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U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey: Hydrographic

Project No.: OPR-N338-NRT3-10

Time Frame: October 2010 - January 2011

LOCALITY

State: Oregon

General Locality: Columbia River

Sublocality: Harrington Point to Three Tree Point

2011

CHIEF OF PARTY

Dan Jacobs

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DATE

Data Acquisition and Processing Report

NOAA NRT 3 - Vessel s1212
OPR-N338-NRT3-10, Columbia River, Oregon
Acting Team Leader: Dan Jacobs

List of Appendices

EQUIPMENT AND HARDWARE

A.1. Vessels

A.1.1. S1212

Figure 1: NOAA S1212

Navigation Response Team 3 operates a single vessel, S1212 (Fig. 1) a SeaArk Commander (SAMA115510000) acquired in January 2001. Originally 27 feet long, the hull was extended in August 2004, to 30 feet to accommodate the weight of two 150-horsepower Yamaha four-stroke outboard motors. In October, 2009 the two original Yamaha four-stroke outboards were replaced with two new Yamaha four-stroke outboard motors. S1212 is eight feet wide and displaces 4.8 tons. S1212 is equipped to acquire vertical beam echosounder (VBES), multibeam echosounder (MBES), side scan sonar (SSS) data, and shoreline feature data. S1212 is equipped with a Kohler generator (model 7.3E), which provides AC power for survey operations.

A.2. Positioning Systems

Refer to Appendix 3 for a comprehensive wiring diagram of S1212's positioning systems.

A.2.1. POS/MV

S1212 is equipped with an Applanix POS/MV 320 version 4. The POS/MV consists of dual Trimble BD950 GPS receivers (with corresponding Zephyr antennas), an inertial motion unit (IMU), and a POS computer system (PCS). The two antennas are mounted 1.9 meters apart atop the launch cabin (see Fig. 2). The primary receiver (on the port side) is used for position and velocity, and the secondary receiver is used to provide heading information as part of the GPS azimuthal measurement sub-system (GAMS).

The POS/MV receives differential (RTCM) correctors from a Trimble DSM212L GPS receiver that includes a dual-channel low-noise MSK beacon receiver, capable of receiving U.S. Coast Guard (USCG) RTCM differential correctors. The DSM212L can also accept RTCM messages from an external source such as a user-established DGPS reference station, but typically USCG beacon correctors are used. There are three modes: Auto-Range, which locks onto the beacon nearest the vessel; Auto-Power, which locks onto the beacon with the greatest signal strength; and Manual, which allows the user to select the desired beacon. NRT3 typically operates with the manual setting. The following parameters are periodically monitored in real-time through Trimble's TSIP Talker software to ensure position data quality: 1) number of satellites used in the solution, 2) horizontal dilution of precision (HDOP), 3) latency of correctors, and 4) beacon signal strength. The DSM212L is configured to the auto-power mode, to go off-line if the age of DGPS correctors exceeds 20 seconds, and to exclude satellites with an altitude below eight degrees.

The IMU contains three solid-state, linear accelerometers and three, solid state, gyros, which together provide a full position and orientation solution. The IMU is mounted on the top of the sonar housing (see Fig. 2), beneath a removable deck plate in aft area of the vessel.

Figure 2: IMU Installation

The POS MV is configured, operated, and monitored via the POS MV Controller software, which is installed on the HYPACK acquisition computer. Refer to Appendix 6 for POS/MV annual calibration results conducted on March 15, 2010.

A.2.2. Trimble GeoXH GPS

NRT3 uses a Trimble GeoXH 2008 Series GPS for shoreline-feature positioning and attribution. The GeoXH uses the Windows Mobile 6 operating system to run TerraSync, a Trimble field-software program used to configure receiver settings and acquire data. NRT3 transfers and post-processes these data using Trimble Pathfinder Office software v4.20, installed on workstations in the office trailer.

The GeoXH provides reliable accuracy to within 1 to 3 meters with real-time or post-processed differential correction. To achieve higher accuracy, the GeoXH can employ H-Star technology, a logging and processing schema that provides 10- to 30-cm accuracy. H-Star logging requires three or more, dual-frequency (L1 and L2) base stations within 200 km of the receiver or 1 dual frequency base station within 80 km. However, the optional Zephyr antenna must be used to attain accuracies below 30 cm. Typical NRT3 settings for common GPS options, accessed via TerraSync, are shown in table 1.

Option	**Setting**	**Option**	**Setting**
Datum	*WGS 1984*	North Reference	*True*
Altitude Reference	*Height Above Ellipsoid*	Lat/Long Format	*DD.MM.SS.ss*
Coordinate System	*Lat/Long*	Angle Units	*Degrees*
Altitude Units	*Meters*	Real-time setting, Choice 1	*Integrated SBAS (WAAS)*
Distance Units	*Meters*	HDOP	*2.5*
Area Units	*Square Meters*	Elevation Mask	*8 degrees*

Table 1: GeoXH Field Settings

A.2.3. Laser Range Finder

A TruPulse 360/B Laser Range Finder by Laser Technology, Inc. is used in tandem with NRT3's Trimble handheld GPS when accessibility to shoreline features is limited. The unit's dimensions and weight are 5" X 2" X 3.5" and 8 ounces, respectively. Via Bluetooth communication, distance and bearing offsets are recorded in Trimble TerraSync. Distance measurements of up to 1000 meters yield accuracies of 30 – 100cm. Higher ranges (2000 meters) may be obtained employing reflective targets; however such ranges are not used. Typically, ranges between 5 and 75 meters are used by NRT3. Azimuth accuracy is rated at 1 degree or less upon entering local magnetic declination values.

A.3. Sound-Speed Measurement Instruments

See Appendix 2 for Sound Speed Calibration Reports.

A.3.1. SeaBird SBE 19, 19+

NRT3 collects conductivity, temperature, and density (CTD) data using SBE 19 and 19+ sensors. Sound speed profiles acquired from these sensors determine sound speed profiles in a column of water, which are used to correct multibeam sonar data. The SBE generates a raw hexadecimal file (*.hex), which is used by VELOCWIN, a NOAA in-house program the converts the .hex files to files used to correct multibeam data.

A.3.2. Odom Digibar Pro

Continuous sound speed measurements at the face of the multibeam transducer are necessary to correct for the geometry of a flat transducer array. This is achieved by mounting an Odom Digibar Pro on the bottom of S1212's transom, near the Simrad flat-faced transducer. The speed of sound is measured by a wet-end probe and sent to a display, which then passes the data on to the Hypack computer via a COM port/RS232 connection.

A.4. **Depth Measurement Equipment**

A.4.1. Lead Line

For purposes of data integrity, NRT3 has in its possession one (1) 30 meter long lead line. The lead line was fabricated and calibrated in April, 2010. Lead line checks are performed periodically throughout the project to verify fathometer accuracy. The line is graduated in 1 decimeter increments by bands of tape along the entire length of the polypropylene line. Annual calibration each year involves comparing the length of the lead line against a survey grade, steel tape in accordance with FPM Section 1.5.3.1.1.

A.4.2. Odom Echotrac CV2 VBES

An Odom Echotrac CV vertical beam echosounder (VBES) employing a single-frequency transducer with beam width set at eight degrees is used for single beam data collection. The echosounder, which is operated at 200 kHz, records both analog and digital data which may be acquired in feet or meters. Soundings are acquired in meters with an assumed speed of sound through water of 1500 m/sec. During data collection the echosounder is controlled and the trace is monitored via an Ethernet driver connection to the HYPACK Survey program. The echosounder trace is recorded to .BIN files which are logged automatically alongside HYPACK line files during acquisition. These files are used for reference during digital data processing.
HYPACK Max Survey Software is used for vessel navigation and line tracking during hydrographic data acquisition. The HYPACK software log “raw” VBES data and to record detached positions in the form of .tgt files.

A.4.3. Kongsberg EM3002 MBES

S1212 is equipped with Kongsberg’s EM3002 multibeam echosounder (MBES) installed December, 2009. The EM3002 replaced an older EM3000. No structural modifications of the boat hull were necessary to install the EM3002, which has the same physical dimensions and mounting configuration as the EM3000. The processing unit (PU) was also replaced.

The EM3002 operates at a nominal frequency of 300 kHz, with a typical range of 1 to 200 meters (in cold ocean water) and a range resolution of 1 cm. It has 254 beams covering a 130° maximum swath width. The transmit beam width is 1.5°, and the receive beam width ranges from 1.5° (at nadir) to 3° (60° from nadir). The system is pitch-stabilization capable, but NRT3 generally does not run with pitch-stabilization enabled, to simplify any potential post-processing requirements. The cylindrical sonar head is mounted to the hull of the vessel at the keel, beneath the inertial measurement unit (IMU) (see Fig. 3).

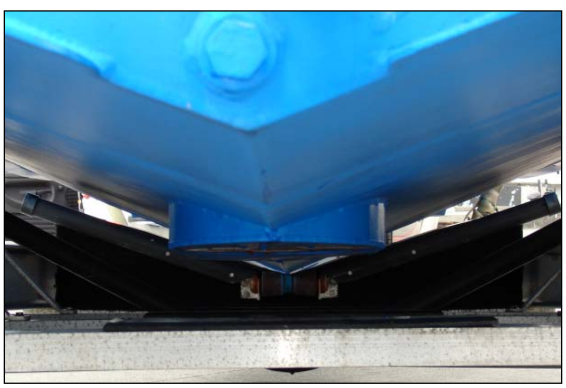


Figure 3: Kongsberg EM3002 Installation

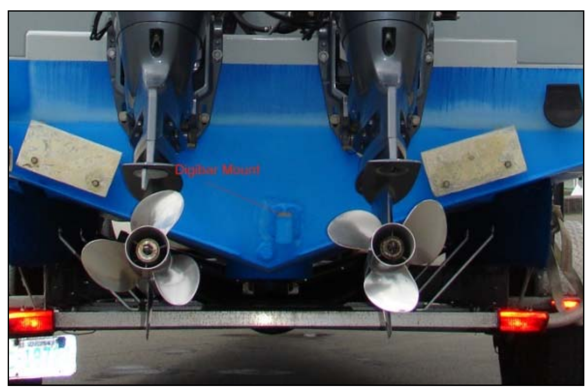


Figure 4: Odom Digibar Pro Mount

An Odom Digibar Pro provides the requisite real-time surface-sound-speed values to SIS, which is installed on the Hypack acquisition computer (see also section A.2.1). The Digibar Pro probe is mounted on the transom (see Fig. 4) and configured through a control unit located inside the cab.

A.4.4. Side-Scan Sonar (SSS) system

The vessel is equipped with a Klein 3000 sonar system. Major components of the system are listed below:

- Dual frequency (100 kHz, 500 kHz) towfish with 300 PSI pressure sensor
- Transceiver Processing Unit (TPU)
- Workstation Display and Control Unit (WDCU)
- Thirty-five meters of Kevlar reinforced tow cable
- SonarPro software and VX Works TPU operating system

The horizontal, or along-track, beam-widths for the low and high frequencies are 0.7° and 0.21°, respectively; the vertical, or across-track, beam-width is 40°. Maximum range scale for the Klein 3000 is 150 meters at high frequency and 450 meters at low frequency. Only the high-frequency data are recorded; the low-frequency data are only monitored during data collection.

S1212 is also equipped with a Dynapar cable counter, which measures the length of deployed towfish cable, or cable out, by counting revolutions of the towing block. The cable-out data are originally fed into Hypack, then to the Klein workstation via the Hypack-generated Delph string. Before each use, the cable counter is calibrated by adjusting the readout to reflect the measured marking on the towfish cable near the tow point.

COMPUTERS AND SOFTWARE

B.1. Computers

A complete list of computers and operating systems is included in the Appendix 4, Hydrographic Systems Inventory.

B.1.1. Office and Vessel Workstations

NRT 3 has three (3) workstations plus one (1) notebook in its office trailer. Two (2) additional workstations are located on launch S1212. Computers in the office trailer are used for data post-processing duties while the workstations on the boat are dedicated to vessel navigation and data acquisition. All computers are running the Windows XP operation system.

B.2. Software

A complete list of software and versions is included in Appendix 4, Hydrographic Systems Inventory.

B.2.1. Hypack

MBES and VBES data are collected on S1212 using HYPACK 2009a, a software suite that interfaces with sonar and navigation hardware, displays survey lines over charts and background information, plots the vessel location, and creates raw sonar data files with the file extension *.hsx.

B.2.2. Sonar Pro

Sonar Pro is a data acquisition program run on a separate computer (than the computer installed with Hypack) and is used to interface with SSS, display sonar data, and create sonar data files with the file extension *.sdf. SonarPro is a program created by Klein Associates, and is provided with the Klein 3000 system.

B.2.3. Caris

All office based computers are loaded with CARIS HIPS & SIPS 7.0. CARIS HIPS and SIPS software was used to convert, edit, and analyze all sounding and side scan data and to apply vertical and horizontal correctors. All computers have been updated with the latest CARIS hotfixes.

B.2.4. HSTP Software and MapInfo

All PCs are also loaded with Pydro and MapInfo – programs used for survey planning and preparation, survey feature and data management, and compilation of the Descriptive Report.

NOAA's Pydro software supplied by the Hydrographic Systems and Technology Program (HSTP) was used for analyzing sounding data and SSS contacts, for processing and editing detached positions, and for decimating data in the creation of preliminary smooth sheet (PSS) files.
HSTP's HydroMI Mapbasic program was used in combination with MapInfo software for a number of pre- and post-survey applications.

HSTP's VelocWin program was used to process sound velocity data obtained with Seacat SBE-19 and SBE 19 plus CTD's and an Odom Digibar profiler.

QUALITY CONTROL

C.1. VBES Data

C.1.1. Acquisition Operations

VBES data is collected with Coastal Ocean graphic's HYPACK version 2009a software suite which interfaces with Odom sonar hardware and Trimble navigation hardware. Hardware devices for each of these programs are set and monitored during acquisition. The VBES data is logged in the HYPACK *.raw format. No VBES Data was acquired for this survey.

C.1.2. Processing Workflow

VBES raw data are converted from HYPACK to the CARIS HDCS format using the CARIS HIPS conversion wizard. Navigation and attitude data are examined using CARIS HIPS attitude and navigation editors. Evident fliers are rejected and the track line between good navigation points is either interpolated or rejected. The digital VBES depths are compared with the trace recorded in the echosounder .Bin files. The digital record is edited when warranted to ensure that peaks of shoals and abrupt changes in slope are properly depicted.

C.2. MBES

C.2.1. Acquisition Operations

HYPACK Max Survey and Hysweep programs are used for vessel navigation and line tracking, as well as swath and coverage monitoring during MBES data acquisition. Unlike the EM3000 (used previously), which was controlled via a device-specific controller in Hypack, the EM3002 is controlled with an unlicensed instance of Kongsberg's acquisition software, Seafloor Information System (SIS); however, the data are still logged as .hsx files in Hypack (version 2009a). A matrix layer, drawn in real-time, shows operators where sonar data has been acquired.

C.2.2. Processing Workflow

MBES raw data are converted from HYPACK to the CARIS HDCS format using the CARIS HIPS conversion wizard. Next, tide correctors are loaded and merged to the converted data and Total Propagated Uncertainty (TPU) is computed.* Then Combined Uncertainty Bathymetric Error (CUBE) surfaces are generated at various resolutions. Finally, swath data is examined in Subset Editor where noise (i.e. fliers, double pings) are rejected, tidal and sound speed artifacts assessed and documented, and seafloor depths are compared against charted soundings. See processing workflow diagram entitled *Raw Data to HDCS* in Appendix I.

*Sound speed files and true heave data are applied real-time, during acquisition in NRT3's current software configuration.

C.3. SSS Data

C.3.1. Acquisition Operations

All SSS data collection is controlled with SonarPro software operating in a Microsoft Windows XP environment on the WDCU. Signals are sent to the towfish and data is received from the towfish via the TPU. The sonar data are recorded digitally and stored on the WDCU in the Klein SDF format.

Side scan sonar lines are spaced according to the range scale appropriate for water depth to assure overlap of at least 25 meters and to assure 200% coverage.

In general, range scale is selected to maximize coverage and to ensure the towfish height above the bottom is 8 to 20 percent of the range scale. Exceptions to this rule are in very shallow areas or areas where rapidly changing terrain raises the risk of collision.

Vessel speed is maintained at or below five knots to ensure that an object one meter square can be detected across the sonar swath. Confidence checks are performed by observing the outer edges of the sonogram while moving alongside pier faces or known submerged targets.

