578     25.1954  NEW MON @ 2007.1995

STATION NAME: ais1  a    7 (ANNETTE ISLAND 1; Annette Island, Alaska, U.S.A.)
 ANTENNA: ASH700829.3     SNOW                                 S/N=11276
XYZ  -2430153.7846  -2737192.8996   5205816.6147  MON @ 1997.0000 (M)
XYZ        -0.0151         0.0008        -0.0082  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0877  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0598  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1540         0.0082        -0.0836  VEL TIMES 10.1982 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0333        -0.0376         0.0719  ARP TO L1 PHASE CENTER
XYZ  -2430153.9719  -2737192.9290   5205816.6030  L1 PHS CEN @ 2007.1995
XYZ         0.0001        -0.0001        -0.0000  + XYZ ADJUSTMENTS
XYZ  -2430153.9718  -2737192.9291   5205816.6030  NEW L1 PHS CEN @ 2007.1995
```

```
 XYZ  -2430153.9385  -2737192.8915   5205816.5311  NEW ARP @ 2007.1995
 XYZ  -2430153.9385  -2737192.8915   5205816.5311  NEW MON @ 2007.1995
 LLH  55  4  8.65871  228 24  1.66998     32.2471  NEW L1 PHS CEN @ 2007.1995
 LLH  55  4  8.65871  228 24  1.66998     32.1594  NEW ARP @ 2007.1995
 LLH  55  4  8.65871  228 24  1.66998     32.1594  NEW MON @ 2007.1995

                        REMOTE STATION INFORMATION

 STATION NAME: uscg       1
  ANTENNA: ASH701975.01AGP NONE                             S/N=UNKNOWN
 XYZ  -2415360.3793  -2718045.5588   5222561.1762  MON @ 2007.1993 (M)
 NEU         0.0000        -0.0000         2.0000  MON TO ARP (M)
 NEU        -0.0000         0.0000         0.0637  ARP TO L1 PHASE CENTER (M)
 NEU        -0.0000         0.0000         0.0440  ARP TO L2 PHASE CENTER (M)
 XYZ        -0.7557        -0.8504         1.6449  MON TO ARP
 XYZ        -0.0241        -0.0271         0.0524  ARP TO L1 PHASE CENTER
 XYZ  -2415361.1590  -2718046.4363   5222562.8735  L1 PHS CEN @ 2007.1995

 BASELINE NAME:   bis1  uscg
 XYZ         0.6817         0.4813        -1.6607  + XYZ ADJUSTMENTS
 XYZ  -2415360.4774  -2718045.9549   5222561.2128  NEW L1 PHS CEN @ 2007.1995
 XYZ  -2415360.4533  -2718045.9278   5222561.1604  NEW ARP @ 2007.1995
 XYZ  -2415359.6976  -2718045.0775   5222559.5155  NEW MON @ 2007.1995
 LLH  55 19 58.67251  228 22 28.10438      5.8533  NEW L1 PHS CEN @ 2007.1995
 LLH  55 19 58.67251  228 22 28.10438      5.7896  NEW ARP @ 2007.1995
 LLH  55 19 58.67251  228 22 28.10438      3.7896  NEW MON @ 2007.1995

 BASELINE NAME:   lev1  uscg
 XYZ         0.6864         0.4936        -1.6609  + XYZ ADJUSTMENTS
 XYZ  -2415360.4727  -2718045.9427   5222561.2127  NEW L1 PHS CEN @ 2007.1995
 XYZ  -2415360.4486  -2718045.9156   5222561.1603  NEW ARP @ 2007.1995
 XYZ  -2415359.6929  -2718045.0652   5222559.5153  NEW MON @ 2007.1995
 LLH  55 19 58.67284  228 22 28.10412      5.8462  NEW L1 PHS CEN @ 2007.1995
 LLH  55 19 58.67284  228 22 28.10412      5.7825  NEW ARP @ 2007.1995
 LLH  55 19 58.67284  228 22 28.10412      3.7825  NEW MON @ 2007.1995

 BASELINE NAME:   ais1  uscg
 XYZ         0.6951         0.4928        -1.6769  + XYZ ADJUSTMENTS
 XYZ  -2415360.4639  -2718045.9435   5222561.1967  NEW L1 PHS CEN @ 2007.1995
 XYZ  -2415360.4398  -2718045.9164   5222561.1443  NEW ARP @ 2007.1995
 XYZ  -2415359.6842  -2718045.0660   5222559.4993  NEW MON @ 2007.1995
 LLH  55 19 58.67268  228 22 28.10452      5.8300  NEW L1 PHS CEN @ 2007.1995
 LLH  55 19 58.67268  228 22 28.10452      5.7663  NEW ARP @ 2007.1995
 LLH  55 19 58.67268  228 22 28.10452      3.7663  NEW MON @ 2007.1995

                                  G-FILES

Axx2007 314   7 314
B2007 31418 5   7 3142035 1 page5 v0612.06IGS     222 1 2 27NGS   2007 4 2IFDDFX
Iant_info.003        NGS   20070320
C00090001 -795614910   19 2696541842   21  945540190   39 X0737AUSCGX0737ABIS1
D  1  2  7550588  1  3 -9307589  2  3 -7806480

Axx2007 314   7 314
B2007 31418 5   7 3142035 1 page5 v0612.06IGS     222 1 2 27NGS   2007 4 2IFDDFX
Iant_info.003        NGS   20070320
C00090002   25310319   17 1389889454   20  707237935   38 X0737AUSCGX0737ALEV1
```

```
D  1  2  8189618  1  3 -9202066  2  3 -7448116

Axx2007 314   7 314
B2007 31418 5   7 3142035 1 page5 v0612.06IGS     222 1 2 27NGS   2007 4 2IFDDFX
Iant_info.003        NGS   20070320
C00090003 -147942543   19 -191478255   22 -167429683   36 X0737AUSCGX0737AAIS1
D  1  2  9369495  1  3 -7883557  2  3 -7554607
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
            OVERALL     03     06     07     10     16     18     19     21
 bis1-uscg|  0.017  0.018  0.016  0.018  0.014  0.019  0.013  0.015    ...
                22     24     25     26     29     30
 bis1-uscg|  0.018  0.015    ...  0.022  0.019    ...

            OVERALL     03     06     07     10     16     18     19     21
 lev1-uscg|  0.018  0.017  0.018  0.019  0.017  0.022  0.017  0.015    ...
                22     24     26     29     30
 lev1-uscg|  0.018  0.013  0.018  0.021    ...

            OVERALL     03     06     07     10     16     18     19     21
 ais1-uscg|  0.018  0.020  0.018  0.018  0.012  0.022  0.016    ...    ...
                22     24     26     29     30
 ais1-uscg|  0.015  0.017  0.015  0.016    ...
```

OBS BY SATELLITE VS. BASELINE

```
            OVERALL     03     06     07     10     16     18     19     21
 bis1-uscg|   2148    155    203    279    102    296    245     28    ...
                22     24     25     26     29     30
 bis1-uscg|    118    284    ...    200    238    ...
            OVERALL     03     06     07     10     16     18     19     21
 lev1-uscg|   2087    155    182    225    106    296    247     28    ...
                22     24     26     29     30
 lev1-uscg|    117    284    200    247    ...
            OVERALL     03     06     07     10     16     18     19     21
 ais1-uscg|   2150    152    207    284    105    295    239    ...    ...
                22     24     26     29     30
 ais1-uscg|    119    283    213    253    ...
```

```
 Covariance Matrix for the xyz OPUS Position (meters2).
    0.0000022467     0.0000002159    -0.0000004052
    0.0000002159     0.0000029444    -0.0000004008
   -0.0000004052    -0.0000004008     0.0000094689

 Covariance Matrix for the enu OPUS Position (meters2).
    0.0000023402    -0.0000002845     0.0000001534
   -0.0000002845     0.0000044782     0.0000029060
    0.0000001534     0.0000029060     0.0000078416

 Horizontal network accuracy =    0.00458 meters.
 Vertical network accuracy   =    0.00549 meters.
```

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2003.0000).

	Xa(m)	Ya(m)	Za(m)	
BIS1	-2494920.37852	-2448391.99956	5317113.26406	2003.00
LEV1	-2412827.84636	-2579057.21856	5293283.07789	2003.00
AIS1	-2430153.14737	-2737194.00189	5205816.33593	2003.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Xr(m)	Yr(m)	Zr(m)	
BIS1	-2494920.37852	-2448391.99956	5317113.26406	2003.00
LEV1	-2412827.84636	-2579057.21856	5293283.07789	2003.00
AIS1	-2430153.14737	-2737194.00189	5205816.33593	2003.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
BIS1	0.00490	0.00450	0.00990
LEV1	0.00220	0.00120	0.00480
AIS1	0.00580	0.00170	0.00110

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
BIS1	-79561.49452	269654.17544	94553.95206	2003.00
LEV1	2531.03764	138988.95644	70723.76589	2003.00
AIS1	-14794.26337	-19147.82689	-16742.97607	2003.00

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```
FILE: 99991892.08O 000401738

                             NGS OPUS SOLUTION REPORT
                             ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: www.ngs.noaa.gov/OPUS/Using_OPUS.html#accuracy

     USER: weston.renoud@noaa.gov                  DATE: July 25, 2008
RINEX FILE: 9999189t.08o                            TIME: 20:44:53 UTC


 SOFTWARE: page5  0612.06 master.pl               START: 2008/07/07  19:50:00
 EPHEMERIS: igs14871.eph [precise]                  STOP: 2008/07/07  23:22:00
 NAV FILE: brdc1890.08n                        OBS USED:  6124 /  7170   :  85%
 ANT NAME: ASH701975.01AGP NONE             # FIXED AMB:    37 /    41   :  90%
ARP HEIGHT: 1.8                             OVERALL RMS: 0.017(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2003.0000)           ITRF00 (EPOCH:2008.5161)

         X:     -2856077.871(m)   0.018(m)         -2856078.763(m)   0.018(m)
         Y:     -1547384.126(m)   0.007(m)         -1547383.076(m)   0.007(m)
         Z:      5470609.931(m)   0.029(m)          5470610.261(m)   0.029(m)

       LAT:   59 28  4.19773      0.005(m)        59 28  4.19524      0.005(m)
     E LON:  208 26 53.63529      0.009(m)       208 26 53.54968      0.009(m)
     W LON:  151 33  6.36471      0.009(m)       151 33  6.45032      0.009(m)
    EL HGT:           16.941(m)   0.034(m)                17.370(m)   0.034(m)
 ORTHO HGT:             7.387(m)   0.125(m) [NAVD88 (Computed using GEOID06)]

                        UTM COORDINATES    STATE PLANE COORDINATES
                         UTM (Zone 05)         SPC (5004 AK 4)
Northing (Y) [meters]     6593040.803           609834.429
Easting (X)  [meters]      582068.589           412038.502
Convergence  [degrees]     1.24749500          -1.33669094
Point Scale                0.99968255           0.99999480
Combined Factor            0.99967990           0.99999215

US NATIONAL GRID DESIGNATOR:  5VNF8206993041(NAD 83)



                             BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
DI9676 KOD5 KODIAK 5 CORS ARP               N573703.690 W1521136.263  209430.6
DJ3029 KEN5 KENAI 5 CORS ARP                N604030.284 W1512100.570  134969.2
AI0952 TSEA ANCHORAGE CORS ARP              N611114.374 W1495341.819  212301.1

                NEAREST NGS PUBLISHED CONTROL POINT
UW5593      GRASS ISLAND 1975 AZ MK         N592918.836 W1512918.639    4256.3
```

BASE STATION INFORMATION

```
STATION NAME: kod5  a    2 (Kodiak 5; Kodiak, Alaska  USA)
ANTENNA: TRM41249USCG    SCIT                               S/N=60100858
XYZ  -3028720.7822  -1597307.4139   5363076.7078  MON @ 1997.0000 (M)
XYZ        -0.0145         0.0111         0.0097  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1670         0.1278         0.1117  VEL TIMES 11.5153 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0385        -0.0203         0.0687  ARP TO L1 PHASE CENTER
XYZ  -3028720.9877  -1597307.3064   5363076.8882  L1 PHS CEN @ 2008.5161
XYZ         0.0001         0.0001         0.0001  + XYZ ADJUSTMENTS
XYZ  -3028720.9876  -1597307.3063   5363076.8883  NEW L1 PHS CEN @ 2008.5161
XYZ  -3028720.9491  -1597307.2860   5363076.8196  NEW ARP @ 2008.5161
XYZ  -3028720.9491  -1597307.2860   5363076.8196  NEW MON @ 2008.5161
LLH  57 37  3.69097  207 48 23.65274     27.2919  NEW L1 PHS CEN @ 2008.5161
LLH  57 37  3.69097  207 48 23.65274     27.2106  NEW ARP @ 2008.5161
LLH  57 37  3.69097  207 48 23.65274     27.2106  NEW MON @ 2008.5161

STATION NAME: ken5  a    2 (Kenai 5; Kenai, Alaska  USA)
ANTENNA: TRM41249USCG    SCIT                               S/N=60051882
XYZ  -2748338.8009  -1501544.4452   5537749.5705  MON @ 1997.0000 (M)
XYZ        -0.0279        -0.0114        -0.0038  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.3213        -0.1313        -0.0438  VEL TIMES 11.5153 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0349        -0.0191         0.0709  ARP TO L1 PHASE CENTER
XYZ  -2748339.1571  -1501544.5956   5537749.5976  L1 PHS CEN @ 2008.5161
XYZ        -0.0000         0.0000        -0.0000  + XYZ ADJUSTMENTS
XYZ  -2748339.1571  -1501544.5956   5537749.5976  NEW L1 PHS CEN @ 2008.5161
XYZ  -2748339.1222  -1501544.5765   5537749.5267  NEW ARP @ 2008.5161
XYZ  -2748339.1222  -1501544.5765   5537749.5267  NEW MON @ 2008.5161
LLH  60 40 30.28022  208 38 59.34315     56.3955  NEW L1 PHS CEN @ 2008.5161
LLH  60 40 30.28022  208 38 59.34315     56.3142  NEW ARP @ 2008.5161
LLH  60 40 30.28022  208 38 59.34315     56.3142  NEW MON @ 2008.5161

STATION NAME: tsea  a    8 (The Surveyors Exchange A; Anchorage, Alaska  USA)
ANTENNA: LEIAT504GG      LEIS                               S/N=319
XYZ  -2666155.0438  -1545828.5805   5565470.2836  MON @ 1997.0000 (M)
XYZ        -0.0182         0.0041        -0.0051  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.1042  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.1238  ARP TO L2 PHASE CENTER (M)
XYZ        -0.2096         0.0472        -0.0587  VEL TIMES 11.5153 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0434        -0.0252         0.0913  ARP TO L1 PHASE CENTER
XYZ  -2666155.2968  -1545828.5585   5565470.3162  L1 PHS CEN @ 2008.5161
XYZ         0.0000         0.0000        -0.0001  + XYZ ADJUSTMENTS
XYZ  -2666155.2968  -1545828.5585   5565470.3161  NEW L1 PHS CEN @ 2008.5161
XYZ  -2666155.2534  -1545828.5333   5565470.2248  NEW ARP @ 2008.5161
XYZ  -2666155.2534  -1545828.5333   5565470.2248  NEW MON @ 2008.5161
LLH  61 11 14.37401  210  6 18.08838     43.0456  NEW L1 PHS CEN @ 2008.5161
LLH  61 11 14.37401  210  6 18.08838     42.9414  NEW ARP @ 2008.5161
LLH  61 11 14.37401  210  6 18.08838     42.9414  NEW MON @ 2008.5161
```

REMOTE STATION INFORMATION

```
STATION NAME: 9999       1
ANTENNA: ASH701975.01AGP NONE                                     S/N=UNKNOWN
XYZ  -2856080.1160  -1547383.5351   5470612.2588  MON @ 2008.5159 (M)
NEU        -0.0000        -0.0000         1.8000  MON TO ARP (M)
NEU        -0.0000         0.0000         0.0637  ARP TO L1 PHASE CENTER (M)
NEU        -0.0000         0.0000         0.0440  ARP TO L2 PHASE CENTER (M)
XYZ        -0.8040        -0.4356         1.5504  MON TO ARP
XYZ        -0.0285        -0.0154         0.0549  ARP TO L1 PHASE CENTER
XYZ  -2856080.9485  -1547383.9861   5470613.8641  L1 PHS CEN @ 2008.5161

BASELINE NAME:   kod5  9999
XYZ         1.3621         0.4617        -2.0109  + XYZ ADJUSTMENTS
XYZ  -2856079.5864  -1547383.5244   5470611.8532  NEW L1 PHS CEN @ 2008.5161
XYZ  -2856079.5579  -1547383.5090   5470611.7983  NEW ARP @ 2008.5161
XYZ  -2856078.7539  -1547383.0734   5470610.2479  NEW MON @ 2008.5161
LLH  59 28  4.19528  208 26 53.54982     19.2176  NEW L1 PHS CEN @ 2008.5161
LLH  59 28  4.19528  208 26 53.54982     19.1539  NEW ARP @ 2008.5161
LLH  59 28  4.19528  208 26 53.54982     17.3539  NEW MON @ 2008.5161

BASELINE NAME:   ken5  9999
XYZ         1.3441         0.4599        -1.9817  + XYZ ADJUSTMENTS
XYZ  -2856079.6044  -1547383.5262   5470611.8824  NEW L1 PHS CEN @ 2008.5161
XYZ  -2856079.5760  -1547383.5108   5470611.8275  NEW ARP @ 2008.5161
XYZ  -2856078.7719  -1547383.0752   5470610.2771  NEW MON @ 2008.5161
LLH  59 28  4.19530  208 26 53.54937     19.2512  NEW L1 PHS CEN @ 2008.5161
LLH  59 28  4.19530  208 26 53.54937     19.1875  NEW ARP @ 2008.5161
LLH  59 28  4.19530  208 26 53.54937     17.3875  NEW MON @ 2008.5161

BASELINE NAME:   tsea  9999
XYZ         1.3526         0.4543        -1.9998  + XYZ ADJUSTMENTS
XYZ  -2856079.5959  -1547383.5318   5470611.8642  NEW L1 PHS CEN @ 2008.5161
XYZ  -2856079.5674  -1547383.5164   5470611.8094  NEW ARP @ 2008.5161
XYZ  -2856078.7634  -1547383.0808   5470610.2590  NEW MON @ 2008.5161
LLH  59 28  4.19513  208 26 53.54994     19.2331  NEW L1 PHS CEN @ 2008.5161
LLH  59 28  4.19513  208 26 53.54994     19.1694  NEW ARP @ 2008.5161
LLH  59 28  4.19513  208 26 53.54994     17.3694  NEW MON @ 2008.5161
```

G-FILES

```
Axx2008 7 7   8 7 7
B2008 7 71949   8 7 72321 1 page5 v0612.06IGS     222 1 2 27NGS   2008
725IFDDFX
Iant_info.003        NGS   20080718
C00090001-1726421952   34 -499242126   18-1075334283   51 X1898A9999X1898AKOD5
D  1  2  9140339  1  3 -7463733  2  3 -7562317

Axx2008 7 7   8 7 7
B2008 7 71949   8 7 72321 1 page5 v0612.06IGS     222 1 2 27NGS   2008
725IFDDFX
Iant_info.003        NGS   20080718
C00090002 1077396498   38  458384987   21  671392496   57 X1898A9999X1898AKEN5
D  1  2  9334424  1  3 -7597895  2  3 -7532433

Axx2008 7 7   8 7 7
B2008 7 71949   8 7 72321 1 page5 v0612.06IGS     222 1 2 27NGS   2008
725IFDDFX
Iant_info.003        NGS   20080718
C00090003 1899235100   39   15545475   17  948599659   54 X1898A9999X1898ATSEA
D  1  2  8316036  1  3 -8052712  2  3 -8652821
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
           OVERALL     02     03     04     06     07     08     10     13
 kod5-9999|  0.017  0.016    ...  0.017    ...    ...  0.018  0.013  0.021
               15     16     19     20     23     24     25     26     27
 kod5-9999|    ...  0.019    ...    ...  0.021    ...  0.014  0.025  0.014

           OVERALL     02     03     04     06     07     08     10     13
 ken5-9999|  0.016  0.014    ...  0.018    ...    ...  0.018  0.014  0.019
               15     16     19     20     23     24     25     26     27
 ken5-9999|    ...  0.020    ...    ...  0.020    ...  0.016    ...  0.014
               28     29
 ken5-9999|    ...    ...

           OVERALL     02     03     04     06     07     08     10     13
 tsea-9999|  0.017  0.014    ...  0.015    ...    ...  0.018  0.014  0.021
               15     16     19     20     21     23     24     25     26
 tsea-9999|    ...  0.019    ...    ...    ...  0.021    ...  0.015  0.019
               27     28     29
 tsea-9999|  0.014    ...    ...
```

```
                    OBS BY SATELLITE VS. BASELINE

          OVERALL     02     03     04     06     07     08     10     13
kod5-9999|   2044    190    ...    111    ...    ...    260    290    263
             15     16     19     20     23     24     25     26     27
kod5-9999|    ...     20    ...    ...    183    ...    298     52    377
          OVERALL     02     03     04     06     07     08     10     13
ken5-9999|   2009    190    ...    111    ...    ...    264    290    257
             15     16     19     20     23     24     25     26     27
ken5-9999|    ...     25    ...    ...    183    ...    315    ...    374
             28     29
ken5-9999|    ...    ...
          OVERALL     02     03     04     06     07     08     10     13
tsea-9999|   2071    190    ...    111    ...    ...    264    290    278
             15     16     19     20     21     23     24     25     26
tsea-9999|    ...     25    ...    ...    ...    184    ...    299     50
             27     28     29
tsea-9999|    380    ...    ...


Covariance Matrix for the xyz OPUS Position (meters^2).
  0.0000091578     0.0000004124    -0.0000010302
  0.0000004124     0.0000023422    -0.0000005312
 -0.0000010302    -0.0000005312     0.0000194800

Covariance Matrix for the enu OPUS Position (meters^2).
  0.0000035434     0.0000022488    -0.0000013629
  0.0000022488     0.0000099429     0.0000045041
 -0.0000013629     0.0000045041     0.0000174937

Horizontal network accuracy =    0.00667 meters.
Vertical network accuracy   =    0.00820 meters.
```

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2003.0000).

	Xa(m)	Ya(m)	Za(m)	
KOD5	-3028720.08248	-1597308.40205	5363076.37683	2003.00
KEN5	-2748338.18060	-1501545.56153	5537749.15284	2003.00
TSEA	-2666154.36828	-1545829.60462	5565469.86580	2003.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Xr(m)	Yr(m)	Zr(m)	
KOD5	-3028720.08248	-1597308.40205	5363076.37683	2003.00
KEN5	-2748338.18060	-1501545.56153	5537749.15284	2003.00
TSEA	-2666154.36828	-1545829.60462	5565469.86580	2003.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
KOD5	0.00680	0.01170	0.02080
KEN5	-0.00600	-0.01070	0.00620
TSEA	0.00380	0.00480	0.00460

Vectors from unknown station monument to reference station monument in NAD_83(CORS96)(EPOCH:2003.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
KOD5	-172642.21148	-49924.27605	-107533.55417	2003.00
KEN5	107739.69040	45838.56447	67139.22184	2003.00
TSEA	189923.50272	1554.52138	94859.93480	2003.00

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```
FILE: KLAB2321.08O 000474805

                              NGS OPUS SOLUTION REPORT
                              ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: www.ngs.noaa.gov/OPUS/Using_OPUS.html#accuracy

      USER: weston.renoud@noaa.gov                    DATE: November 19, 2008
RINEX FILE: klab232t.08o                              TIME: 22:59:33 UTC


  SOFTWARE: page5  0810.20 master23.pl 081023      START: 2008/08/19  19:39:00
 EPHEMERIS: igs14932.eph [precise]                  STOP: 2008/08/20  16:26:00
  NAV FILE: brdc2320.08n                        OBS USED: 29751 / 38895   :
76%
  ANT NAME: THA800961+REC   NONE             # FIXED AMB:   272 /   368   :
74%
ARP HEIGHT: 2                                OVERALL RMS: 0.019(m)


 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)           ITRF00 (EPOCH:2008.6346)

         X:     -2856077.860(m)   0.088(m)          -2856078.755(m)   0.088(m)
         Y:     -1547384.156(m)   0.034(m)          -1547383.099(m)   0.034(m)
         Z:      5470609.946(m)   0.048(m)           5470610.272(m)   0.048(m)

       LAT:   59 28  4.19785      0.056(m)        59 28  4.19531      0.056(m)
     E LON:  208 26 53.63730      0.045(m)       208 26 53.55121      0.045(m)
     W LON:  151 33  6.36270      0.045(m)       151 33  6.44879      0.045(m)
    EL HGT:           16.957(m)   0.084(m)                17.381(m)   0.084(m)
 ORTHO HGT:            7.403(m)   0.146(m) [NAVD88 (Computed using GEOID06)]

                        UTM COORDINATES    STATE PLANE COORDINATES
                         UTM (Zone 05)         SPC (5004 AK 4)
Northing (Y) [meters]     6593040.807           609834.432
Easting (X)  [meters]      582068.621           412038.534
Convergence  [degrees]     1.24749548          -1.33669046
Point Scale                0.99968255           0.99999480
Combined Factor            0.99967989           0.99999215

US NATIONAL GRID DESIGNATOR:  5VNF8206993041(NAD 83)



                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
DI9676 KOD5 KODIAK 5 CORS ARP              N573703.690 W1521136.263  209430.6
DK4055 TBON ANCHORAGE AK DOT CORS ARP      N611046.980 W1494706.414  214235.2
DJ3661 CHI5 CP HINCHINBROOK 5 CORS ARP     N601415.040 W1463847.551  287888.7

                 NEAREST NGS PUBLISHED CONTROL POINT
UW5593      GRASS ISLAND 1975 AZ MK        N592918.836 W1512918.639    4256.3
```

BASE STATION INFORMATION

```
STATION NAME: kod5  a    2 (Kodiak 5; Kodiak, Alaska  USA)
 MONUMENT: NO DOMES NUMBER
XYZ  -3028720.7822  -1597307.4139   5363076.7078  MON @ 1997.0000 (M)
XYZ        -0.0145         0.0111         0.0097  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0034        -0.0019         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0037        -0.0015         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.1687         0.1291         0.1129  VEL TIMES 11.6341 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0419        -0.0200         0.0668  ARP TO L1 PHASE CENTER
XYZ  -3028720.9928  -1597307.3047   5363076.8875  L1 PHS CEN @ 2008.6346
XYZ         0.0002         0.0000         0.0001  + XYZ ADJUSTMENTS
XYZ  -3028720.9927  -1597307.3047   5363076.8876  NEW L1 PHS CEN @ 2008.6346
XYZ  -3028720.9507  -1597307.2848   5363076.8208  NEW ARP @ 2008.6346
XYZ  -3028720.9507  -1597307.2848   5363076.8208  NEW MON @ 2008.6346
LLH  57 37  3.69086  207 48 23.65251     27.2933  NEW L1 PHS CEN @ 2008.6346
LLH  57 37  3.69097  207 48 23.65263     27.2120  NEW ARP @ 2008.6346
LLH  57 37  3.69097  207 48 23.65263     27.2120  NEW MON @ 2008.6346

STATION NAME: tbon  a    2 (Anchorage AK DOT; Anchorage, Alaska  USA)
 MONUMENT: NO DOMES NUMBER
XYZ  -2663849.7606  -1551322.7408   5565105.5749  MON @ 1997.0000 (M)
XYZ        -0.0194        -0.0002        -0.0105  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU         0.0025         0.0013         0.1065  ARP TO L1 PHASE CENTER (M)
NEU        -0.0007         0.0013         0.1254  ARP TO L2 PHASE CENTER (M)
XYZ        -0.2257        -0.0023        -0.1222  VEL TIMES 11.6341 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0418        -0.0259         0.0945  ARP TO L1 PHASE CENTER
XYZ  -2663850.0281  -1551322.7690   5565105.5473  L1 PHS CEN @ 2008.6346
XYZ        -0.0000         0.0000        -0.0001  + XYZ ADJUSTMENTS
XYZ  -2663850.0282  -1551322.7689   5565105.5472  NEW L1 PHS CEN @ 2008.6346
XYZ  -2663849.9863  -1551322.7431   5565105.4527  NEW ARP @ 2008.6346
XYZ  -2663849.9863  -1551322.7431   5565105.4527  NEW MON @ 2008.6346
LLH  61 10 46.97824  210 12 53.49451     93.2325  NEW L1 PHS CEN @ 2008.6346
LLH  61 10 46.97816  210 12 53.49442     93.1260  NEW ARP @ 2008.6346
LLH  61 10 46.97816  210 12 53.49442     93.1260  NEW MON @ 2008.6346

STATION NAME: chi5  a    2 (CP Hinchinbrook 5; Cape Hinchinbrook, Alaska  USA)
 MONUMENT: NO DOMES NUMBER
XYZ  -2651399.3405  -1745185.8197   5513742.9228  MON @ 1997.0000 (M)
XYZ        -0.0053         0.0225         0.0079  VEL (M/YR)
NEU         0.0000         0.0000         0.0000  MON TO ARP (M)
NEU        -0.0034        -0.0019         0.0813  ARP TO L1 PHASE CENTER (M)
NEU        -0.0037        -0.0015         0.0689  ARP TO L2 PHASE CENTER (M)
XYZ        -0.0617         0.2618         0.0919  VEL TIMES 11.6341 YRS
XYZ         0.0000         0.0000         0.0000  MON TO ARP
XYZ        -0.0372        -0.0222         0.0689  ARP TO L1 PHASE CENTER
XYZ  -2651399.4394  -1745185.5802   5513743.0836  L1 PHS CEN @ 2008.6346
XYZ         0.0001        -0.0001        -0.0001  + XYZ ADJUSTMENTS
XYZ  -2651399.4393  -1745185.5803   5513743.0835  NEW L1 PHS CEN @ 2008.6346
XYZ  -2651399.4021  -1745185.5580   5513743.0147  NEW ARP @ 2008.6346
XYZ  -2651399.4021  -1745185.5580   5513743.0147  NEW MON @ 2008.6346
LLH  60 14 15.04627  213 21 12.35592     94.8327  NEW L1 PHS CEN @ 2008.6346
LLH  60 14 15.04638  213 21 12.35605     94.7514  NEW ARP @ 2008.6346
LLH  60 14 15.04638  213 21 12.35605     94.7514  NEW MON @ 2008.6346
```

REMOTE STATION INFORMATION

```
STATION NAME: klab       1
 MONUMENT: NO DOMES NUMBER
XYZ  -2856078.9790  -1547383.1462   5470612.3161  MON @ 2008.6334 (M)
NEU         0.0017         0.0031         2.0000  MON TO ARP (M)
NEU        -0.0017        -0.0031         0.3622  ARP TO L1 PHASE CENTER (M)
NEU        -0.0003        -0.0015         0.3594  ARP TO L2 PHASE CENTER (M)
XYZ        -0.8906        -0.4860         1.7236  MON TO ARP
XYZ        -0.1646        -0.0856         0.3111  ARP TO L1 PHASE CENTER
XYZ  -2856080.0341  -1547383.7179   5470614.3508  L1 PHS CEN @ 2008.6346

BASELINE NAME:   kod5  klab
XYZ         0.1920         0.0600        -2.0474  + XYZ ADJUSTMENTS
XYZ  -2856079.8421  -1547383.6579   5470612.3033  NEW L1 PHS CEN @ 2008.6346
XYZ  -2856079.6776  -1547383.5723   5470611.9922  NEW ARP @ 2008.6346
XYZ  -2856078.7870  -1547383.0862   5470610.2687  NEW MON @ 2008.6346
LLH  59 28  4.19464  208 26 53.54953      19.7519  NEW L1 PHS CEN @ 2008.6346
LLH  59 28  4.19470  208 26 53.54973      19.3897  NEW ARP @ 2008.6346
LLH  59 28  4.19464  208 26 53.54953      17.3897  NEW MON @ 2008.6346

BASELINE NAME:   tbon  klab
XYZ         0.2796         0.0561        -2.0657  + XYZ ADJUSTMENTS
XYZ  -2856079.7546  -1547383.6617   5470612.2851  NEW L1 PHS CEN @ 2008.6346
XYZ  -2856079.5900  -1547383.5761   5470611.9740  NEW ARP @ 2008.6346
XYZ  -2856078.6994  -1547383.0901   5470610.2504  NEW MON @ 2008.6346
LLH  59 28  4.19644  208 26 53.55239      19.6980  NEW L1 PHS CEN @ 2008.6346
LLH  59 28  4.19649  208 26 53.55259      19.3358  NEW ARP @ 2008.6346
LLH  59 28  4.19644  208 26 53.55239      17.3358  NEW MON @ 2008.6346

BASELINE NAME:   chi5  klab
XYZ         0.2002         0.0256        -2.0178  + XYZ ADJUSTMENTS
XYZ  -2856079.8340  -1547383.6923   5470612.3330  NEW L1 PHS CEN @ 2008.6346
XYZ  -2856079.6694  -1547383.6067   5470612.0219  NEW ARP @ 2008.6346
XYZ  -2856078.7788  -1547383.1206   5470610.2983  NEW MON @ 2008.6346
LLH  59 28  4.19487  208 26 53.55170      19.7821  NEW L1 PHS CEN @ 2008.6346
LLH  59 28  4.19493  208 26 53.55189      19.4199  NEW ARP @ 2008.6346
LLH  59 28  4.19487  208 26 53.55170      17.4199  NEW MON @ 2008.6346
```

G-FILES