C.3.2. Processing Workflow

Raw SSS data is also converted to the CARIS HDCS format using the CARIS HIPS conversion wizard and then reviewed with the attitude and navigation editors in the same manner as the sounding data. The CARIS Sensor Layout tool is used to examine the values of the active sensors, cleaning where necessary. Towfish navigation is recomputed, bottom tracking (fish height) is corrected if necessary, and the sonogram is slant-range corrected. The sonogram is then examined for significant contacts (shadow height of 1.0 meter or greater). Contacts selected for development are exported to MapInfo, where the HydroMI program is used to generate HYPACK target and line files. Assurance that adequate side scan coverage has been acquired is achieved through the generation of mosaics in a CARIS field sheet – one mosaic for the first 100% and one for the second 100%. See processing workflow diagram entitled Raw Data to HDCS in Appendix I in this report.

C.3.3. Side-Scan Sonar Accuracy

The SSS calibration procedure was conducted twice. In the first iteration, the data were acquired over a charted wreck. Although the wreck was detected in all but one line, the resulting 95% confidence radius (CR) was more than double the recommended maximum 95% confidence radius. The large CR was attributed to using an inappropriately large target. Selecting the same spot on the wreck in all lines was difficult due to the nature of the wreck and the quality of the imagery.

The target for the second iteration was the G"3" buoy block at the western end of Guemes Channel, near Anacortes, WA. The data were acquired slightly after predicted slack water, while the predicted ebb current was under 1kt. The buoy was minimally affected by the current, but the boat was crabbing noticeably, particularly on the north/south lines.

The buoy block was detected in all lines, but the quality of the return was marginal in the outer ranges. The initial position of the selected contacts (the hollow circles in the image below) revealed a systematic, heading-dependant bias. Calculated with the "MapInfo calculate statistics" method, the initial 95% CR (11.77m) exceeded the recommended 10m maximum. Although the systematic bias was not clearly attributable solely to a timing latency, a -1 second timing correction was added to the navigation sensor in the HVF to help improve positioning. The 95% CR based on the adjusted contact positions was 9.87m. Without two outlier contact positions, the adjusted 95% CR improved to 4.81m thus conforming to the accuracy requirement per the *NOS Hydrograpic Surveys Specifications and Deliverables* document (HSSD) dated April, 2010. See figure 5.

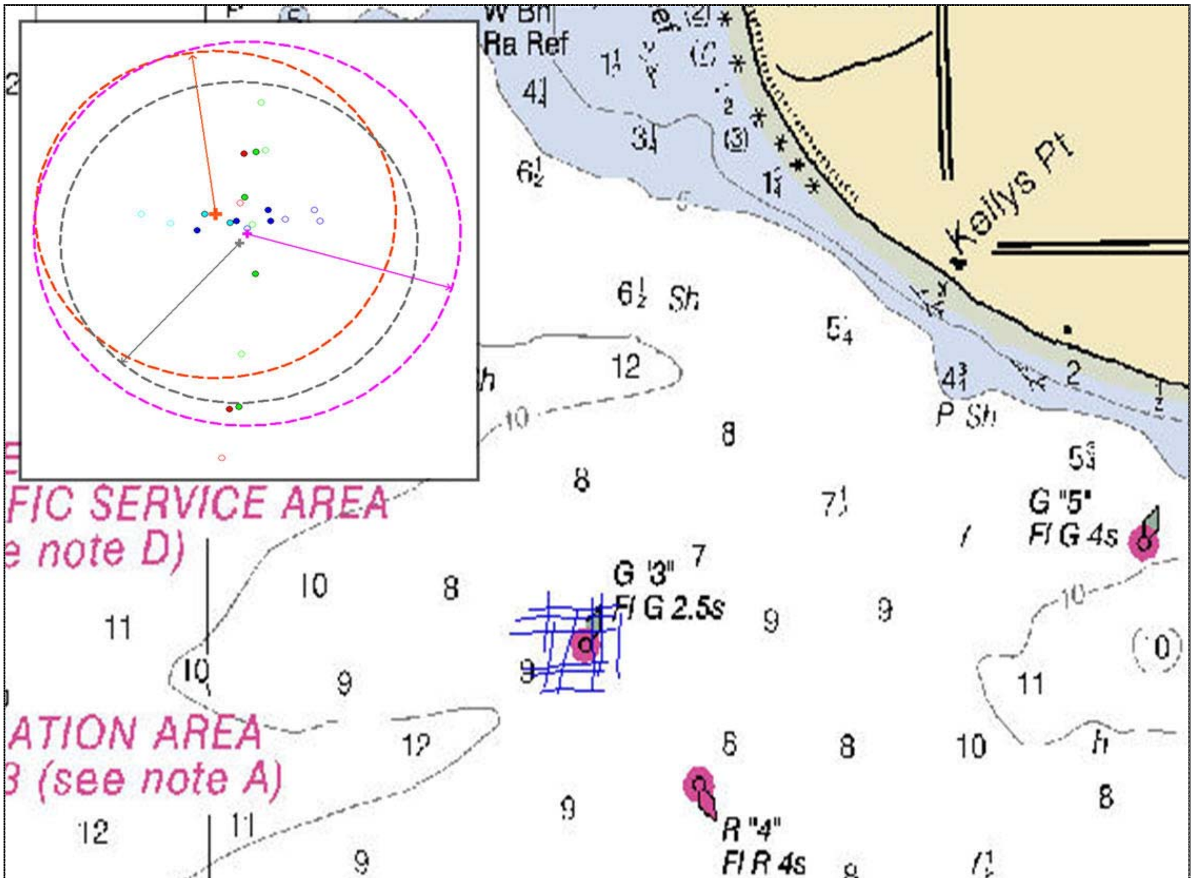


Figure 5: Plot of SSS contacts overlain on Chart 18427 (track lines in blue).

C.4. Feature Data

C.4.1. Acquisition Operations

Point features are generally positioned using detached positions with a range and bearing from the survey launch, or by direct occupation with a portable Trimble GeoXH dual band GPS receiver. Line features or the extents of areas are bounded by recording data as the launch passes as close as possible to the feature, taking DPs at the extents of the feature, or using a roving portable GPS to walk the extents ashore. Data is manually encoded with S-57 attribution during the time of acquisition by use of a data dictionary.
Shoreline features are classified in four (4) ways: verified, changed/modified, disproved, or new in accordance with Field Procedures Manual section 3.5.5.4.

C.4.2. Processing Workflow

First, features are inserted into Pydro. Highest quality, least depth soundings and best imagery are flagged as "Primary." Features of lower quality, yet still valuable in correlating a Primary Feature are flagged "Secondary."
Next, Primary features are deemed either "Significant" or "Resolved" (not significant). A feature deemed significant may require more investigation to discover a least depth or a diver to

investigate/identify the object. In such an instance, the feature is classified as “Investigate” in Pydro.
Finally, the Hydrographer must decide whether or not to plot the feature on the Smooth Sheet. If so, the feature will be included in the Descriptive Report and also be assigned to the category of “Report. A feature’s status becomes “Resolved” after being described in its entirety in the DR. See Diagram entitled “Detached Position Processing in Pydro” in Appendix I.

CORRECTIONS TO SOUNDINGS

See Appendix 5 for NRT3’s HVF Report.

D.1. Sound Speed

The speed of sound through the water is determined by sound velocity casts conducted in accordance with the NOS Hydrographic Surveys Specifications and Deliverables (HSSD). Corrections for speed of sound through the water column are computed from data obtained from Seabird’s SBE-19 Seacat CTD, SBE-19 Plus, and an Odom Digibar Pro sensor. NOAA’s VelocWin software is used to process casts and generates sound velocity files for CARIS HIPS.

Although sound velocity correctors are usually applied to sounding data in CARIS HIPS after data is acquired, NRT3’s flat-faced multibeam echosounder dictates a different method. Velocity casts are applied real-time in Simrad’s SIS acquisition program through use of two sensors. One sensor (Digibar Pro) is transom mounted and continuously sends surface readings to SIS for the purpose of beam formation. The second sensor, the SBE-19/19 Plus, is used several times a day to capture complete SV water column profiles which are applied real-time, as soundings are logged. Operators are prompted to take a new cast when surface readings between the two sensors differ by more than 5 meters a second. See processing workflow diagram entitled *RAW SSS Data to HDCS* in Appendix I.

Currently, NRT3 is working with HSTP and other NRTs on a more desirable acquisition configuration and processing workflow for sound speed. Calibration reports for the Odom Digibar, SBE-19 Seacat and SBE-19 Seacat Plus are included in Appendix 2.

D.2. Static Draft

New static draft measurements for the multibeam and single beam transducers were calculated on March 14, 2010 (DN 073) employing the following procedure.
To determine the “static draft” (i.e., the height of the waterline above/below the reference point), two new reference marks and an easily repeatable method were established. A reference mark was established on the port and starboard gunwales, closely aligned with the RP, or IMU, in the along ship dimension (see the figure 5and 6 below).

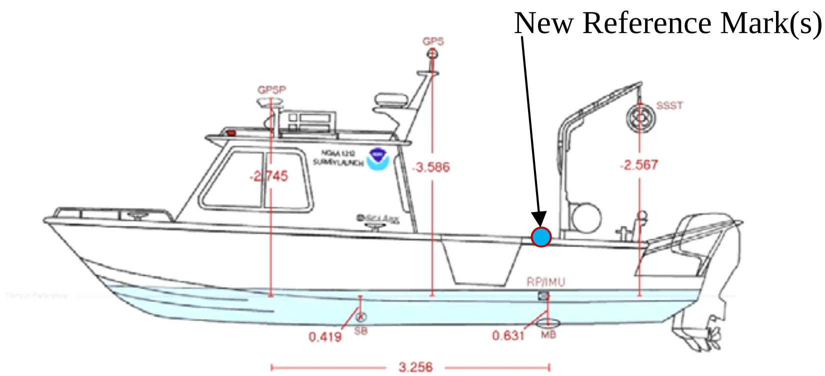


Figure 6

The static draft of .022 was calculated by subtracting the waterline-to-gunwale vertical distance (0.658 m) from the RP-to-gunwale vertical distance (0.680 m).

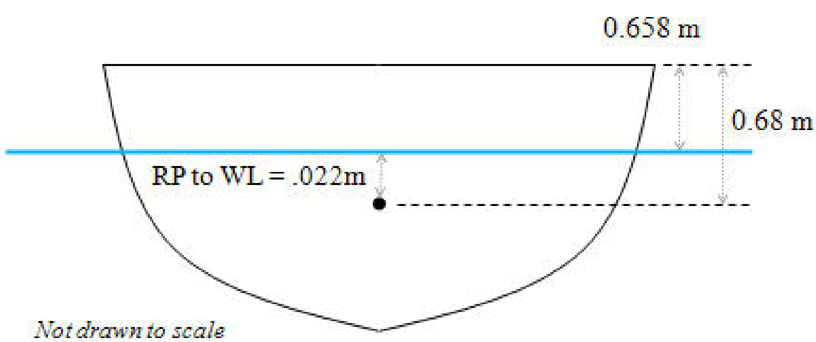


Figure 7

The vertical positions of the newly established reference marks were tied into the vessel coordinate frame by running a string taut athwartship over the RP (top mark on IMU). This athwartship string, orthogonal to the Z-axis of the vessel coordinate frame, provided a convenient point, nearly directly over the IMU*, at which to indirectly measure the RP-to-gunwale vertical distance. To account for the slight slope of the gunwale, a "wedge" was placed over both reference marks. See Figure 7.

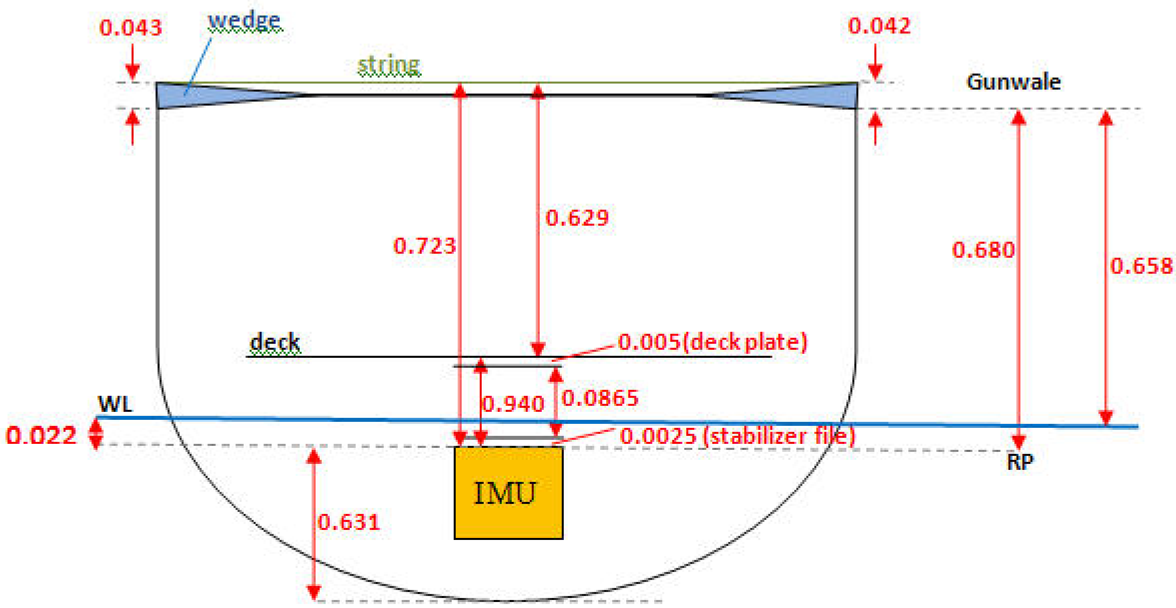


Figure 8.

D.3. Dynamic Draft

New dynamic draft measurements were calculated on March 15, 2010 (DN 074), using the multibeam echosounder method described in FPM 1.4.2.1.6. Data for the measurements were acquired over a region selected for minimum cross-track error. Offsets measured from the reference point to the transducer, sensors and antenna were, together with static and dynamic draft correctors, incorporated into the 'vessel config' files and applied during the merge process in CARIS. See Table 2 and Figure 9 for updated values. (Also, refer to Appendix 5, for the most recent Caris *HVF Report*.)

Draft (Meters)	Speed (Meters per Second)
.01	2.41
.01	2.74
.02	3.08
.03	3.49
.03	3.80
.04	4.08
.04	4.20
.04	4.44
.02	4.80
-.01	5.42
-.05	6.39

Table 2: Dynamic Draft Values, 2010.

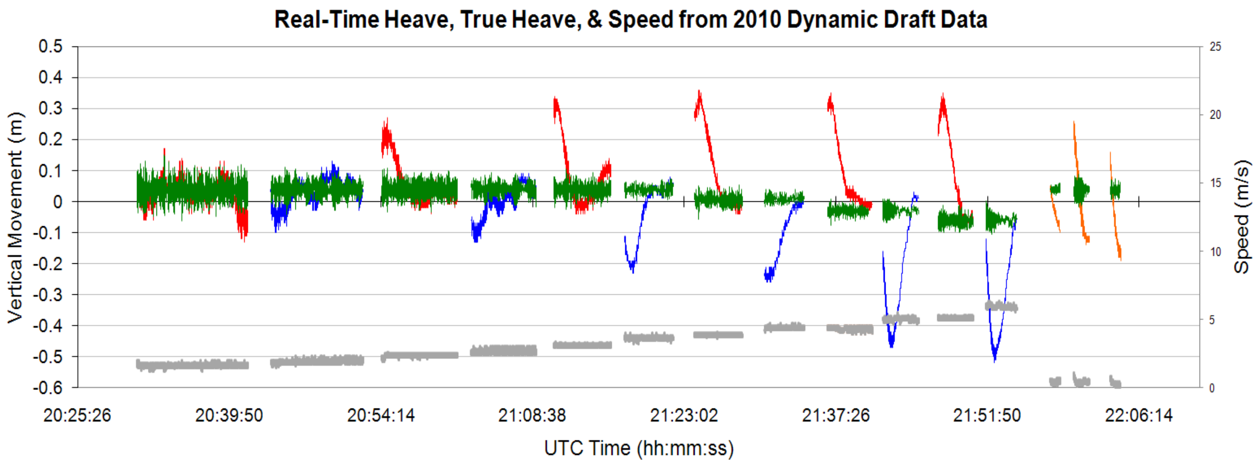


Figure 9: Dynamic Draft Graph

D.4. True Heave

At the time of project OPR-N338-NRT3-10, NTR3's acquisition software integration schema did not allow for post-survey incorporation of True Heave data but only real-time heave. Beginning field 2011, True Heave will be incorporated into NRT3's processing.

D.5. Tide Correctors

The vertical datum for this project is Mean Lower-Low Water (MLLW). The operating National Water Level Observation Network (NWLON) primary tide station at Astoria, Oregon (943-9040) served as control for datum determination and as the primary source for water level reducers for survey H12276. No tertiary gauges were required.