```
Axx2008 819   8 820
B2008 8191938   8 8201626 1 page5 v0810.20IGS     222 1 2 27NGS
20081119IFDDFX
Iant_info.003        NGS   20081104
C00090001-1726421637   35 -499241985   12-1075334479   49 X2328AKLABX2328AKOD5
D  1  2  8824158  1  3  1127043  2  3   959933

Axx2008 819   8 820
B2008 8191938   8 8201626 1 page5 v0810.20IGS     222 1 2 27NGS
20081119IFDDFX
Iant_info.003        NGS   20081104
C00090002 1922287131   33  -39396530   11  944952022   57 X2328AKLABX2328ATBON
D  1  2  1460405  1  3   141929  2  3 -7917980

Axx2008 819   8 820
B2008 8191938   8 8201626 1 page5 v0810.20IGS     222 1 2 27NGS
20081119IFDDFX
Iant_info.003        NGS   20081104
C00090003 2046793768   22-1978024374   26  431327163   39 X2328AKLABX2328ACHI5
D  1  2 -3860857  1  3 -3616611  2  3 -6103363
```

POST-FIT RMS BY SATELLITE VS. BASELINE

```
            OVERALL     02     03     04     05     06     07     08     09
 kod5-klab|  0.017  0.022  0.025  0.019    ...  0.013  0.020  0.020  0.015
                10     11     12     13     14     15     16     17     18
 kod5-klab|  0.016    ...  0.029  0.015  0.020  0.017  0.015  0.018  0.020
                19     20     21     22     23     24     25     26     27
 kod5-klab|  0.013  0.013  0.018  0.017  0.018  0.014  0.013  0.015  0.017
                28     29     30     31     32
 kod5-klab|  0.017  0.019  0.016  0.023  0.018

            OVERALL     02     03     04     05     06     07     08     09
 tbon-klab|  0.021  0.027  0.054  0.018    ...  0.015  0.022  0.019  0.018
                10     11     12     13     14     15     16     17     18
 tbon-klab|  0.020  0.024  0.024  0.018  0.021  0.018  0.016  0.023  0.020
                19     20     21     22     23     24     25     26     27
 tbon-klab|  0.029  0.018  0.018  0.022  0.020  0.015  0.022  0.016  0.018
                28     29     30     31     32
 tbon-klab|  0.022  0.031  0.018  0.022  0.025

            OVERALL     02     03     04     05     06     07     08     09
 chi5-klab|  0.020  0.022  0.017  0.028  0.016  0.017  0.020  0.018  0.021
                10     11     12     13     14     15     16     17     18
 chi5-klab|  0.018  0.015  0.021  0.028  0.025  0.017  0.015  0.021  0.023
                19     20     21     22     23     24     25     26     27
 chi5-klab|  0.022  0.019  0.025  0.021  0.021  0.019  0.019  0.017  0.016
                28     29     30     31     32
 chi5-klab|  0.018  0.018  0.023  0.019  0.024
```

OBS BY SATELLITE VS. BASELINE

	OVERALL	02	03	04	05	06	07	08	09
kod5-klab|	9737	158	14	318	...	507	208	100	621
	10	11	12	13	14	15	16	17	18
kod5-klab|	207	...	24	217	543	317	383	508	614
	19	20	21	22	23	24	25	26	27
kod5-klab|	486	432	418	408	155	319	64	219	184
	28	29	30	31	32				
kod5-klab|	605	80	618	518	492				
	OVERALL	02	03	04	05	06	07	08	09
tbon-klab|	9757	157	47	322	...	534	209	46	615
	10	11	12	13	14	15	16	17	18
tbon-klab|	223	77	78	288	558	144	374	508	573
	19	20	21	22	23	24	25	26	27
tbon-klab|	405	460	423	450	204	311	63	217	177
	28	29	30	31	32				
tbon-klab|	494	80	618	498	604				
	OVERALL	02	03	04	05	06	07	08	09
chi5-klab|	10257	164	527	258	326	576	255	81	295
	10	11	12	13	14	15	16	17	18
chi5-klab|	251	533	517	184	544	218	455	467	625
	19	20	21	22	23	24	25	26	27
chi5-klab|	181	418	27	426	362	380	47	243	162
	28	29	30	31	32				
chi5-klab|	445	467	235	400	188				

Covariance Matrix for the xyz OPUS Position (meters2).

0.0000062178	0.0000000451	-0.0000000201
0.0000000451	0.0000020911	-0.0000002353
-0.0000000201	-0.0000002353	0.0000159356

Covariance Matrix for the enu OPUS Position (meters2).

0.0000029898	0.0000015658	-0.0000007002
0.0000015658	0.0000079725	0.0000045985
-0.0000007002	0.0000045985	0.0000132821

Horizontal network accuracy = 0.00598 meters.
Vertical network accuracy = 0.00715 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD_83(CORS96)(EPOCH:2002.0000).

	Xa(m)	Ya(m)	Za(m)	
KOD5	-3028720.08248	-1597308.40205	5363076.37683	2003.00
TBON	-2663849.09248	-1551323.79098	5565105.12546	2003.00
CHI5	-2651398.59721	-1745186.74080	5513742.60884	2003.00

Position of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr(m)	Yr(m)	Zr(m)	
KOD5	-3028720.08248	-1597308.40205	5363076.37683	2003.00
TBON	-2663849.09248	-1551323.79098	5565105.12546	2003.00
CHI5	-2651398.59721	-1745186.74080	5513742.60884	2003.00

Velocity of reference station monument in NAD_83(CORS96)(EPOCH:2002.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
KOD5	0.00680	0.01170	0.02080
TBON	0.00260	0.00050	-0.00080
CHI5	0.01660	0.02320	0.01770

Vectors from unknown station monument to reference station monument
in NAD_83(CORS96)(EPOCH:2002.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
KOD5	-172642.22248	-49924.24605	-107533.56917	2003.00
TBON	192228.76752	-3939.63498	94495.17946	2003.00
CHI5	204679.26279	-197802.58480	43132.66284	2003.00

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

Kukkamaki April 1, 2008 (Dn 092)

On April 1, 2008 (Dn092) ENS Morgan, ENS Andrews and ST Campbell performed a Kukkamaki on both Carl Zeiss NI2 (stadia: 333) levels (S/N 103267 and S/N 100056).

The Kukkamaki course was set up on the pier at ISC Seattle in the early afternoon. The weather was sunny and cool with light wind. A 40 meter straight line was set up on level ground and divided into 10 meter intervals. The level was then set up on the 30 meter mark and a backsight and foresight were shot to the 20 and 40 meter marks respectively. Next, the level was set up at the 0 meter mark, and a backsight and foresight were shot to the 20 and 40 meter marks, respectively. (See *fig. 1*)

The Carl Zeiss level S/N 103267 had a collimation error of -0.01, which is within the allowed +/- 0.05 tolerance required by the *Field Procedures Manual, May 2008*. The Carl Zeiss level S/N 100056 was also within tolerance with the same collimation error of -0.01.

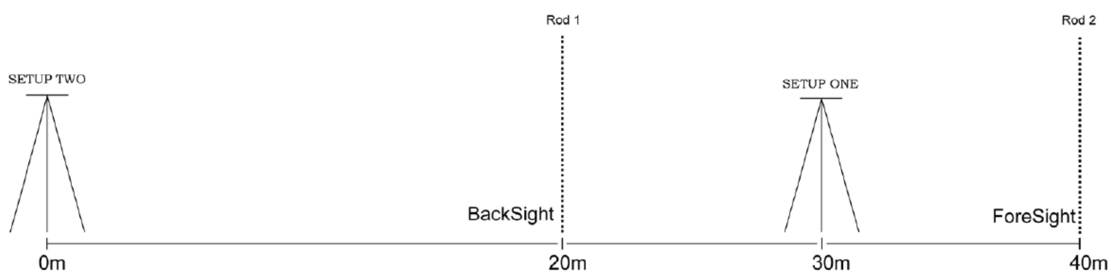


Fig 1. Diagram of Kukkamaki setup.

NOAA FORM 75-29 (12-75)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	HSRR	100056	SHEET	OF
PRECISE LEVELING *THREE-WIRE*		FROM B.M.	TO B.M.		
		Kukkamaki	12:45	DATE: DN 092, 1 April 2008	
FORWARD RUN *(See reverse for BACKWARD RUN)*		WEATHER Sunny, cool			

Setup	BACKSIGHTS THREAD READING	MEAN	THREAD INTERVAL	SUM OF INTERVALS	ROD TEMP	FORESIGHTS THREAD READING	MEAN	THREAD INTERVAL	SUM OF INTERVALS	___3____ ORDER, CLASS ___1____ REMARKS	
	1415	BS1				1415	FS1			C = (Δh1 - Δ2) - 0.2mm	
1	1400	1400				1400	1400			20 m	
	1385					1385				where BS1 - FS1 = Δh1	
	4200					4200				BS2 - FS2 = Δh2	
	1398	20mS				1428	40mS			Δh1-	0.00
2	1368	1368				1368	1368			Δh2	0
	1338					1308				Δh1-Δh2 =	0.00
	4104					4104				- 0.2 (CR)	-0.20
										÷20m	-0.01
										C =	-0.01
										"C" must be < + 0.05mm/m	
										Instrument SN: 100056	
										Rod SN: B	
										Party Chief: Baird	
										Observer: Campbell	
										Recorder: Morgan	
										Rod Person: Andrews	

Fill in YELLOW shaded cells.

NOAA FORM 75-29 (12-75)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	HSRR	103267	SHEET	OF
PRECISE LEVELING		FROM B.M.	TO B.M.		
THREE-WIRE		**Kukkamaki**	12:45	DATE: DN 092, 1 April 2008	
FORWARD RUN *(See reverse for BACKWARD RUN)*		WEATHER Sunny, cool			

	BACKSIGHTS					**FORESIGHTS**				**___3____ ORDER, CLASS ___1____**	
Setup	THREAD READING	MEAN	THREAD INTERVAL	SUM OF INTERVALS	ROD TEMP	THREAD READING	MEAN	THREAD INTERVAL	SUM OF INTERVALS	REMARKS	
	1344	BS1				1344	FS1			C = (Δh1 - Δ2) - 0.2mm	
1	1330	1329.33				1330	1329.33			20 m	
	1314					1314				where BS1 - FS1 = Δh1	
	3988					3988				BS2 - FS2 = Δh2	
	1365	20mS				1395	40mS			Δh1-	0.00
2	1335	1335				1335	1335			Δh2	0
	1305					1275				Δh1-Δh2 =	0.00
	4005					4005				- 0.2 (CR)	-0.20
										÷20m	-0.01
										C =	-0.01

Fill in YELLOW shaded cells.

"C" must be < + 0.05mm/m

Instrument SN: 103267
Rod SN: B
Party Chief: Baird
Observer: Andrews
Recorder: Campbell
Rod Person: Morgan

Vertical Control Equipment Test
March 2008

The 2008 test of the FAIRWEATHER's vertical control equipment included testing five 8210 Sutron "bubbler" Tide Gauges that were provided by the Center for Operational Oceanographic Products and Services (CO-OPS). The gauges are equipped with Paros Scientific Sensors (SDI-12) for measuring pressure. Each year, the gauges are checked by the CO-OPS Field Operations Center to ensure their accuracy.

CO-OPS does not provide calibration or quality assurance documentation to the FAIRWEATHER. FAIRWEATHER personnel are responsible for installation and removal of the water level gauges. CO-OPS is responsible for delivering final approved vertical correctors to the FAIRWEATHER for application to the hydrographic data set. As FAIRWEATHER receives new gauges, data quality assurance checks will be conducted in a similar manner as the procedures listed below to ensure full functionality prior to deployment.

Five tide gauges: #16 (33452648), #12 (3344B1D0), #08 (33445222), #17 (3351E1F2) and #4 (334211E6) were set up and tested by ship personnel at Federal Center South in Seattle, WA from March 12th through March 28th. Each gauge was tested for at least 48 hours to insure proper data collection. The orifice was placed just off the pier by the gauge in approximately 12 meters of water. The GPS antenna was facing open sky to the South (Figure 1). The set-up was periodically checked to insure proper transmission and to check for any leaks in the system.

CO-OPS was able to verify that all the above gauges had strong transmissions to the GOES satellite, and were collecting accurate tide curves. Gauge #4 produced an unusual tidal curve when checked with the Tuffbook although CO-OPS verified this information as well. It would probably be wise to use the other 4 gauges before opting to use gauge #4.

Figure 1: Tide gauge testing at Federal Center South: March 11-28, 2008

PTC Electronics Incorporated

PO Box 72, Wyckoff, NJ 07481 Phone: (201) 847-0500 • Fax: (201) 847-1394 • URL: www.PTCElectronics.com

DATE	04/02/2008
TRANSDUCER TYPE	Digital Pressure Gage-D2000
SERIAL NUMBER	68337
PRESSURE RANGE/ACC'Y	0-100psia 0.1% fs.
EXCITATION VOLTAGE	NA
PRESSURE STANDARD USED	DRUCK DPI 600
SPECIFIED ACCURACY	0.03%
CALIBRATION PERIOD	Bi-annual
LAST CALIBRATED	06/01/06
READOUT	Digital
DATA TAKEN BY	John C. Kicks

CALIBRATION CONDITIONS:

BAROMETRIC PRESSURE	14.64 psia
AMBIENT TEMPERATURE	72°F
PRESSURE MEDIA	Air

PRESSURE APPLIED	REFERENCE PRESSURE	OUTPUT (UNITS) psia Increasing	Decreasing
-1.00	13.64	13.47	13.47
0.00	14.64	14.48	14.47
1.00	15.64	15.48	15.48
2.00	16.64	16.48	16.48
3.00	17.64	17.48	17.48
4.00	18.64	18.48	18.49
5.00	19.64	19.48	19.48
6.00	20.64	20.48	20.49
7.00	21.64	21.48	21.48
12.00	26.64	26.49	26.49
17.00	31.64	31.48	31.48
22.00	36.64	36.49	36.50
27.00	41.64	41.47	41.47
32.00	46.64	46.48	

APPROVED by

Alan F. Kicks, Q.A. Manager

NOAA Ship FAIRWEATHER
LASER LEVEL Accuracy test
3.8 **sn# 000676**
Laser Technology, Inc. Impulse 200 laser ranging instrument

Testing date: 02/27/2006

Trial	Actual Distance	LL Distance	Actual Height	LL Height
1	10	10.0	2.0	2.0
2	10	10.0	2.0	2.0
3	10	10.0	2.0	2.0
4	20	20.0	2.0	1.9
5	20	19.9	2.0	2.0
6	20	20.0	2.0	2.0
7	50	50.1	2.0	2.0
8	50	50.1	2.0	2.1
9	50	50.1	2.0	2.1
10	100	100.1	2.0	2.1
11	100	100.1	2.0	1.9
12	100	100.1	2.0	1.8

LL = Laser Level
all distances are measured in meters

Comparison Testing Lasers 000676 and i0929 and Trimble

Testing date: 03/03/2006

	Trial	Trimble Distance	000676 Distance	i0929 Distance	000676 Height	i0929 Height	Actual Height		
	1.0	30.0	32.8	33.0	2.1	2.4	2.0	2.8	
	2.0	23.5	27.3	27.8	2.0	1.9	2.0	3.8	
	3.0	20.2	24.0	24.2	2.2	2.0	2.0	3.8	
	4.0	34.0	31.9	32.4	2.6	2.3	2.0	2.1	
	5.0	26.8	26.2	25.8	2.1	2.0	2.0	0.6	
	7.0	30.6	28.5	28.5	2.0	2.4	2.0	2.1	
	6.0	51.9	38.7	38.5	2.0	2.3	2.0	13.2	
sum		217.0	209.4	210.2	15.0	15.3	14.0	28.4	15.2
mean		31.0	29.9	30.0	2.1	2.2	2.0	4.1	2.5
standard deviation		10.3	5.0	4.9	0.2	0.2	0.0		

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 10_01_04
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 6/11/2008

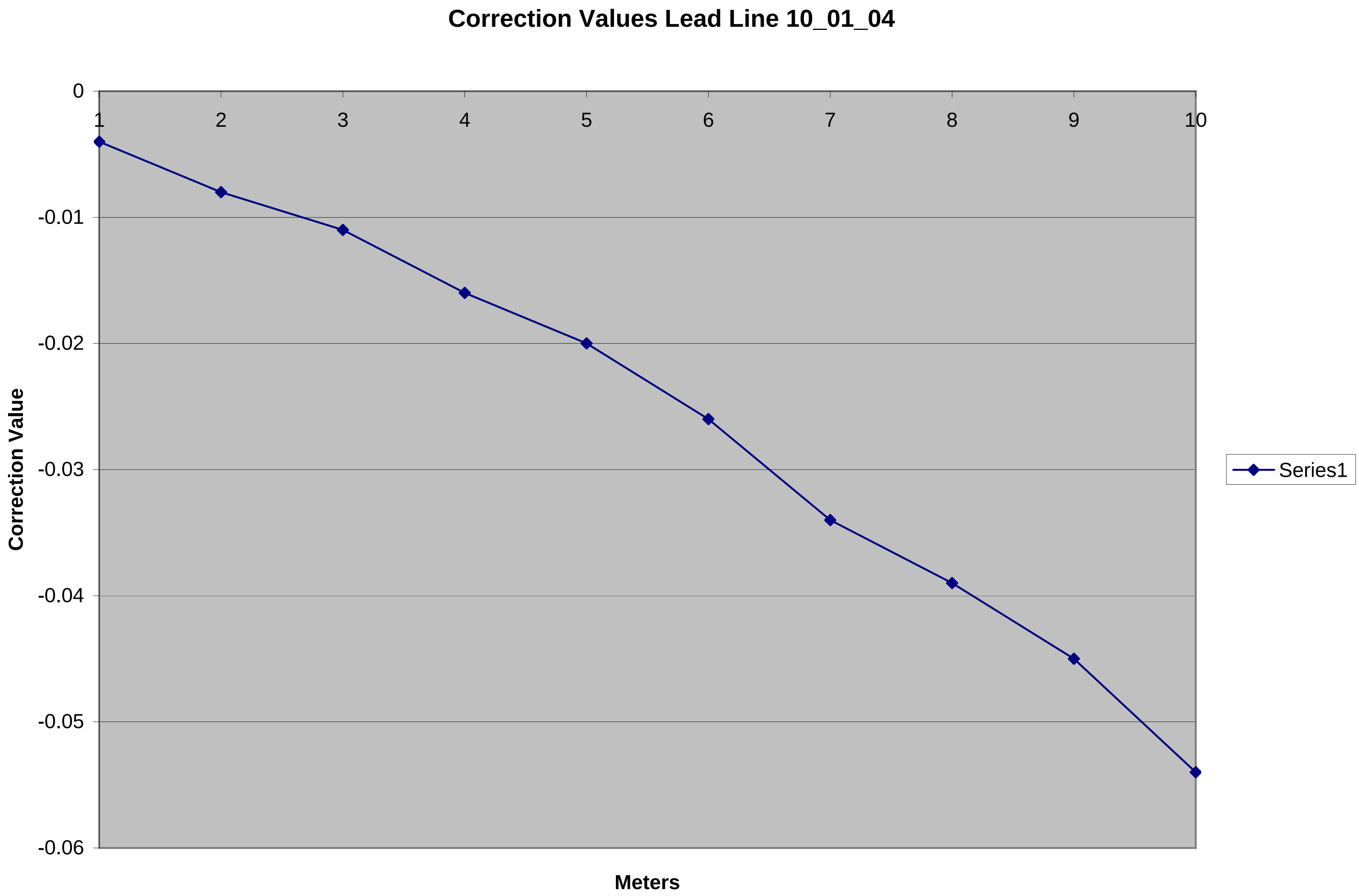
Method of Calibration: X Steel tape Permanent graduation marks Other

Location: Ketchikan, Alaska

Chief of Party: CDR Baird

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: Tyanne Faulkes & Weston Renoud	**Recorded by: Weston Renoud**	**Checked by:**
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	0.996	-0.004
2	1.992	-0.008
3	2.989	-0.011
4	3.984	-0.016
5	4.98	-0.02
6	5.974	-0.026
7	6.966	-0.034
8	7.961	-0.039
9	8.955	-0.045
10	9.946	-0.054
	Average Correction	-0.01285
	Standard Deviation	0.016819631


Correction Values Lead Line 10_01_04
Correction Value
Meters
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
1
2
3
4
5
6
7
8
9
10
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 10_01_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 6/11/2008

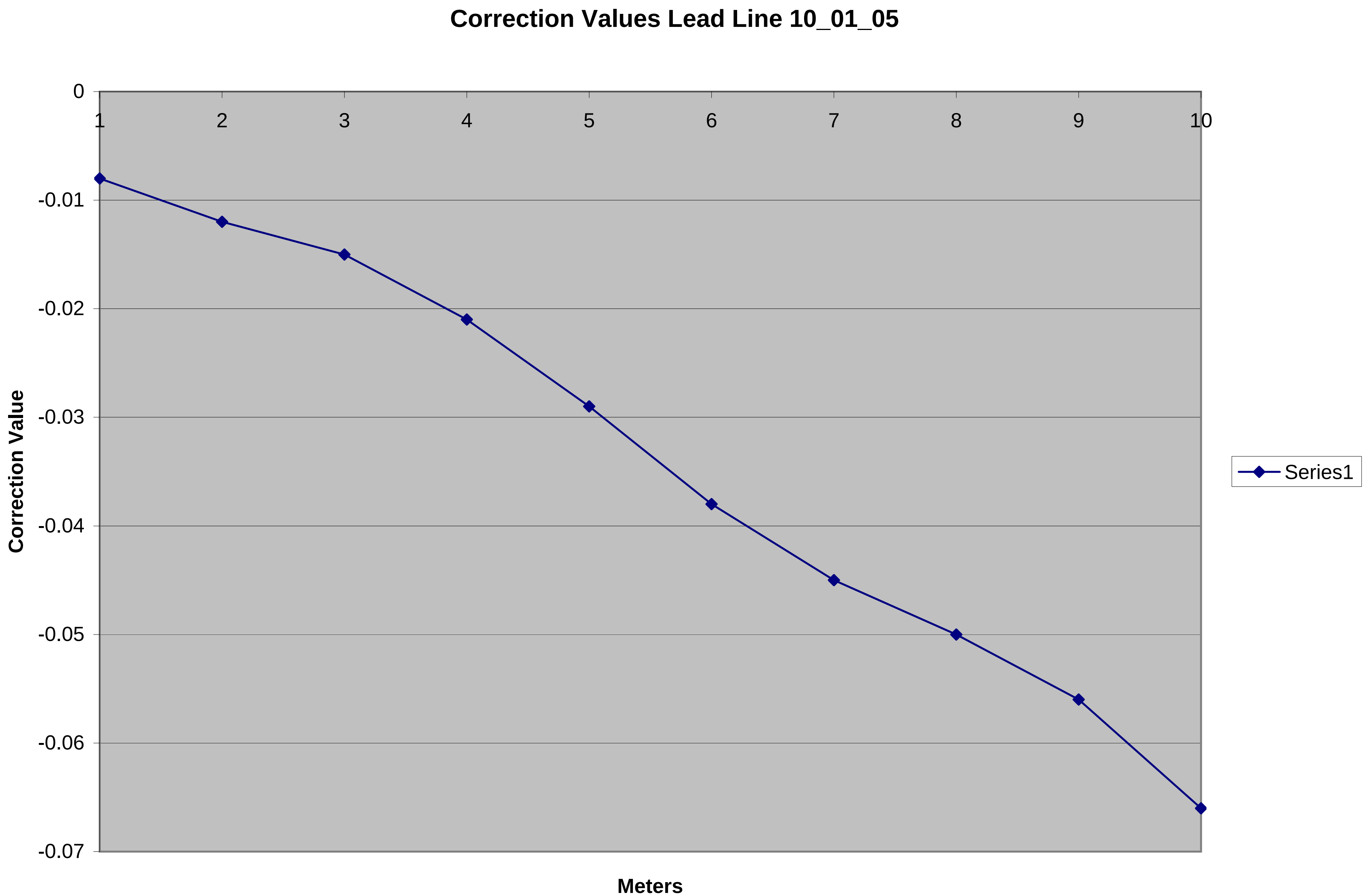
Method of Calibration: X **Steel tape** **Permanent graduation marks** **Other**

Location: Ketchikan, Alaska

Chief of Party: CDR Baird

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: Tyanne Faulkes & Weston Renoud	**Recorded by: Weston Renoud**	**Checked by:**
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	0.992	-0.008
2	1.988	-0.012
3	2.985	-0.015
4	3.979	-0.021
5	4.971	-0.029
6	5.962	-0.038
7	6.955	-0.045
8	7.95	-0.05
9	8.944	-0.056
10	9.934	-0.066
	Average Correction	-0.017
	Standard Deviation	0.020044395


Correction Values Lead Line 10_01_05
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
1
2
3
4
5
6
7
8
9
10
Correction Value
Meters
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 10_02_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 6/11/2008

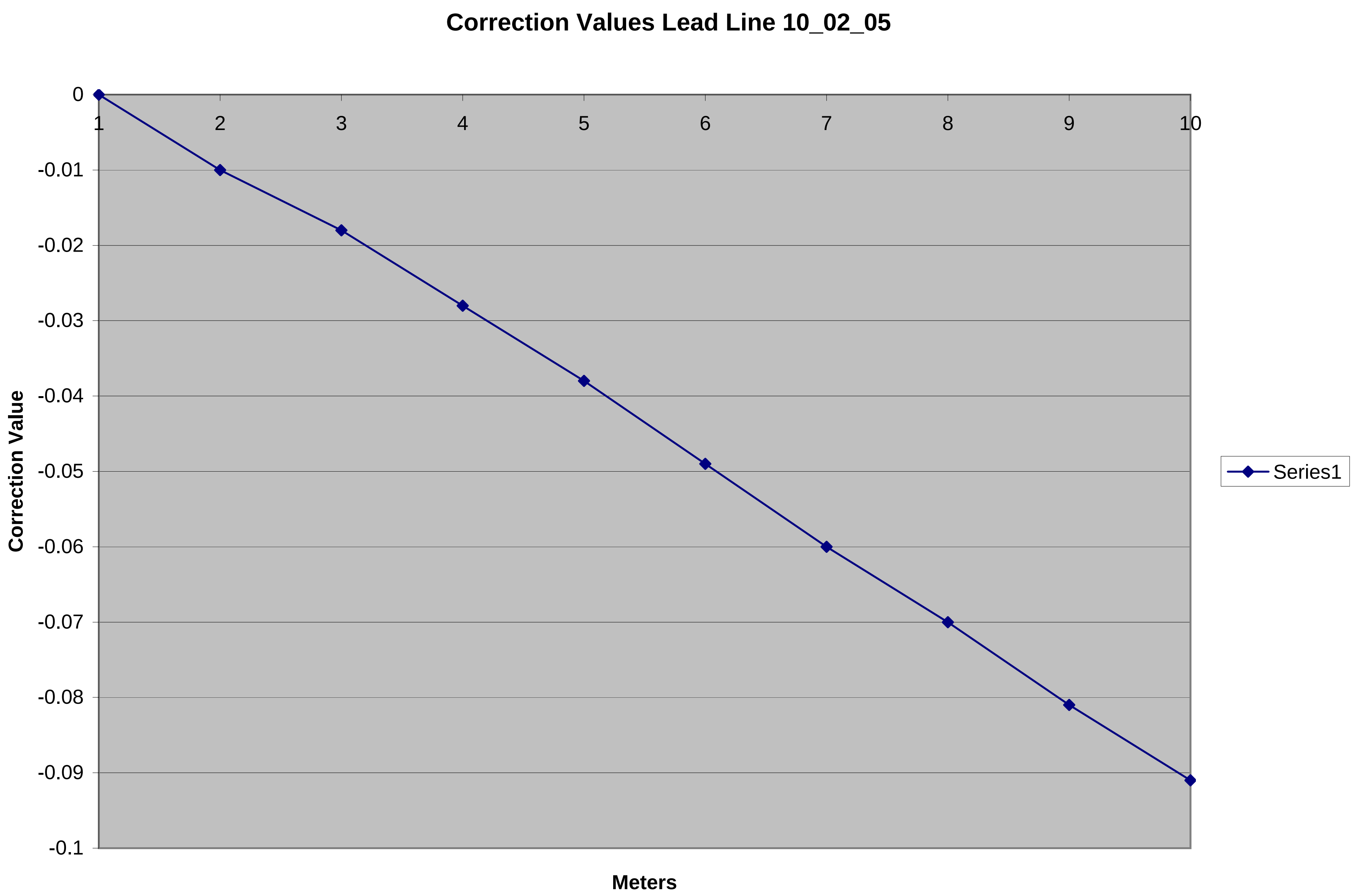
Method of Calibration: **X Steel tape** **Permanent graduation marks** **Other**

Location: Ketchikan, Alaska

Chief of Party: CDR Baird

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: Tyanne Faulkes & Weston Renoud	Recorded by: Tyanne Faulkes	Checked by:
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	1	0
2	1.99	-0.01
3	2.982	-0.018
4	3.972	-0.028
5	4.962	-0.038
6	5.951	-0.049
7	6.94	-0.06
8	7.93	-0.07
9	8.919	-0.081
10	9.909	-0.091
	Average Correction	-0.02225
	Standard Deviation	0.03089858



Correction Values Lead Line 10_02_05
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.1
1
2
3
4
5
6
7
8
9
10
Correction Value
Meters
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 20_01_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 6/11/2008

Method of Calibration: X Steel tape Permanent graduation marks Other

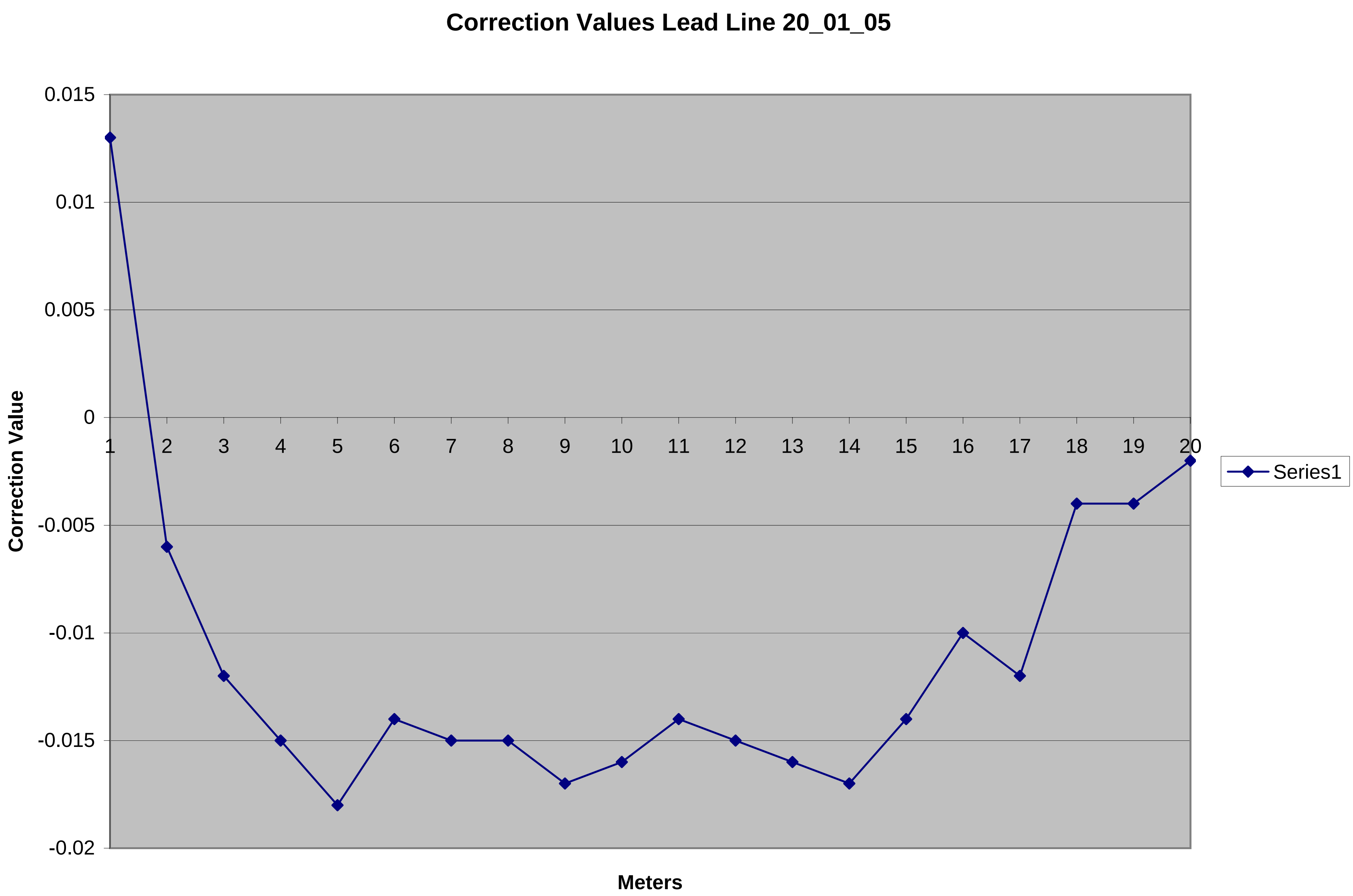
Location: Ketchikan, Alaska

Chief of Party: CDR Baird

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: Tyanne Faulkes & Weston Renoud	**Recorded by: Tyanne Faulkes**	**Checked by:**
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	1.013	0.013
2	1.994	-0.006
3	2.988	-0.012
4	3.985	-0.015
5	4.982	-0.018
6	5.986	-0.014
7	6.985	-0.015
8	7.985	-0.015
9	8.983	-0.017
10	9.984	-0.016
11	10.986	-0.014
12	11.985	-0.015
13	12.984	-0.016
14	13.983	-0.017

Graduated Marking (a)	Calibration Measurement (b)	Lead Line Corrector (c = b - a)
15	14.986	-0.014
16	15.99	-0.01
17	16.988	-0.012
18	17.996	-0.004
19	18.996	-0.004
20	19.998	-0.002
	Average Correction	-0.01115
	Standard Deviation	0.007414602



Correction Values Lead Line 20_01_05
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
Correction Value
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Meters
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 20_02_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 5/30/2008

Method of Calibration: X Steel tape Permanent graduation marks Other

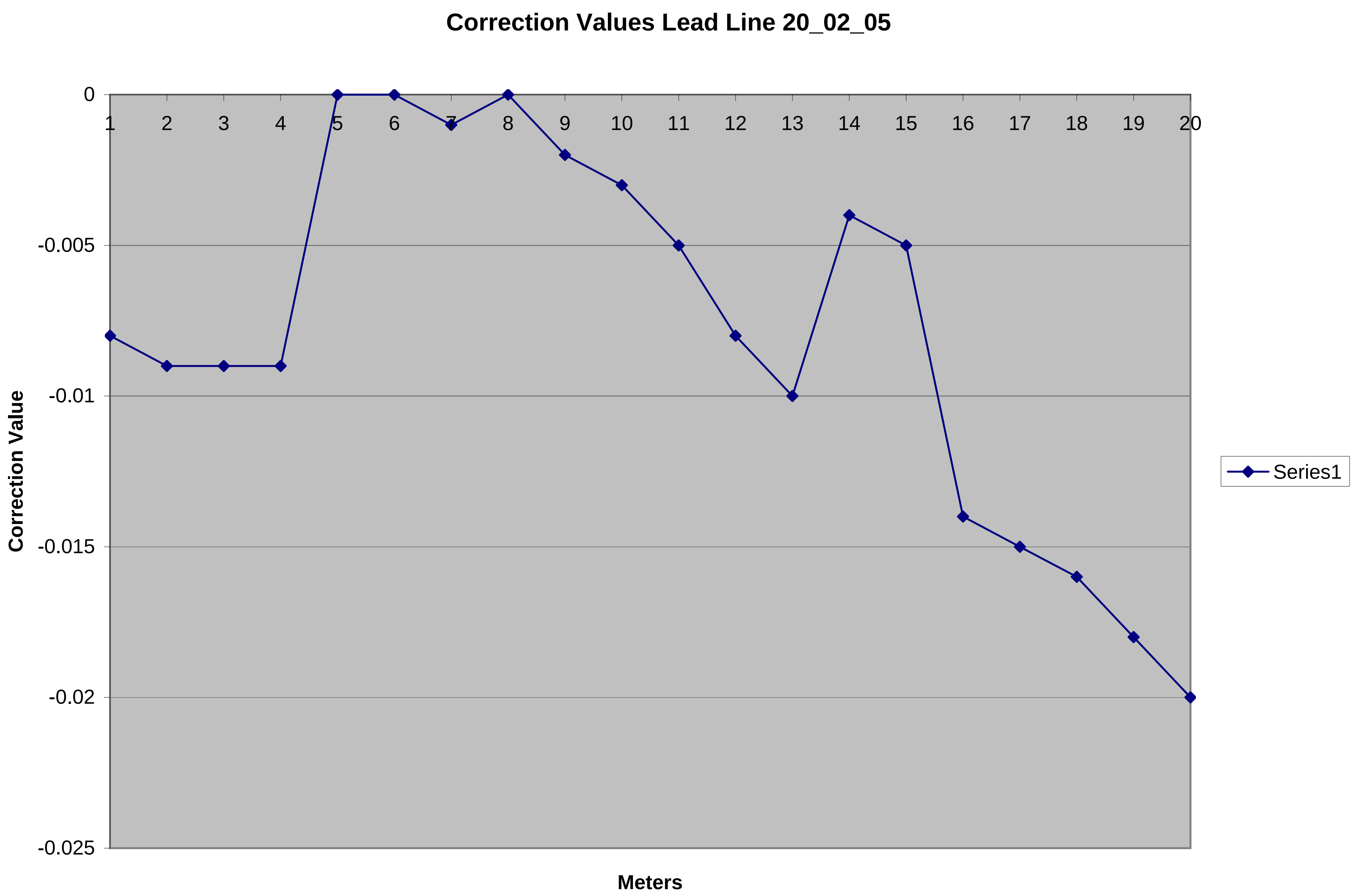
Location: Ketchikan, Alaska

Chief of Party: CDR Baird

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: Megan Bucher, Tyanne Faulkes, Brenna Campbell	**Recorded by: Megan Bucher**	**Checked by:**
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	0.992	-0.008
2	1.991	-0.009
3	2.991	-0.009
4	3.991	-0.009
5	5	0
6	6	0
7	6.999	-0.001
8	8	0
9	8.998	-0.002
10	9.997	-0.003
11	10.995	-0.005
12	11.992	-0.008
13	12.99	-0.01
14	13.996	-0.004

Graduated Marking (a)	Calibration Measurement (b)	Lead Line Corrector (c = b - a)
15	14.995	-0.005
16	15.986	-0.014
17	16.985	-0.015
18	17.984	-0.016
19	18.982	-0.018
20	19.98	-0.02
	Average Correction	-0.0078
	Standard Deviation	0.006220509



Correction Values Lead Line 20_02_05
0
-0.005
-0.01
-0.015
-0.02
-0.025
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Correction Value
Meters
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 20_03_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration: 3/26/2007

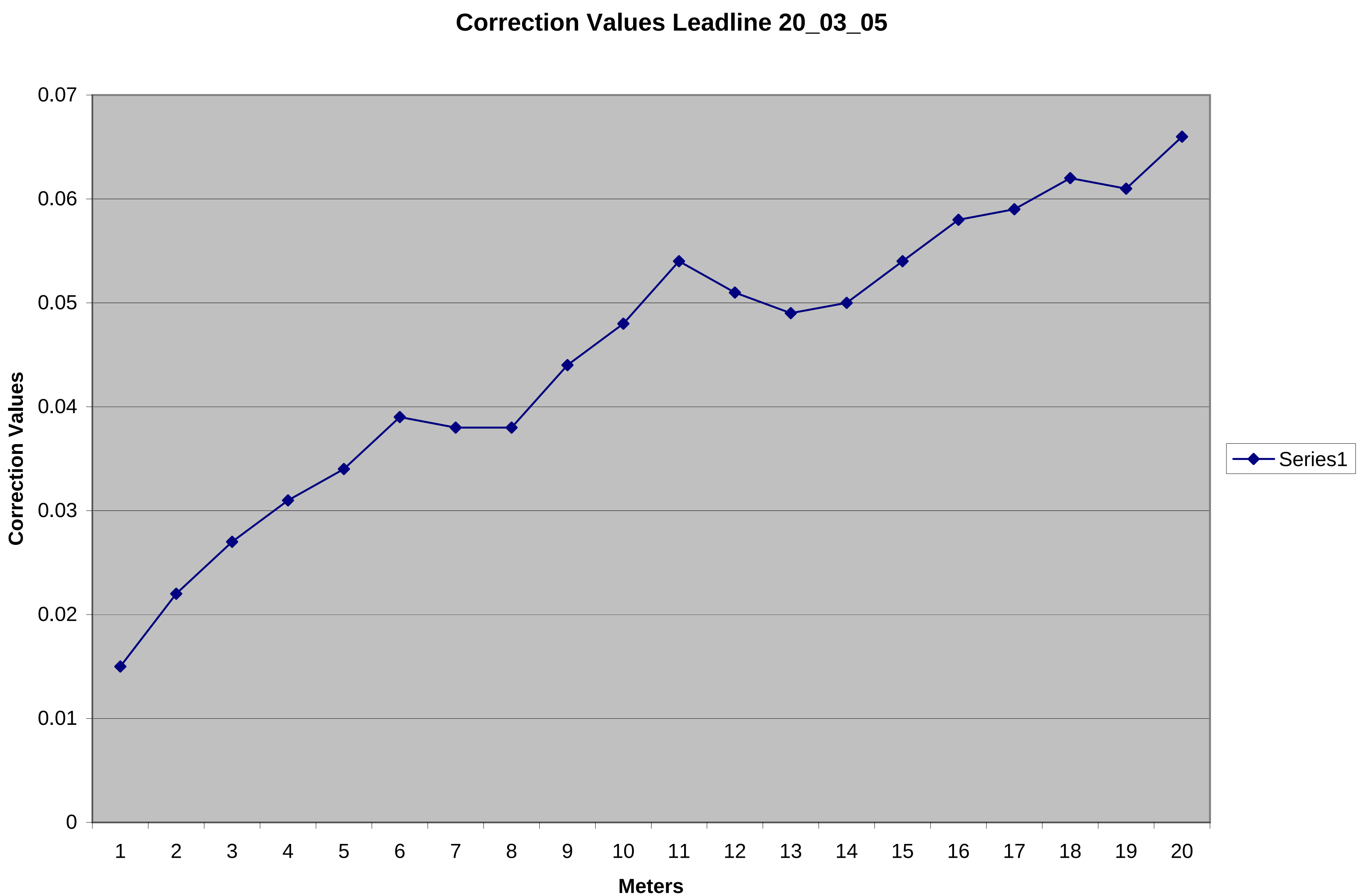
Method of Calibration: **X Steel tape** **Permanent graduation marks** **Other**

Location: Ketchikan, Alaska

Chief of Party: Cdr. Andrew Beaver/NOAA Ship Fairweather

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: BC/DJ	**Recorded by: BC**	**Checked by: BC**
Graduated Marking (a)	**Calibration Measurement (b)**	**Lead Line Corrector (c = b - a)**
1	0.985	0.015
2	1.978	0.022
3	2.973	0.027
4	3.969	0.031
5	4.966	0.034
6	5.961	0.039
7	6.962	0.038
8	7.962	0.038
9	8.956	0.044
10	9.952	0.048
11	10.946	0.054
12	11.949	0.051
13	12.951	0.049
14	13.95	0.05
15	14.946	0.054
16	15.942	0.058
17	16.941	0.059
18	17.938	0.062
19	18.939	0.061
20	19.934	0.066
	Average Correction	0.045
	Standard Deviation	0.014


Correction Values Leadline 20_03_05
Correction Values
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Meters
Series1

Lead Line & Sounding Pole Calibration Report

Field unit: FA

Lead Line / Sounding Pole Identification Number: Leadline 30_01_05
(Unique Identifier, with equipment type, date made, etc.)

Date of Calibration:

Method of Calibration: **X** **Steel tape** **Permanent graduation marks** **Other**

Location: Ketchikan, Alaska

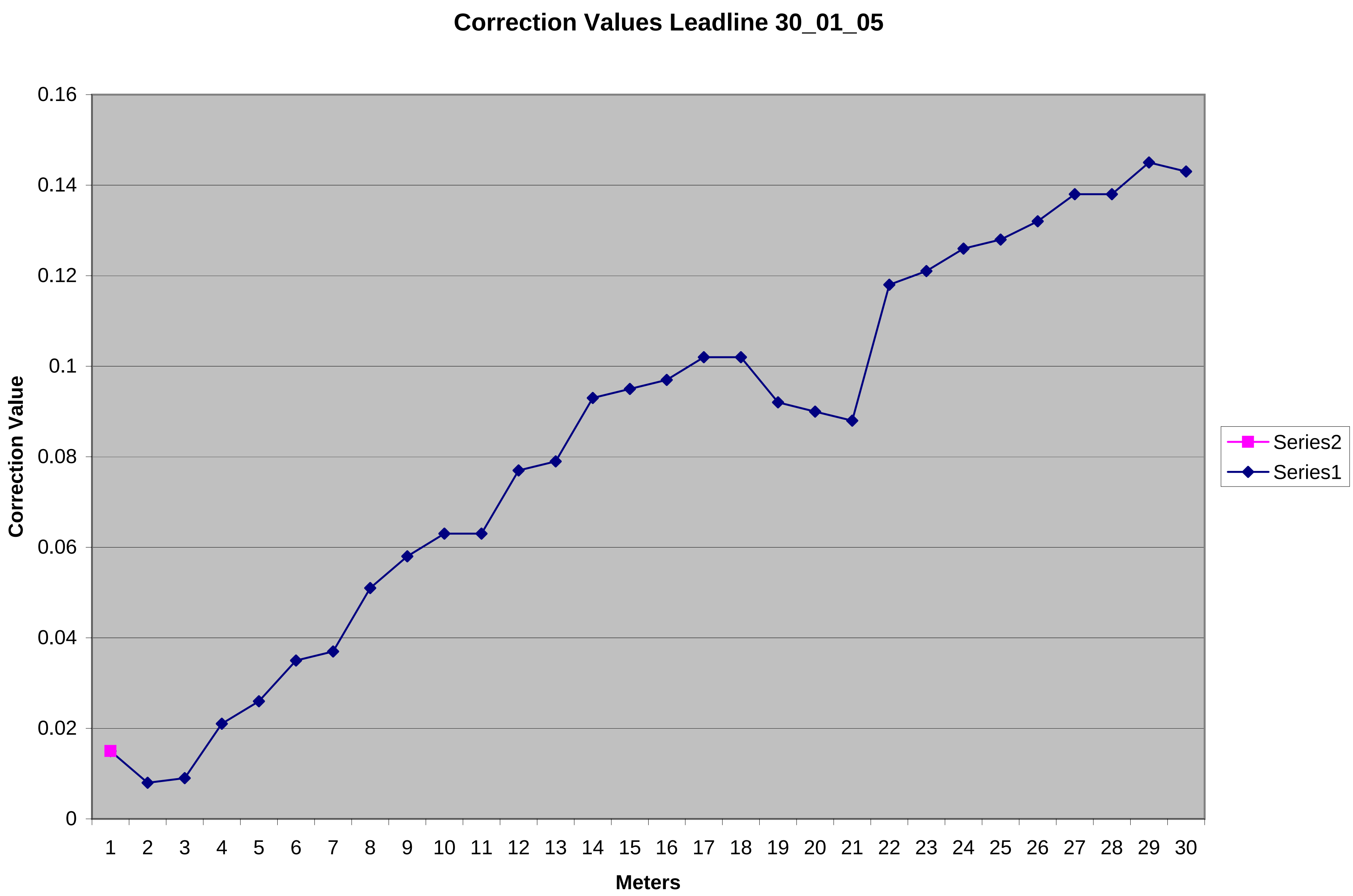
Chief of Party: CO Andrew Beaver/NOAA Ship Fairweather

Lead Line / Sounding Pole Unit of Measure: Meters

Measured by: BC/ACA	**Recorded by: BC**	**Checked by: BC**

Graduated Marking (a)	Calibration Measurement (b)	Lead Line Corrector (c = b - a)
1	1.015	0.015
2	1.992	0.008
3	2.991	0.009
4	3.979	0.021
5	4.974	0.026
6	5.965	0.035
7	6.963	0.037
8	7.949	0.051
9	8.942	0.058
10	9.937	0.063
11	10.937	0.063
12	11.923	0.077
13	12.921	0.079
14	13.907	0.093

Graduated Marking (a)	Calibration Measurement (b)	Lead Line Corrector (c = b - a)
15	14.905	0.095
16	15.903	0.097
17	16.898	0.102
18	17.898	0.102
19	18.908	0.092
20	19.91	0.09
21	20.912	0.088
22	21.882	0.118
23	22.879	0.121
24	23.874	0.126
25	24.872	0.128
26	25.868	0.132
27	26.862	0.138
28	27.862	0.138
29	28.855	0.145
30	29.857	0.143
	Average Correction	0.083
	Standard Deviation	0.043



Correction Values Leadline 30_01_05
Correction Value
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Meters
Series2
Series1

APPLIED MICROSYSTEMS Because it's not just H_2O

Certificate of Calibration

Customer: Brooke Ocean Technology Ltd.

Reference: Job#: 11232 PO#: credit card

Part No: Smart SV & Pressure

Serial No: 4986

Comments: New invar rods for SV sensor, new zinc,
re-calibration of sound velocity and pressure.

______________________ Date: Jan 13/06

Jeff Bosma

Electronics Technologist

APPLIED MICROSYSTEMS LTD. CERTIFIES THAT THE ABOVE DESCRIBED EQUIPMENT HAS BEEN CALIBRATED WITH EQUIPMENT REFERENCED TO TRACEABLE STANDARDS. ANY REPAIRS/CALIBRATIONS PERFORMED ON THIS INSTRUMENT WERE APPROVED BY THE CONTRACT/PURCHASE ORDER NAMED ABOVE.

AML Calibration Equipment

Temperature Calibrations

Performed using either of two Hart Scientific "Black Stack" Model 1560 Power Bases with attached Hart Scientific Model 2563 Thermistor Modules connected to a Thermometrics AS125 4 Wire Thermistor Standard

1: Hart Scientfic Power Base 1560 S/N 79263 / Thermistor Module 2563 S/N 79039 / Thermometrics AS125 4 Wire Thermistor Standard S/N 2131
2: Hart Scientfic power Base 1560 S/N A05690 / Thermistor Module 2563 S/N A05693 / Thermometrics AS125 4 Wire Thermistor Standard S/N 2128

Temperature calibration equipment is calibrated yearly and verified bi-monthly as per Applied Microsystems Ltd. Calibration Schedule T11.2 utilizing a Hart Scientific Model 5901 Triple Point of Water Cell. All temperature calibrations and verifications are ITS-90 and NIST traceable

Pressure Calibrations

Performed using a Budenburg Model 380D S/N 18564 Range 0-8000 psi Deadweight Tester. Calibrations and verifications are implemented as per Applied Microsystems Ltd. Calibration Schedule T11.2. All pressure calibrations and verifications are NIST traceable.

Conductivity Calibrations

Performed using either of two Guildline 8400B S/N 59251 or Guildline 8400 S/N 43385 Autosals. Both Conductivity Calibrators are calibrated and verified using Ocean Scientific International IAPSO Standard Seawater as per Applied Microsystems ltd. Calibration Schedule T11.2. All Conductivity Calibrations and verifications are NIST traceable

Battery Channel Calibrations

Performed using a Precision Fluke Model 45 Multimeter S/N 4720162. Calibrations and verifications are implemented as per Applied Microsystems Ltd. Calibration Schedule T11.2 All calibrations and verifications are NIST traceable.

Sound Velocity Calibrations

Performed using an Applied Microsystems Ltd Temperature Standard S/N 9998 in distilled water, <5 ppm TDS, and sound velocity reference is Del Grosso and Mader's Pure Water Equation. Calibrations and verifications are implemented as per Applied Microsystems Ltd. Calibration Schedule T11.2 All temperature calibrations and verifications are ITS-90 and NIST traceable.

APPLIED MICROSYSTEMS

004986 Certificate of Calibration

Customer:	NOAA - Pacific Marine Center
Asset Serial Number:	004986
Asset Type:	004986 (Smart SV&P)
Calibrated Pressure Range:	1000 dBar

Certification Date:	02/10/2008 (dd/mm/yyyy)
Certified By:	

Applied Microsystems Ltd.

Robert Haydock,
President
Applied Microsystems

Applied Microsystems certifies that the equipment described above has been calibrated with equipment referenced to traceable standards. Any repairs / calibrations completed on this instrument were approved by the instrument owner under purchase order.

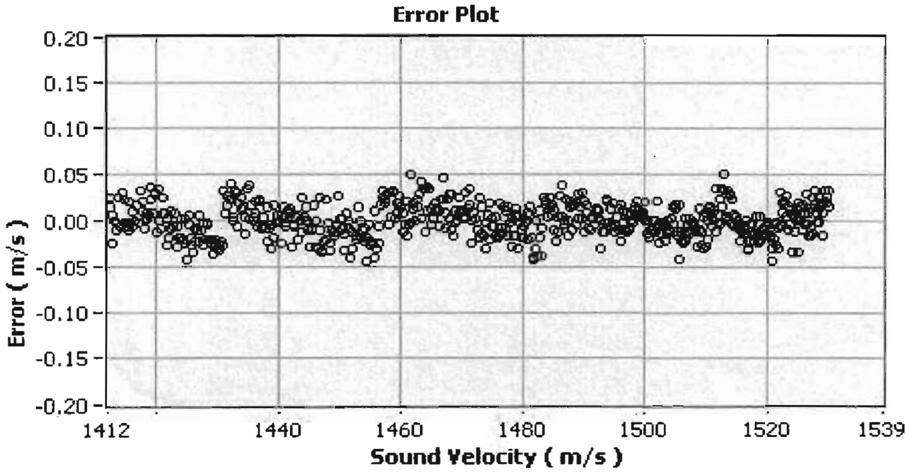
This instrument has been recalibrated. Please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software (ie. Smart Talk) that you use. Instrument configuration files are available at our Client Service & Support Portal (see web address below).

For a complete service history of this instrument, please consult our on-line Client Service & Support Portal at http://www.appliedmicrosystems.com/customers/index.htm

Applied Microsystems
2071 Malaview Avenue
Sidney, B.C. V8L 5X6 CANADA
Tel: +1-250-656-0771 Fax: +1-250-655-3655

Sound Velocity Calibration

Date:	9/23/2008	**RMS Error:**	0.018
Instrument SN:	004986	**Range:**	1400 to 1550 m/s
Calibrator:	Les Woodland		



m/s=A+B*((NH-N)/(NH-NL))+C*((NH-N)/(NH-NL))^2+D*((NH-N)/(NH-NL))^3

Coefficients

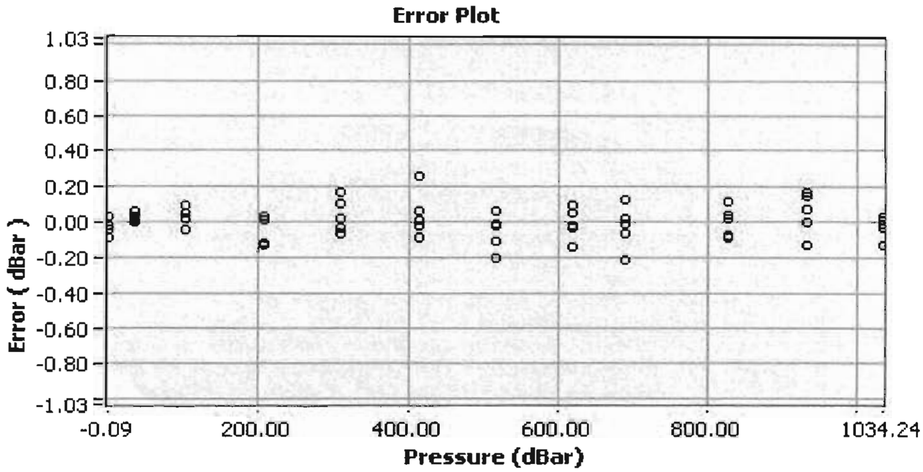
A=1.521719E+3
B=-1.065195E+2
C=8.413916E+0
D=-7.328216E-1

APPLIED MICROSYSTEMS Because it's not just H_2O

2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

Pressure Calibration

Date (mm/dd/yy):	09/30/08	**RMS Error:**	0.086
Instrument SN:	004986	**Range:**	1000 dBar
Calibrator:	Les Woodland		



dBar=A+B*T+C*T^2+D*T^3+(E+F*T+G*T^2+H*T^3)*Raw+(I+J*T+K*T^2+L*T^3)*Raw^2

Coefficients

A=-1.774596E+3 G=-3.214595E-7
B=9.062190E-2 H=9.150362E-9
C=2.005744E-2 I=-1.404551E-8
D=-3.298937E-4 J=3.282178E-10
E=5.909598E-2 K=-4.517941E-12
F=-7.414152E-6 L=-5.695738E-14

APPLIED MICROSYSTEMS Because it's not just H2O

2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

APPLIED MICROSYSTEMS Because it's not just H_2O

5229 Certificate of Calibration

Customer:	NOAA - Pacific Marine Center
Instrument Serial Number:	INS-05229
Instrument Type:	Smart SV&P
Instrument Description:	Real-time instrument with sound velocity (invar) and pressure
Calibrated Pressure Range:	1000 dBar

Certification Date: 08/02/2008 (dd/mm/yyyy)

Certified By:

Robert Haydock,
General Manager
Applied Microsystems

Applied Microsystems certifies that the equipment described above has been calibrated with equipment referenced to traceable standards. Any repairs / calibrations completed on this instrument were approved by the instrument owner under purchase order.

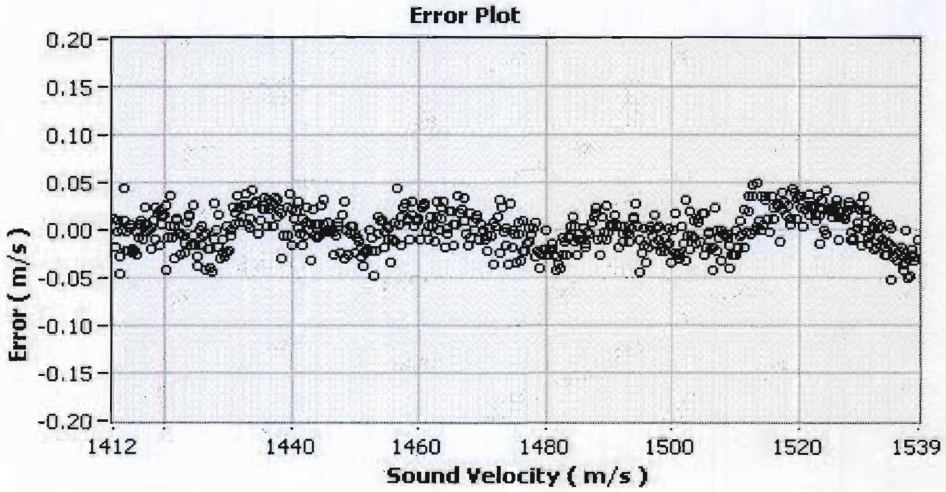
This instrument has been recalibrated. Please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software (ie. Smart Talk) that you use. Instrument configuration files are available at our Client Service & Support Portal (see web address below).

For a complete service history of this instrument, please consult our on-line Client Service & Support Portal at http://www.appliedmicrosystems.com/customers/index.htm

Applied Microsystems
2071 Malaview Avenue
Sidney, B.C. V8L 5X6 CANADA
Tel: +1-250-656-0771 Fax: +1-250-655-3655

Sound Velocity Calibration

Date:	2/8/2008		
Instrument SN:	005229	**RMS Error:**	0.020
Calibrator:	Matt Tradewell	**Range:**	1400 to 1550 m/s



m/s=A+B*((NH-N)/(NH-NL))+C*((NH-N)/(NH-NL))^2+D*((NH-N)/(NH-NL))^3

Coefficients

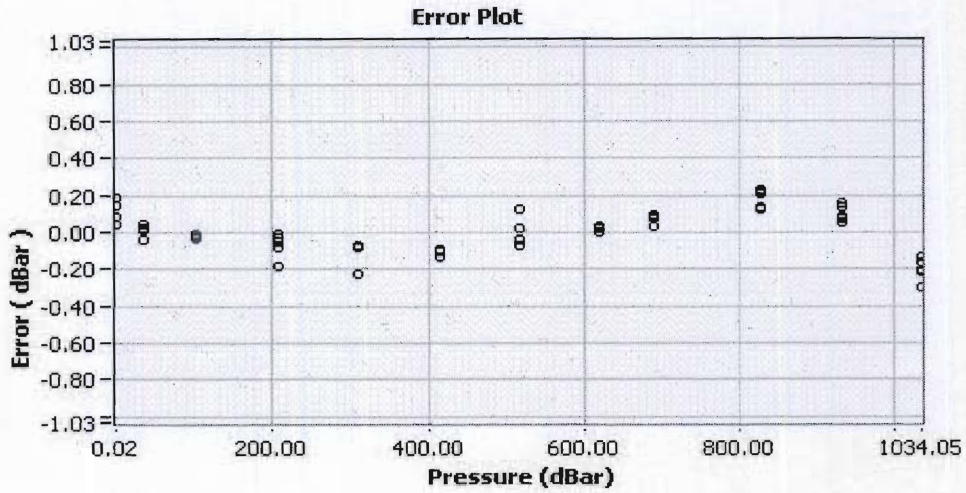
A=1.521988E+3
B=-1.067986E+2
C=8.820610E+0
D=-9.938356E-1

APPLIED MICROSYSTEMS Because it's not just H_2O

2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

Pressure Calibration

Date:	2/6/2008	**RMS Error:**	0.1141
Instrument SN:	005229	**Range:**	1000 dBar
Calibrator:	Matt Tradewell		



dBar=A+B*T+C*T^2+D*T^3+(E+F*T+G*T^2+H*T^3)*Raw+(I+J*T+K*T^2+L*T^3)*Raw^2

Coefficients

A=-1.468823E+3 G=2.642032E-7
B=-4.145866E-1 H=-1.446059E-8
C=-1.325764E-3 I=-1.195644E-9
D=2.944354E-4 J=-5.100709E-13
E=4.653640E-2 K=-5.746673E-12
F=1.484535E-5 L=1.502744E-13

APPLIED MICROSYSTEMS Because it's not just H_2O

2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

Subject: [Fwd: Re: AML SV+P .cfg file]
Date: Tue, 18 Apr 2006 15:49:46 +0000
From: "grant froelich" <grant.froelich@noaa.gov>
To: chiefst fairweather <chiefst.fairweather@noaa.gov>,
foo fairweather <foo.fairweather@noaa.gov>,
mike castle <mike.castle@noaa.gov>

--

Grant Froelich
Senior Survey Technician
NOAA Ship FAIRWEATHER
(907)254-2842 Cell
(808)659-0054 At Sea

Subject: RE: AML SV+P .cfg file
Date: Tue, 18 Apr 2006 09:45:18 -0300
From: Murray Eisan <meisan@brooke-ocean.com>
To: "'grant froelich'" <grant.froelich@noaa.gov>
CC: "'Darrell Groom'" <dgroom@brooke-ocean.com>

Hi Grant,

The calibration coefficients have been applied to the sensor at AML. The MVP software logs the corrected data being outputted from the sensor. The AML configuration file does not need to be applied to the MVP software.

Regards,

Murray Eisan

From: grant froelich [mailto:grant.froelich@noaa.gov]
Sent: Monday, April 17, 2006 2:02 PM
To: support@brooke-ocean.com
Subject: AML SV+P .cfg file

Hello,

We recently sent our AML SV+P sensor out for calibration and when it returned we also received a .cfg file. Is this something that the MVP software needs to correct the sound velocity files produced? If so, how is that done?

thanks
grant

--

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4585
CALIBRATION DATE: 12-Dec-07

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.155809e-003
a1 = 2.760002e-004
a2 = -1.131690e-006
a3 = 1.883899e-007

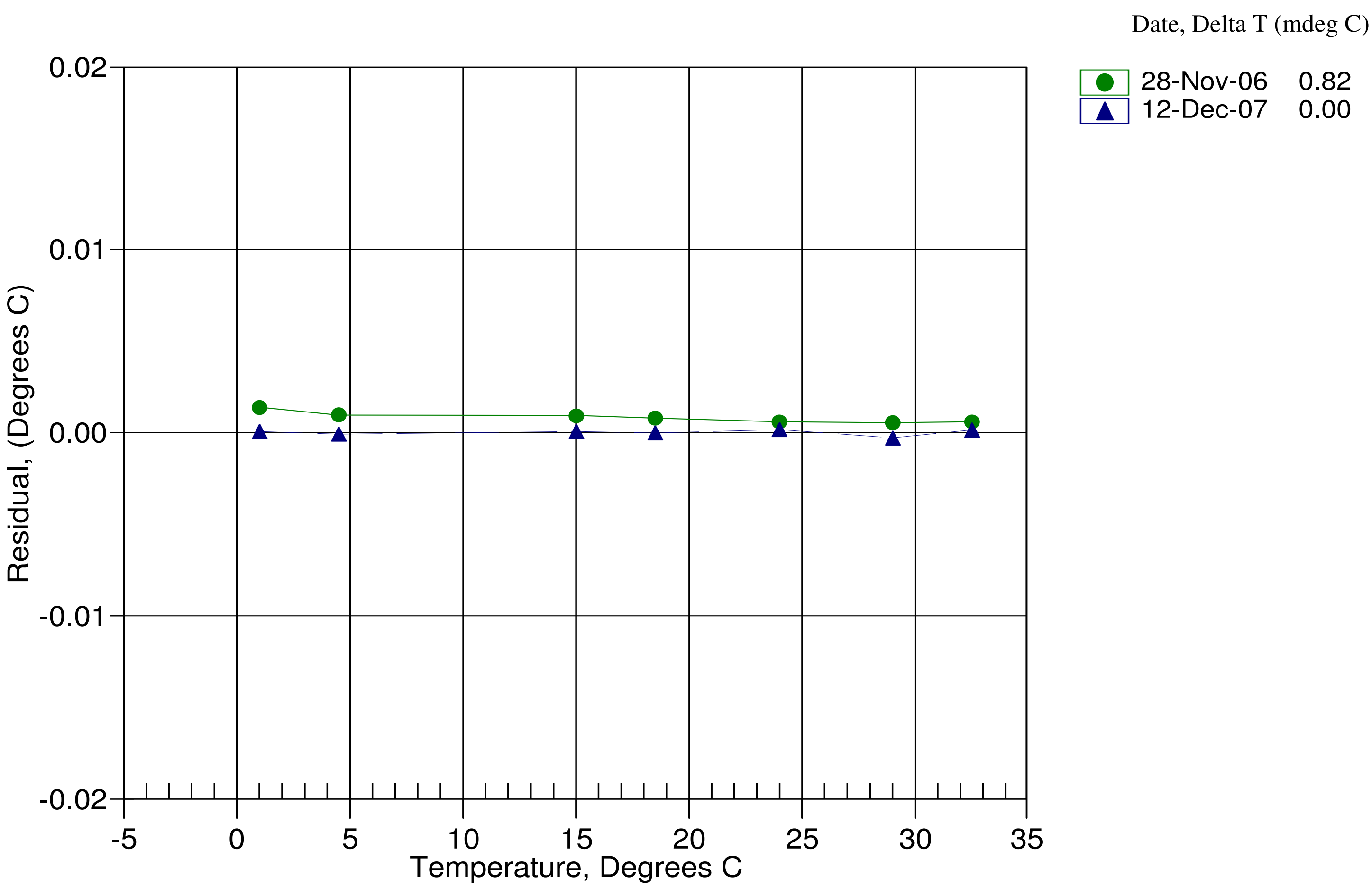
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	686687.361	1.0001	0.0001
4.4999	614004.754	4.4998	-0.0001
15.0000	430460.754	15.0001	0.0001
18.5000	380363.738	18.5000	-0.0000
23.9998	311750.672	23.9999	0.0001
29.0000	259033.738	28.9997	-0.0003
32.5001	226967.357	32.5002	0.0001

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

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

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

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 4585
CALIBRATION DATE: 12-Dec-07

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

COEFFICIENTS:

```
g = -1.029961e+000
h =  1.489672e-001
i = -1.464344e-004
j =  3.212420e-005

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

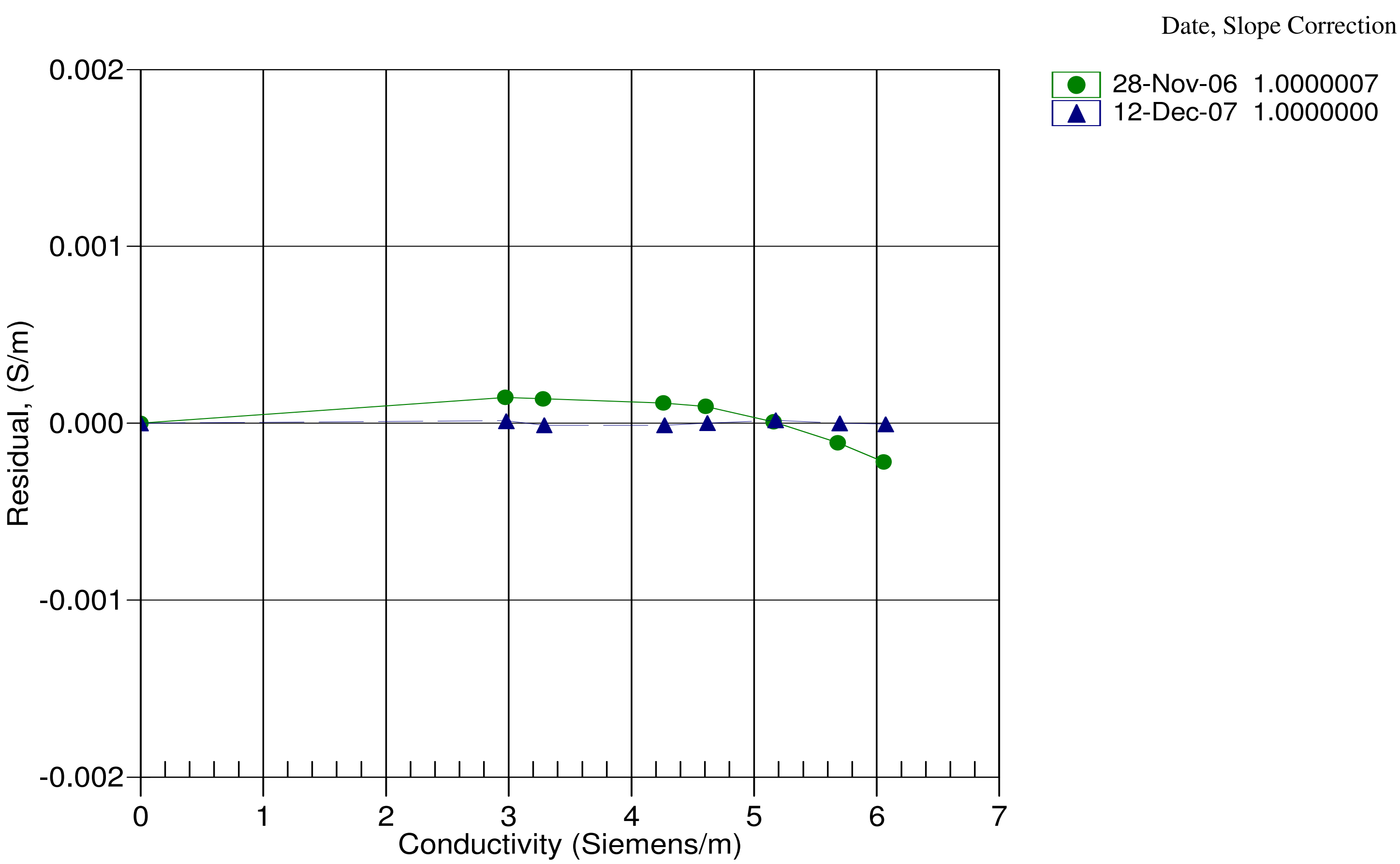
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2630.89	0.0000	0.00000
1.0000	34.8802	2.98091	5187.07	2.9809	0.00001
4.4999	34.8601	3.28844	5381.59	3.2884	-0.00001
15.0000	34.8163	4.27161	5960.38	4.2716	-0.00001
18.5000	34.8066	4.61722	6150.68	4.6172	0.00000
23.9998	34.7949	5.17577	6446.10	5.1758	0.00002
29.0000	34.7874	5.69812	6710.31	5.6981	-0.00000
32.5001	34.7815	6.07062	6892.38	6.0706	-0.00001

f = INST FREQ / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 4585
CALIBRATION DATE: 10-Dec-07

SBE19plus PRESSURE CALIBRATION DATA
5076 psia S/N 5433

COEFFICIENTS:

PA0 =	2.922174e-001	PTCA0 =	5.087658e+005
PA1 =	1.545394e-002	PTCA1 =	-1.236026e+000
PA2 =	-6.665107e-010	PTCA2 =	1.032771e-001
PTEMPA0 =	-6.655343e+001	PTCB0 =	2.398063e+001
PTEMPA1 =	5.244972e+001	PTCB1 =	-2.075000e-003
PTEMPA2 =	-5.868691e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.79	509710.3	1.7	14.69	-0.00
1026.63	575259.9	1.7	1026.43	-0.00
2038.77	641202.0	1.7	2038.44	-0.01
3050.69	707532.0	1.7	3050.55	-0.00
4062.52	774241.1	1.7	4062.52	-0.00
5074.51	841338.6	1.7	5074.38	-0.00
4062.62	774260.8	1.7	4062.82	0.00
3050.70	707557.8	1.7	3050.94	0.00
2038.71	641225.7	1.7	2038.81	0.00
1026.59	575280.9	1.7	1026.75	0.00
14.79	509728.3	1.7	14.96	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.93	509766.17
29.00	1.86	509744.49
24.00	1.76	509724.13
18.50	1.65	509708.34
15.00	1.58	509701.13
4.50	1.38	509692.64
1.00	1.31	509693.49

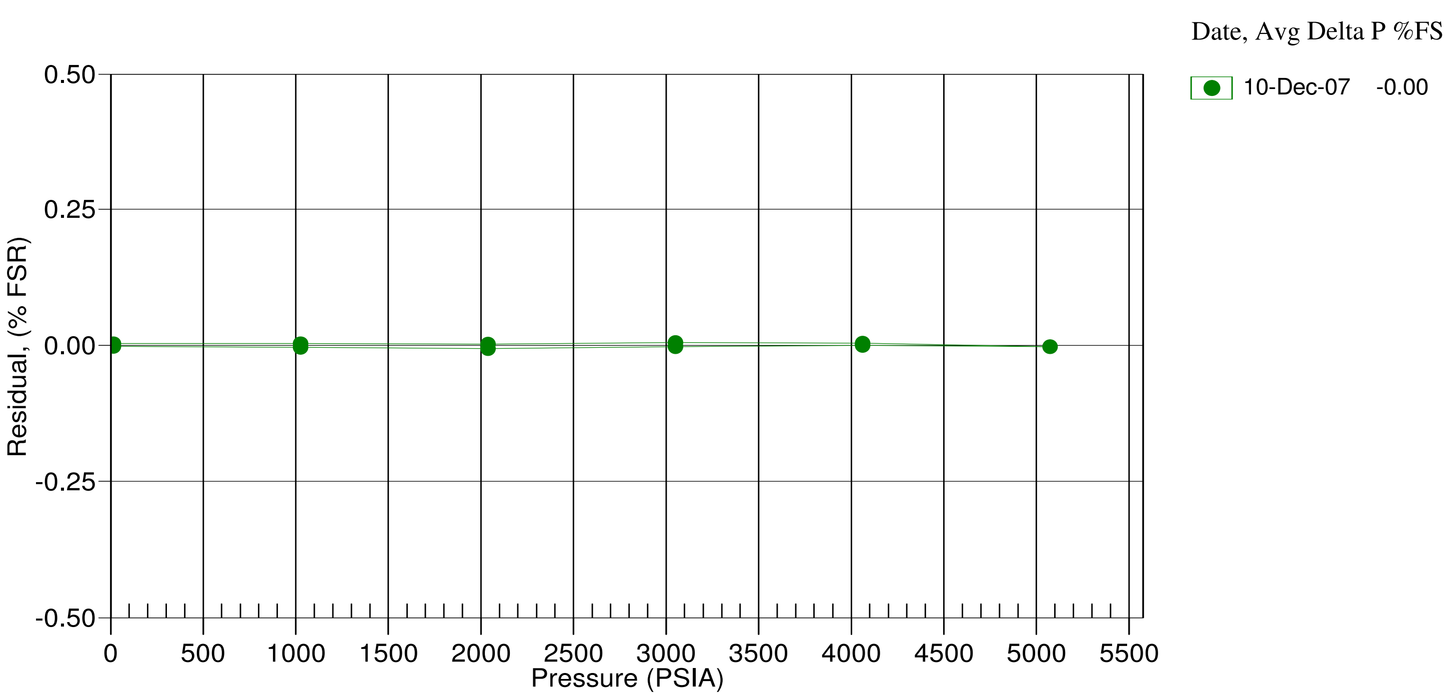
TEMP(ITS90)	SPAN(mV)
-5.00	23.99
35.00	23.91

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

$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$

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

$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$



SEA-BIRD ELECTRONICS, INC.
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Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	**Date of Report:**	12/12/2007
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4585

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/12/2007 Drift since last cal: 0.0000 PSU/month*

Comments:

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

Date: Drift since Last cal: PSU/month*

Comments:

****Measured at 3.0 S/m***

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

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Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA

Job Number:	48749	**Date of Report:**	12/12/2007
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4585

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/12/2007 Drift since last cal: -0.00079 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: **Degrees Celsius/year**

Comments:

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SENSOR SERIAL NUMBER: 4616
CALIBRATION DATE: 13-Dec-07

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.245436e-003
a1 = 2.665741e-004
a2 = -5.451407e-007
a3 = 1.711935e-007

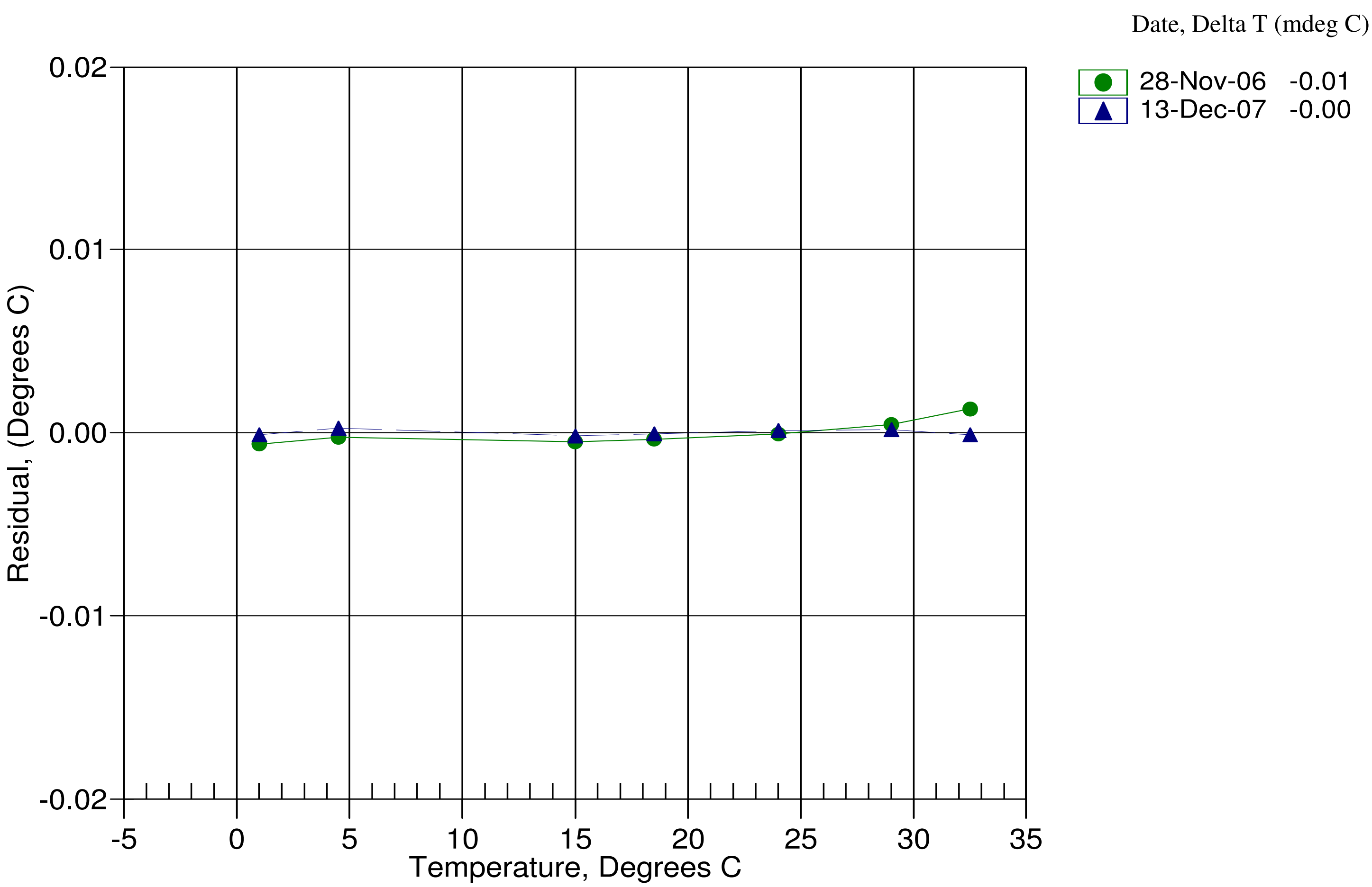
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	622352.492	0.9999	-0.0001
4.4999	552562.262	4.5001	0.0002
15.0000	379380.892	14.9998	-0.0002
18.5000	332889.692	18.4999	-0.0001
23.9999	269790.831	24.0000	0.0001
29.0000	221777.615	29.0002	0.0002
32.4938	192838.308	32.4937	-0.0001

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

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

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

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 4616
CALIBRATION DATE: 13-Dec-07

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

COEFFICIENTS:

g = -1.045279e+000
h = 1.452251e-001
i = -2.415830e-004
j = 3.756860e-005

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

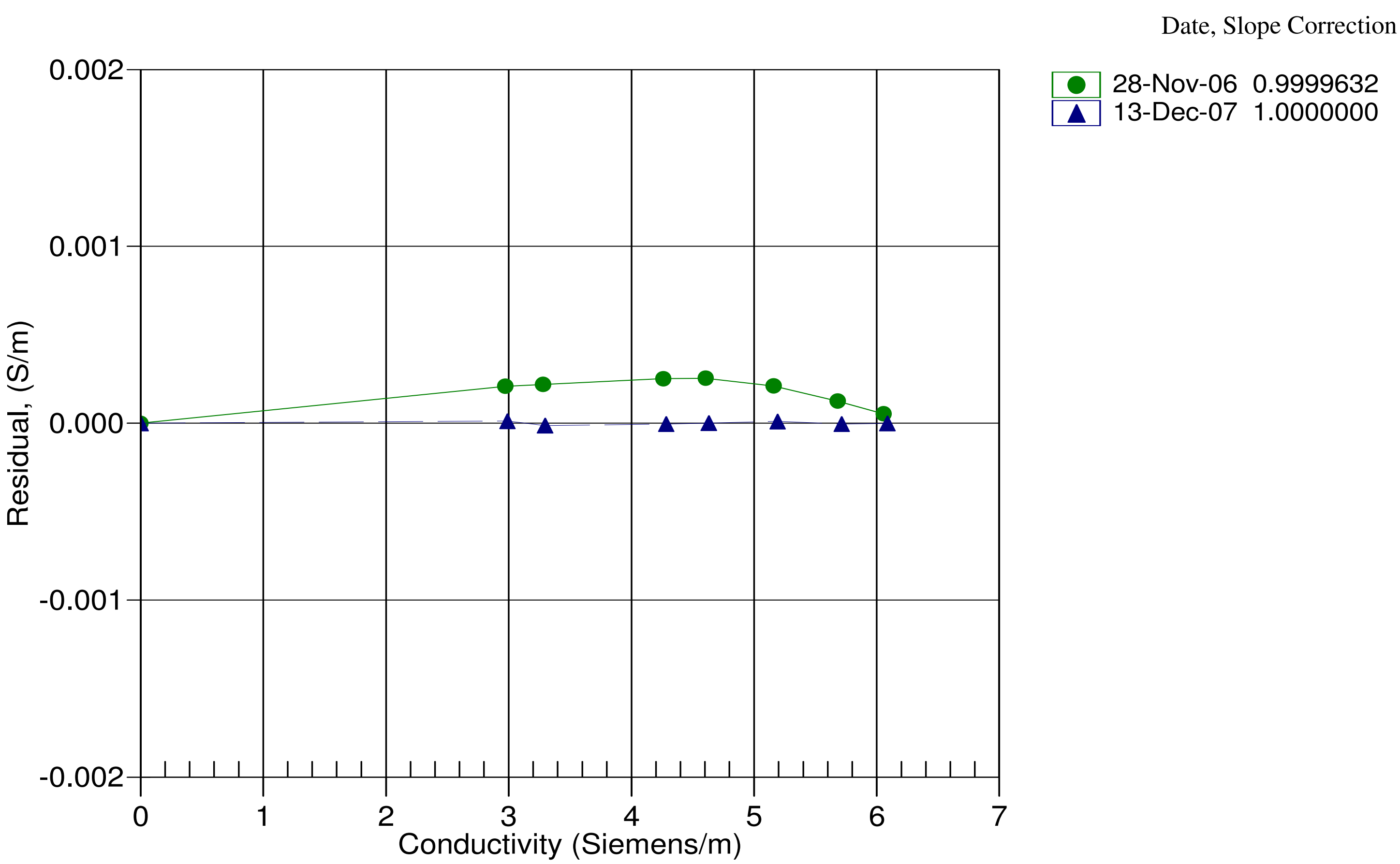
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2686.34	0.0000	0.00000
1.0000	34.9774	2.98842	5274.42	2.9884	0.00001
4.4999	34.9578	3.29675	5471.69	3.2967	-0.00001
15.0000	34.9141	4.28234	6058.72	4.2823	-0.00000
18.5000	34.9046	4.62882	6251.74	4.6288	0.00000
23.9999	34.8936	5.18884	6551.44	5.1889	0.00001
29.0000	34.8864	5.71250	6819.45	5.7125	-0.00000
32.4938	34.8808	6.08529	7003.83	6.0853	-0.00000

f = INST FREQ / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 4616
CALIBRATION DATE: 10-Dec-07

SBE19plus PRESSURE CALIBRATION DATA
1450 psia S/N 5512

COEFFICIENTS:

PA0 =	8.124251e-001	PTCA0 =	5.204224e+005
PA1 =	4.422250e-003	PTCA1 =	1.484391e+001
PA2 =	1.768021e-012	PTCA2 =	-2.799470e-001
PTEMPA0 =	-7.642684e+001	PTCB0 =	2.473825e+001
PTEMPA1 =	4.928816e+001	PTCB1 =	5.000000e-005
PTEMPA2 =	-2.749656e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.78	523770.2	2.0	14.80	0.00
301.38	588585.5	2.0	301.43	0.00
588.09	653389.3	2.0	588.02	-0.00
874.82	718238.8	2.0	874.82	0.00
1161.77	783121.3	2.0	1161.79	0.00
1448.57	847925.4	2.0	1448.42	-0.01
1161.59	783131.6	2.0	1161.83	0.02
874.88	718257.8	2.0	874.90	0.00
588.18	653396.8	2.0	588.05	-0.01
301.35	588564.1	2.0	301.33	-0.00
14.79	523775.1	2.0	14.82	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.49	2.24	523877.65
29.00	2.17	523876.71
24.00	2.06	523874.45
18.50	1.95	523860.32
15.00	1.88	523848.83
4.50	1.66	523759.51
1.00	1.59	523689.02

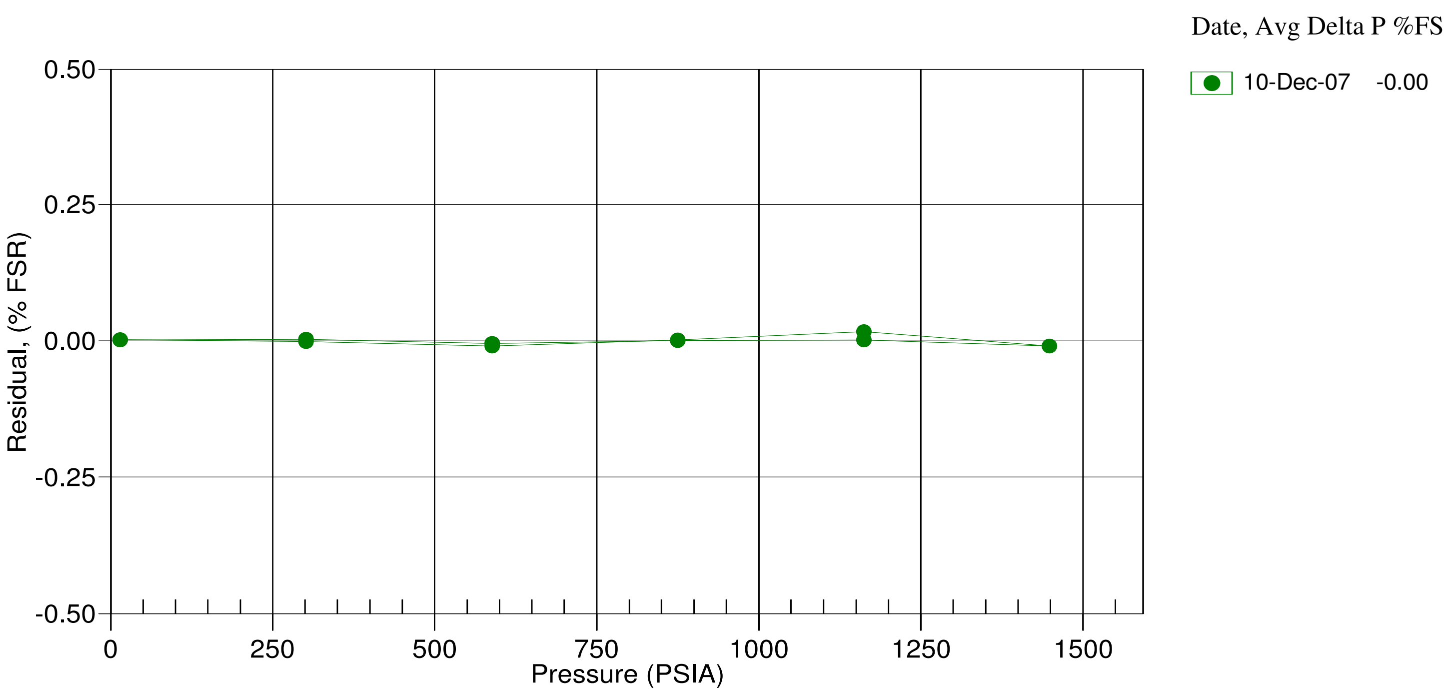
TEMP(ITS90)	SPAN(mV)
-5.00	24.74
35.00	24.74

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

$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$

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

$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$



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Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	**Date of Report:**	12/13/2007
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4616

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2007 Drift since last cal: +0.00001 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

SBE

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Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	Date of Report:	12/13/2007
Model Number	SBE 19Plus	Serial Number:	19P36026-4616

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2007 Drift since last cal: -0.00010 PSU/month*

Comments:

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

Date: Drift since Last cal: PSU/month*

Comments:

**Measured at 3.0 S/m*

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

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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 13-Dec-07

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.249803e-003
a1 = 2.684771e-004
a2 = -5.378021e-007
a3 = 1.749472e-007

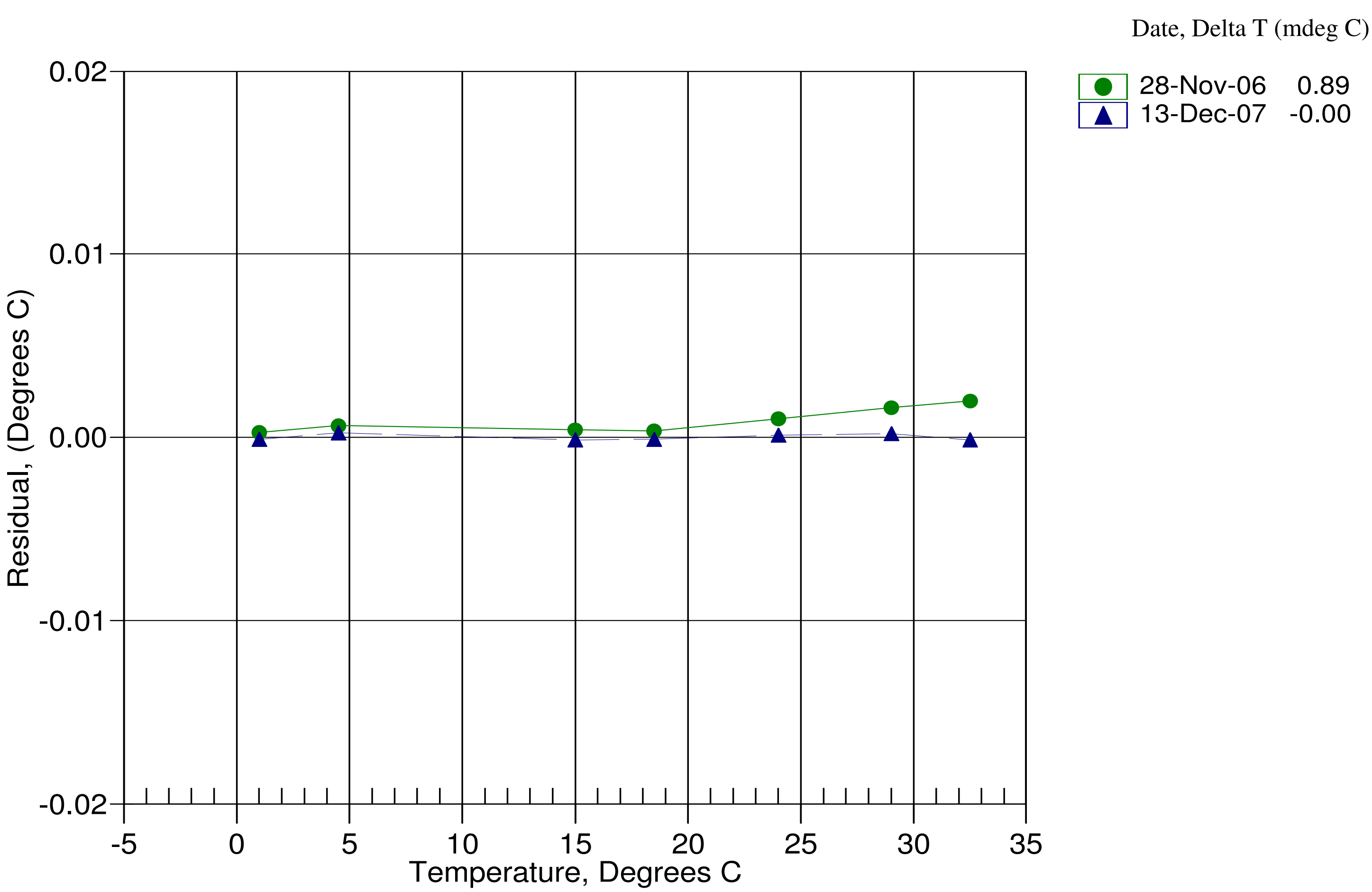
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	585637.556	0.9999	-0.0001
4.4999	518796.730	4.5001	0.0002
15.0000	354148.365	14.9999	-0.0001
18.5000	310217.905	18.4999	-0.0001
23.9999	250753.413	24.0000	0.0001
29.0000	205617.349	29.0002	0.0002
32.4938	178453.619	32.4936	-0.0002

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

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

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

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 13-Dec-07

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

COEFFICIENTS:

g = -9.990138e-001
h = 1.277431e-001
i = -2.519900e-004
j = 3.310361e-005

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

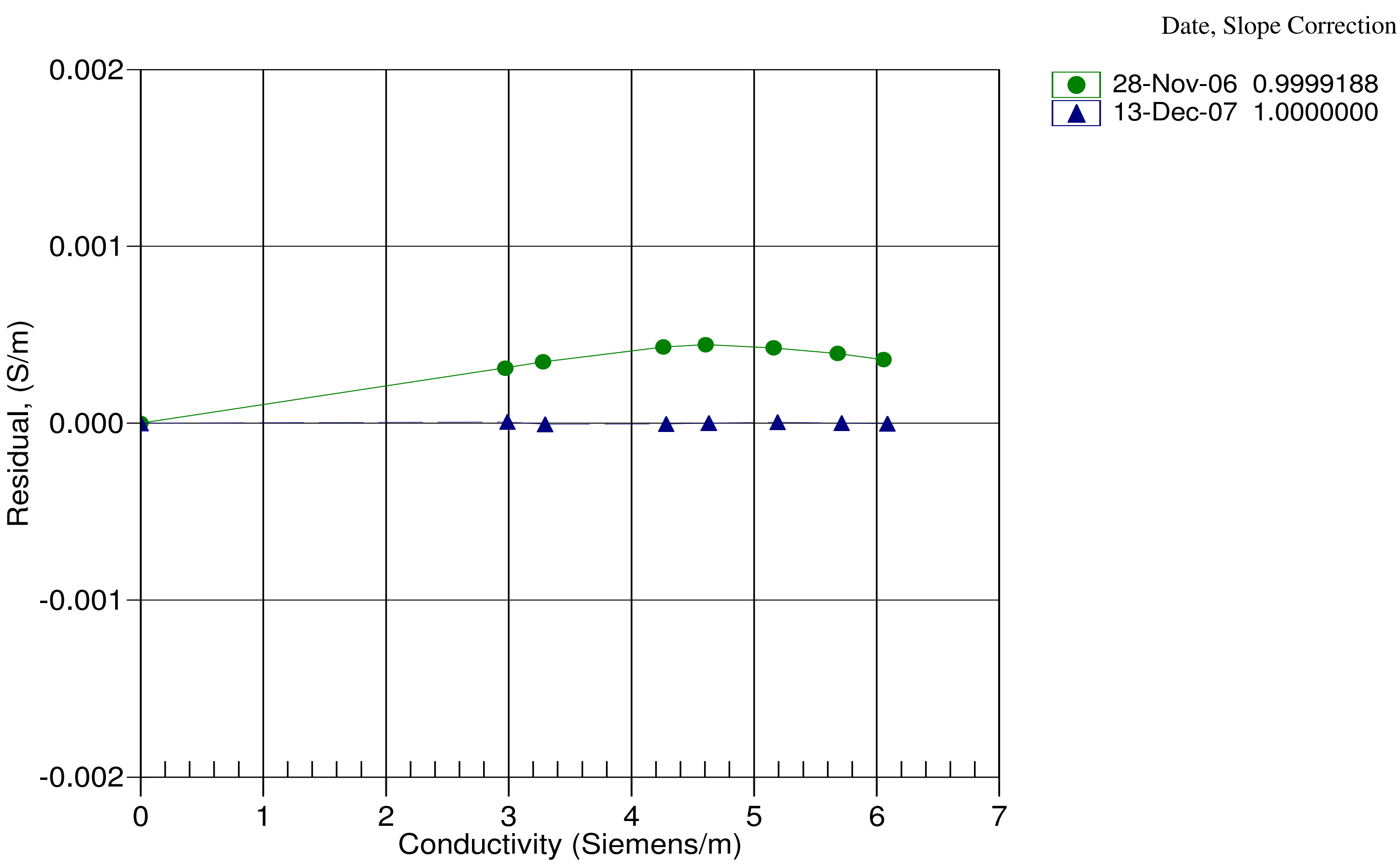
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2801.41	0.0000	0.00000
1.0000	34.9774	2.98842	5595.19	2.9884	0.00001
4.4999	34.9578	3.29675	5806.90	3.2967	-0.00001
15.0000	34.9141	4.28234	6436.33	4.2823	-0.00000
18.5000	34.9046	4.62882	6643.17	4.6288	0.00000
23.9999	34.8936	5.18884	6964.18	5.1888	0.00000
29.0000	34.8864	5.71250	7251.14	5.7125	0.00000
32.4938	34.8808	6.08529	7448.49	6.0853	-0.00000

f = INST FREQ / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 4617
CALIBRATION DATE: 10-Dec-07

SBE19plus PRESSURE CALIBRATION DATA
1450 psia S/N 5513

COEFFICIENTS:

PA0 = -5.664293e-001
PA1 = 4.439833e-003
PA2 = -1.670012e-012
PTEMPA0 = -7.900853e+001
PTEMPA1 = 4.920630e+001
PTEMPA2 = -4.145551e-001

PTCA0 = 5.192344e+005
PTCA1 = -1.164606e+001
PTCA2 = 2.696057e-001
PTCB0 = 2.460838e+001
PTCB1 = 6.750000e-004
PTCB2 = 0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.78	522575.4	2.0	14.81	0.00
301.38	587178.0	2.0	301.47	0.01
588.09	651759.9	2.0	588.03	-0.00
874.82	716399.3	2.0	874.82	0.00
1161.77	781070.7	2.0	1161.75	-0.00
1448.57	845699.8	2.0	1448.46	-0.01
1161.59	781079.1	2.0	1161.78	0.01
874.88	716427.5	2.0	874.95	0.00
588.18	651770.8	2.0	588.07	-0.01
301.35	587126.9	2.0	301.25	-0.01
14.79	522574.3	2.1	14.81	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.49	2.31	522683.38
29.00	2.24	522684.22
24.00	2.13	522672.38
18.50	2.02	522665.05
15.00	1.94	522665.13
4.50	1.72	522730.73
1.00	1.65	522784.76

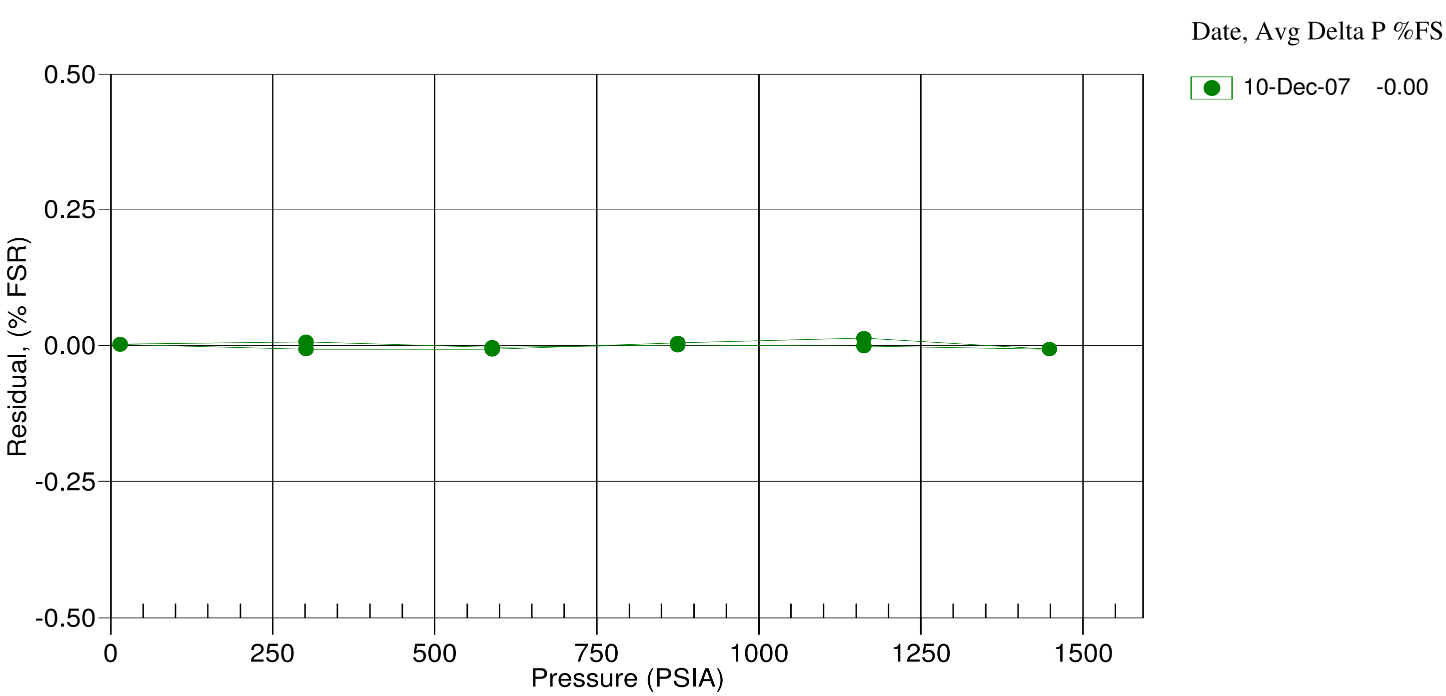
TEMP(ITS90)	SPAN(mV)
-5.00	24.61
35.00	24.63

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

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

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

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



SBE
SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA

Job Number:	48749	**Date of Report:**	12/13/2007
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4617

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2007 Drift since last cal: -0.00085 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: **Degrees Celsius/year**

Comments:

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1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	**Date of Report:**	12/13/2007
Model Number	SBE 19Plus	**Serial Number:**	19P36026-4617

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2007 Drift since last cal: -0.00020 PSU/month*

Comments:

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

Date: Drift since Last cal: PSU/month*

Comments:

**Measured at 3.0 S/m*

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

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0117
CALIBRATION DATE: 08-Jan-08

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.031942e+000
h = 1.269033e-001
i = -2.218276e-004
j = 3.318496e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -3.1803e-006

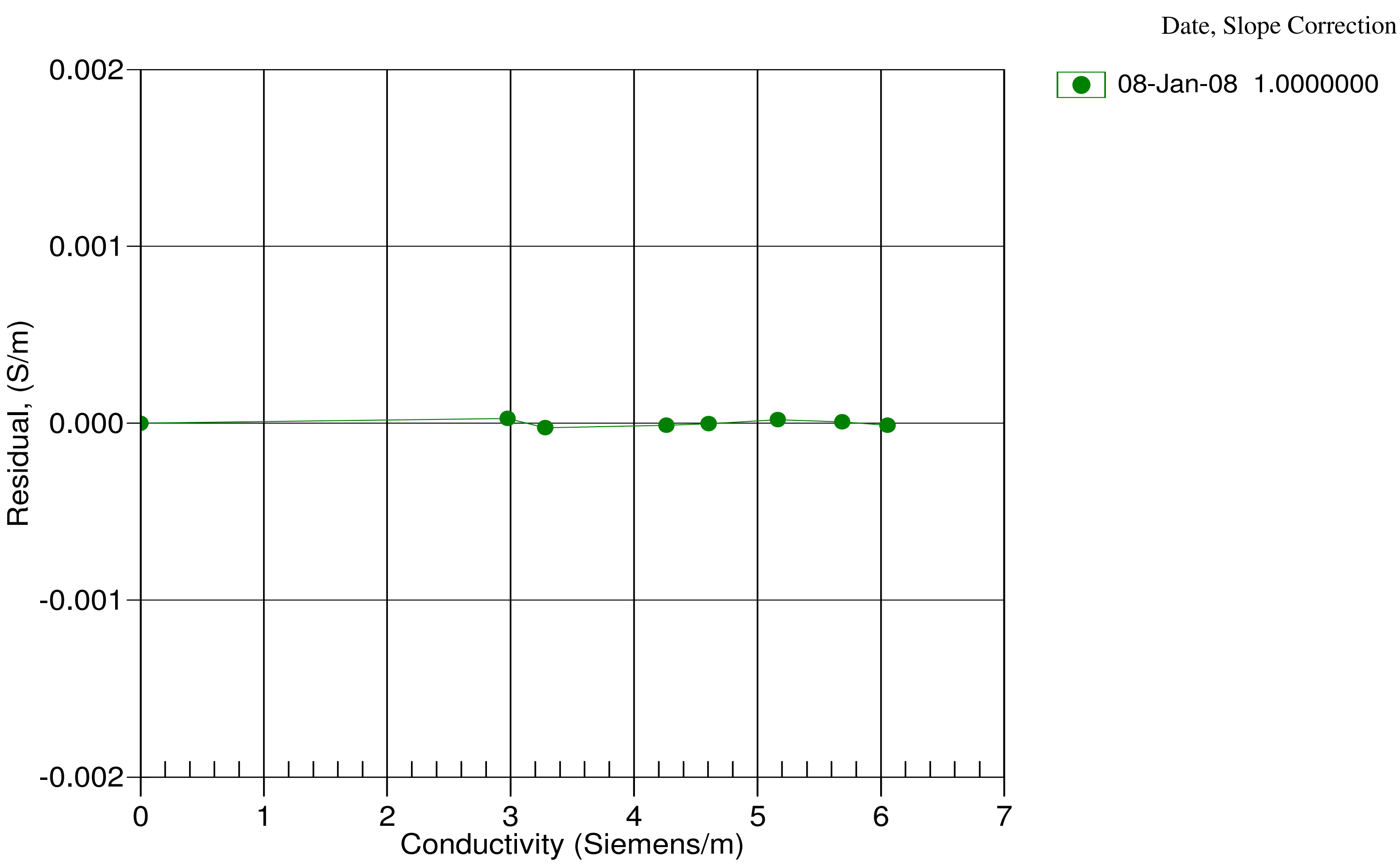
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2855.80	0.00000	0.00000
1.0000	34.7807	2.97321	5622.31	2.97324	0.00003
4.4999	34.7610	3.28001	5832.94	3.27999	-0.00003
14.9999	34.7176	4.26078	6459.57	4.26076	-0.00001
18.5000	34.7080	4.60555	6665.57	4.60555	-0.00000
24.0000	34.6969	5.16282	6985.35	5.16285	0.00002
29.0000	34.6902	5.68399	7271.30	5.68399	0.00001
32.4999	34.6851	6.05568	7468.33	6.05567	-0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0117
CALIBRATION DATE: 11-Dec-07

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.029836e+000
h = 1.264890e-001
i = -1.244736e-004
j = 2.698268e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -3.1803e-006

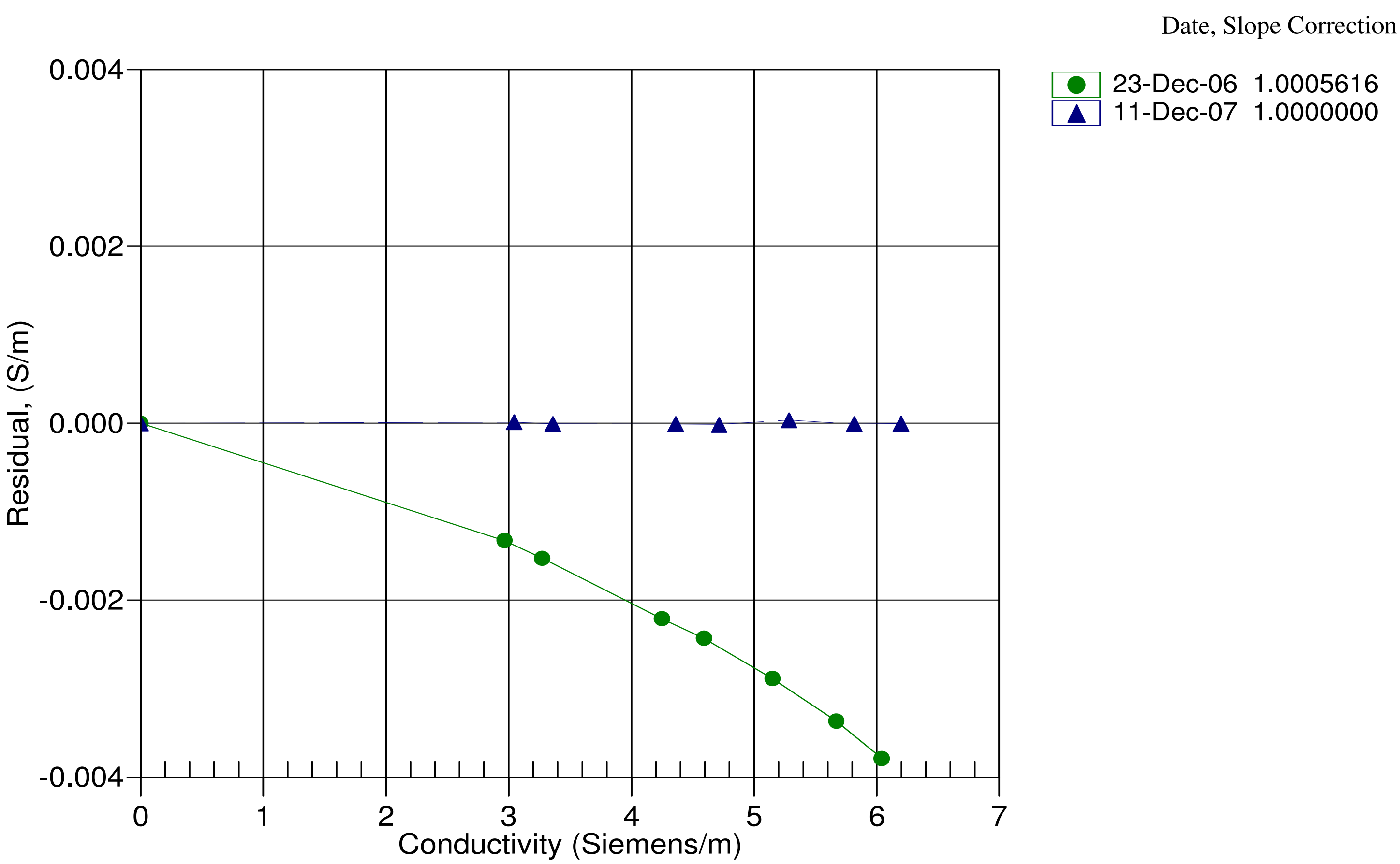
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2854.99	0.00000	0.00000
1.0000	35.7009	3.04425	5671.69	3.04426	0.00001
4.5000	35.6792	3.35798	5885.14	3.35797	-0.00001
15.0000	35.6327	4.36100	6519.96	4.36099	-0.00001
18.5000	35.6226	4.71361	6728.60	4.71359	-0.00002
23.9999	35.6111	5.28357	7052.48	5.28361	0.00003
29.0000	35.6023	5.81635	7341.91	5.81634	-0.00001
32.5001	35.5947	6.19615	7541.26	6.19615	-0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0117
CALIBRATION DATE: 08-Jan-08

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

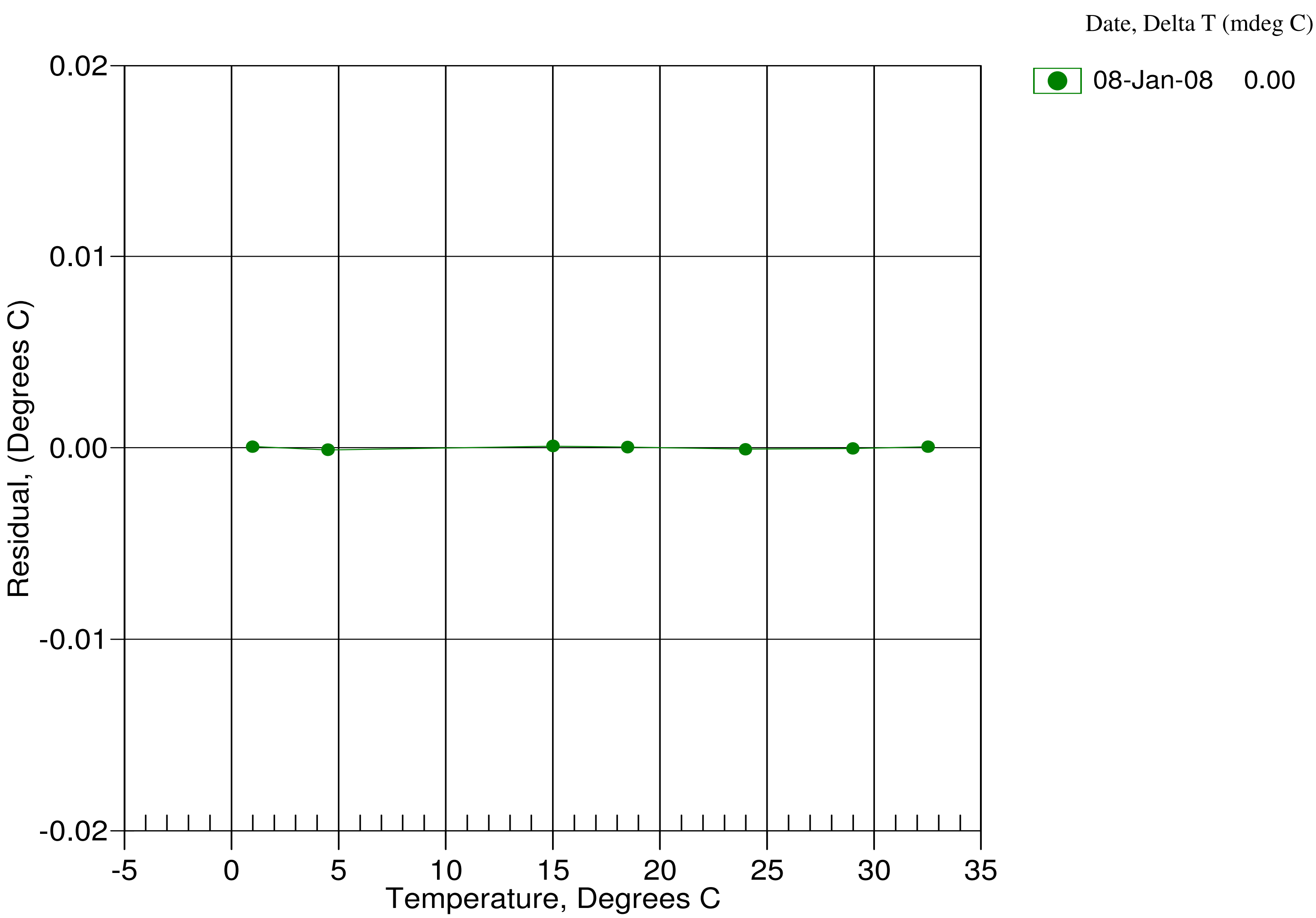
ITS-90 COEFFICIENTS

a0 = -2.444687e-004
a1 = 3.101067e-004
a2 = -4.608202e-006
a3 = 2.066460e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	825687.0	1.0001	0.0001
4.4999	708009.0	4.4998	-0.0001
14.9999	455003.1	15.0000	0.0001
18.5000	395051.1	18.5000	0.0000
24.0000	318250.6	23.9999	-0.0001
29.0000	263033.5	29.0000	-0.0000
32.4999	230938.9	32.4999	0.0000

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

Residual = instrument temperature - bath temperature



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Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0117
CALIBRATION DATE: 11-Dec-07

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

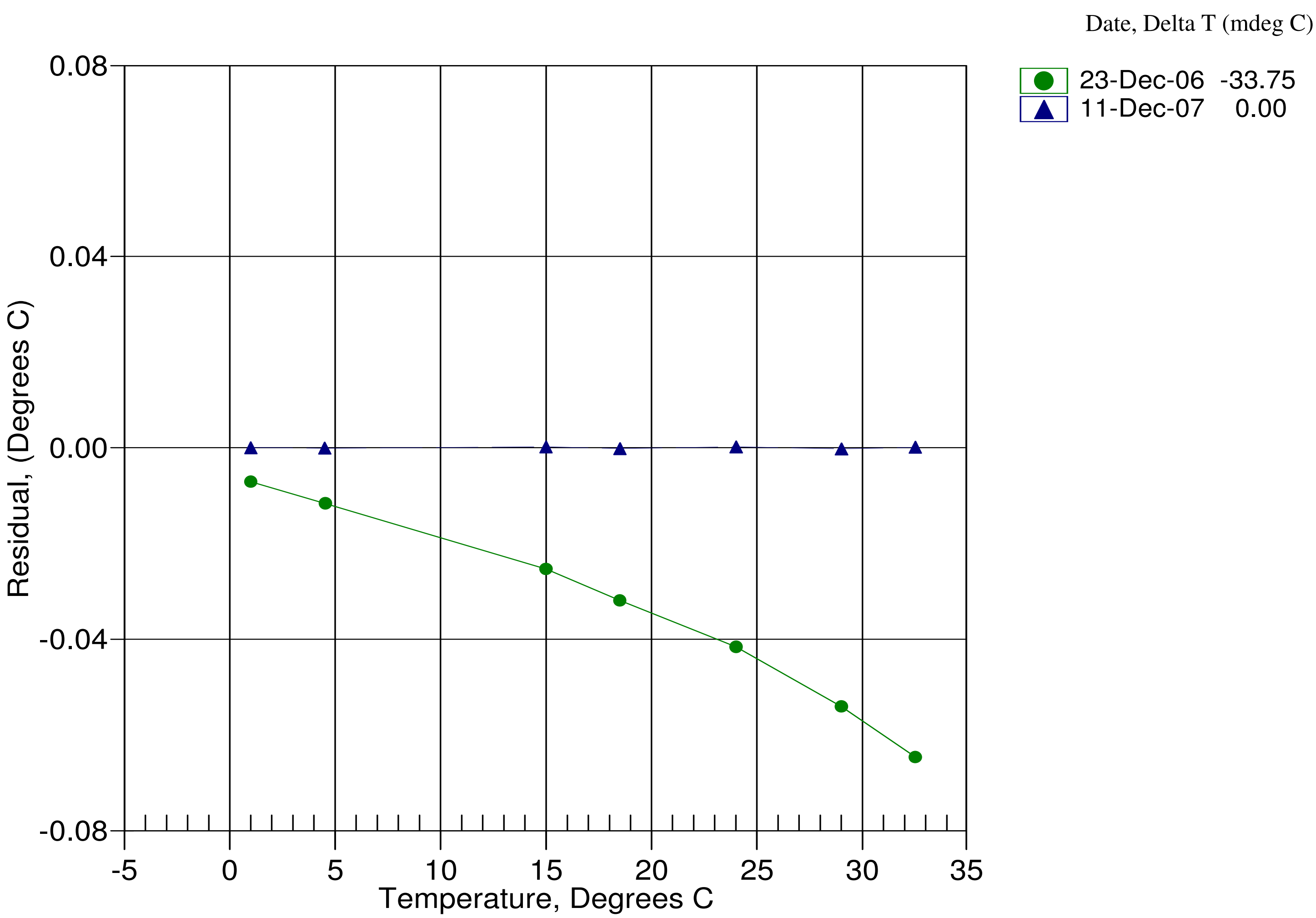
ITS-90 COEFFICIENTS

a0 = -1.865866e-004
a1 = 2.970047e-004
a2 = -3.621420e-006
a3 = 1.819198e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	825650.8	1.0001	0.0001
4.5000	707981.6	4.4999	-0.0001
15.0000	455000.0	15.0002	0.0002
18.5000	395058.3	18.4998	-0.0002
23.9999	318252.4	24.0001	0.0002
29.0000	263036.0	28.9998	-0.0002
32.5001	230933.8	32.5002	0.0001

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

Residual = instrument temperature - bath temperature



SBE

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Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	**Date of Report:**	1/8/2008
Model Number	SBE 45	**Serial Number:**	4536628-0117

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/11/2007 Drift since last cal: +0.00150 PSU/month*

Comments:

'CALIBRATION AFTER REPAIR' ☑ Performed ☐ Not Performed

Date: 1/8/2008 Drift since Last cal: N/A PSU/month*

Comments:

Measured at 3.0 S/m

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

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Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Pacific Marine Center / NOAA		
Job Number:	48749	**Date of Report:**	1/8/2008
Model Number	SBE 45	**Serial Number:**	4536628-0117

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

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

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/11/2007 Drift since last cal: +0.03490 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' ☑ Performed ☐ Not Performed

Date: 1/8/2008 Drift since Last cal: N/A **Degrees Celsius/year**

Comments:

GeoLine
POSITIONING SYSTEMS

Certificate of Calibration

Model: Nikon DTM310

Serial Number: 842575

This certifies that the above instrument has been inspected and calibrated by the GeoLine Positioning Systems Inc. Service Department. At the time of completion of this service, GeoLine Positioning Systems, Inc. certifies that the above stated product meets all factory specifications and tolerances for product parameters and performance of this product model.

All product calibration and specification parameters were tested and/or adjusted using applicable factory calibration jigs, precision optical collimation systems and electronic test equipment. All collimation systems have been properly checked and calibrated according to industry standard practices. All electronic test equipment used have had current calibration.

Date of Calibration: 6/28/04

Next Recommended Calibration Date: 12/28/04

Signed: [signature] Date: 6/28/04

Title: Service Technician

GeoLine Positioning Systems, Inc.
1331 118th Avenue SE, Suite 400
Bellevue, WA 98005
425.452.2711 • 425.452.2703 fax

GeoLine
POSITIONING SYSTEMS

Certificate of Calibration

Model: Sokkia SET 5F

Serial Number: 16288

This certifies that the above instrument has been inspected and calibrated by the GeoLine Positioning Systems Inc. Service Department. At the time of completion of this service, GeoLine Positioning Systems, Inc. certifies that the above stated product meets all factory specifications and tolerances for product parameters and performance of this product model.

All product calibration and specification parameters were tested and/or adjusted using applicable factory calibration jigs, precision optical collimation systems and electronic test equipment. All collimation systems have been properly checked and calibrated according to industry standard practices. All electronic test equipment used have had current calibration.

Date of Calibration: 7/19/04

Next Recommended Calibration Date: 7/19/05

Signed: Sean Valer Date: 7/19/04

Title: Service Technician

GeoLine Positioning Systems, Inc.
1331 118th Avenue SE, Suite 400
Bellevue, WA 98005
425.452.2711 • 425.452.2703 fax

Appendix VI

Correspondence

- **System Check Correspondence**
- **Data Representation**
- **CUBE Results**

Subject: [Fwd: [Fwd: DGPS: P-checks & Nav DQA]]
Date: Mon, 12 Sep 2005 18:22:20 -0800
From: "foo fairweather" <foo.fairweather@noaa.gov>
To: chiefst.fairweather@noaa.gov

Subject: [Fwd: DGPS: P-checks & Nav DQA]
Resent-Date: Mon, 12 Sep 2005 20:17:27 GMT
Resent-From: FOO.Fairweather@noaa.gov
Date: Mon, 12 Sep 2005 20:29:01 +0100
From: "FOO Rainier" <foo.rainier@noaa.gov>
To: _NMAO MOP FOO Fairweather <FOO.Fairweather@noaa.gov>,
abigail higgins <abigail.higgins@noaa.gov>

Abigail,

I assume you're checking FOO-FA now, so sorry if you get this twice. Anyway, here's the email from Gerd from the spring about P-checks. Looks like it was a question from Lynn which prompted it in the first place.

Ben

-------- Original Message --------
Subject: DGPS: P-checks & Nav DQA
Date: Wed, 25 May 2005 17:01:38 -0400
From: Gerd Glang <Gerd.Glang@noaa.gov>
Organization: NOAA Hydro Systems & Technology Programs (301-713-2653, x152)
To: holly.dehart.atsea@noaa.gov
CC: Jack Riley <Jack.Riley@noaa.gov>, "Lynnette V. Morgan" <Lynnette.V.Morgan@noaa.gov>, "Holly A. Dehart" <Holly.A.Dehart@noaa.gov>, Benjamin K Evans <Benjamin.K.Evans@noaa.gov>, Guy Noll <Guy.Noll@noaa.gov>
References: <793c68e7.68e7793c@fairweather.nmao.noaa.gov>

Hi Holly (I hear my train leaving),

Your "atsea" e-mail keeps getting bounced back...so I'm copying Lynn on this.

Short answer - No.

USCG Beacons are subject to their own rigorous integrity monitoring. If the beacon signal is being received w/ good signal strength, it should be valid for correcting your position (simple answer). The Specs and Deliverables requirements assume this.

What we need to do is check that our receivers are working properly and no bogus antenna offsets were entered. Probably adequate to do this once per season as part of the system cert, or when you suspect a problem. Our MB data (and side scan data) are spatially dense enough that any problems would be apparent in the data right away. Also, the several GPS failures we've experienced this year have all been pretty catastrophic, i.e., there was no doubt the POS GPS had failed. Bottom line, it's not in the current draft FPM, its not in the Specs and Deliverables. Should be a reqt for the System Cert process.

So the two things I would require:

1) During data acquisition, conscientious monitoring of all sensor data (POS controller window, POS CPU lights, USCG Beacon Receiver display/lights, Isis display, etc).
2) During daily post-processing, a systematic and careful review of the data - treat as a directed editing problem.

Of course, we often fiddle with acquisition system configurations, both hardware and software, for one reason or another (or some gremlin gets into the system). It would be prudent to have a system cert-like checklist to run thru on Monday mornings after a long inport to prompt the briefly-befuddled or newly-trained OIC and chase Mr. Murphy away. Sort of like a pre-flight checklist. You may recall, we once had a case on the WH where an entire launch day (+4 hrs OT) of data was hosed because the Isis config was messed up the night before, and the JO's (who shall remain nameless but were nevertheless well qualified) didn't pay attention to #1.

(The complacent hydrographer will soon go aground - GFG).

BTW - RA has SonarPro for SSS (haven't used it much lately). NRTs use SonarPro.

G2

Holly DeHart atsea wrote:

> Hi Gerd,
>
> Lynn was asking me about comparing differential beacons, where you
> take coincident positions w/ two systems on different beacons. Sounds
> like WH's old p-check system. Do we still need to do these? If so at
> what frequency? They've been doing it weekly all season w/ no errors,
> is this still necessary?
>
> Holly
>
>

--
LT Ben Evans, NOAA
Field Operations Officer
NOAA Ship RAINIER (s221)
NOAA Marine Operations Center, Pacific
1801 Fairview Ave. E
Seattle, WA 98102

Glen Rice
4/30/08

Thoughts on data representation

The purpose of a Caris Base Surface is to accurately represent the soundings collected in a grid that best models the depth of the seafloor. Various statistical means are used to weight individual soundings and represent them at absolute locations (nodes) on the surface. Basic settings exist to change how nodes represent data collected. Several of these settings affect the number of soundings contributing to the node and this is of primary concern here.

Node spacing creates an expectation of data density. Higher grid resolution should be balanced with greater data density. Implementing a minimum number of soundings per node would clarify the amount of data any given node represents. While there may be robust statistical arguments to how much data should support each node, we can also define practical grid resolutions - given a min. number of sounding per node – based on past data captured with current survey methods. How many soundings support each node is dependent on survey detection criteria and is not discussed here.

Which soundings are contributing to each node is also important. If contributing sounding data is being gathered over a distance greater than one nodal separation, the node does not solely represent the area associated with its grid resolution. To have nodes properly represent their spacing, only data that is near the node should be contributing to it.

The foot print of each beam from a MBES should also be represented by the nodal spacing. If a beam has a larger foot print than the grid resolution used to represent that data, regardless of data density, the grid resolution should not be significantly smaller.

A Look at Past Field Data

Without an increase in survey time or a change in how data is collected, more data density cannot be obtained. Past data densities should be used to predict appropriate grid resolutions for future surveys. Past data density can be obtained as follows:

Open a surface in CUBE and query the surface with depth and density layers checked. The density layer is all data presented to each node. To normalize to sounding/meter^2 values from the density layer must be divided by the capture area of each node (equation 1).

$$d_m = \frac{d_n}{\pi * (\frac{c}{100} * z)^2} \qquad \text{equation 1}$$

where d_m is density in sounding/meter^2, d_n is the soundings per node from the density layer, c is the capture distance, and z is the depth. It is important to normalize to sounding/meter^2 so that surfaces can be compared for their data density regardless of the grid resolution and survey of origin.

The data density in sounding/meter^2 can be interesting when plotted vs depth, but does not show grid resolution directly. To decide what grid resolution is best the number of soundings per node should be established. By dividing sounding/node by the sounding/meter^2 the grid resolution supported by the data density falls out (equation 2).

$$r_g = \sqrt{\frac{d_d}{d_m}} \qquad \text{equation 2}$$

where r_g is the resolution supported at that node, d_d is the desired data density, and d_m is the field data density in sounding/meter^2 from equation 1. A plot of depth vs r_g reveals the grid resolution supported at each depth with the desired supporting soundings. Figure 1 shows the supported grid resolutions as a function of depth with 3 soundings per node. Further discussion is needed to define a specific of soundings per node for use in the field.

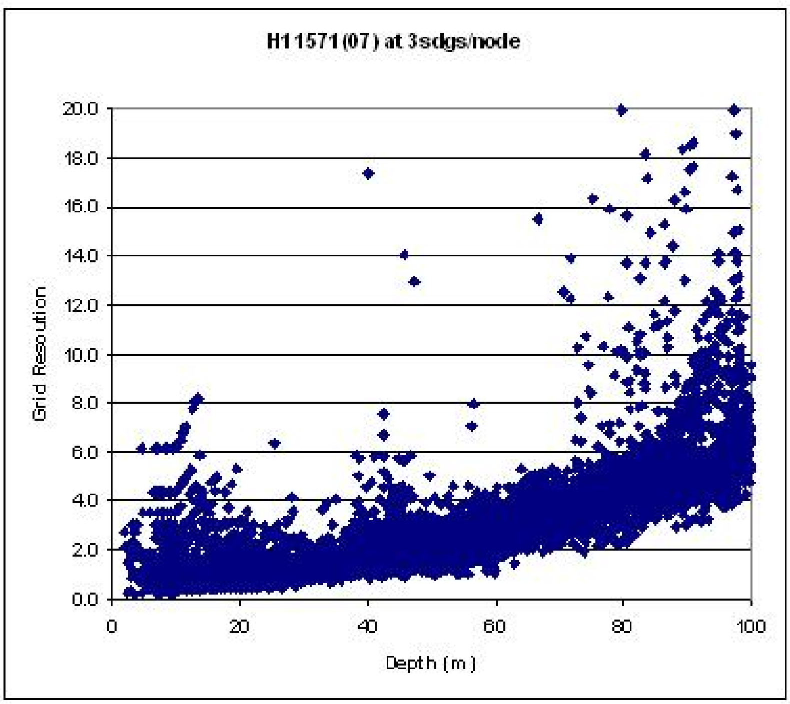


Figure 1

With supported grid resolution as a function of depth and soundings per node, grid resolutions at particular depths can be chosen. A line can be drawn across the plot designating a particular resolution (figure 2).