Preliminary zoning was accepted as the final zoning for project OPR-N338-NRT3-2010. All data were reduced to MLLW using the final approved water levels (verified tides) from the Astoria, OR station (943-9040) by applying tide file 9439040.tid and time and height correctors through the zone corrector file N338NRT32010CORP.zdf.

The request for Final Approved Water Levels for H12276 was submitted to CO-OPS on January 24, 2011 in accordance with the Field Procedures Manual dated April, 2010.

D.6. Patch Test

Residual bias data for roll, pitch, heading, and navigation timing error was acquired on DN074 2010 in accordance with the method prescribed in Section 1.5.5.1.2., *2010 Field Procedures Manual*. The test was conducted over a 4 and 1/4 Fathom wreck (Figure 10) for the purpose of estimating the heading bias component of the calibration.

Data was post-processed and analyzed in Caris's calibration utility. Offset results are documented in Table 3 and were inserted into the current Caris".hvf" file (See Appendix 5).

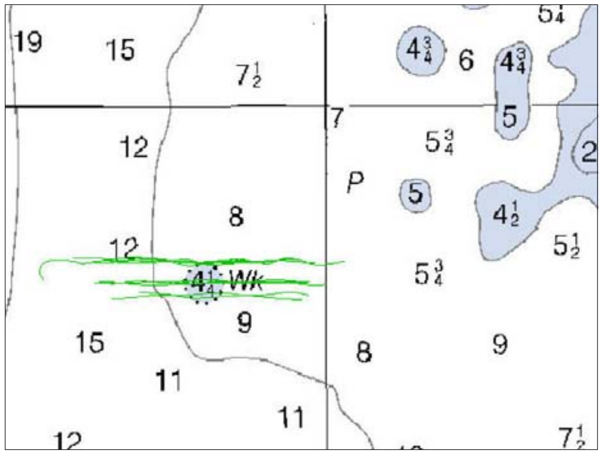


Figure 10: Chart 18427, Patch Test Lines (green).

	Offset	"RMS σ"		
Timing	0.000	0.00		
Pitch	-0.177	0.34		
Roll	-0.150	0.14		
Yaw	-0.009	0.36		

Table 3: POS/MV Calibration

APPROVAL SHEET

As Chief of Party, I have ensured that standard field surveying and processing procedures were used during this project in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables Manual, as updated for 2010.

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

Approved and Forwarded:

Dan Jacobs
I am the author of this document
2011.05.03 07:41:37 -07'00'