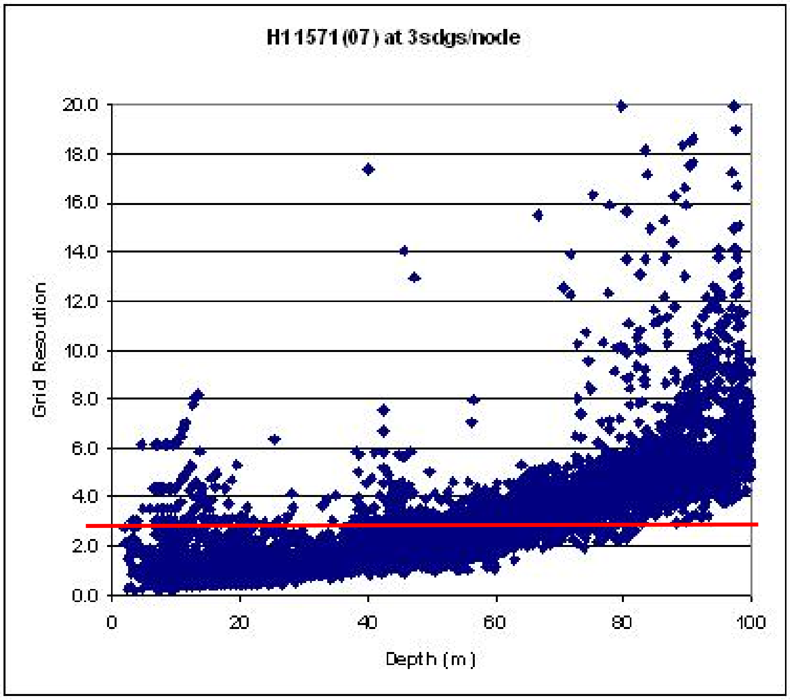


Figure 2

The red line drawn across figure 2 delineates a 3 meter grid resolution. In shallower areas the 3 meter grid resolution can be supported most of the time since most of the data is below the line. Between 40 meters and 80 meters this resolution is supported only some of the time. Beyond 80 meters and at this resolution, there would never be the three soundings per node as required.

To support picking a particular resolution, an envelope around the data can be drawn that will ensure a certain percentage of the data will satisfy the density requirement. In the approach here the mean density plus some multiple of the standard deviation forms the upper bounds. (Figure 3)

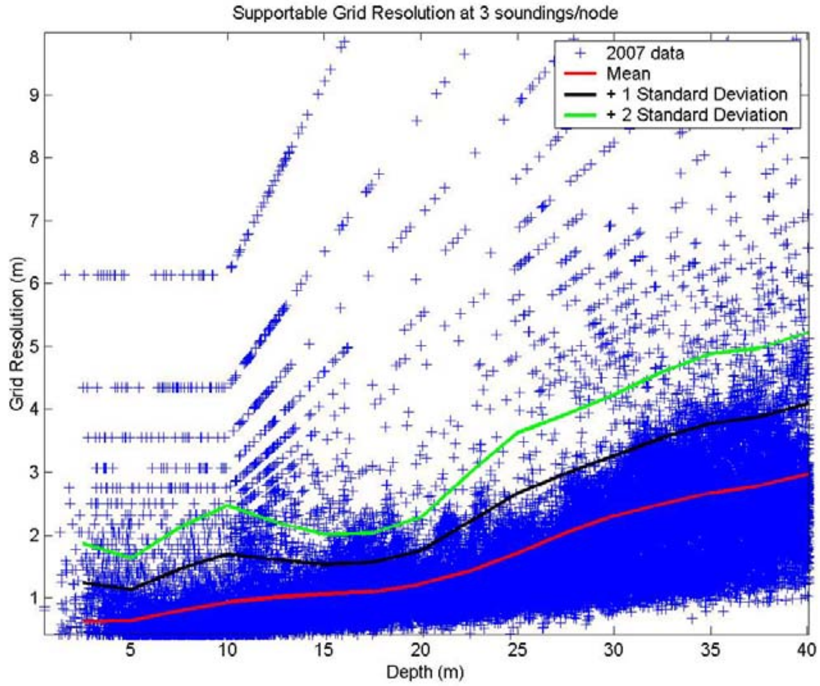


Figure 3

Figure 3 shows what grid resolution would be supported by a subset of data from all 2007 FAIRWEATHER surveys requiring 3 soundings per node 50% of the time (mean), 68% of the time (mean + 1 standard deviation), and 95% of the time (mean + 2 standard deviations). Using this guideline, more informed decisions can be made about what grid resolutions are used. The mean and standard deviation were calculated using a 5m bin size that overlapped 2.5m.

Also important when deciding the grid resolution is the beam foot print. Approximate beam foot prints for the Reson 8101, 8111 and 8160 (calculated using a 1.5 degree foot print) can be found in Figure 4.

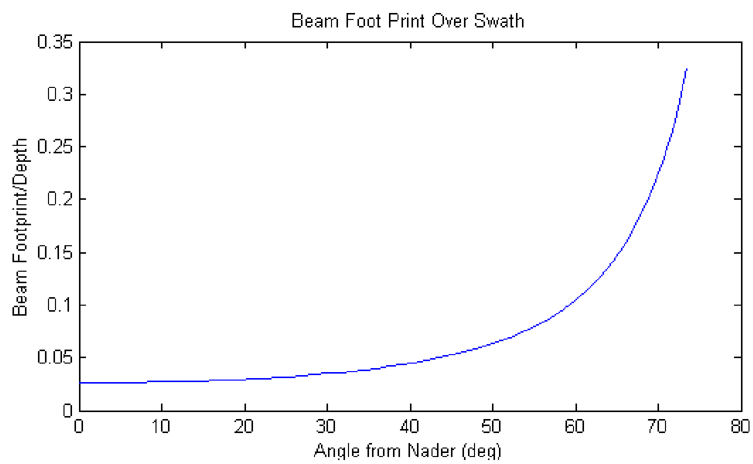


Figure 4

The foot print of each beam increases quickly when moving away from nadir. FAIRWEATHER roughly overlaps adjacent lines starting around 60 degrees from nadir. The beam at 60 degrees has a foot print of 0.105 times the water depth. This can be added to a plot of what grid resolutions would support. Figure 5 shows the data supported at several different soundings per node at the 95% confidence level as well as the 60 degree beam foot print.

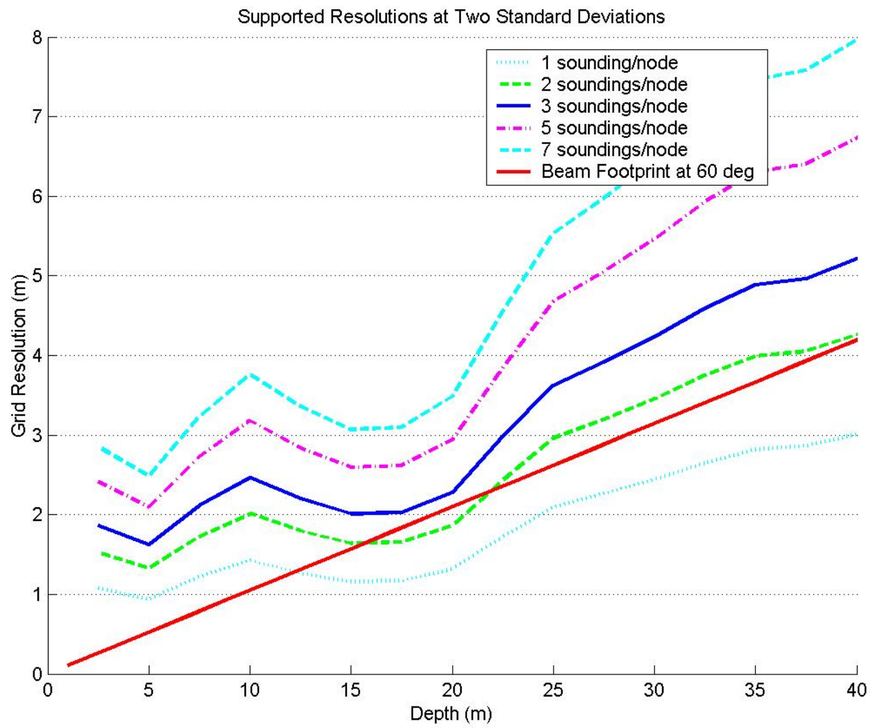


Figure 5

Figure 5 demonstrates how both the beam foot print and the data density need to be taken into account depending on the data density desired and the depth range in question. In greater depth, which is not shown here, the data density becomes the dominant variable.

Just as important as the actual data density, capture distance defines how localized the data contributing to each node is. Once a grid resolution is decided upon for a particular depth range there are two ways to set the capture distance when using CUBE. For a single resolution grid, with the capture distance set very small (1% of water depth), and the minimum capture distance set to the distance from the node to the corner of its grid resolution, or 0.707 times the grid resolution in use (figure 6).

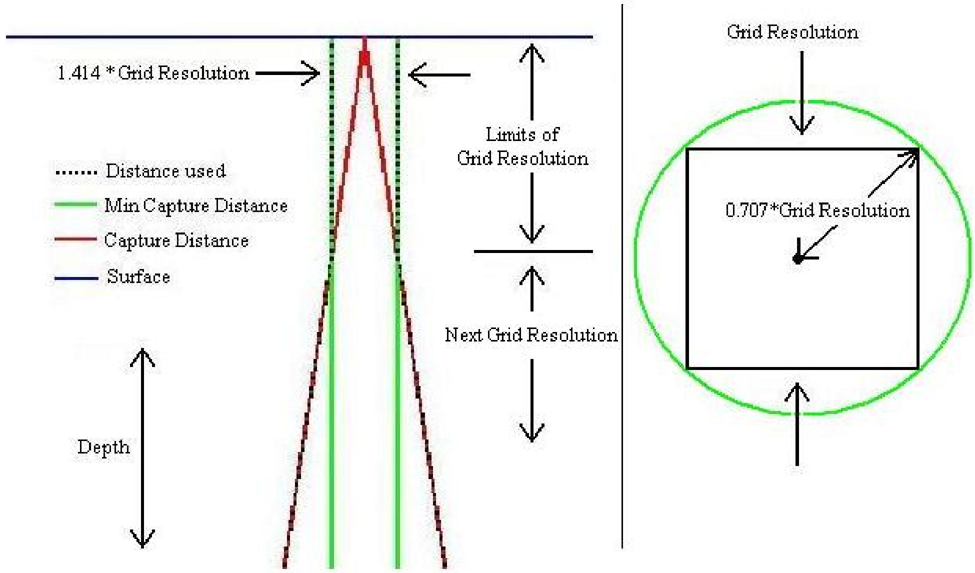


Figure 6

By using a small capture distance the minimum capture distance will be in use over the depth range of the grid resolution. This ensures that only data being represented by the node is being used to compute the nodal depth and prevents oversized capture distances. A similar method can be used to determine an appropriate capture distance setting for use in multi resolution surfaces but is not explained here.

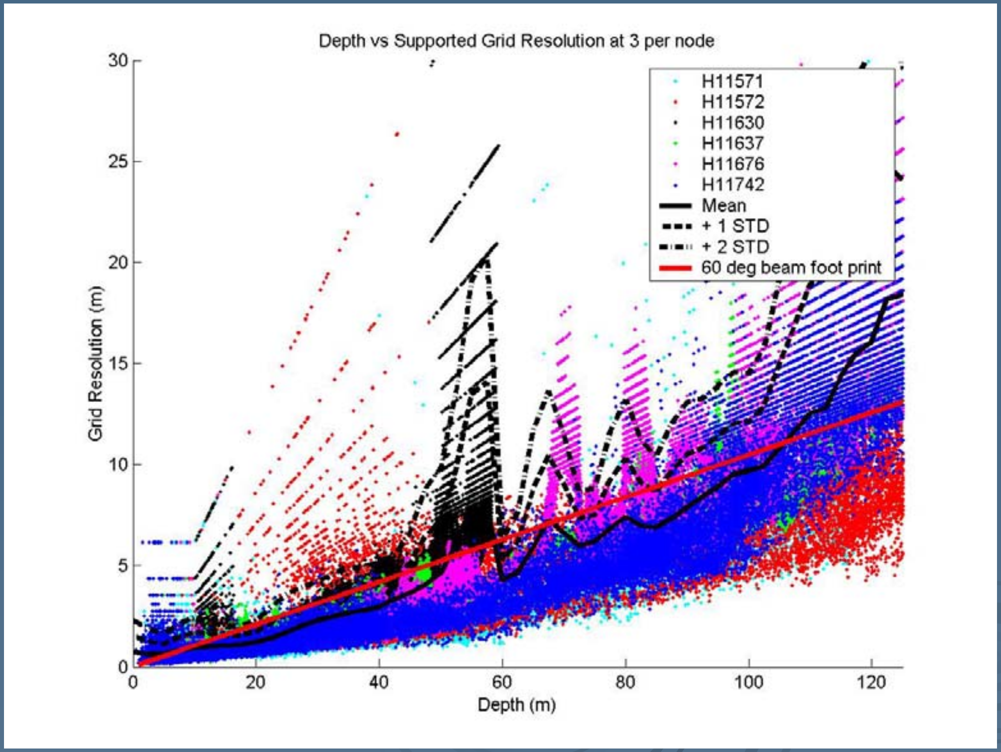
Limiting the capture distance to the grid resolution prevents over smoothing the data. Surfaces would represent the data collected and pretty pictures can always be made later. This is particularly important when operating on steep slopes. Because CUBE approximates the bottom as flat, it is best to limit the capture distance, decreasing the influence of data outside of the grid resolution.

Final Thoughts

Implementing these steps provides a hind sight perspective on the data collected and the surfaces produced. Preliminary testing on FAIRWEATHER shows this method makes sense when used on 2007 data. Field testing is needed on new data once minimum sounding density parameters are established.

Current methods using large capture distances with small grid resolutions are only averaging small amounts of data to make nicer looking surfaces. This also makes the data density look misleadingly high in the data density surface layer. To represent the data collected a quantitative approach to grid resolution and capture distance is needed.

This document contains images derived from the methodology outlined in the previous posting by FAIRWEATHER'S HACK. The purpose is to provide some calibration and insight to the methodology discussed. The supportable grid resolutions have been derived using previously explained methods in the document labeled Data Representation. These lines were picked from the 2 standard deviation curve for 3 soundings per node.



For the purposes of this initial inquiry, these are the ranges used:

1m Resolution: 0 to 20 meters
2m Resolution: 0 to 20 meters
4m Resolution: 15 to 30 meters
8m Resolution: 25 to 45 meters
16m Resolution: 40 and higher

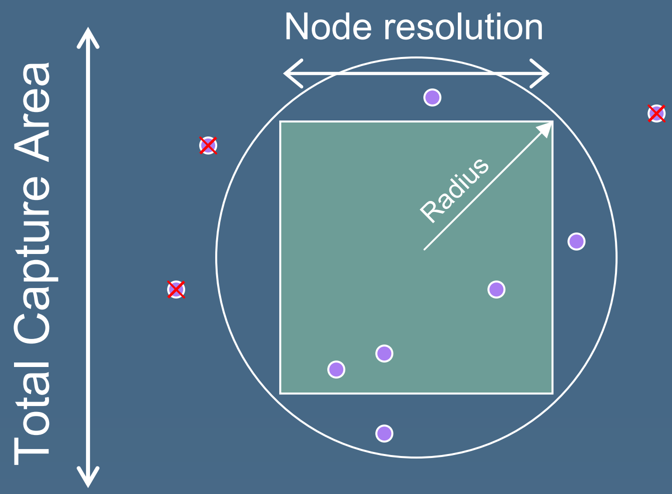
Each surface is filtered for nodes that have greater than 2.999 soundings per node.

In the course of calculating our CUBE Surfaces, we altered some parameters and maintained some from the CUBE Default profile. For each grid resolution a separate profile was created within the cubeparams.xml file allowing the user to select a complete parameter profile when calculating each surface resolution. The parameters defined within each profile were Estimate Offset (EO), Capture Distance Scale (CDS), Capture Distance Minimum (CDM), and Horizontal Error Scalar (HES). The profiles were created as follows:

1metergrid: EO= 4.00, CDS = 1.00, CDM = 0.71, HES = 2.95
2metergrid: EO= 4.00, CDS = 1.00, CDM = 1.41 HES= 2.95
4metergrid: EO= 4.00, CDS = 1.00, CDM = 2.83, HES = 2.95
8metergrid: EO= 4.00, CDS = 1.00, CDM = 5.67, HES = 2.95
16metergrid: EO= 4.00, CDS = 10.00, CDM = 11.31, HES = 2.95

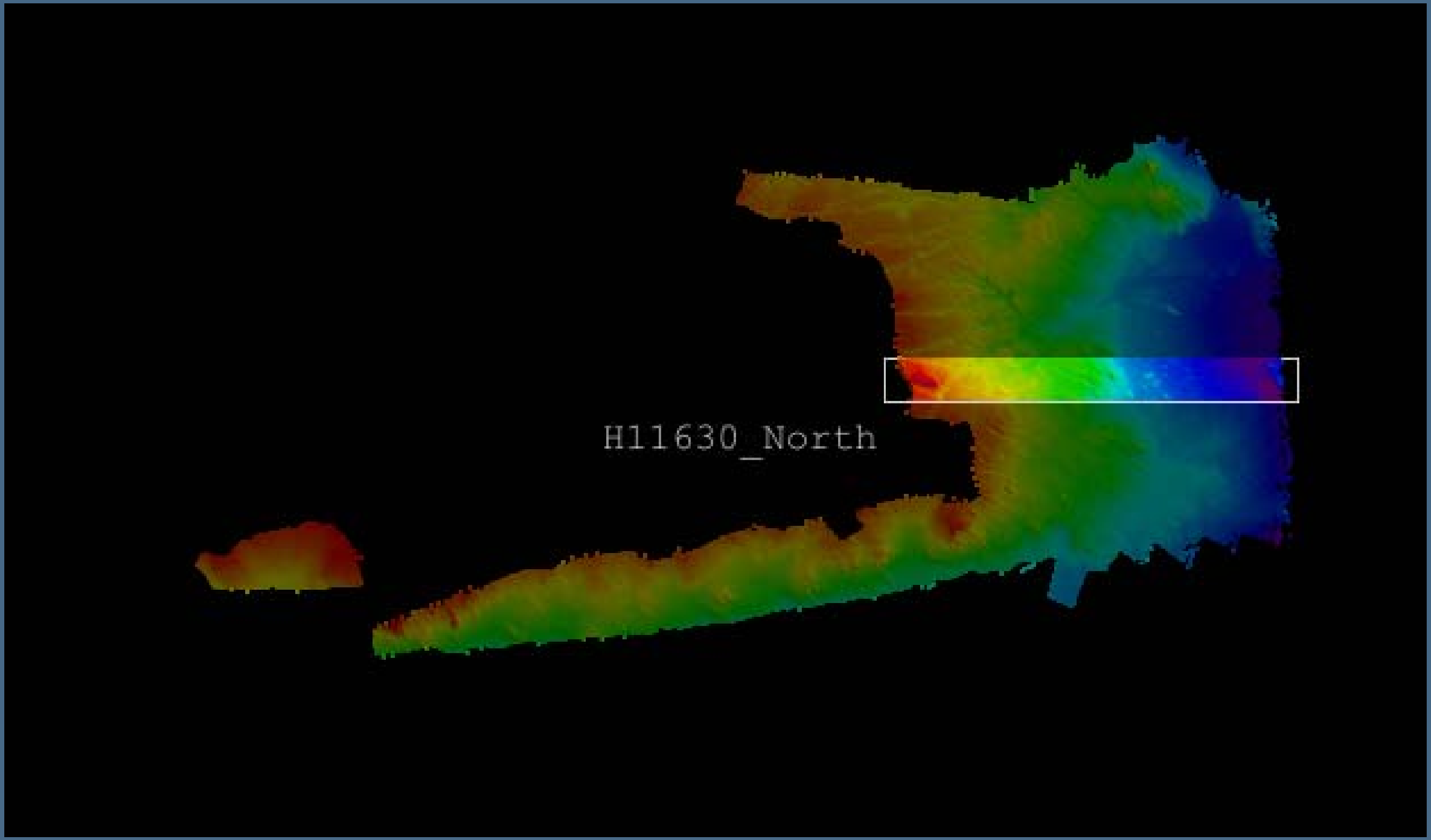
Capture Distance Scalar values were created very small to remove their influence on a node's capture distance, and Capture Distance Minimum values were created to define the node's ultimate capture distance, regardless of depth. To achieve a node capable of capturing all soundings within it's area, a capture distance equal to a circle encompassing nodal corners was created. Grid resolutions are ideally inviolable, allowing the creation of BASE Surface profiles that can then be applied to acquired data along defined depth ranges – though the depth ranges may be flexible.

CDM = $(\sqrt{2})$*Node Resolution / 2
CDM = Radius
Total Capture Area = πr^2



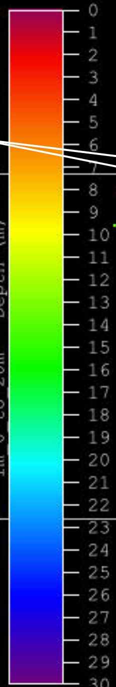
Afterwards, a selection of screen shots are created to make a comparison with identical BASE Surface creation using the recommended resolutions and recommended depth ranges. We provide this comparison to establish whether a change in processing requirements is justified, and the degree to which it is.

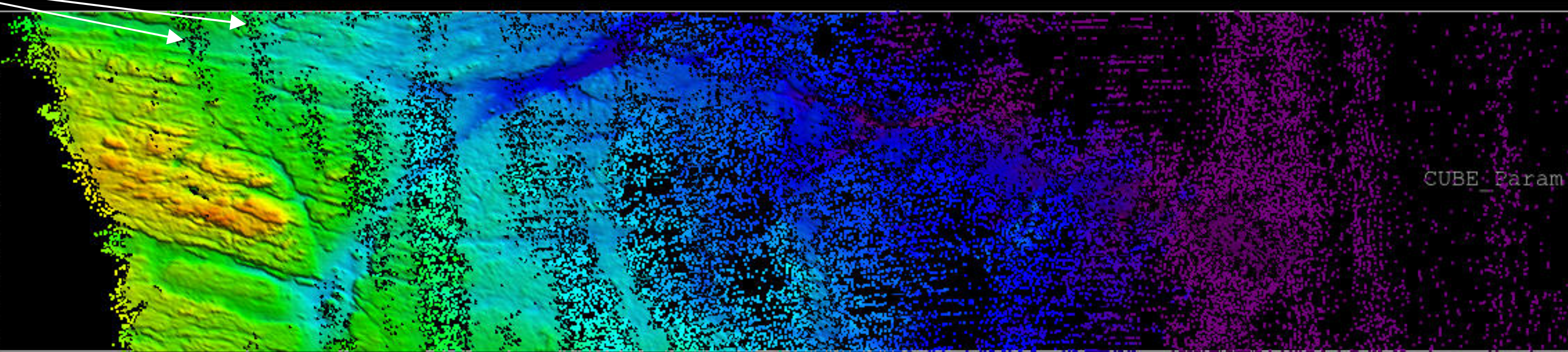
H11630



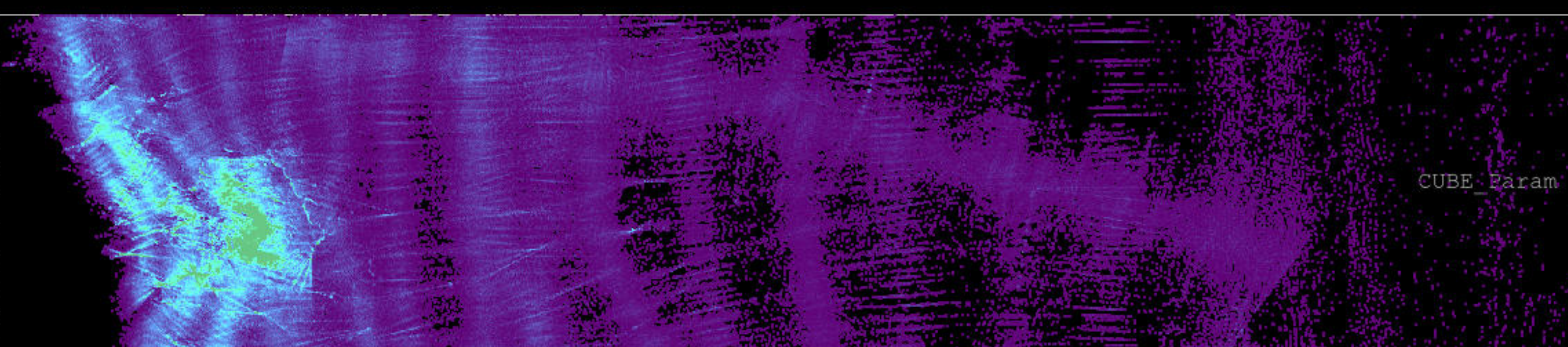
The smaller highlighted area represents the section of Survey H11630 used to test new Base Surface parameters for all grid resolution. Along this fieldsheet, the depth ranges from roughly 9 meters to 56 meters.

1 meter grid resolution, CDM = .707

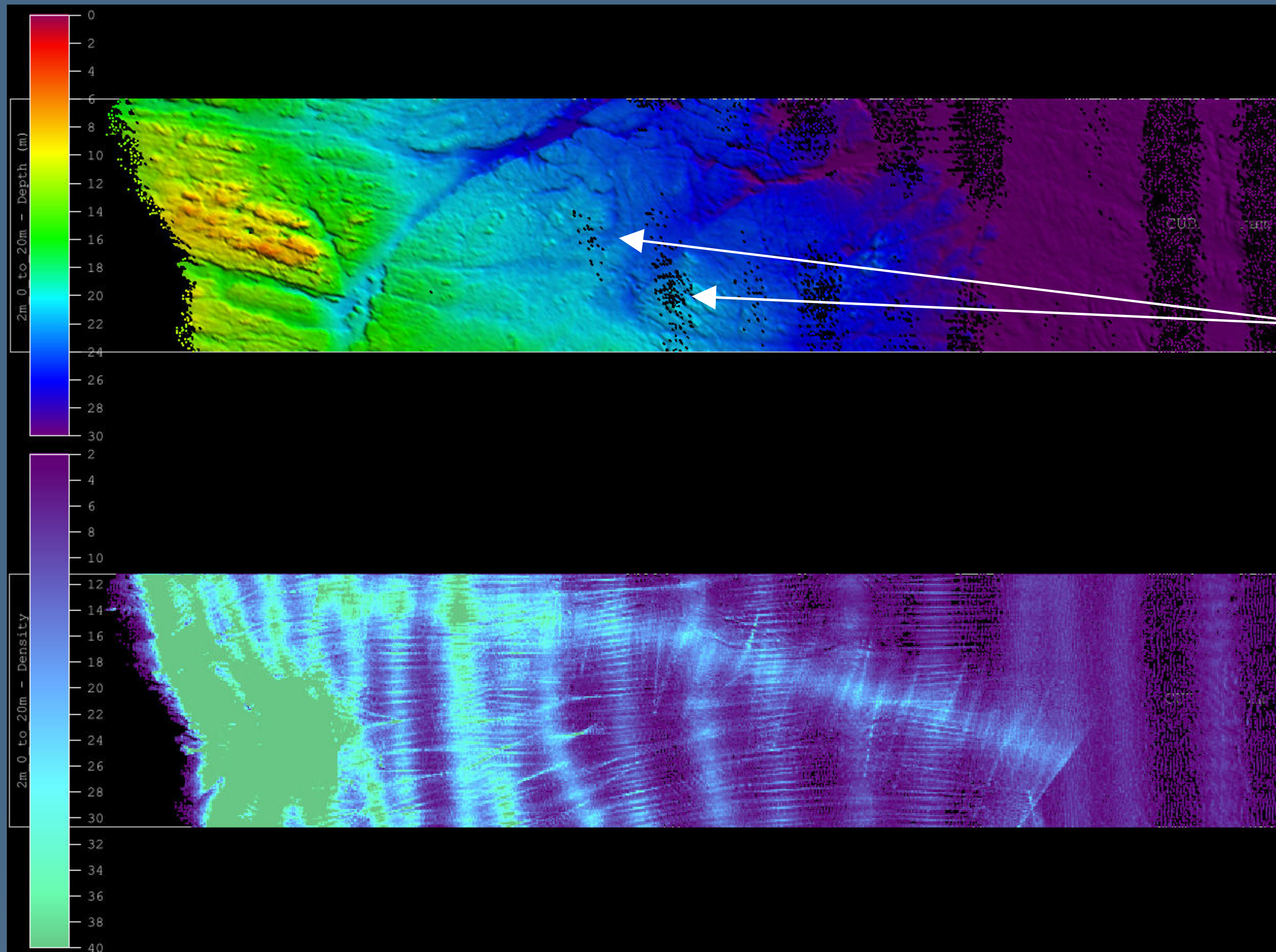




The data density acquired during this survey, and requiring a minimum of 3 soundings per node, does not support a one meter grid.



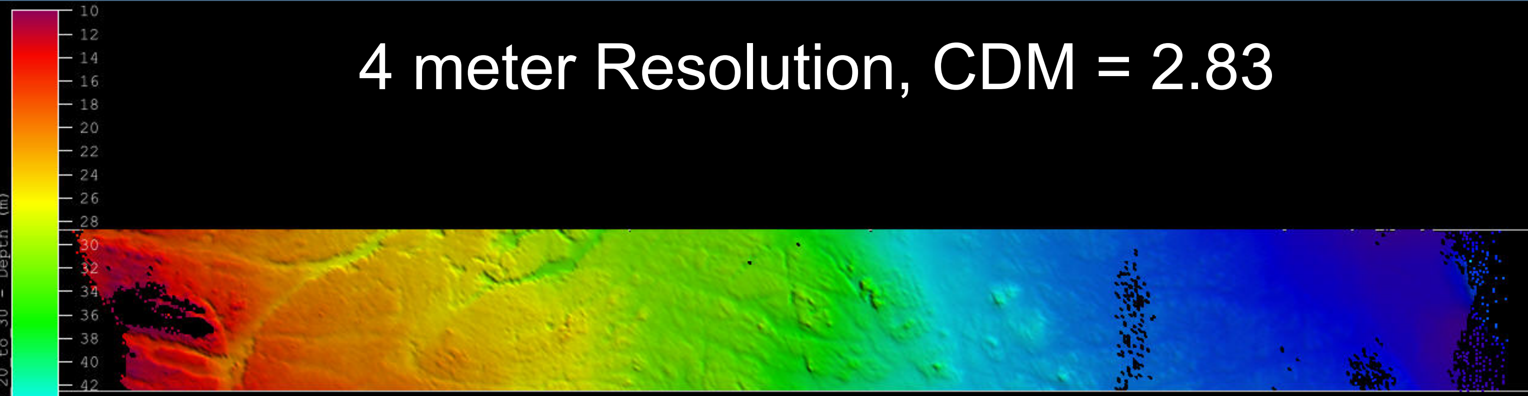
2 meter Grid Resolution, CDM = 1.41



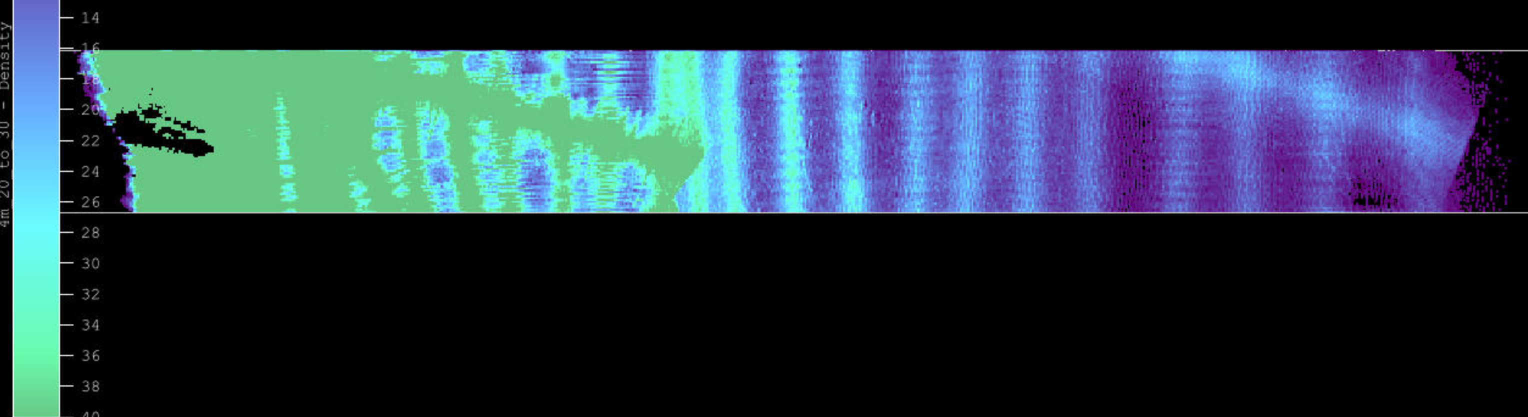
Insufficient coverage

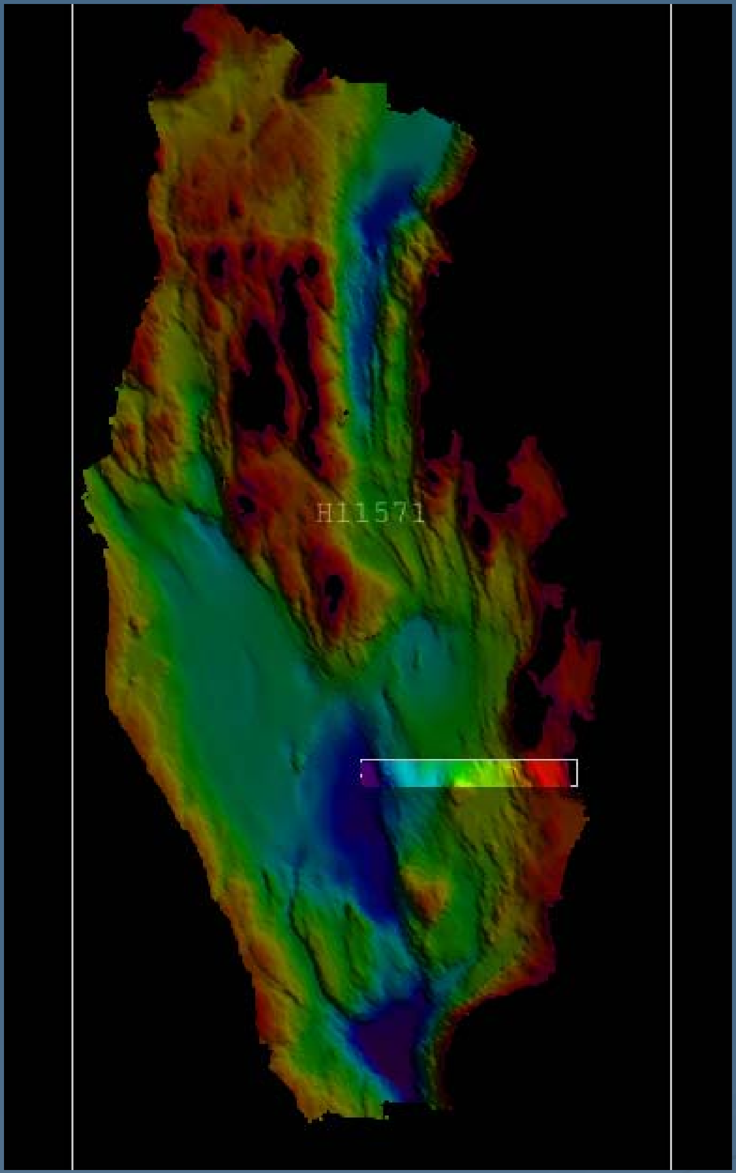
Calculations based on past survey data densities indicate that we can support a full coverage 2 meter grid resolution from 0 to 20 meters. Current survey specifications of a 2 meter grid to 40 meters is unsupportable using current survey methods at 3 soundings per node.

4 meter Resolution, CDM = 2.83



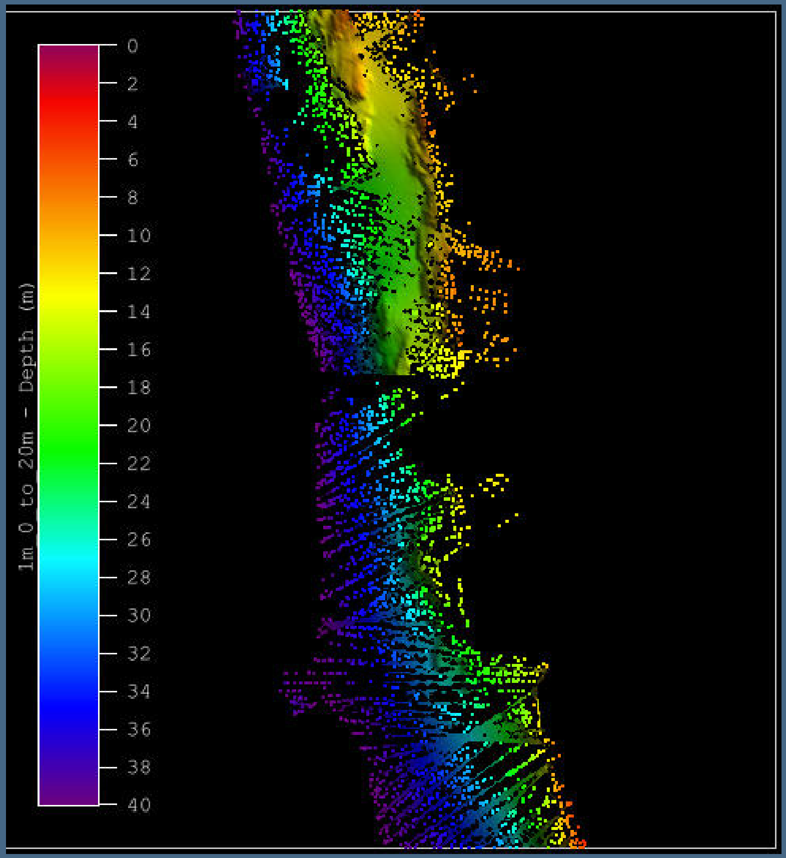
Our calculations indicate that a 4 meter grid resolution, based on past data, can be used to create a full coverage surface from 20 to 35 meters in depth. Our usual specifications would have the depth range from about 25 meters to 60 meters at this resolution. Coverage appears to be complete to 50 meters, well above the prediction made.

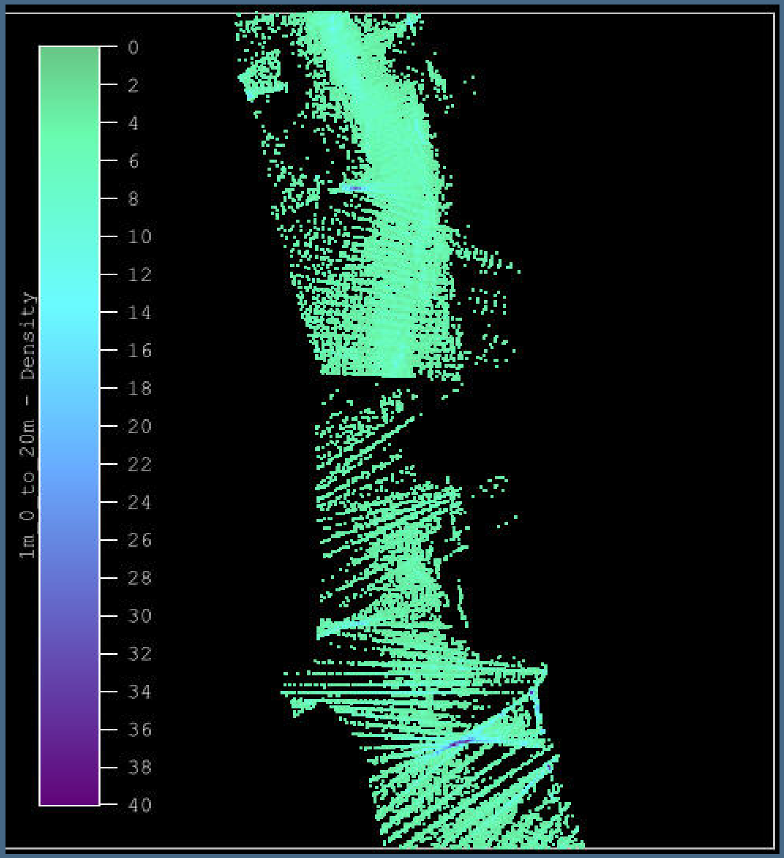




The smaller highlighted area represents the section of Survey H11571 used to test new Base Surface parameters for all grid resolutions. Along this fieldsheet, the depth ranges from roughly 6 meters to 540 meters.

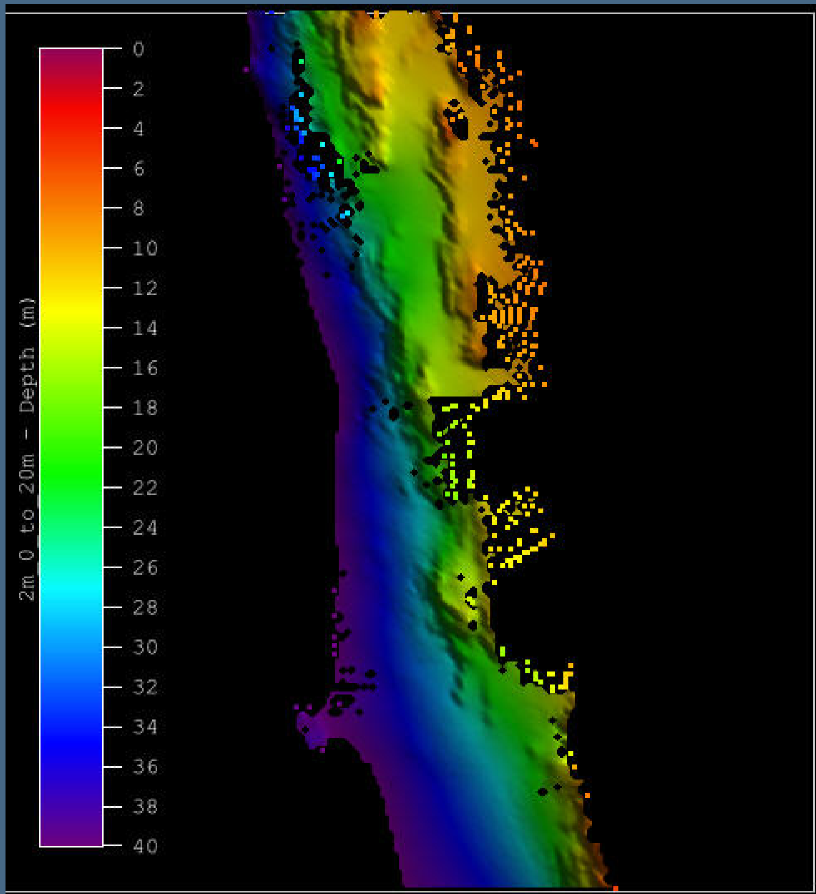
Grid resolution = 1 meter, CDM = .707

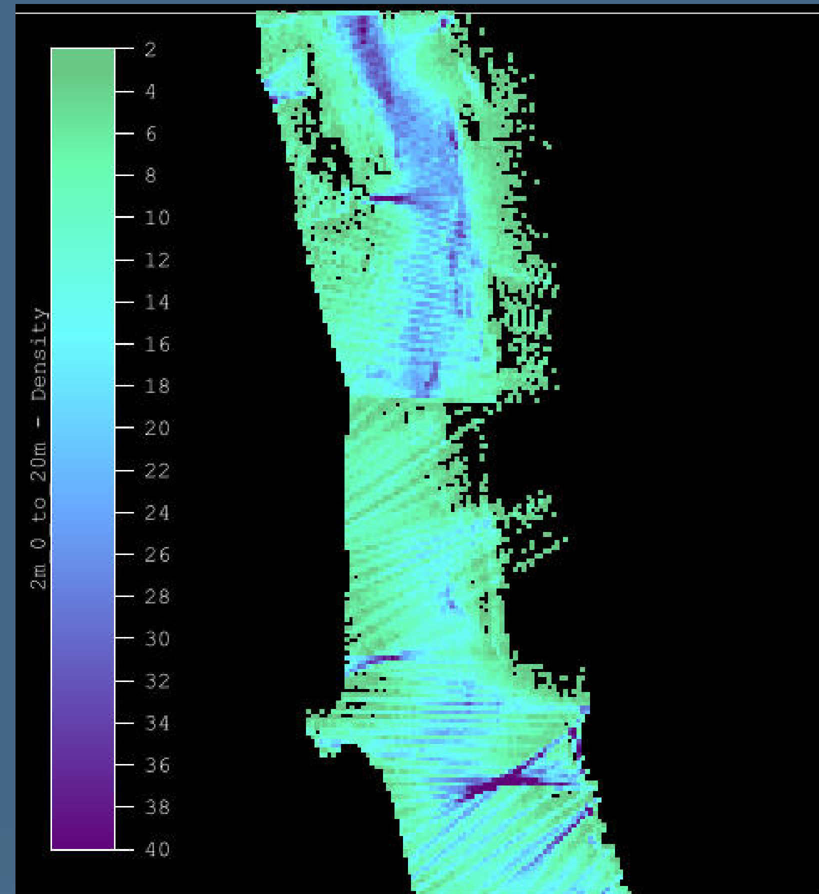




Our calculations indicate that a one meter grid is not often supportable at 3 soundings per node. This survey supports this prediction.

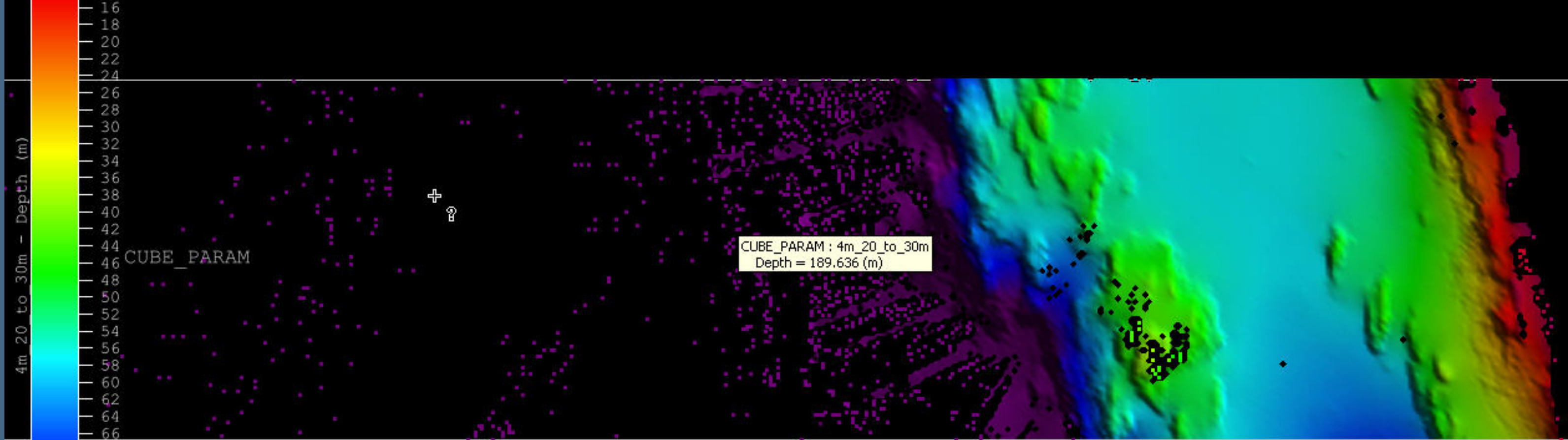
Grid resolution = 2 meter, CDM = 1.41



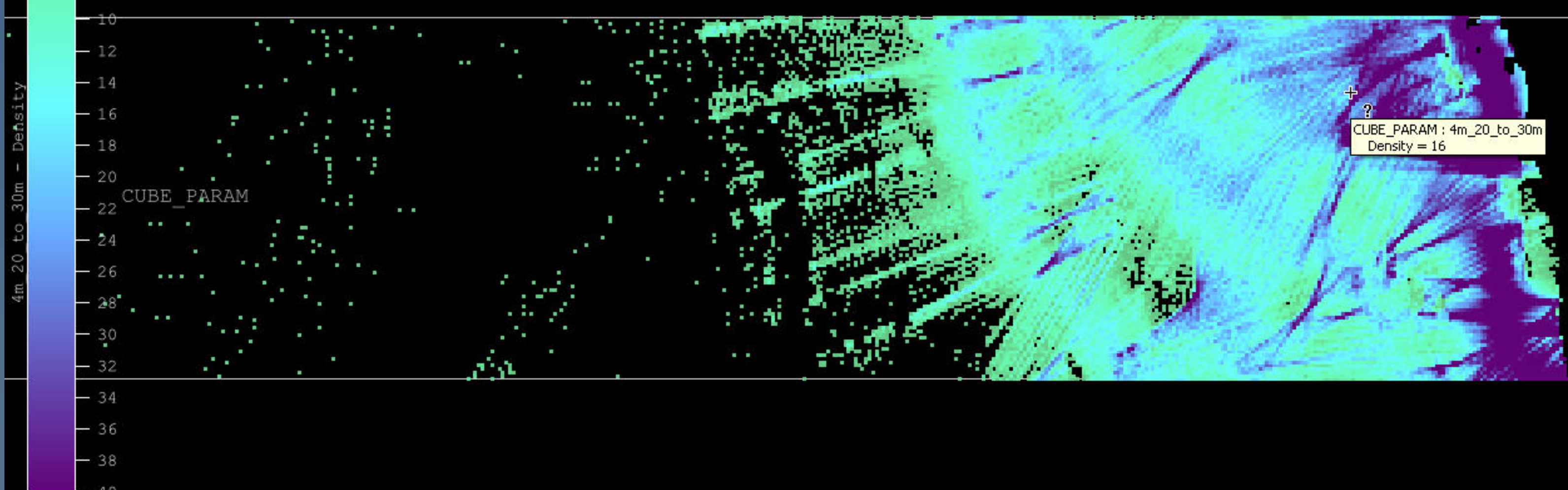


In the case of this very steep and deep survey, we find evidence of a 2 meter grid resolution being supported for a depth range of 0-20 meters as predicted. Reasonable coverage extends down to 30 meters.

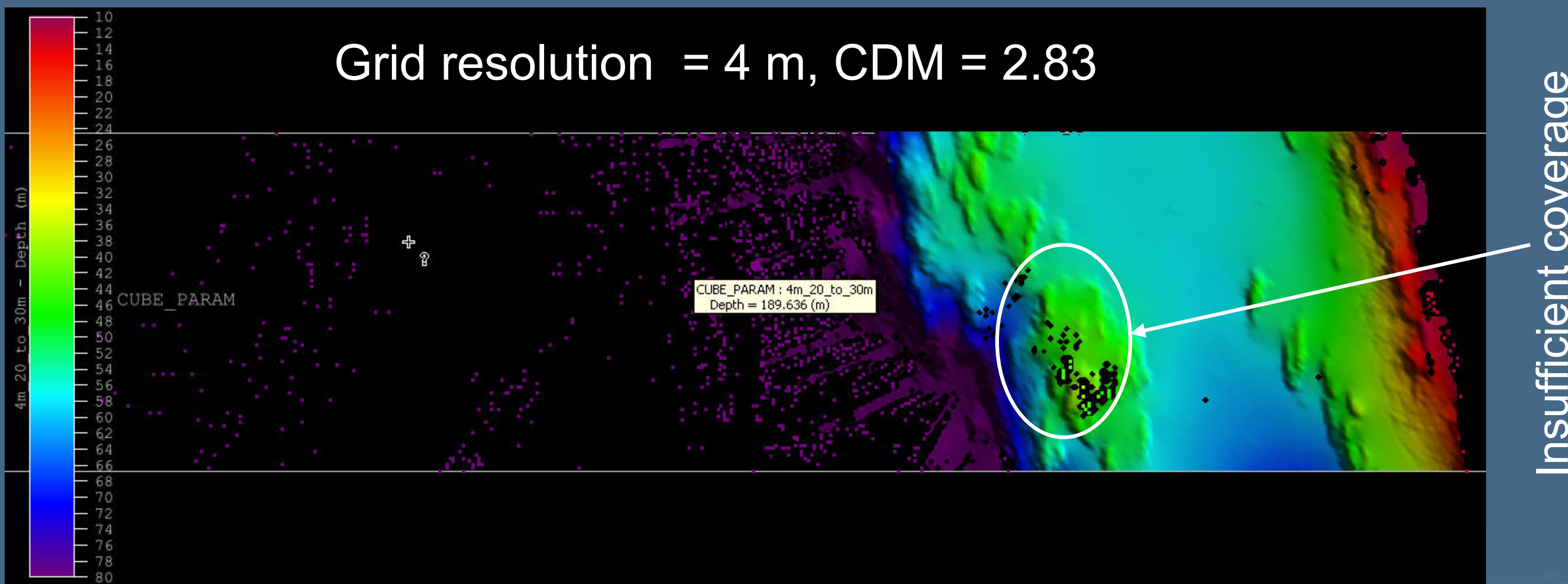
Grid resolution = 4 m, CDM = 2.83



Our calculations indicate that a 4 meter grid resolution, based on past data, can be used to create a full coverage surface from 20 to 35 meters in depth. In fact, the data densities found in this survey indicate that complete coverage can be produced to a depth of 80 meters.

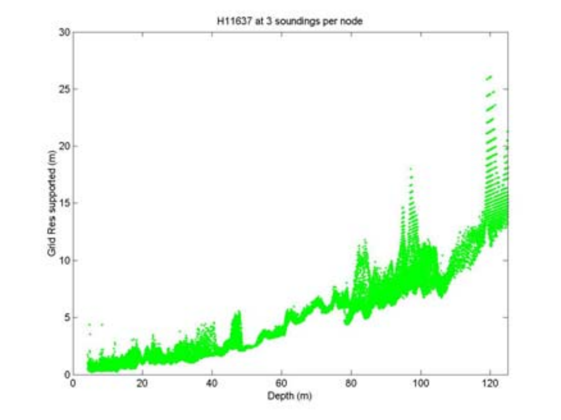


In both surveys examined, as depth increased, the model over-predicted the resolution required to provide full coverage. We find that 8m and 16m resolution grids are usable to a much greater depth than anticipated.

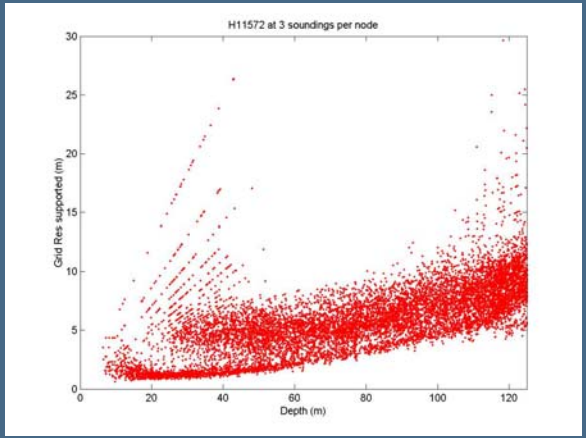


Previously, areas of low data density were not always discovered because of enlarged capture distances. The method used here assumes that previous coverage was adequate in previous surveys, an assumption that doesn't hold. Previously, in areas where "Deep" settings were used, areas of inadequate data density were obscured.

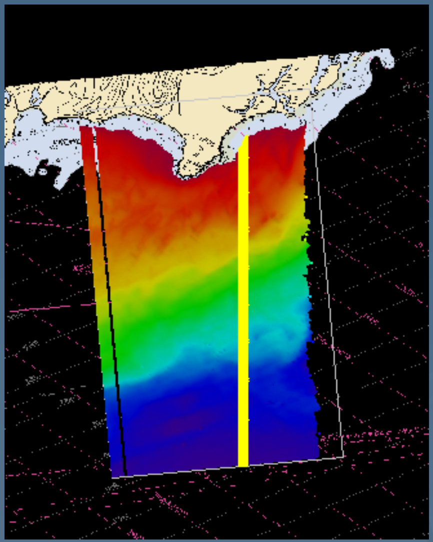
While the original approach was to define usable grid resolutions from past data, particularly low density data was skewing the mean values. To counteract the effects of these data sets only surveys with tight resolution distributions were used when picking a new set of grid resolutions.

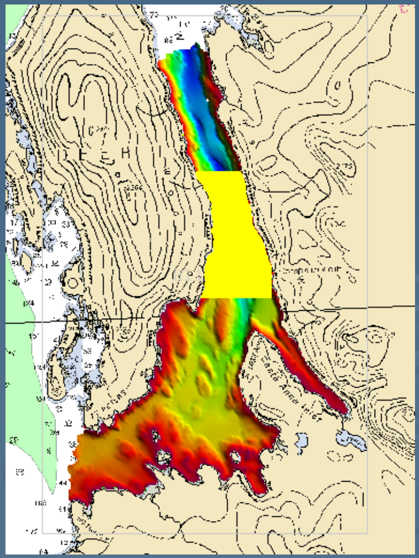


Tight resolution (H11637)

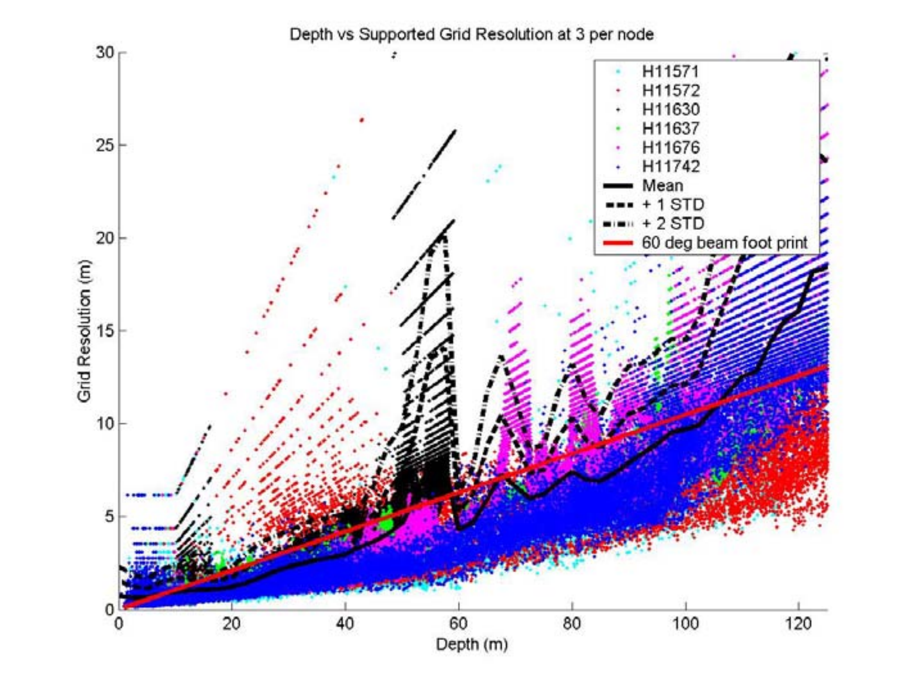


Loose resolution (H11572)

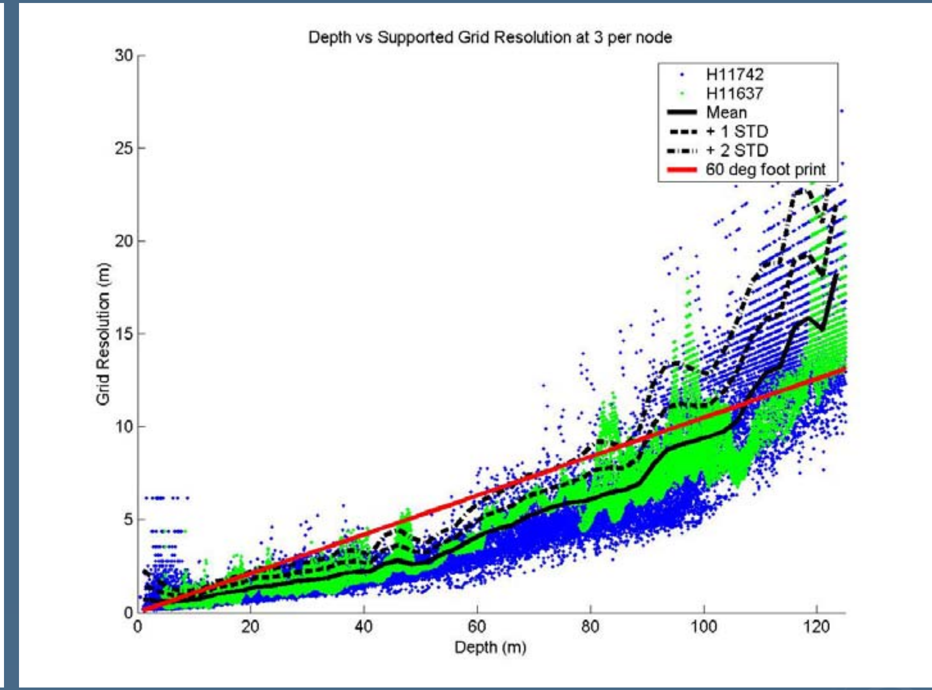




Using tighter data sets allow for higher grid resolutions, but also may bias the density goals for future surveys to a higher, less obtainable standard.



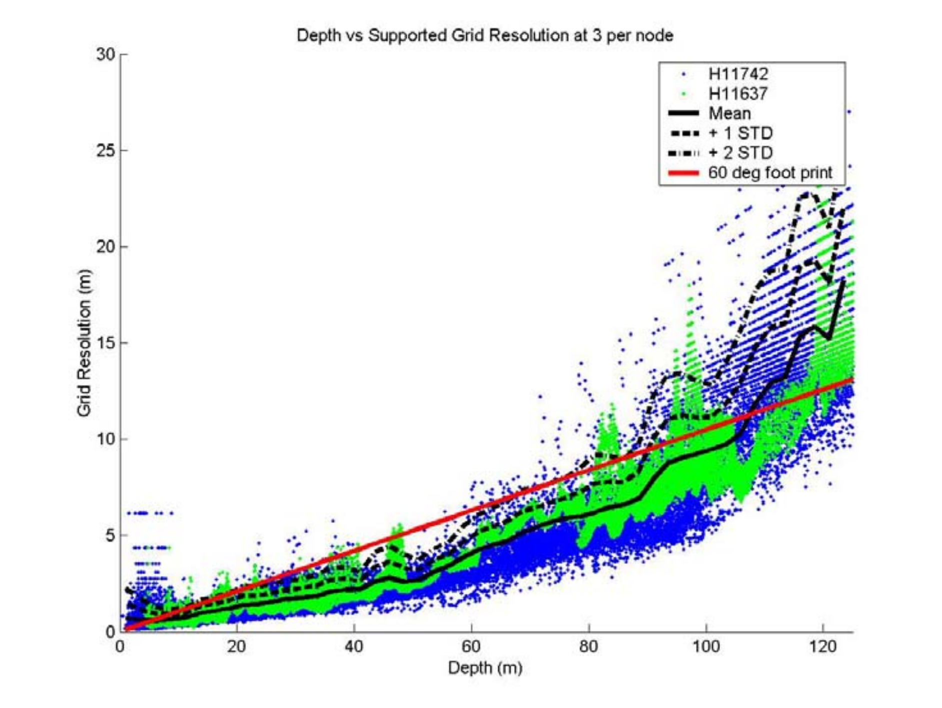
Surveys used in original method



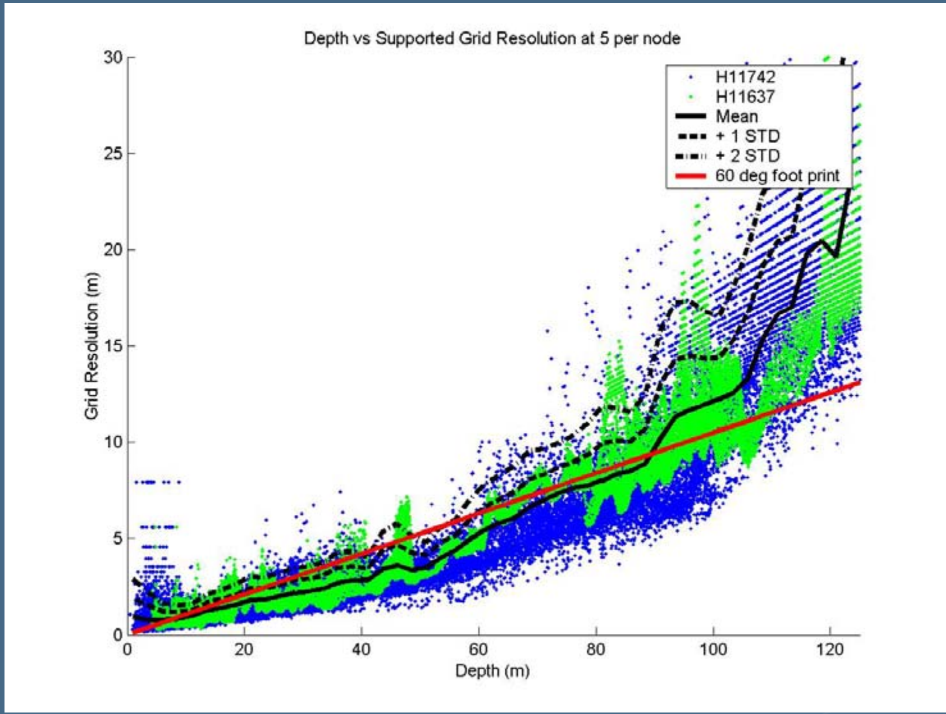
Surveys used that have only tight resolution distributions

An interesting result of using surveys with tighter density distribution is the beam foot print at 60 degrees becomes the limiting factor for the grid resolution that is usable for part of the depth range.