Dan Jacobs, Team Lead
Navigation Response Team 3

APPENDIX 1
Processing Flow Diagrams

Raw SSS/Hypack Data to Pydro

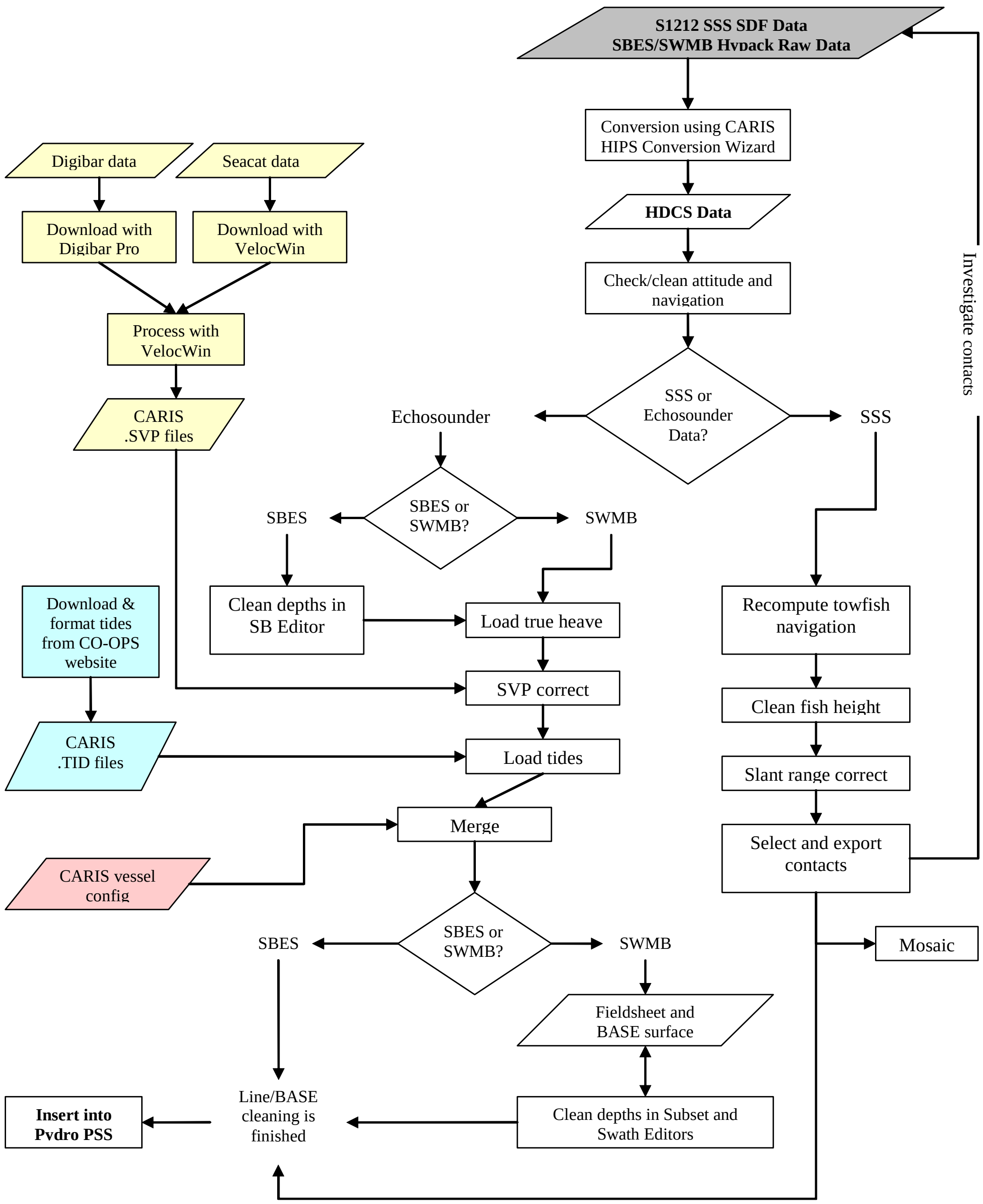


Figure 11: Raw Data to Pydro

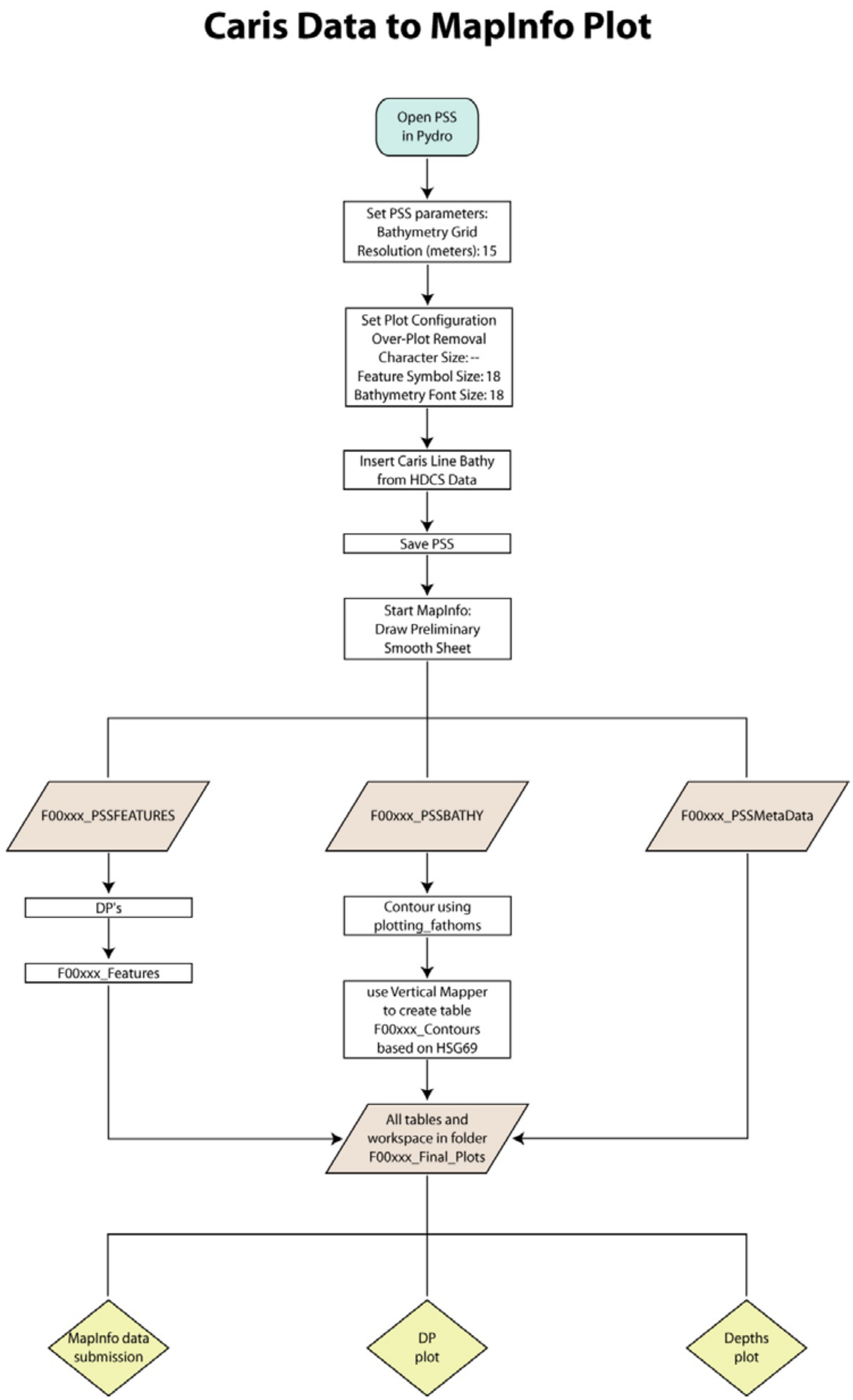


Figure 12: Caris Data to MapInfo Plot

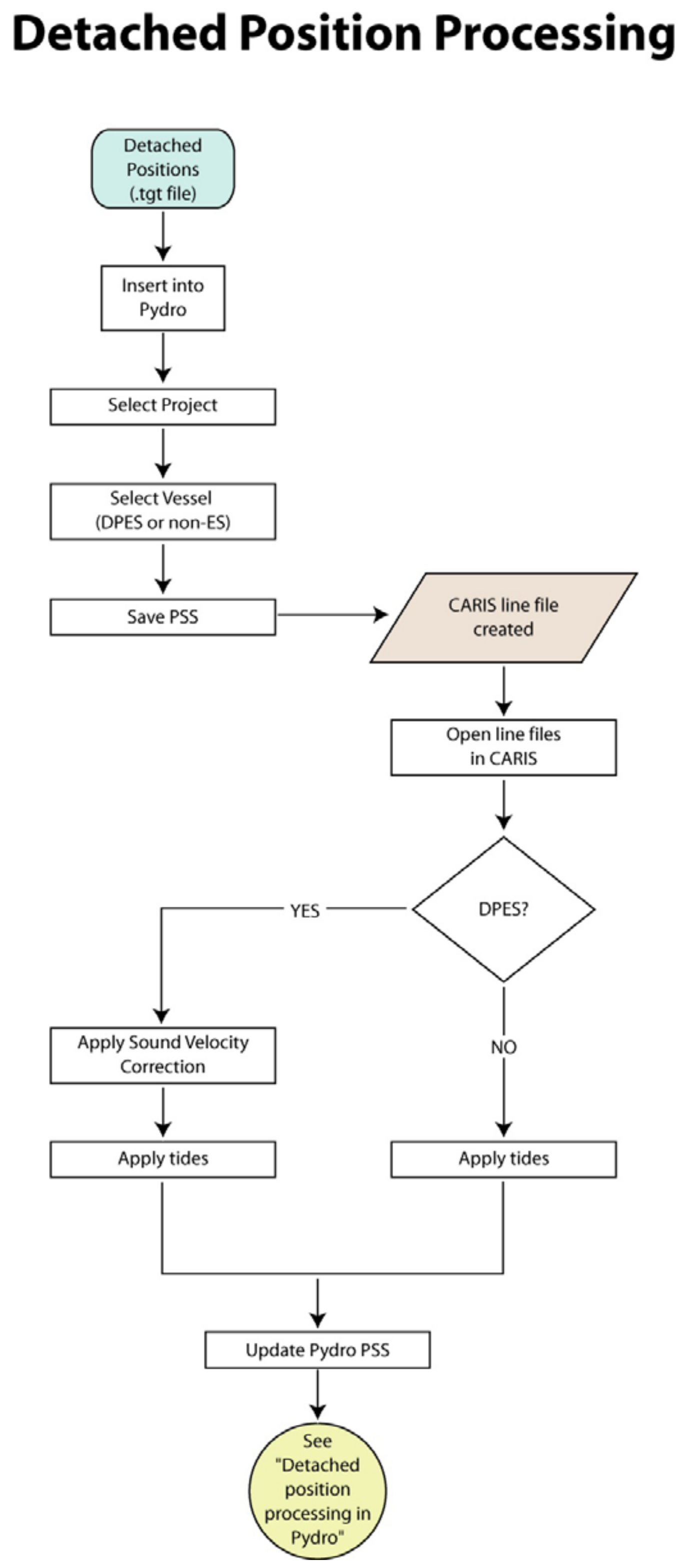


Figure 13: Detached Position Processing

Detached Position processing in Pydro

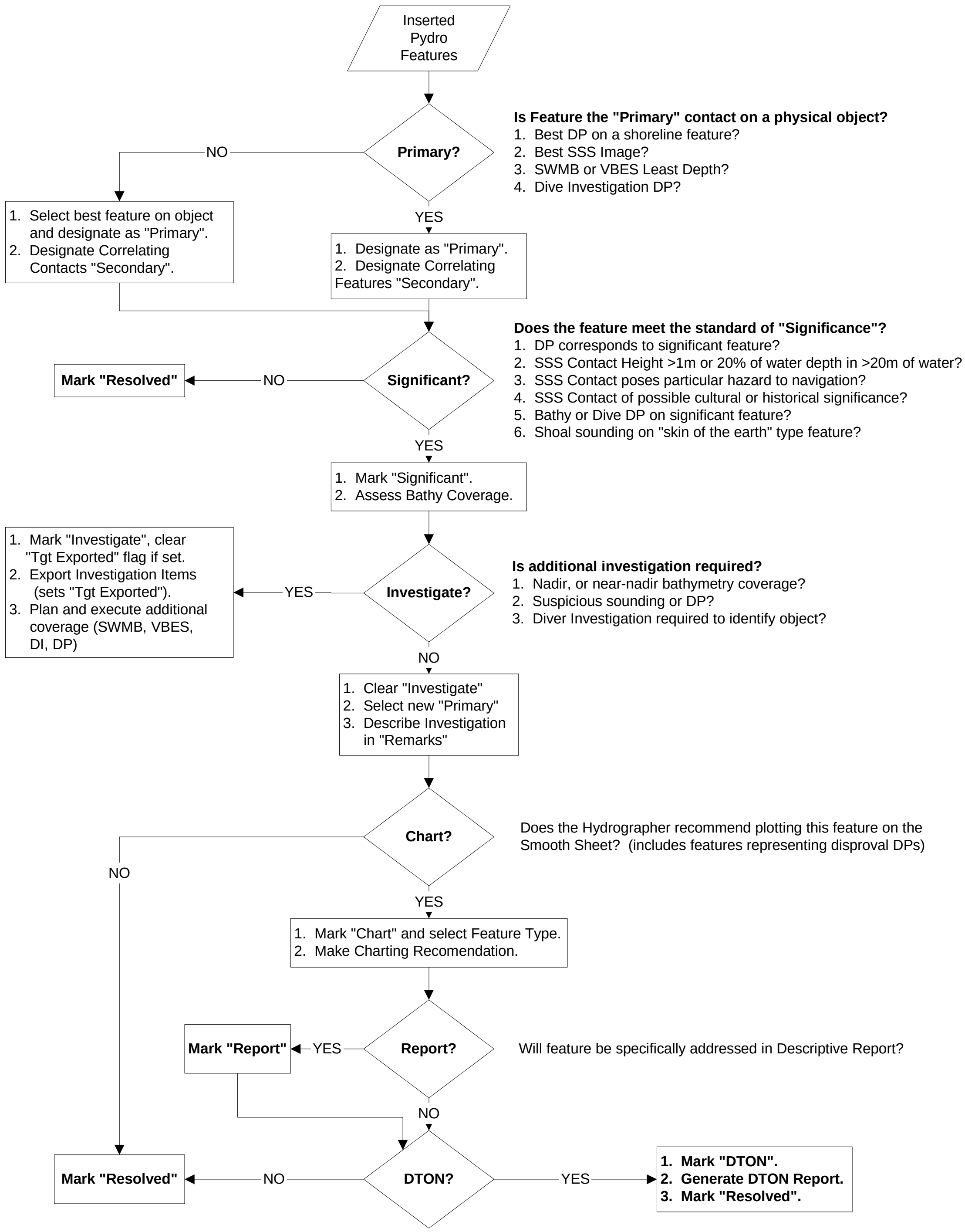


Figure 14: Detached Position Processing in Pydro

Raw Data to HDCS

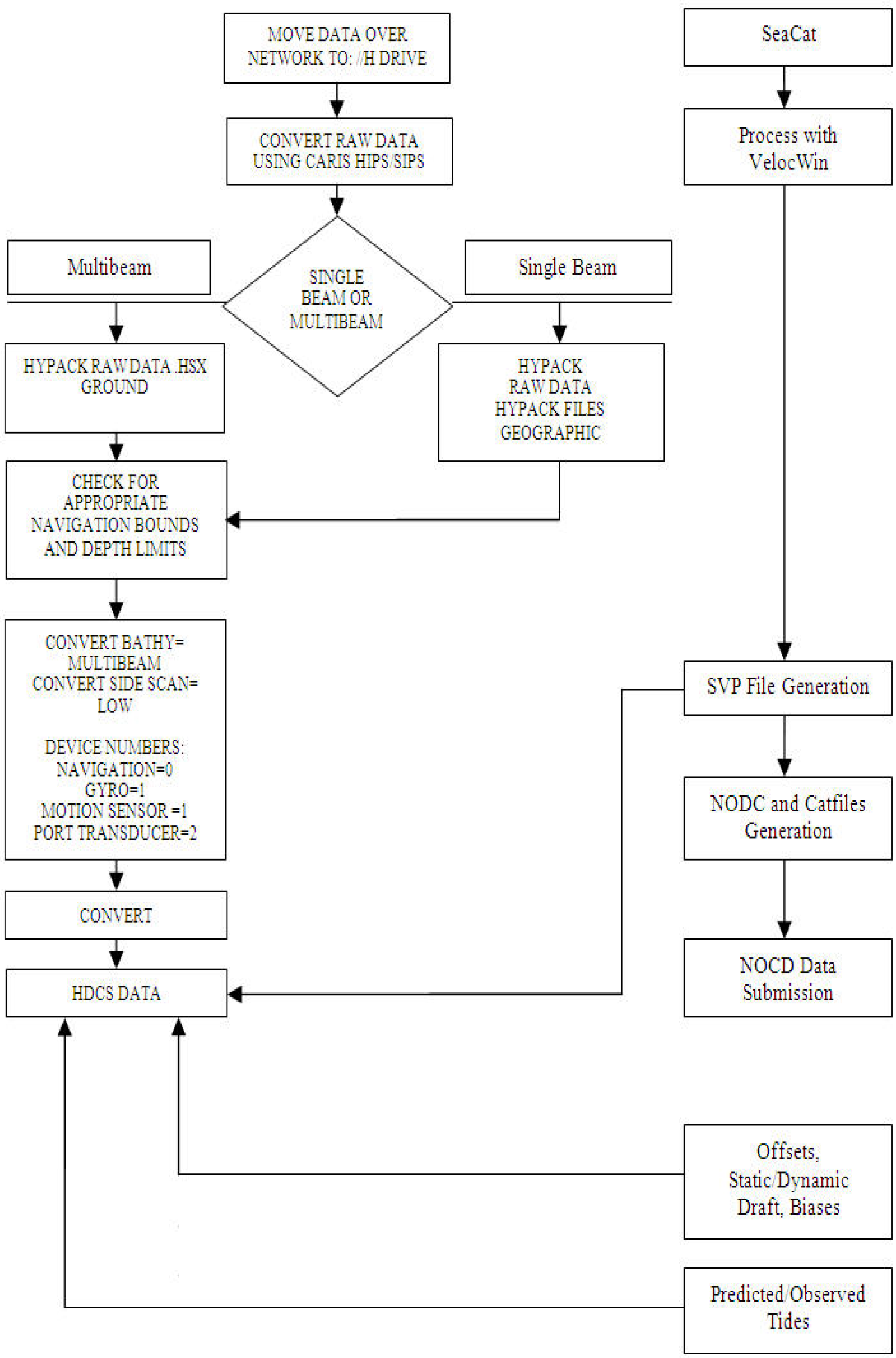


Figure 15: Raw Data to HDCS

APPENDIX 2

Sound Speed Sensor Calibration Reports

NRT 3 2010 HSRR
Sound Speed comparison

Two comparisons were performed between the field unit's Sound Speed measuring equipment listed in table 1.

Equipment Type	Manufacturer	Model	Serial Number
Sound Speed Profiler	Sea-bird	SeaCat SBE-19	1913768-2039
Sound Speed Profiler	Sea-bird	SeaCat SBE-19+	19P44126-4778
Velocimeter Probe	Odom	Digibar Pro	98314

Table 1: NRT 3 Sound speed measuring equipment.

An initial test involved two simultaneous casts taken with two Sea-bird (CTD) SeaCat profilers. Analysis of the cast profiles revealed good agreement throughout the majority of the water column, however a slight abnormality at the surface was observed (figure 1).

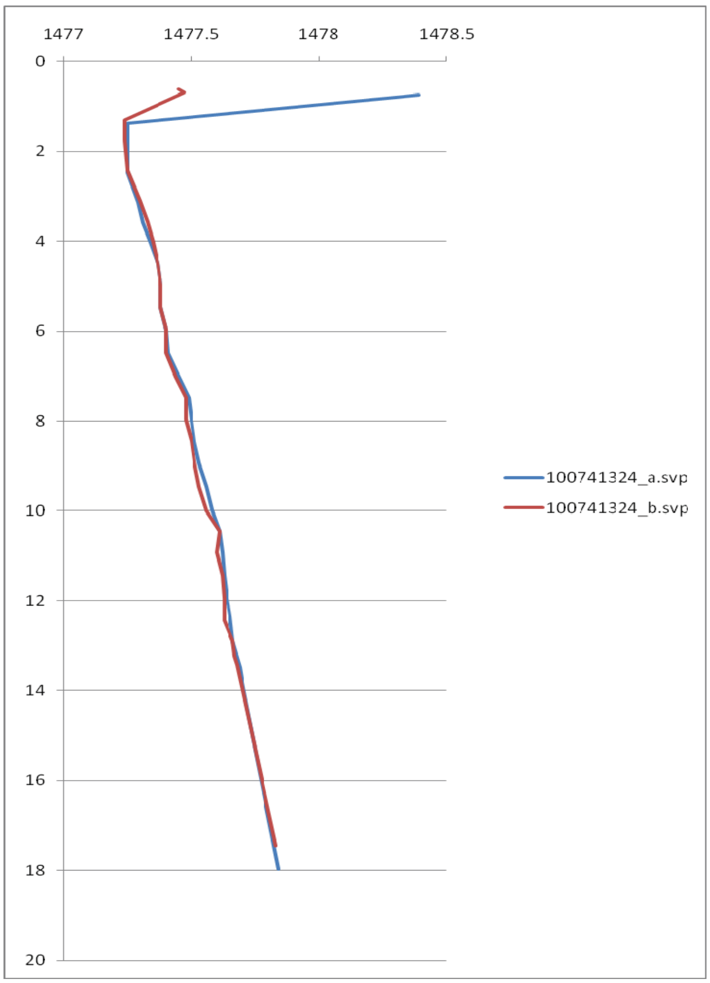


Figure 1: Cast results between Sea-bird SeaCat units.

A second comparison was performed, this time involving a simultaneous cast of the same two SeaCat units and an Odom Digibar Pro. The results of this test are shown in figure 2.

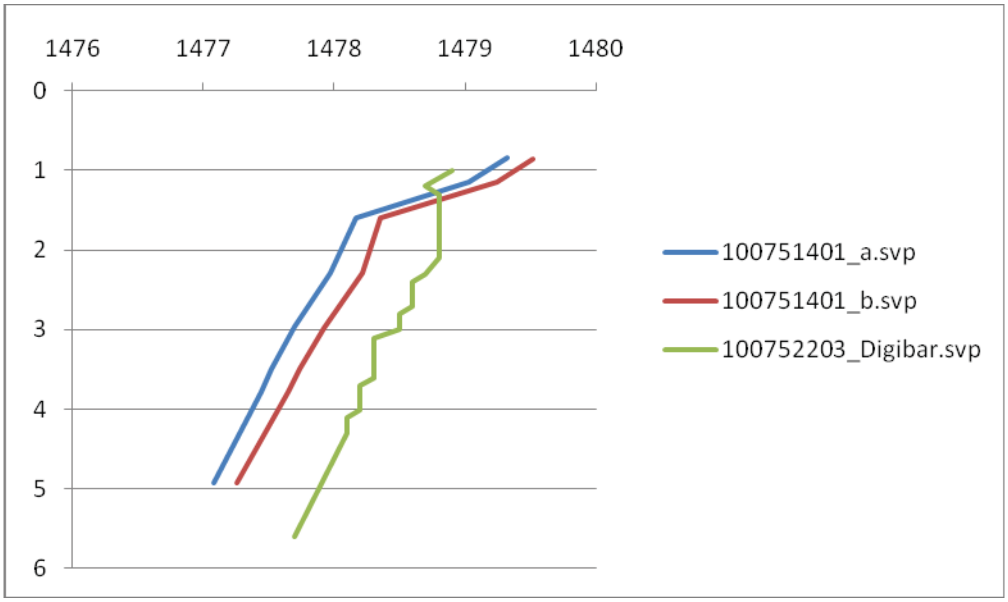


Figure 2: Cast results between Sea-bird and Odom sound speed instruments.

Using Velocwin version 8.96, DQA comparisons were performed between the SeaCat units, and between each SeaCat unit and the Digibar Pro. Velocwin summary of results for each DQA indicated that the percent depth difference was within recommended bounds.

Date:
Jan 31, 2010

Serial #:
98314-013110

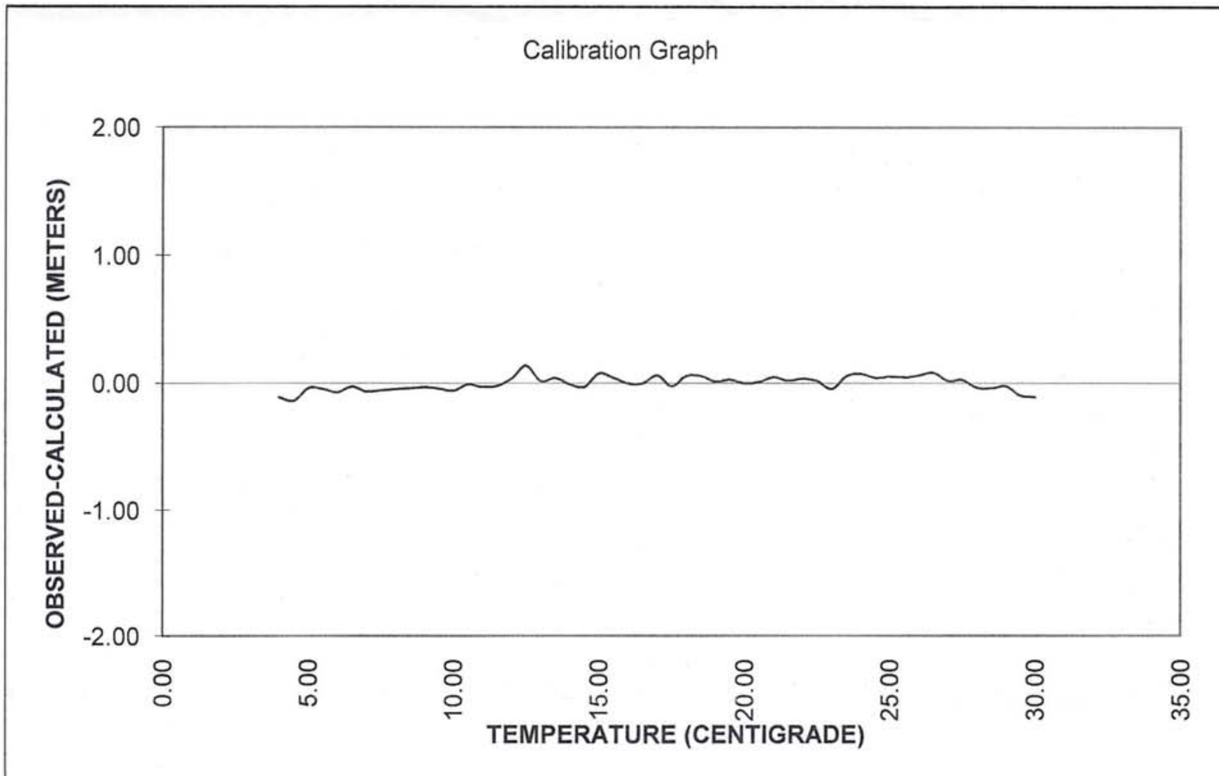
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

Burn these numbers to EPROM:

	Gradient	**3350**
	Intercept	**295**



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

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

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

Digibar

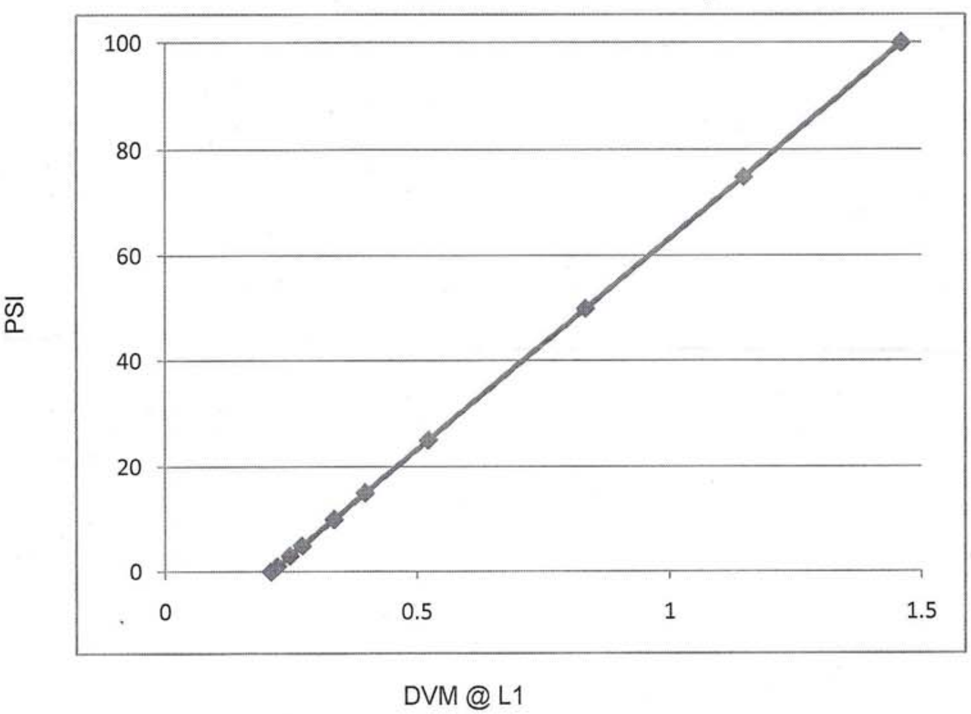
Date	2/5/2010
Serial #	98314
SW Version	1.11
Cable Length	20m

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

Press Transducer	68240
Zero Voltage	.21
Span Volage	2.71
Mid-Scale Voltage	1.46
R5	3.9K
R9	10K
Gradient	3350
Intercept	295

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

Pressure Transducer Linearity



Transducer Linearity	
PSI	DVM@L1
0	0.21
1	0.223
3	0.247
5	0.272
10	0.335
15	0.397
25	0.522
50	0.834
75	1.147
100	1.46

Date:
Jan 31, 2010

Serial #:
98314-013110

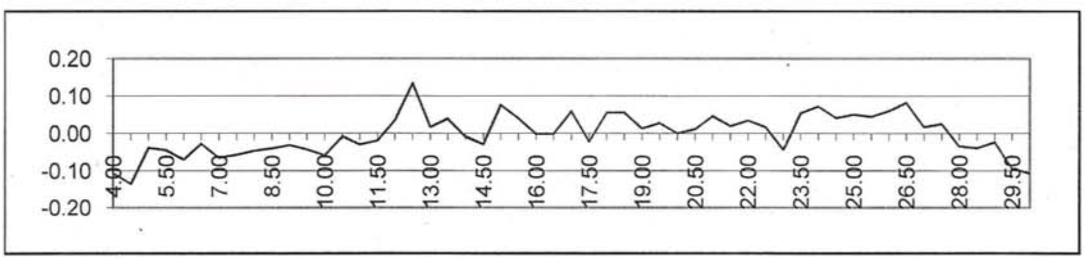
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL	TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5544.61	1421.51	-0.11	17.50	1474.38	5746.55	1474.36	-0.02
4.50	1423.90	5553.21	1423.76	-0.14	18.00	1476.01	5753.07	1476.07	0.06
5.00	1426.15	5562.19	1426.11	-0.04	18.50	1477.62	5759.22	1477.67	0.06
5.50	1428.38	5570.67	1428.33	-0.04	19.00	1479.21	5765.12	1479.22	0.01
6.00	1430.58	5578.98	1430.51	-0.07	19.50	1480.77	5771.16	1480.80	0.03
6.50	1432.75	5587.45	1432.72	-0.03	20.00	1482.32	5776.96	1482.32	0.00
7.00	1434.90	5595.51	1434.83	-0.06	20.50	1483.84	5782.83	1483.85	0.01
7.50	1437.02	5603.65	1436.96	-0.06	21.00	1485.35	5788.71	1485.39	0.05
8.00	1439.12	5611.70	1439.07	-0.05	21.50	1486.83	5794.28	1486.85	0.02
8.50	1441.19	5619.64	1441.15	-0.04	22.00	1488.29	5799.93	1488.33	0.04
9.00	1443.23	5627.49	1443.20	-0.03	22.50	1489.74	5805.38	1489.75	0.02
9.50	1445.25	5635.17	1445.21	-0.04	23.00	1491.16	5810.59	1491.12	-0.04
10.00	1447.25	5642.74	1447.19	-0.06	23.50	1492.56	5816.33	1492.62	0.05
10.50	1449.22	5650.47	1449.22	-0.01	24.00	1493.95	5821.69	1494.02	0.07
11.00	1451.17	5657.83	1451.14	-0.03	24.50	1495.32	5826.79	1495.36	0.04
11.50	1453.09	5665.22	1453.08	-0.02	25.00	1496.66	5831.97	1496.71	0.05
12.00	1454.99	5672.69	1455.03	0.04	25.50	1497.99	5837.02	1498.03	0.05
12.50	1456.87	5680.24	1457.01	0.14	26.00	1499.30	5842.08	1499.36	0.06
13.00	1458.72	5686.87	1458.74	0.02	26.50	1500.59	5847.09	1500.67	0.08
13.50	1460.55	5693.95	1460.59	0.04	27.00	1501.86	5851.70	1501.88	0.02
14.00	1462.36	5700.67	1462.35	-0.01	27.50	1503.11	5856.52	1503.14	0.03
14.50	1464.14	5707.41	1464.12	-0.03	28.00	1504.35	5861.01	1504.31	-0.03
15.00	1465.91	5714.54	1465.98	0.08	28.50	1505.56	5865.64	1505.52	-0.04
15.50	1467.65	5721.05	1467.69	0.04	29.00	1506.76	5870.28	1506.74	-0.02
16.00	1469.36	5727.45	1469.36	0.00	29.50	1507.94	5874.52	1507.85	-0.09
16.50	1471.06	5733.93	1471.06	0.00	30.00	1509.10	5878.91	1509.00	-0.11
17.00	1472.73	5740.55	1472.79	0.06					



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

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: 4778
CALIBRATION DATE: 31-Oct-09

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.259556e-003
a1 = 2.589328e-004
a2 = 3.971279e-007
a3 = 1.338143e-007

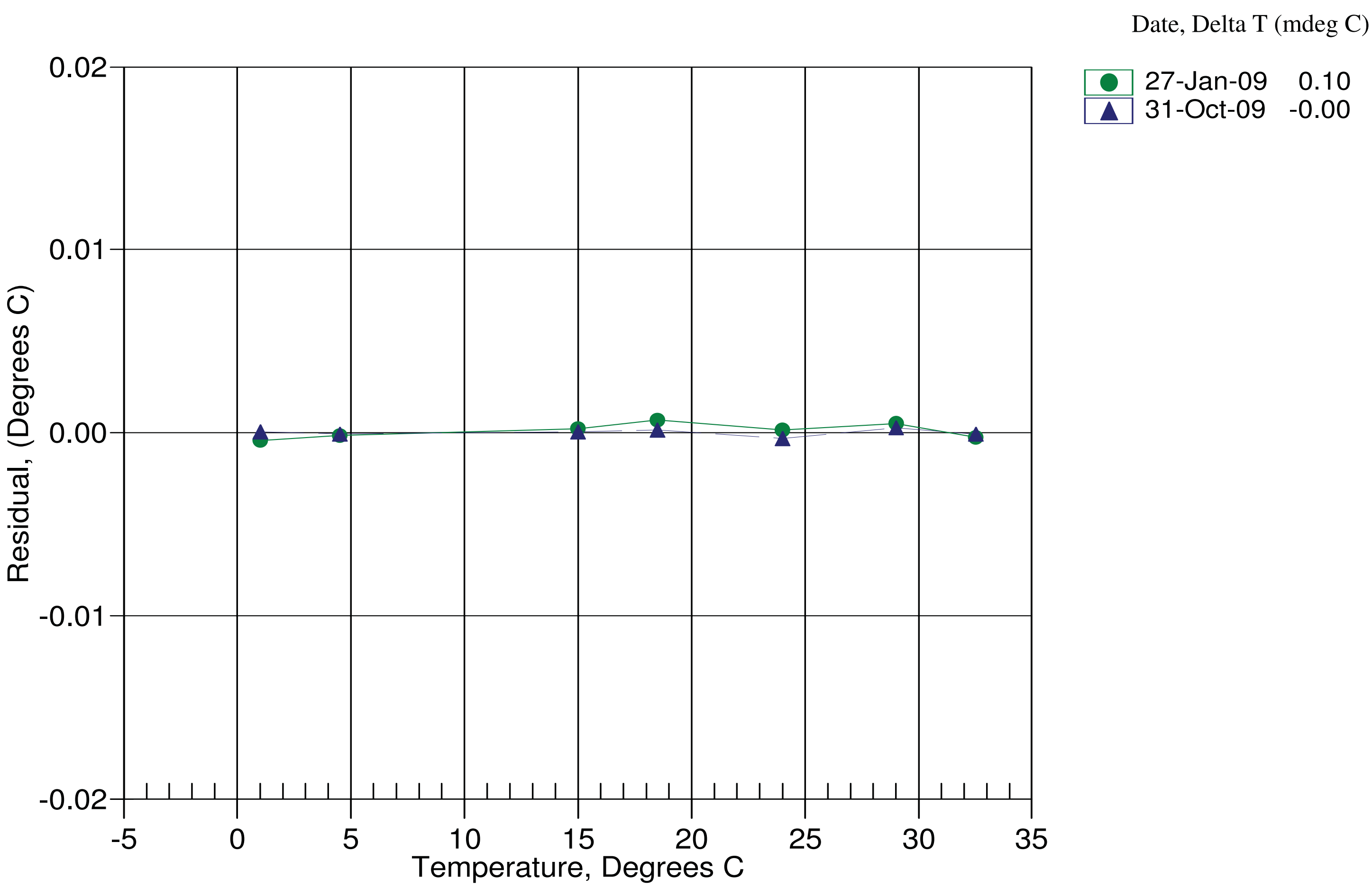
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	631201.771	1.0000	0.0000
4.5000	560947.029	4.4999	-0.0001
15.0000	386181.029	15.0000	0.0000
18.5000	339160.600	18.5001	0.0001
24.0000	275270.900	23.9997	-0.0003
29.0000	226582.243	29.0003	0.0003
32.5000	197161.543	32.4999	-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 = $1/\{a0 + a1[\mathit{ln}(R)] + a2[\mathit{ln}^2(R)] + a3[\mathit{ln}^3(R)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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: 4778
CALIBRATION DATE: 30-Oct-09

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 6975

COEFFICIENTS:

```
PA0 =   -1.677111e-001          PTCA0 =  5.333877e+005
PA1 =    1.550379e-003          PTCA1 = -4.066675e+000
PA2 =    8.900391e-012          PTCA2 = -6.833135e-002
PTEMPA0 = -7.470151e+001        PTCB0 =  2.569000e+001
PTEMPA1 =  4.886177e+001        PTCB1 = -2.000000e-004
PTEMPA2 = -4.126384e-001        PTCB2 =  0.000000e+000
```

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.64	542826.0	2.0	14.64	-0.00
104.89	601004.0	2.0	104.89	0.00
204.90	665402.0	2.0	204.86	-0.01
304.90	729786.0	2.0	304.89	-0.00
404.91	794117.0	2.0	404.90	-0.00
504.93	858397.0	2.0	504.91	-0.00
404.91	794145.0	2.0	404.94	0.01
304.91	729819.0	2.0	304.94	0.01
204.92	665442.0	2.0	204.92	0.00
104.92	601029.0	2.0	104.93	0.00
14.64	542829.0	2.0	14.64	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.24	542925.77
29.00	2.16	542947.35
24.00	2.06	542988.31
18.50	1.94	543030.59
15.00	1.87	543050.82
4.50	1.64	543107.60
1.00	1.57	543121.95

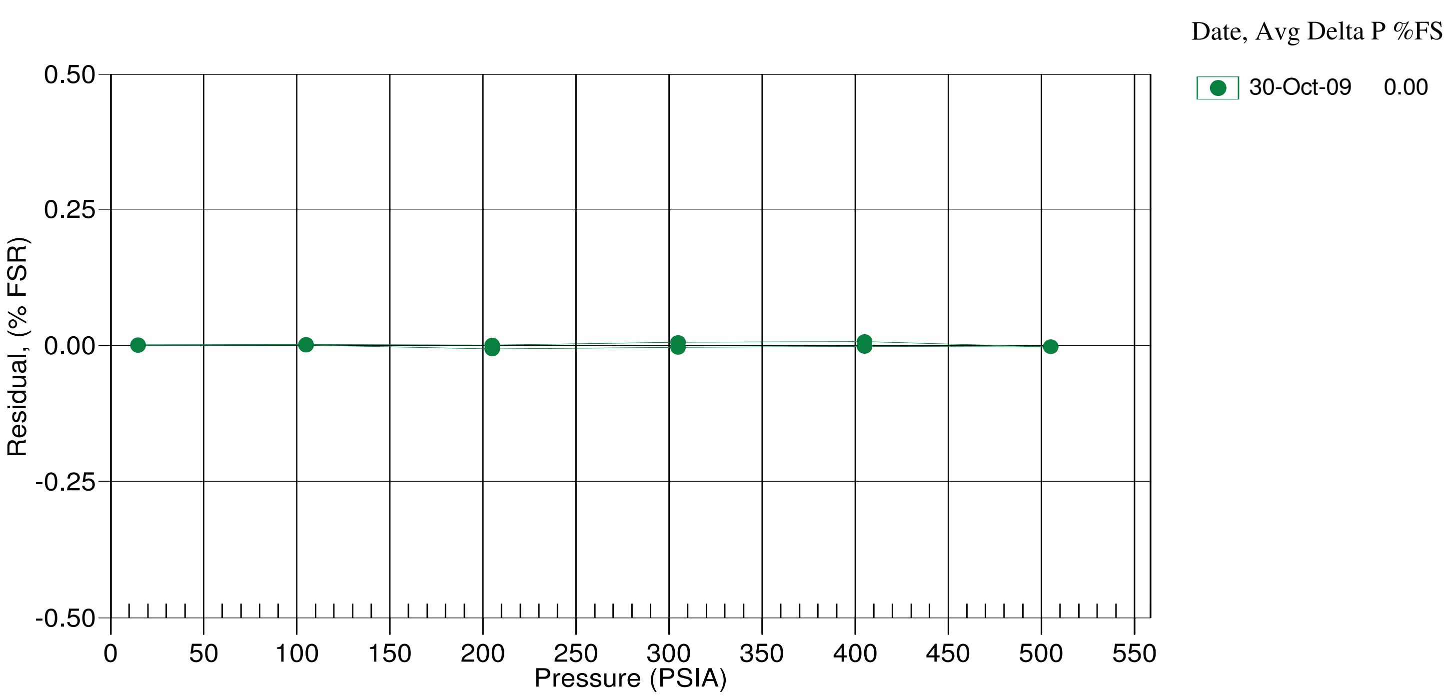
TEMP(ITS90)	SPAN(mV)
-5.00	25.69
35.00	25.68

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.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4778
CALIBRATION DATE: 31-Oct-09

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

COEFFICIENTS:

g = -1.024318e+000
h = 1.566004e-001
i = -5.058721e-004
j = 6.298500e-005

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

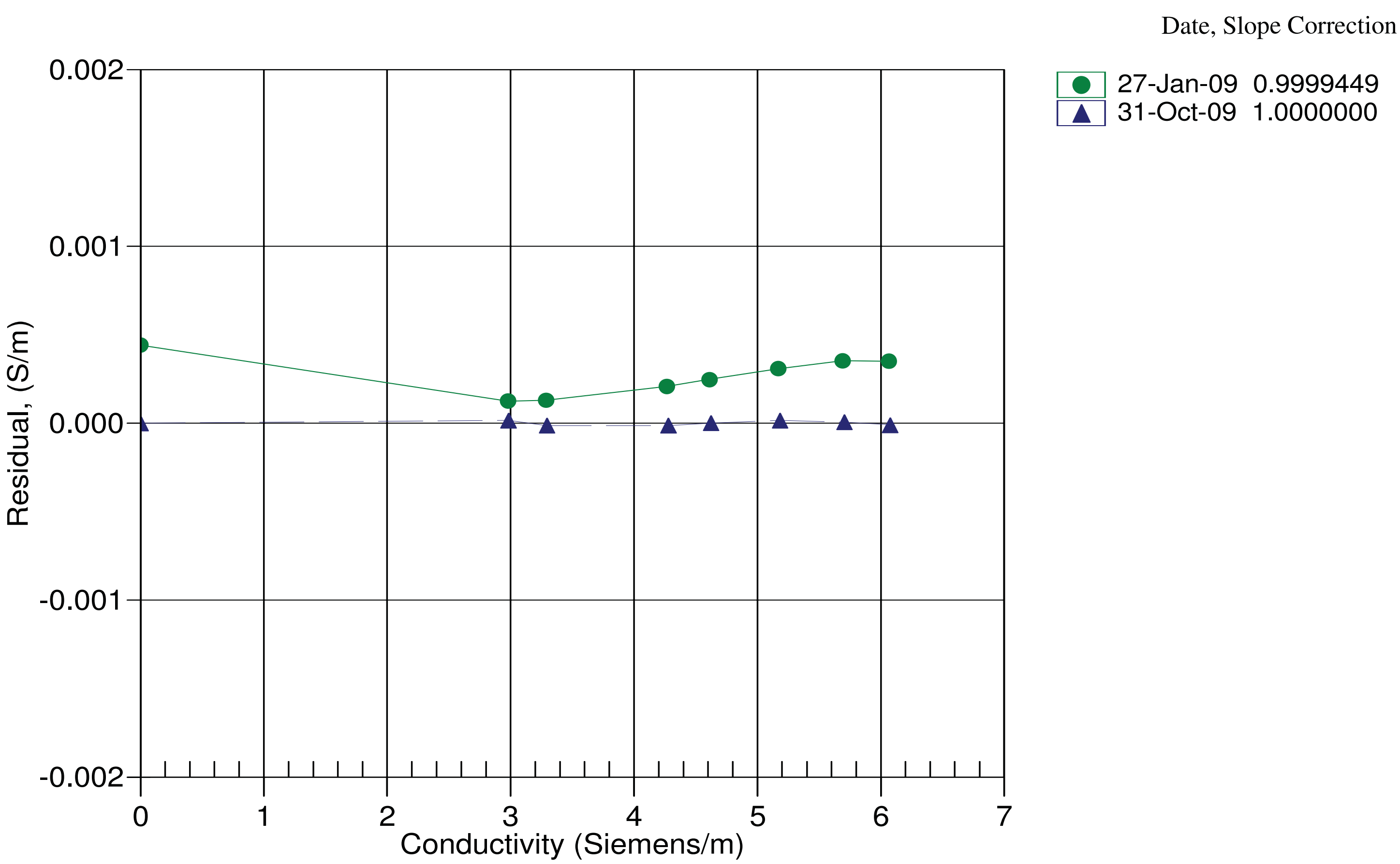
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2564.77	0.0000	0.00000
1.0000	34.9179	2.98382	5074.47	2.9838	0.00002
4.5000	34.8980	3.29167	5265.28	3.2917	-0.00001
15.0000	34.8550	4.27586	5832.83	4.2758	-0.00001
18.5000	34.8455	4.62182	6019.36	4.6218	0.00000
24.0000	34.8337	5.18093	6308.83	5.1809	0.00002
29.0000	34.8252	5.70361	6567.55	5.7036	0.00001
32.5000	34.8202	6.07659	6745.88	6.0766	-0.00001

f = INST FREQ / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2039
CALIBRATION DATE: 31-Oct-09