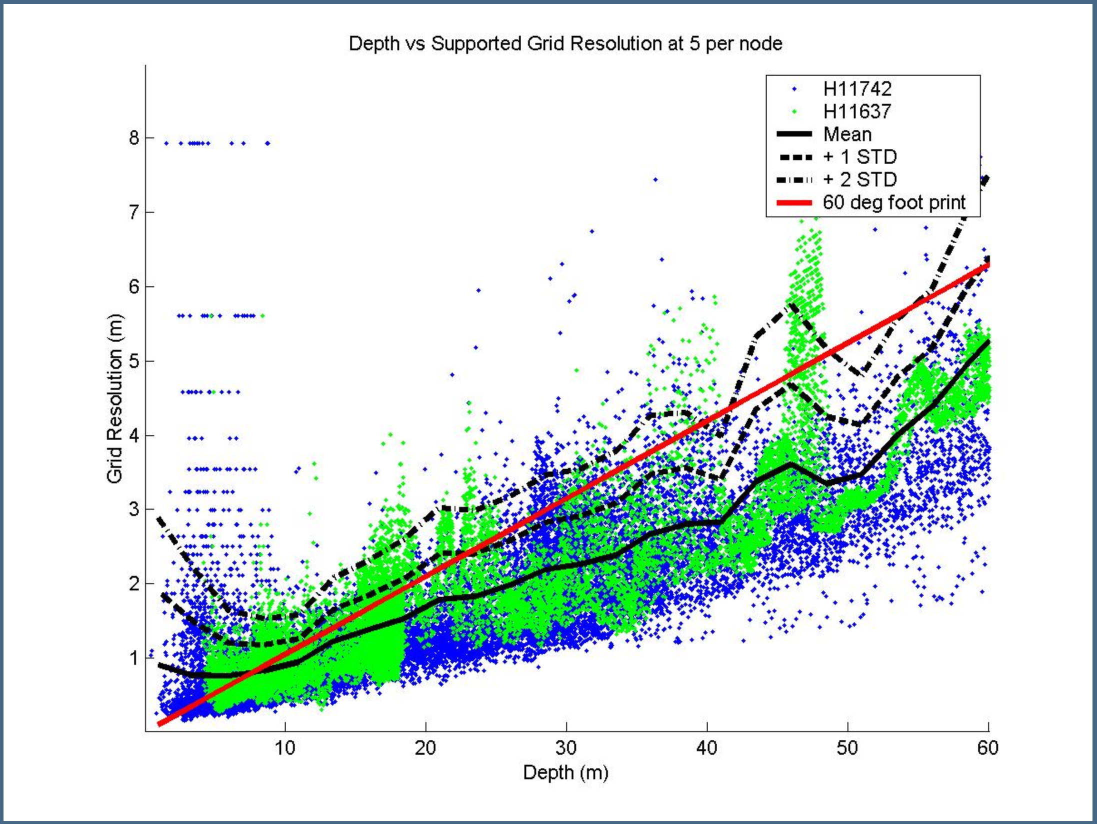
If beam foot print becomes the limiting factor, higher data densities should be obtainable.



3 soundings per node



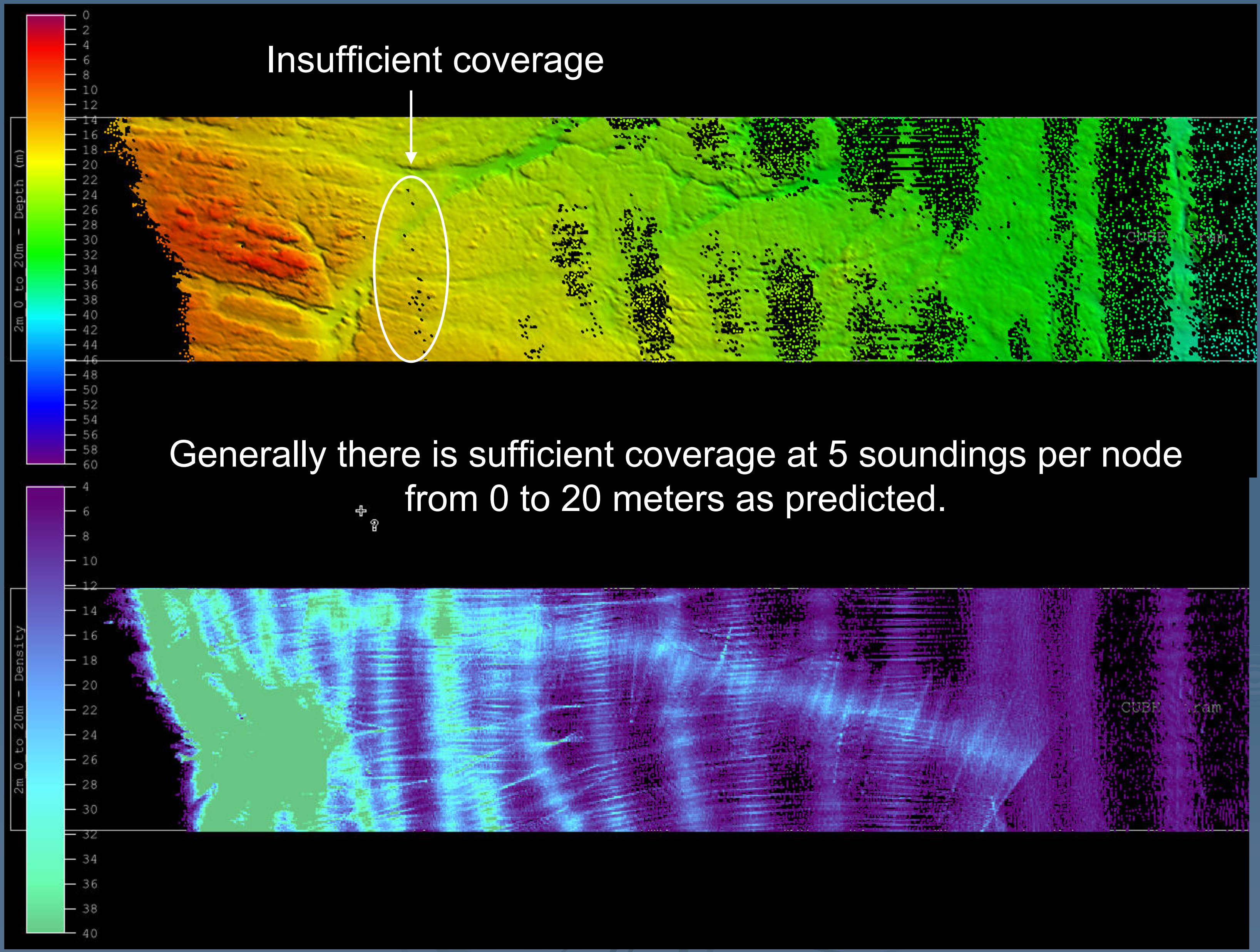
5 soundings per node



Based on 5 soundings per node and the limits of the 60 degree beam foot print the previous surveys were re-examined with grid resolutions at:
2m Resolution: 0 to 20 meters
4m Resolution: 15 to 40 meters
8m Resolution: 35 to 80 meters
16m Resolution: 70 and higher (with lower densities and enlarged beam footprints)

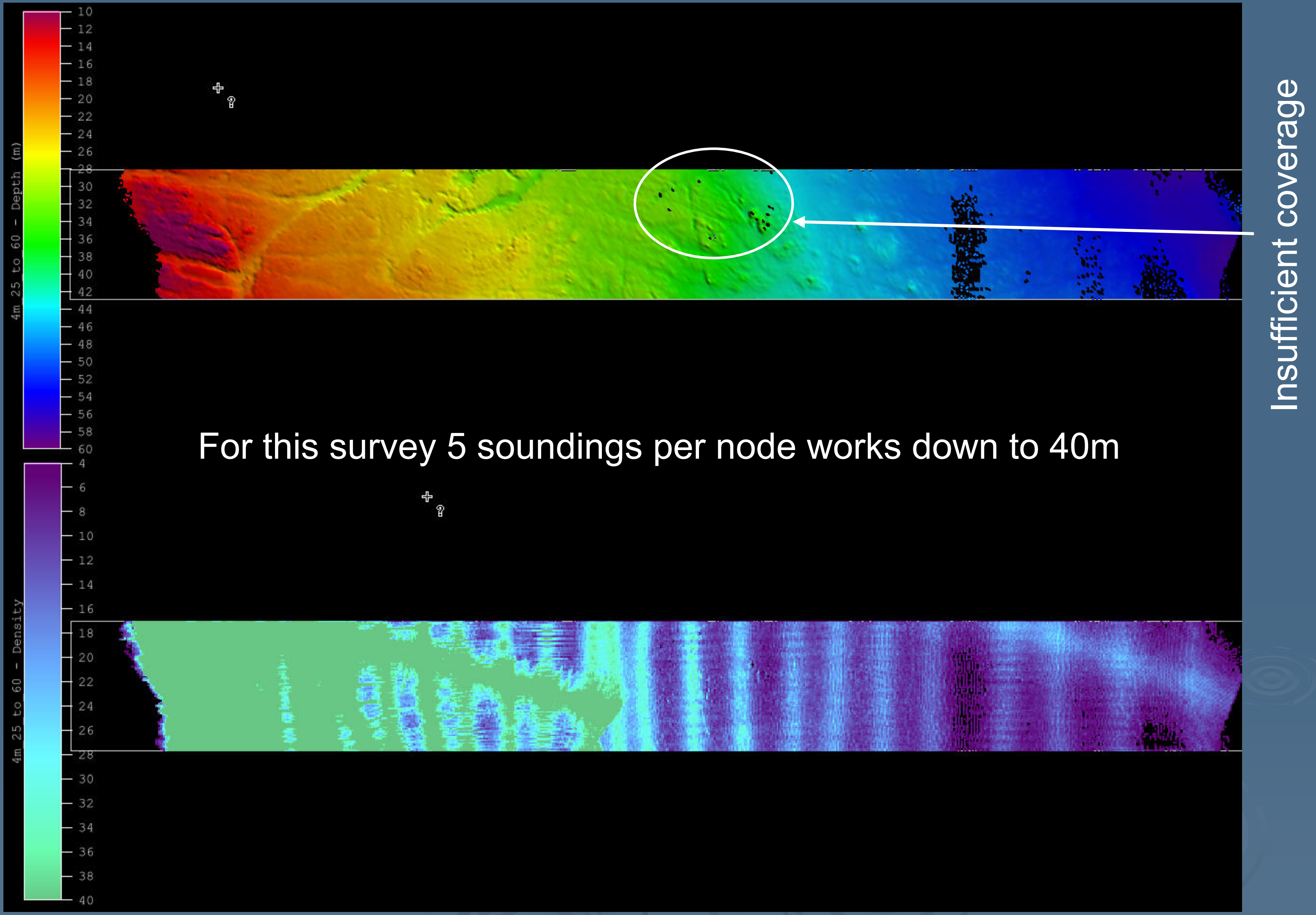
H11630

2 meter Grid Resolution, CDM = 1.41



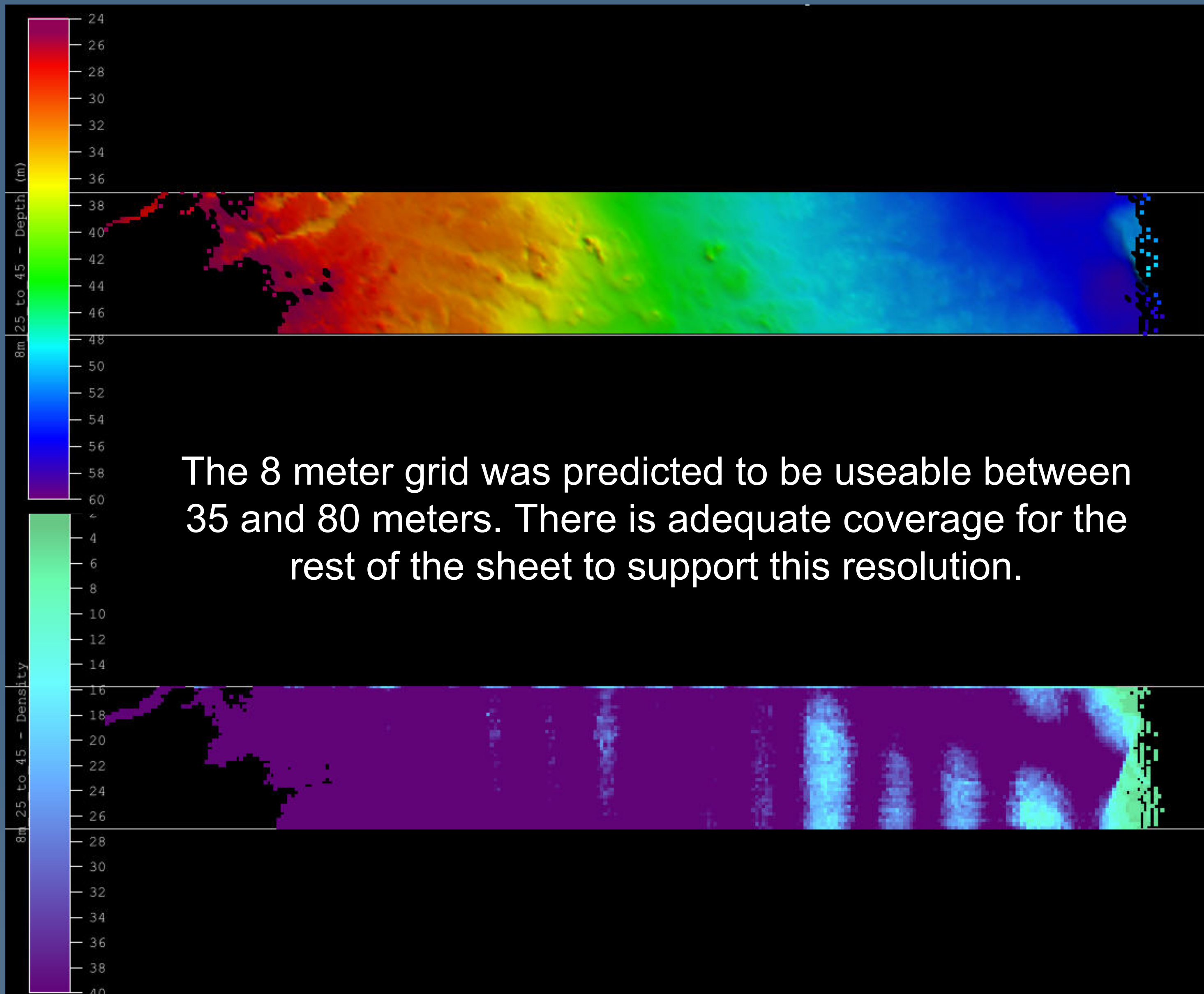
H11630

4 meter Grid Resolution, CDM = 2.83



H11630

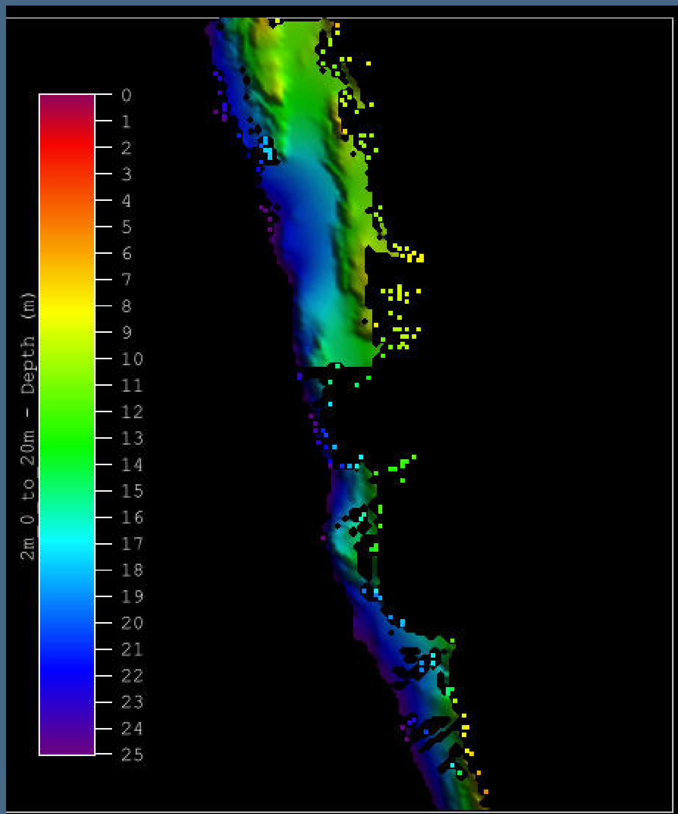
8 meter Grid Resolution, CDM = 5.67

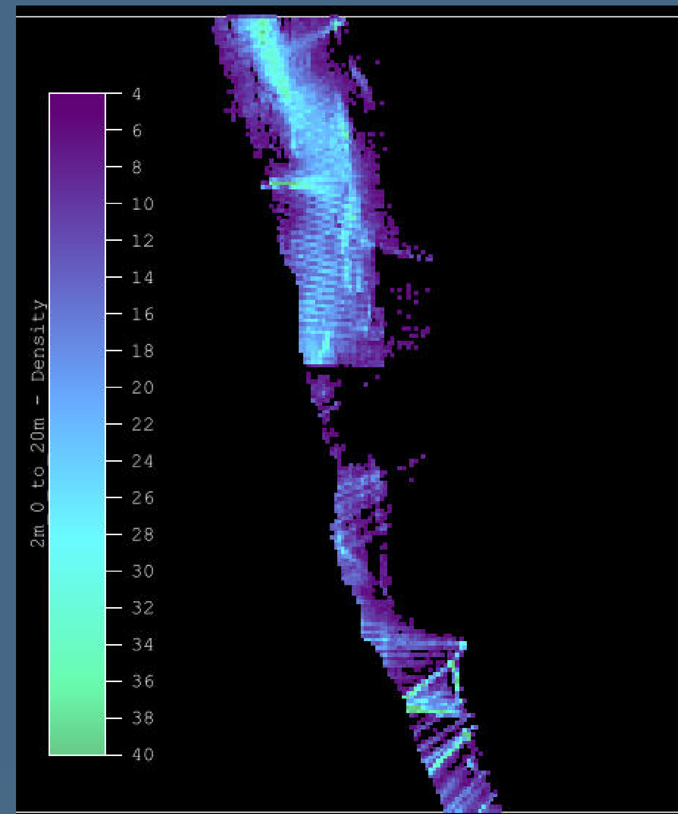


The 8 meter grid was predicted to be useable between 35 and 80 meters. There is adequate coverage for the rest of the sheet to support this resolution.

H11571

2 meter Grid Resolution, CDM = 1.41



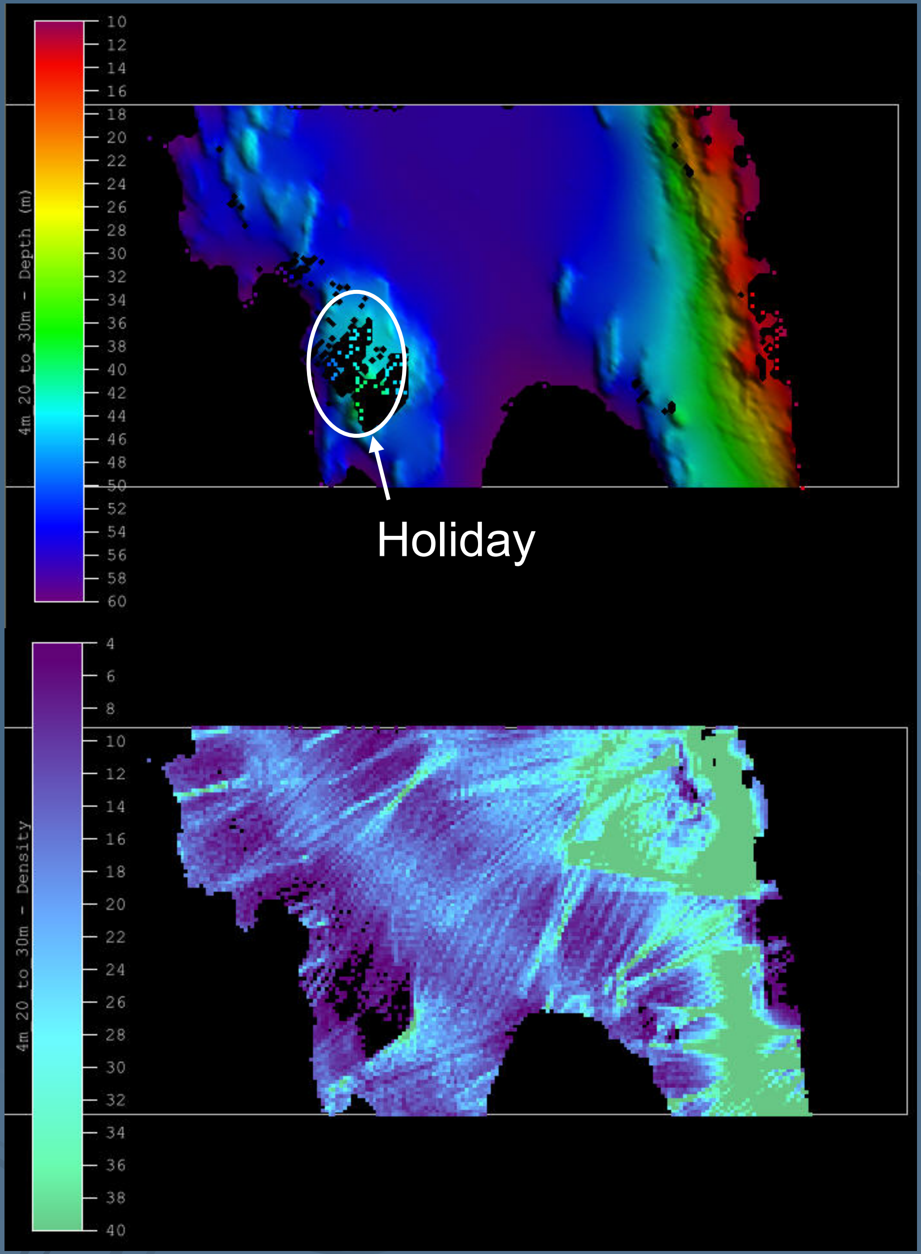


A 2 meter grid resolution is not supported in this area. Because only the outer beams (1 though 20) are run along shore data is sparse. Being steep and deep, only one pass was made while collecting data for this resolution range. 3 soundings per node was supported in the previous section. This is an example of an area that would need to be rerun with a small change in required data density.

H11571

4 meter Grid Resolution, CDM = 2.83

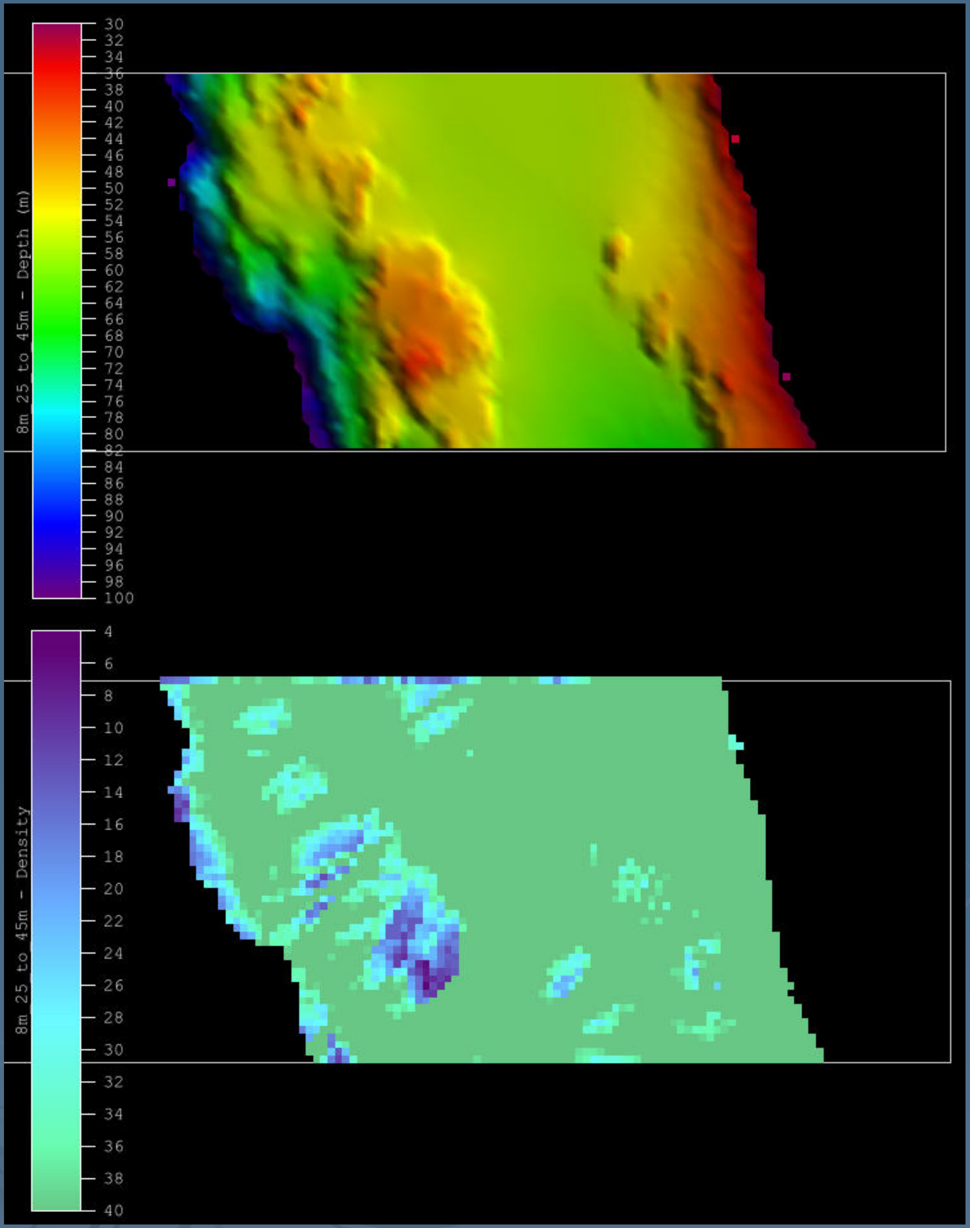
Adequate coverage is shown down to 60 meters for 5 soundings per node, except in the large holiday which did not have complete coverage at 3 soundings per node. This is an area that would need to have more data collected over it. The methodology provided describes 50 meters of depth as supportable for this grid resolution. In this case the grid resolution is being limited to 4 meters by the 60 degree beam footprint.



H11571

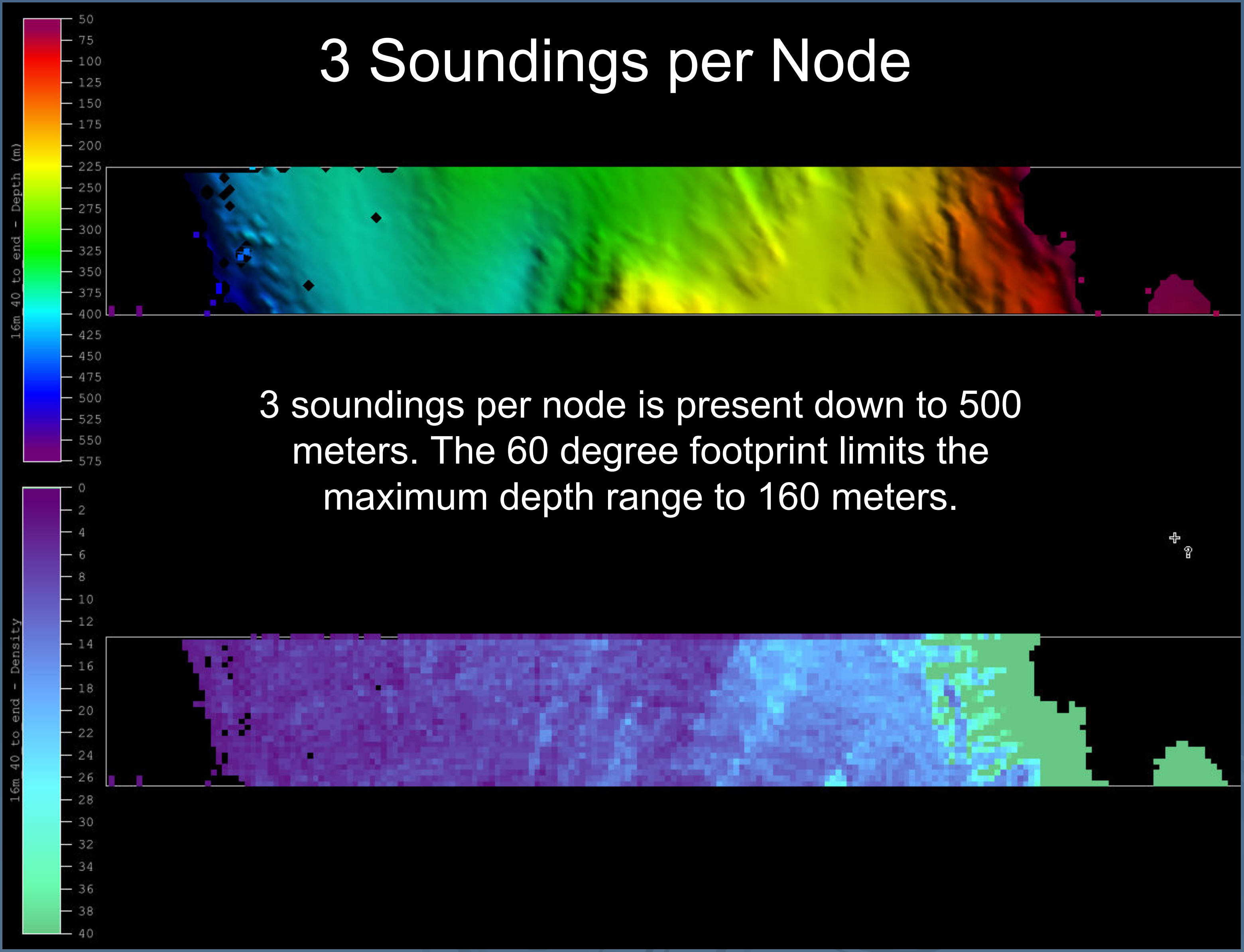
8 meter Grid Resolution, CDM = 5.67

Adequate coverage is shown at this resolution for this depth range.



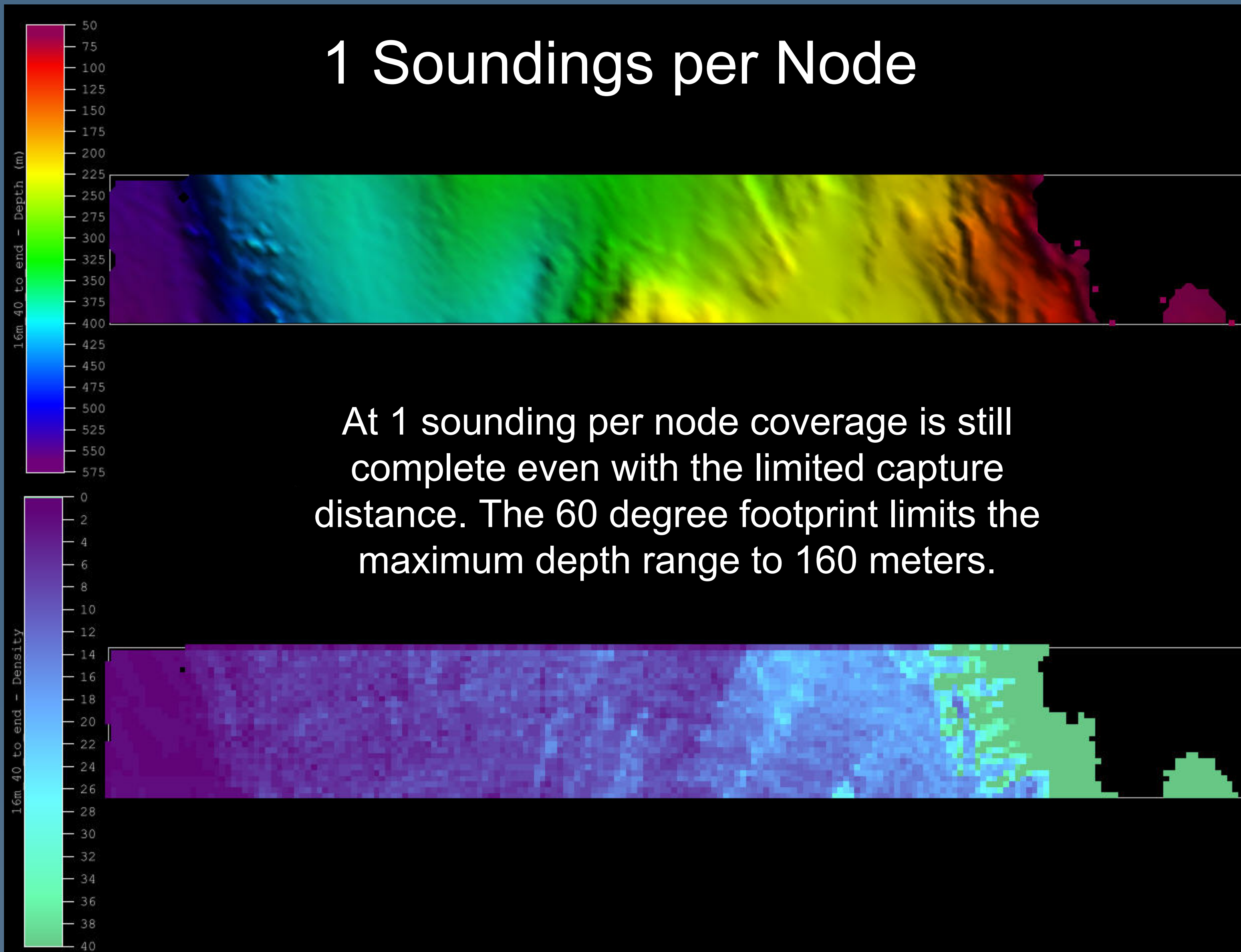
H11571

16 meter Grid Resolution, CDM = 11.31



H11571

16 meter Grid Resolution, CDM = 11.31



The original objective was to look at past data and determine how well the methodology predicted the usable grid resolutions. Given the wide range of survey conditions and results no particular finding has become evident. The intention was to use a line of reasoning backed by a mathematical approach to define specific useable resolutions. As most things in the field, it is messy and a large amount of experience is needed to make best practices clear. Insufficient testing has been completed to define specific resolution, but the methodology has been tested and shows promise.

The author believes that without large changes to current survey practices aboard FAIRWEATHER the best resolutions to be used are as follows:

Grid Resolution	Depth Range
2 meters	0 to 20 meters
4 meters	15 to 40 meters
8 meters	35 to 80 meters
16 meters	70 meters and up