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.16976817e-003
h = 5.92144512e-004
i = 1.45173351e-006
j = -2.46808391e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.64763814e-003
b = 5.83889404e-004
c = 8.04059461e-006
d = -2.46782658e-006
f0 = 2426.834

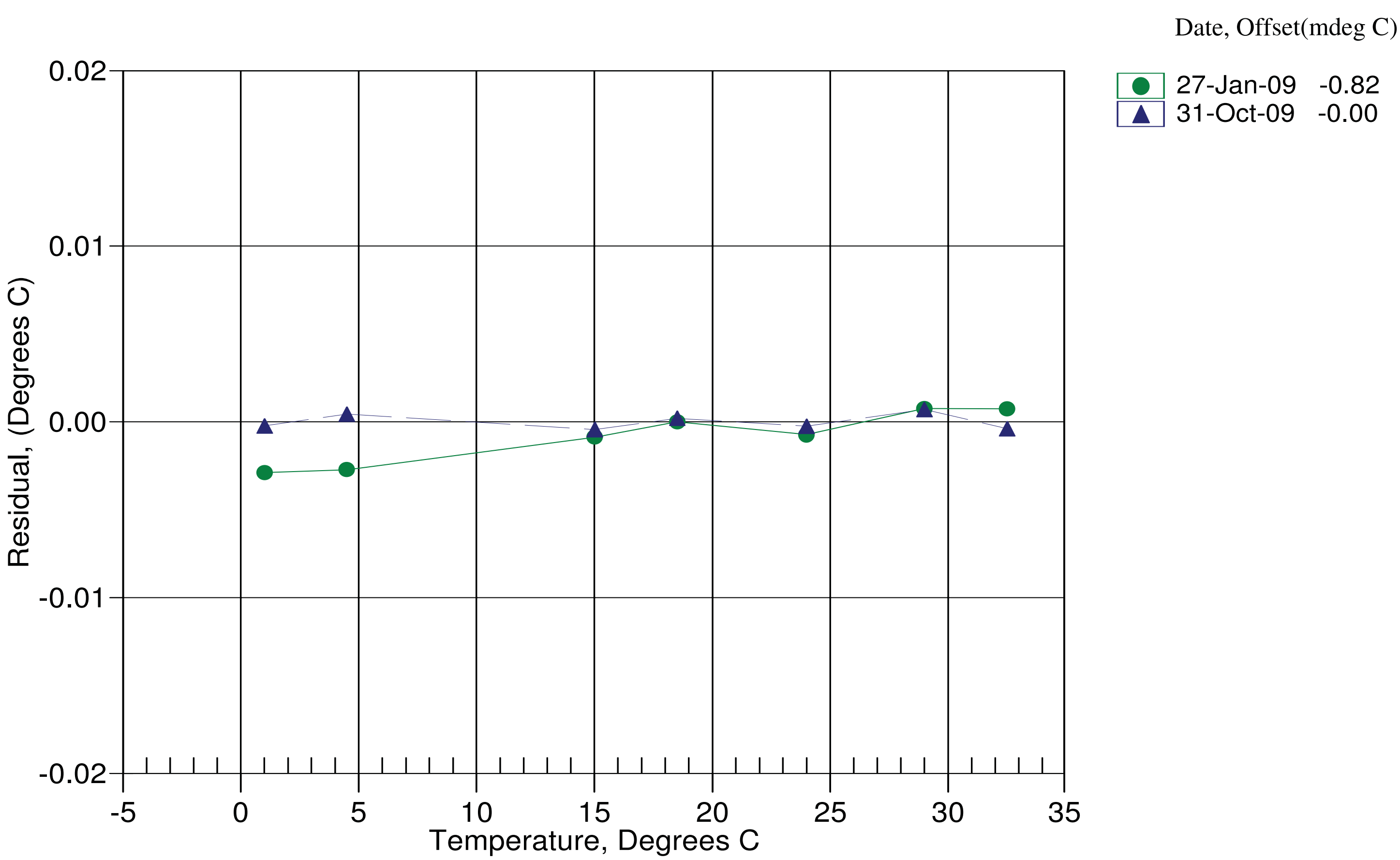
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2426.834	0.9998	-0.00024
4.5000	2625.993	4.5004	0.00044
15.0000	3292.265	14.9996	-0.00044
18.5000	3538.546	18.5002	0.00020
24.0000	3951.108	23.9997	-0.00026
29.0000	4354.455	29.0007	0.00070
32.5000	4653.170	32.4996	-0.00039

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



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: 2039
CALIBRATION DATE: 06-Nov-09

SBE19 PRESSURE CALIBRATION DATA
300 psia S/N 133248 TCV: 489

QUADRATIC COEFFICIENTS:

PA0 = 1.484942e+002
PA1 = -3.906524e-002
PA2 = 2.602000e-008

STRAIGHT LINE FIT:

M = -3.906278e-002
B = 1.486406e+002

PRESSURE PSIA	INST OUTPUT(N)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.54	3438.0	14.50	-0.01	14.34	-0.07
59.79	2278.0	59.64	-0.05	59.66	-0.04
119.79	740.0	119.60	-0.06	119.73	-0.02
179.82	-799.0	179.72	-0.03	179.85	0.01
239.81	-2332.0	239.74	-0.02	239.73	-0.02
299.80	-3862.0	299.75	-0.02	299.50	-0.10
239.81	-2337.0	239.93	0.04	239.93	0.04
179.82	-806.0	180.00	0.06	180.13	0.10
119.82	732.0	119.91	0.03	120.05	0.08
59.83	2271.0	59.91	0.03	59.93	0.03
14.54	3434.0	14.65	0.04	14.50	-0.01

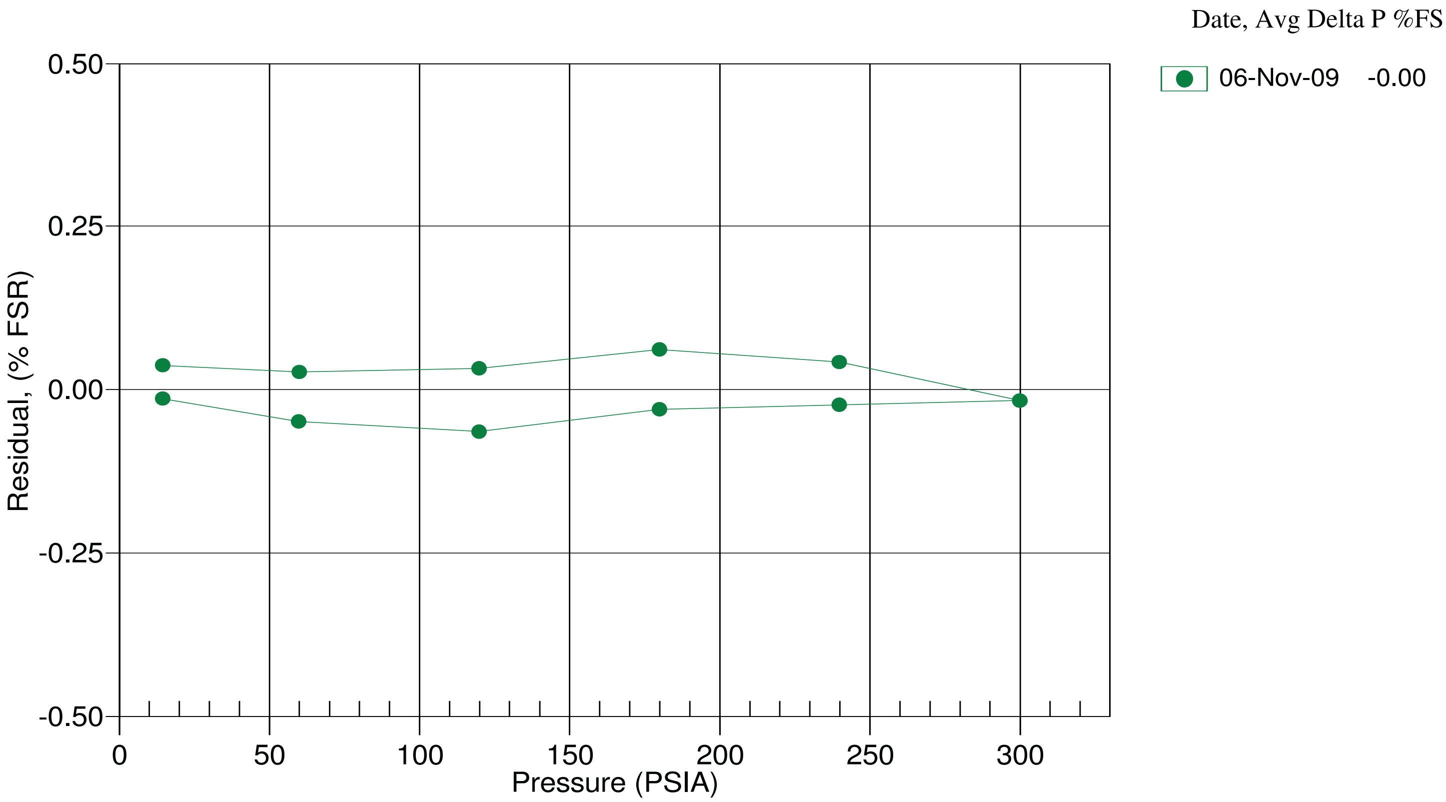
Straight Line Fit:

Pressure (psia) = M * N + B (N = binary output)

Quadratic Fit:

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

Residual = (instrument pressure - true pressure) * 100 / Full Scale Range



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: 2039
CALIBRATION DATE: 31-Oct-09

SBE19 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -3.94476532e+000
h =  4.70227496e-001
i =  1.35285583e-003
j = -3.86685138e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  4.77589616e-002
b =  4.19633439e-001
c = -3.93448088e+000
d = -1.51614104e-004
m =  2.1
CPcor = -9.5700e-008 (nominal)
```

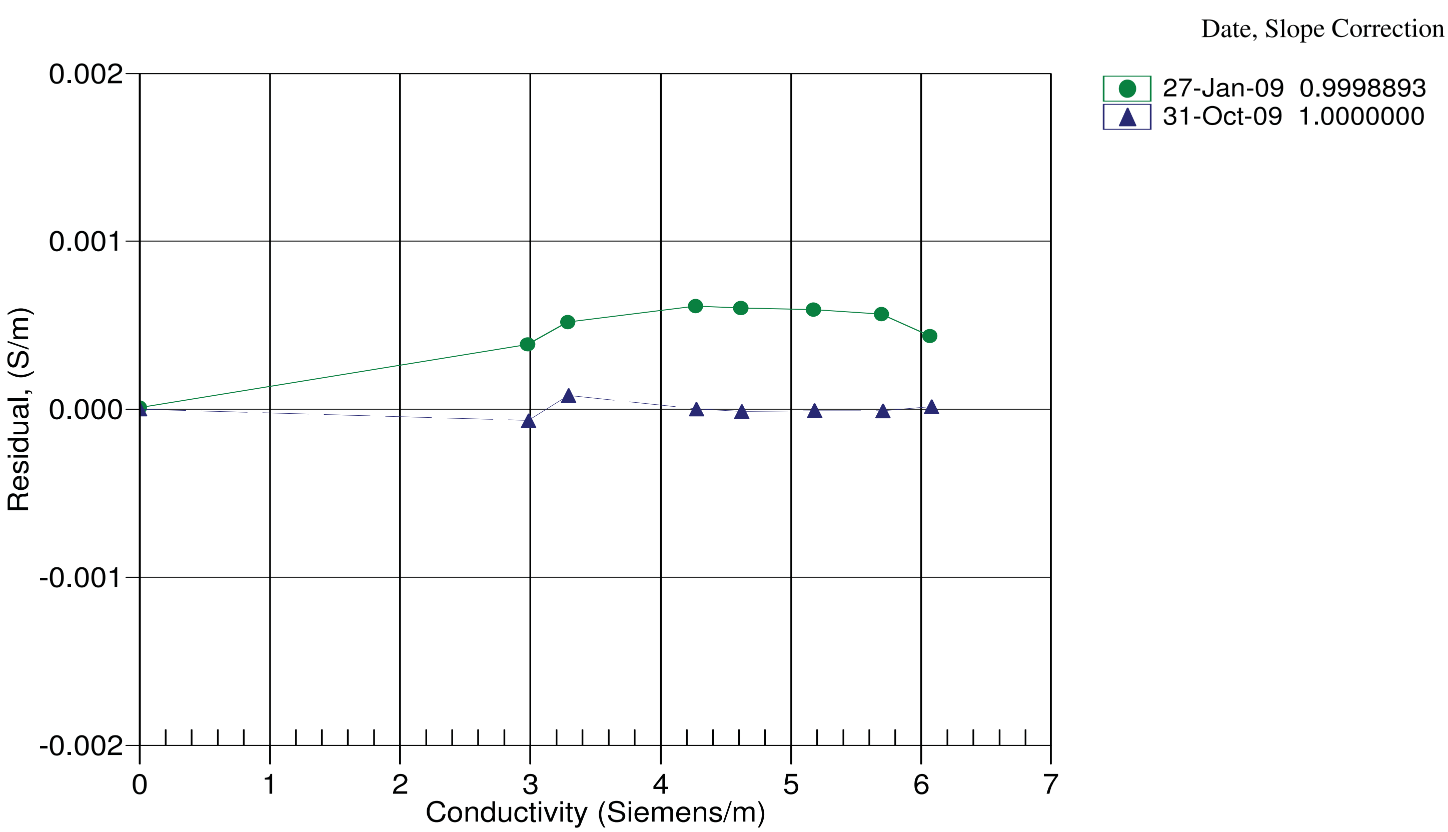
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88542	0.00000	0.00000
1.0000	34.9179	2.98382	8.39924	2.98375	-0.00007
4.5000	34.8980	3.29167	8.77147	3.29175	0.00008
15.0000	34.8550	4.27586	9.86617	4.27586	0.00000
18.5000	34.8455	4.62182	10.22293	4.62181	-0.00001
24.0000	34.8337	5.18093	10.77434	5.18092	-0.00001
29.0000	34.8252	5.70361	11.26527	5.70360	-0.00001
32.5000	34.8202	6.07659	11.60285	6.07661	0.00001

Conductivity = $(g + hf^2 + if^3 + jf^4) /10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

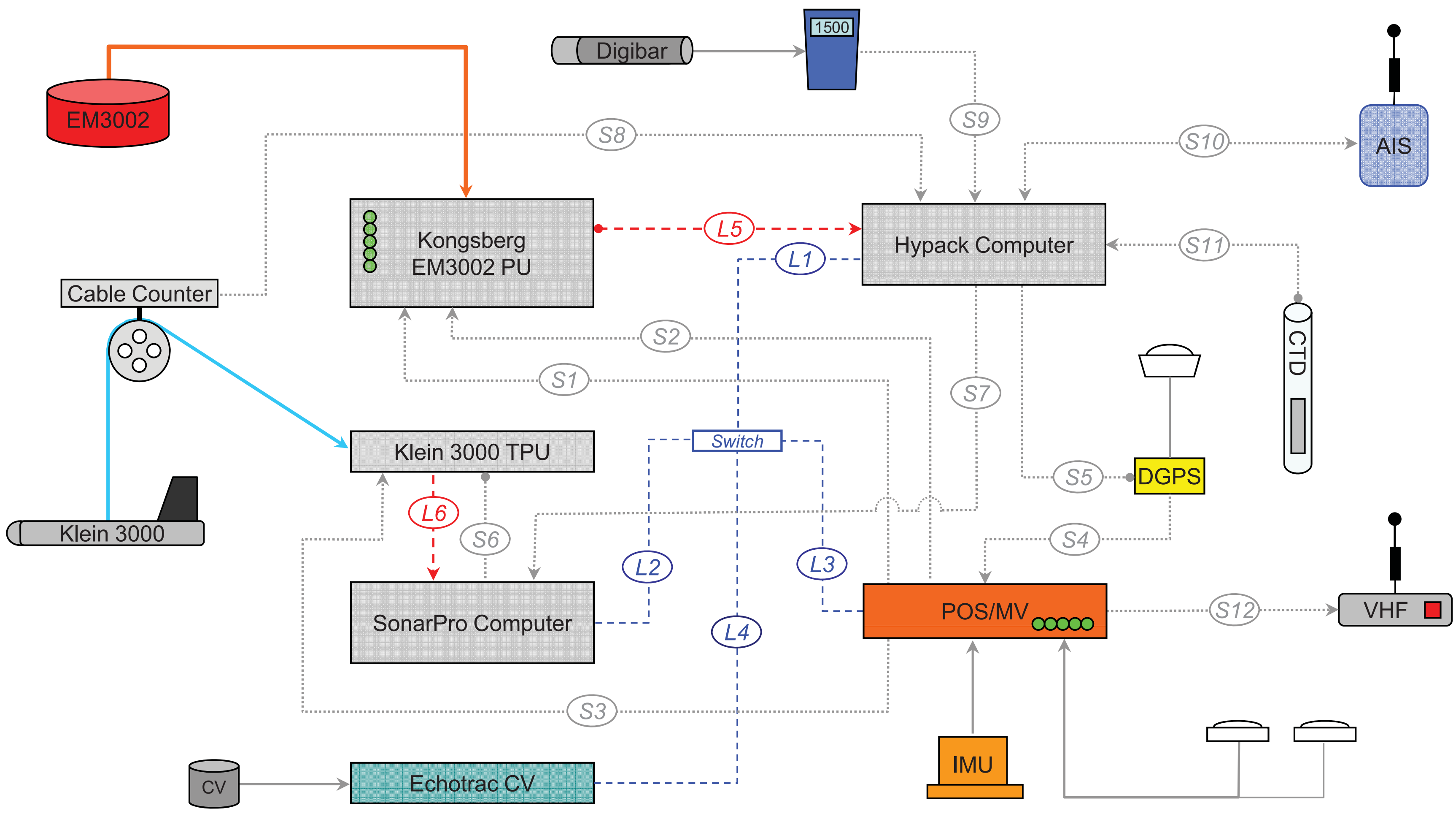
t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



APPENDIX 3

Wiring Diagram for Launch S1212



Serial
LAN
LAN (crossover)
Other

→ *Arrow-end indicates data flow*

•— *Dot-end indicates cable is for device control/configuration*

NOAA NRT3 (S1212)
Survey-System Configuration
March 15, 2010

Cable	End1	End2	Settings	Description
L1	Hypack Computer 129.100.1.230 255.255.0.0	Network Switch	n/a	Connects to SonarPro Computer, POS/MV and Echotrac CV
L2	SonarPro Computer 129.100.1.240 255.255.0.0	Network Switch	n/a	Network share with Hypack Computer for SSS data download
L3	POS/MV 129.000.1.231 255.255.0.0	Network Switch	n/a	UDP broadcast of depth, attitude, & PosPac data to Hypack
L4	Echotrac CV3 Automatic IP	Network Switch	n/a	UDP broadcast to Hypack
L5	EM3002 157.237.2.61 255.255.255.0	Hypack Computer 157.237.2.30 255.255.255.0	Port 16103	UDP broadcast of various EM datagrams (crossover)
L6	Klein 3000 TPU 192.168.0.81 255.255.255.0	SonarPro Computer 192.168.0.82 255.255.255.0	n/a	SSS data stream (crossover)
S1	POS/MV Com 1	EM3002 PU Com 3	9600,8,n,1	Position data to EM3002 (GGA) @ 1 Hz
S2	POS/MV Com 2	EM3002 PU Com 2	19200,8,n,1	Attitude data to EM3002 (Simrad 1000 TSS1) @ 50 Hz
S3	POS/MV Com 4	Klein 3000 TPU Com 2	4800,8,n,1	Position and Speed to Klein TPU (RMC & VTG)
S4	Trimble DGPS Port B	POS/MV Com 3	9600,8,n,1	RTCM DGPS correctors to POS/MV
S5	Trimble DGPS Port A	Hypack Computer Com 4	9600,8,n,1	Trimble DGPS configuration via TSIP talker
S6	SonarPro Computer Com 1	Klein 3000 TPU Com 1	9600,8,n,1	HyperTerminal connection to view Klein TPU bootup sequence
S7	Hypack Computer Com 3	SonarPro Computer Com 1	9600,8,n,1	Cable out to SonarPro via Hypack-generated delph string
S8	Cable Counter	Hypack Computer Com 5	2400,7,n,1	Cable out from Dynapar unit to Hypack
S9	Digibar	Hypack Computer Com 10	9600,8,n,1	Surface sound speed to SIS for EM3002 beam forming/steering
S10	AIS Transceiver	Hypack Computer Com 6	38400,8,n,1	AIS (automatic identification system) broadcast and receive
S11	Seabird SBE 19+	Hypack Computer Com 9	9600,8,n,1	Download CTD cast data
S12	POS/MV Com 5	VHF radio	4800,8,n,1	Position (GGA) sent to non-NOAA VHF radio for DSC (digital selective calling) capability

APPENDIX 4

Hydrographic Systems Inventory

Software Versions and Hardware Serial Numbers

In-service date	Software	Version
	Acquisition	
04/20/2009	Hypack Max	2009
03/15/2008	Klein 3000 Sonar Pro	11.2
08/01/2006	TSIP Talker	2.0
08/01/2006	POS MV Controller	3.3.0.1
08/01/2006	EM3000 Controller	1.0.91
08/01/2006	Echotrac Control Software	3.08
03/11/2010	Terrasync GPS	4.20
	Processing	
03/11/2010	Pydro	9.9 (r2712)
08/01/2006	KapConv	5.7.3
01/10/2009	MapInfo	10
01/29/2010	HydroMI	8.1
08/01/2006	Vertical Mapper	2.0
07/29/2009	Caris HIPS/SIPS SP1/HF5	7.0
03/09/2009	CARIS Notebook	3.1
07/19/2007	Nobeltec Tides & Currents	3.5.107
01/10/2009	GPS Pathfinder Office	4.20
	Sound Velocity	
05/21/2007	VelocWin	8.86
03/31/2005	Digibar Pro Log	2.3
05/01/2007	Sea Term	1.57

In-service date	Equipment	Serial Number
	Survey Launch 1212	
03/03/2004	Klein 3000 Dual Frequency Towfish (Model 3210)	456
03/03/2004	Klein 3000 TPU	312
03/03/2004	Klein 3000 Workstation	22-291
03/03/2004	Trimble DSM212L	0220164491
03/03/2004	Trimble Antenna	0220330095
03/03/2004	Dynapar Max Count Cable Counter	N/A
03/31/2005	Odom Digibar Pro DB-200 Controller	98308
08/01/2007	Odom Digibar Pro DB-200 Probe	98314
05/18/2007 through 08/01/2007	Odom Digibar Pro DB-200 Probe	98206
10/24/2005	Odom ETCVX2 (Echotrac CV)	23015
01/28/2009	POS MV Controller	A014934
08/01/2006	POS MV IMU	Unknown
08/01/2006	Trimble Zephyr Antennas	Port 60080830 Stbd 60069001
11/01/2009	Simrad EM 3002 Multibeam Sonar	Currently Unknown
11/01/2009	Simrad EM 3002 Controller	1683 Dongle 040131
11/01/2009	New Hypack Computer from PHB; Dell Precision T3400	HLMWTK1
09/05/2006	SBE 19 Seacat	1913768-2039
10/10/2006	SBE 19 Plus Seacat	19P44126-4778
	NRT3 Office	
08/01/2006	NRT3-1 Data Processing CPU	9VQLKB1
08/01/2006	NRT3-2 Data Processing CPU	BVQLKB1
08/01/2006	NRT3-3 Data Processing CPU(Hard Disk Failure 04/09/09)	H5TYT61
10/01/2008	NRT Data Processing CPU	1K5N2H1
	Handheld GPS Unit/Accessories	
10/01/2009	Trimble GeoXH Dual Channel GPS Receiver/Handheld	SN 4928419533 / PN 70950-00
10/01/2009	LTI Laser Rangefinder 360B	SN 024956 / PN 0144801

Hydrographic Personnel Roster

Field Unit:	NRT3
Effective Date:	02/28/2010
Updated Through:	04/11/2010

Team Leader

Name and Grade	Current Position	Years of Hydrographic Experience	Notes
Dan Jacobs (Acting Team Lead)	Physical Scientist	5	

Team Members

Name and Rate	Current Position	Years of Hydrographic Experience	Notes
Barry Jackson	Physical Science Technician	5	
Ian Colvert	Physical Science Technician	5	

ROTATING HYDROGRAPHERS & VISITORS *(involved in survey work)*

Name and Rate	Current Position	Years of Hydrographic Experience	Notes & Dates Embarked

APPENDIX 5

HVF Report

Vessel Name: NRT3_S1212_EM3002.hvf
Vessel created: August 27, 2010

Depth Sensor:

Sensor Class: Swath
Time Stamp: 2009-345 00:00

Comments: EM3002 replaced old EM3000 in 12/09
Time Correction(s) 0.000

Transduer #1:

Pitch Offset: 0.000
Roll Offset: -0.175
Azimuth Offset: 0.050

DeltaX: -0.003
DeltaY: -0.032
DeltaZ: 0.631

Manufacturer: Kongsberg
Model: em3002
Serial Number:

Depth Sensor:

Sensor Class: Swath
Time Stamp: 2010-074 00:00

Comments: 2010 HSRR Patch Test in Anacortes, WA, no sonar offsets are entered in SIS
Time Correction(s) 0.000

Transduer #1:

Pitch Offset: -0.177
Roll Offset: -0.150
Azimuth Offset: -0.009

DeltaX: -0.003
DeltaY: -0.032
DeltaZ: 0.631

Manufacturer: Kongsberg
Model: em3002
Serial Number:

Depth Sensor:

Sensor Class: Swath
Time Stamp: 2010-096 00:00

Comments: sonar offsets were entered in SIS, BUT because we had the "Use EM combined..." option NOT checked, the vertical sonar offset was not reflected in the data logged to hsx files

Time Correction(s) 0.000

Transduer #1:

Pitch Offset: -0.177
Roll Offset: -0.150
Azimuth Offset: -0.009

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.631

Manufacturer: Kongsberg
Model: em3002
Serial Number:

Depth Sensor:

Sensor Class: Swath
Time Stamp: 2010-097 00:00

Comments: sonar offsets were entered in SIS, and because we had the "Use EM combined..." option NOT checked, the vertical sonar offset was not reflected in the data logged to hsx filessonar offsets were entered in SIS, BUT because we had the "Use EM combined..." option checked, they are reflected in the data logged to hsx files, so we don't need to have in HVF
Time Correction(s) 0.000

Transduer #1:

Pitch Offset: -0.177
Roll Offset: -0.150
Azimuth Offset: -0.009

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Manufacturer: Kongsberg
Model: em3002
Serial Number:

Navigation Sensor:

Time Stamp: 2006-234 00:00

Comments: RP
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Manufacturer: Applanix
Model: POS/MV4
Serial Number: (null)

Time Stamp: 2009-345 00:00

Comments:
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Manufacturer:
Model:
Serial Number:

Time Stamp: 2010-074 00:00

Comments:
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Manufacturer: Applanix
Model: POS/MV4
Serial Number:

Gyro Sensor:

Time Stamp: 2006-234 00:00

Comments: (null)
Time Correction(s) 0.000

Time Stamp: 2009-345 00:00

Comments:
Time Correction(s) 0.000

Time Stamp: 2010-074 00:00

Comments:
Time Correction(s) 0.000

Heave Sensor:

Time Stamp: 2006-234 00:00

Comments: (null)
Apply Yes
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Offset: 0.000

Manufacturer: Applanix
Model: POS/MV4
Serial Number: (null)

Time Stamp: 2009-345 00:00

Comments:
Apply No
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000
Offset: 0.000

Manufacturer: Applanix
Model: POS MV4
Serial Number:

Time Stamp: 2010-074 00:00

Comments: heave applied real time in SIS
Apply No
Time Correction(s) 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000
Offset: 0.000

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Time Stamp: 2006-234 00:00

Comments: (null)
Apply Yes
Time Correction(s) 0.000
Pitch offset: 0.000

Manufacturer: Applanix
Model: POS/MV4
Serial Number: (null)

Time Stamp: 2009-345 00:00

Comments:
Apply No
Time Correction(s) 0.000
Pitch offset: 0.000

Manufacturer: Applanix
Model: POS MV4
Serial Number:

Time Stamp: 2010-074 00:00

Comments: pitch applied real time by SIS
Apply No
Time Correction(s) 0.000
Pitch offset: 0.000

Manufacturer:
Model:
Serial Number:

Roll Sensor:

Time Stamp: 2006-234 00:00

Comments: (null)
Apply Yes
Time Correction(s) 0.000
Roll offset: 0.000

Manufacturer: Applanix
Model: POS/MV4
Serial Number: (null)

Time Stamp: 2009-345 00:00

Comments:
Apply No
Time Correction(s) 0.000
Roll offset: 0.000

Manufacturer: Applanix
Model: POS MV4
Serial Number:

Time Stamp: 2010-074 00:00

Comments: applied real time by SIS
Apply No
Time Correction(s) 0.000
Roll offset: 0.000

Manufacturer:
Model:
Serial Number:

Draft Sensor:

Time Stamp: 2006-234 00:00

Apply Yes
Comments: (null)
Time Correction(s) 0.000

Entry 1) Draft: 0.000   Speed: 4.599
Entry 2) Draft: -0.003 Speed: 5.171
Entry 3) Draft: 0.029   Speed: 5.853
Entry 4) Draft: 0.028   Speed: 6.685
Entry 5) Draft: 0.044   Speed: 7.361
Entry 6) Draft: 0.014   Speed: 8.013
Entry 7) Draft: 0.032   Speed: 8.421
Entry 8) Draft: -0.013 Speed: 9.251
Entry 9) Draft: -0.064 Speed: 10.503
Entry 10) Draft: -0.048 Speed: 11.848
Entry 11) Draft: -0.140 Speed: 14.153

Time Stamp: 2009-345 00:00

Apply No
Comments: ERS
Time Correction(s) 0.000

Time Stamp: 2010-074 00:00

Apply Yes
Comments:
Time Correction(s) 0.000

Entry 1) Draft: 0.014   Speed: 4.675
Entry 2) Draft: 0.010   Speed: 5.332
Entry 3) Draft: 0.024   Speed: 5.985
Entry 4) Draft: 0.032   Speed: 6.778
Entry 5) Draft: 0.032   Speed: 7.394
Entry 6) Draft: 0.036   Speed: 7.935
Entry 7) Draft: 0.036   Speed: 8.162
Entry 8) Draft: 0.037   Speed: 8.627
Entry 9) Draft: 0.020   Speed: 9.334
Entry 10) Draft: -0.011 Speed: 10.536
Entry 11) Draft: -0.049 Speed: 12.415

TPU

Time Stamp: 2009-345 00:00

Comments:
Offsets

Motion sensing unit to the transducer 1
X Head 1 -0.003
Y Head 1 -0.032
Z Head 1 0.631
Motion sensing unit to the transducer 2
X Head 2 0.000

```
      Y Head 2 0.000
      Z Head 2 0.000
Navigation antenna to the transducer 1
      X Head 1 -0.947
      Y Head 1 3.288
      Z Head 1 3.376
Navigation antenna to the transducer 2
      X Head 2 0.000
      Y Head 2 0.000
      Z Head 2 0.000

Roll offset of transducer number 1 0.000
Roll offset of transducer number 2 0.000

Heave Error: 0.050 or 5.000'' of heave amplitude.
Measurement errors: 0.020
Motion sensing unit alignment errors
Gyro:0.500  Pitch:0.010 Roll:0.010
Gyro measurement error: 0.020
Roll measurement error: 0.020
Pitch measurement error: 0.020
Navigation measurement error: 0.700
Transducer timing error: 0.010
Navigation timing error: 0.001
Gyro timing error: 0.001
Heave timing error: 0.001
PitchTimingStdDev: 0.001
Roll timing error: 0.001
Sound Velocity speed measurement error: 0.000
Surface sound speed measurement error: 0.000
Tide measurement error: 0.000
Tide zoning error: 0.000
Speed over ground measurement error: 0.030
Dynamic loading measurement error: 0.030
Static draft measurement error: 0.050
Delta draft measurement error: 0.010
StDev Comment: (null)
```

Svp Sensor:

```
Time Stamp:  2006-234 00:00

Comments:
Time Correction(s) 0.000

Svp #1:
-------------
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     -0.003
DeltaY:     -0.032
DeltaZ:     0.631

SVP #2:
-------------
```

```
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     0.000
DeltaY:     0.000
DeltaZ:     0.000


Time Stamp:  2006-248 00:00

Comments: (null)
Time Correction(s) 0.000

Svp #1:
-------------
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     -0.003
DeltaY:     -0.032
DeltaZ:     0.631

SVP #2:
-------------
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     0.000
DeltaY:     0.000
DeltaZ:     0.000


Time Stamp:  2009-345 00:00

Comments:
Time Correction(s) 0.000

Svp #1:
-------------
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     -0.003
DeltaY:     -0.032
DeltaZ:     0.631

SVP #2:
-------------
Pitch Offset:     0.000
Roll Offset:      0.000
Azimuth Offset:   0.000

DeltaX:     0.000
```

DeltaY: 0.000
DeltaZ: 0.000

Time Stamp: 2010-074 00:00

Comments: data is NOT SVP corrected in Caris at present time because Hypack receives already ray-traced depths
Time Correction(s) 0.000

Svp #1:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: -0.003
DeltaY: -0.032
DeltaZ: 0.631

SVP #2:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Time Stamp: 2010-096 00:00

Comments: data is NOT SVP corrected in Caris at present time because Hypack receives already ray-traced depthsdata is NOT SVP corrected in Caris at present time because Hypack receives already ray-traced depths
Time Correction(s) 0.000

Svp #1:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.631

SVP #2:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Time Stamp: 2010-097 00:00

Comments: data is NOT SVP corrected in Caris at present time because Hypack receives already ray-traced depthsdata is NOT SVP corrected in Caris at present time because Hypack receives already ray-traced depths
Time Correction(s) 0.000

Svp #1:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

SVP #2:

Pitch Offset: 0.000
Roll Offset: 0.000
Azimuth Offset: 0.000

DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

WaterLine:

Time Stamp: 2006-234 00:00

Comments: RP to WL as surveyed
Apply Yes
WaterLine 0.020

Time Stamp: 2009-345 00:00

Comments: HOOD RIVER ERS
Apply No
WaterLine 0.000

Time Stamp: 2010-074 00:00

Comments: Anacortes HSRR
Apply Yes
WaterLine -0.022

Time Stamp: 2010-096 00:00

Comments: the water line was entered into SIS, BUT because we did not have the "Use EM Combined..." option checked in Hyspwee Hardware, it was not included in the data stored in the hsx.
Apply Yes
WaterLine -0.022

Time Stamp: 2010-097 00:00

Comments: the water line is accounted for in SIS (the "Use EM Combined..." option was checked (therefore, it's reflected in the data stored in the hsx)

Apply No

WaterLine 0.000

APPENDIX 6

POS/MV Calibration Results

POS/MV Calibration Report

Field Unit: NRT 3

SYSTEM INFORMATION

Vessel: S1212

Date: 3/15/2010 **Dn:** 74

Personnel: Forfinski, Jacobs, jackson

PCS Serial # 2245 (A014934)

IP Address: 129.100.1.231

POS controller Version (Use Menu Help > About) 3.4.00

POS Version (Use Menu View > Statistics) MV-320, Version 4

GPS Receivers

Port Receiver 60080830

Starboard Recceiver 60069001

CALIBRATION AREA

Location: Anacortes, WA

Approximate Position:

	D	M	S
Lat	48	31	35 N
Lon	122	36	29 W

DGPS Beacon Station: Whidbey Island, WA

Frequency: 302 kHZ

Satellite Constellation

(Use View> GPS Data)

Primary GPS (Port Antenna)

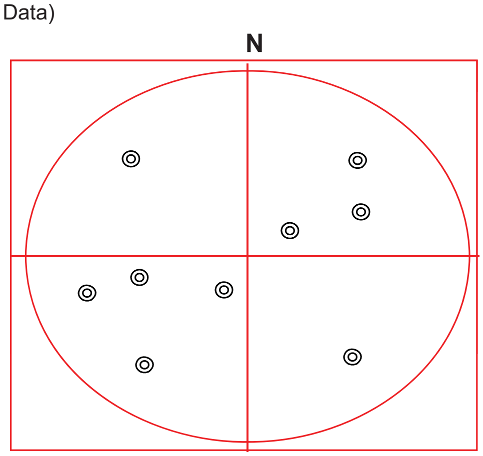
HDOP: 0.873

VDOP: 1.033

Sattelites in Use: 9

1,4,11,13,16,20,23,25,30

PDOP 1.352 (Use View> GAMS Solution)



Note: Secondary GPS satellite constellation and number of satellites were exactly the same as the Primary GPS

POS/MV CONFIGURATION

Settings

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

User Entries, Pre-Calibration

1.834	Two Antenna Separation (m)
0.30	Heading Calibration Threshold
0	Heading Correction

Baseline Vector

0	X Component (m)
0	YComponent (m)
0	Z Component (m)

Configuration Notes: GAMS needed re-calibration because the leverarm for IMU to Port Antenna was incorrect

POS/MV CALIBRATION

Calibration Procedure:

(Refer to POS MV V3 Installation and Operation Guide, 4-25)

Start time: 10:18 UTC

End time: 10:20 UTC

Heading accuracy achieved for calibration: 0.099

Calibration Results:

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

POS/MV Post-Calibration Values

1.831	Two Antenna Separation (m)
0.300	Heading Calibration Threshold
0	Heading Correction

Baseline Vector

-0.002	X Component (m)
1.831	YComponent (m)
0.021	Z Component (m)

GAMS Status Online? X

Save Settings? X

Calibration Notes: Took over an hour to get fixed OTF solution and GAMS Ready Offline

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

File Name: POSMV_09012004.nvm

GENERAL GUIDANCE

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:

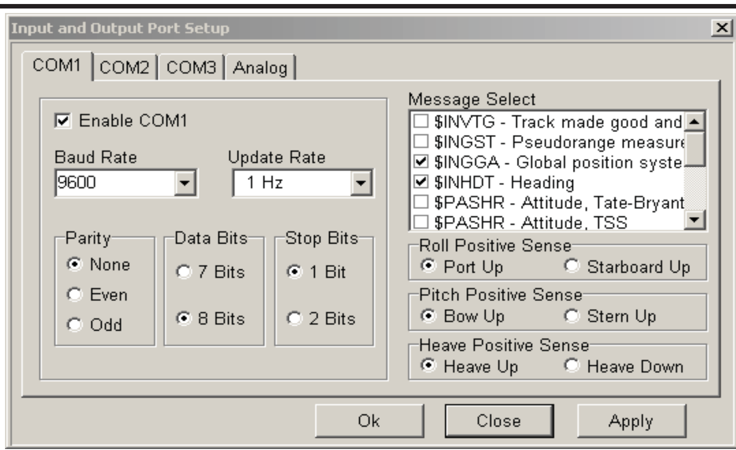
a) Heading rotation - apply a right-hand screw rotation θz about the z-axis to align one frame with the other.

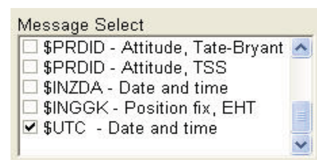
b) Pitch rotation - apply a right-hand screw rotation θy about the once-rotated y-axis to align one frame with the other.

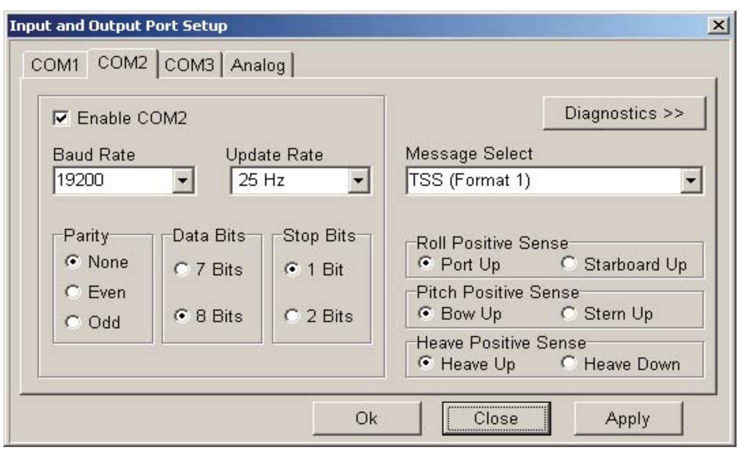
c) Roll rotation - apply a right-hand screw rotation θx about the twice-rotated x-axis to align one frame with the other.

SETTINGS (insert screen grabs)

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

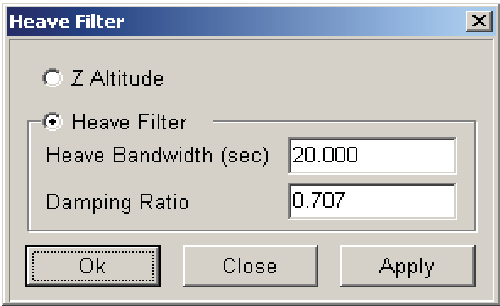




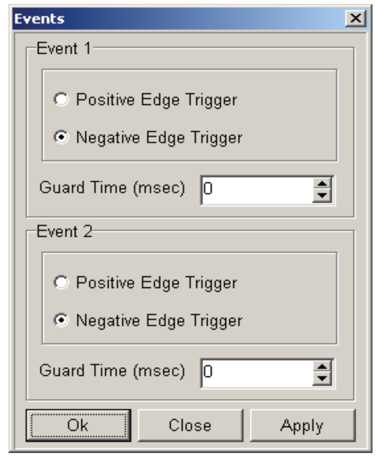


NOTE: COM3 and Analog are not used.

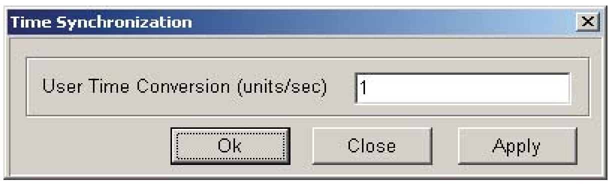
Heave Filter (Use Settings > Heave)



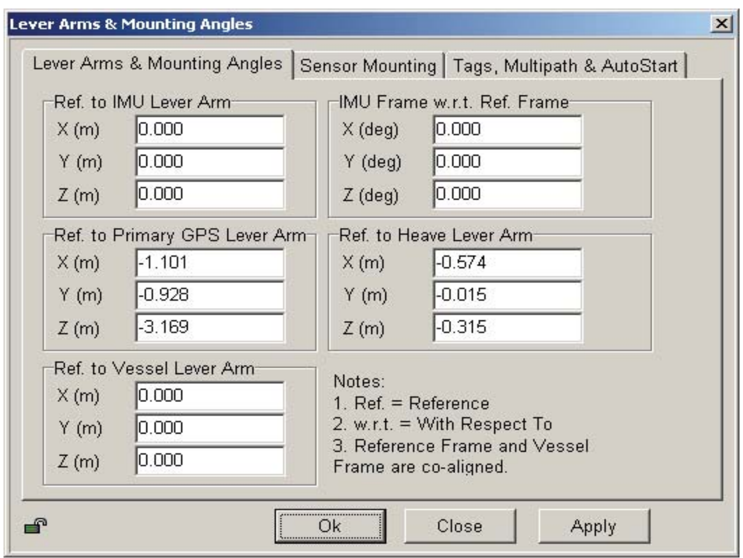
Events (Use Settings > Events)



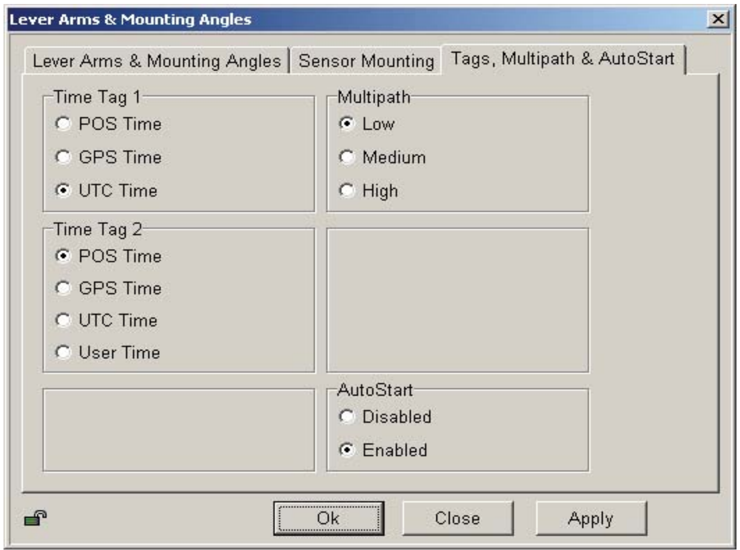
Time Sync (Use Settings > Time Sync)



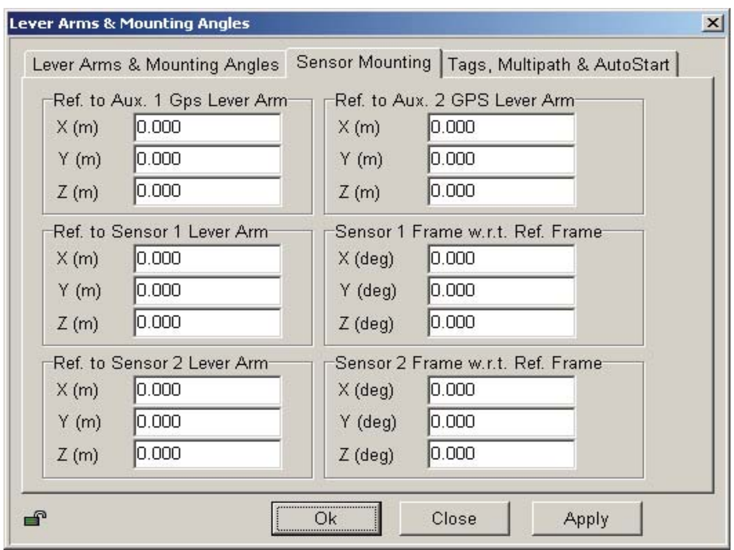
Installation (Use Settings > Installation)



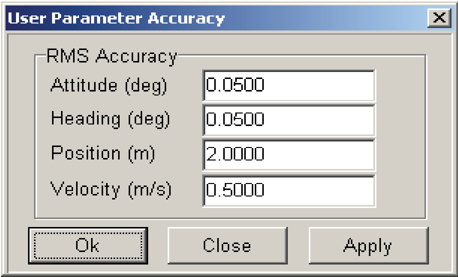
Tags, Multipath and Auto Start (Use Settings > Installation > Tags, Multipath and Auto Start)



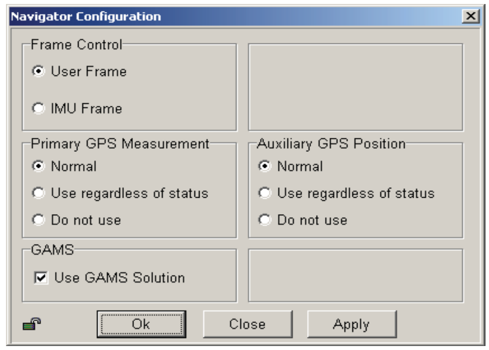
Sensor Mounting (Use Settings > Installation > Sensor Mounting)



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

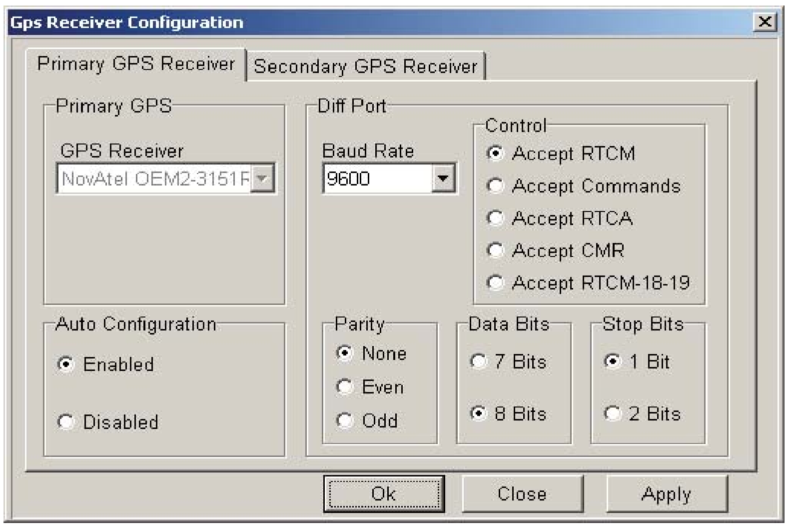


Frame Control (Use Tools > Config)



GPS Receiver Configuration (Use Settings> Installation> GPS Receiver Configuration)

Primary GPS Receiver



Secondary GPS Receiver