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Data Acquisition and Processing Report

NOAA S3003

S-L920-NRT6-05

A. Equipment

This Data Acquisition and Processing Report (DAPR) describes all Navigation Response Team 6 (NRT6) survey equipment and the standard methods utilized by NRT6 to acquire and process survey data.

The individual system(s) chosen for use in a given area were decided at the discretion of the hydrographer using the guidance stated in the Project Instructions, the Hydrographic Letter Instructions, and the Field Procedures Manual. The choice of system used also depended on the limitations of each system, the bottom topography, the water depth, and the ability of the vessel to safely navigate the area.

A.1. Survey Launch S3003

Survey launch S3001, a 27-foot SeaArk Commander, was used to acquire single-beam echosounder data, side scan sonar data, sound velocity profiles and detached positions. The 4.5-ton launch is eight feet wide, has a static draft of 0.4 meters and is powered by two 130hp outboards. Vessel descriptions and offset measurements are included in Appendix III of this report.

Hull Number:	S3003
Builder:	SeaArc
Built:	2003
Length Overall:	33 ft.
Beam:	8 ft.
Draft:	1.6 ft.
Cruising Speed	28kts
Min/Max Survey Speed	4-8kts.
Primary Echosounder	Boom mounted Simrad EM3000 MBES
Secondary Echosouner	Rigid hull-mounted Innerspace SBES
Imagery System	Towed Klein 3000 Side Scan Sonar system
Sound Velocity Probe:	Sea-Bird SeaCat SBE 19+ CTD Profiler
2nd Sound Velocity Probe	ODOM Digibar Pro

NOAA Survey Launch S3003

Vessel offsets such as sonar locations, POS MV offsets, and static draft were determined during the Vessel Offset Survey and are included in Appendix I.

These offsets are recorded in the Vessel Offsets Document in Appendix III.

Offsets are entered into CARIS HIPS vessel configuration file and applied to data in post-processing.

2.1.2 Center of Roll and Pitch

The precise position of rotation for Survey Launch S3003 is unknown. It is assumed that the current position of the RP (near the IMU) in the vessel offset survey is the approximate location of the center of rotation.

3. Hardware Systems

3.1 Multibeam Echosounder

S3003 is equipped with a Kongsberg Simrad EM3000 shallow water multibeam echosounder. The Simrad EM3000 is a single-frequency echosounder with a central frequency of 300 kHz. The EM3000 has 127 beams each of which has a 1.5° beamwidth. The ping rate of this echosounder varies up to 25 Hz. Soundings are acquired in meters.

Simrad EM 3000 Multibeam Arm on S3003

The sonar head contains a flat-face transducer (Mills Cross configuration) and all transmitter and receiver elements encased in an acoustically transparent medium. The transmit beam is steerable to compensate for mounting angle and vessel pitch.

The processing unit performs the beamforming, bottom detection and controls the sonar head with respect to gain, ping rate and transmit angle. It also contains the interfaces for all time-critical external sensors such as attitude data, position, and the 1 PPS (pulse per second) signal.

EM3000 controller software, operating on the Hypack computer and communicating via Ethernet connection, is used to control adjustable parameters such as range scale, power, gain and pulse width. The controller software also transmits real time sound velocity measurements (from a Digibar Pro sound velocimeter mounted near the sonar head) to the processing unit for initial beamforming and steering.

The EM3000 sonar head is mounted on a reinforced aluminum arm located on the starboard side of the vessel. After lowering the arm, it is locked into place with a steel pin and braced in the fore and aft direction with a supporting arm. The arm can be

deployed by two persons. Operation of the system is limited to approximately seven knots, at which point the transducer arm begins to vibrate.

A patch test was performed with the EM 3000 system to determine residual biases of the system on July 27, 2005. The results are included in Appendix I.

To verify proper operation of the MBES, lead line comparison tests are performed periodically throughout the survey. MBES data and lead line readings are taken in shallow water with a flat bottom. Lead line comparison test results will be included in the Data Acquisition and Processing Report.

A lead line calibration report is included in Appendix I.

3.2 Single-Beam Echosounder

S3003 is equipped with an Innerspace Technology 455 Survey Depth Sounder, which is a single frequency (208 kHz) analog and digital recording single beam echosounder (SBES). The beam width is 8° with an optional 3° beam width. Soundings are acquired in meters. The analog screens are continuously captured during data collection and stored on an external zip drive for later use during data processing.

To verify proper operation of the SBES, lead line comparison tests are performed periodically throughout the survey. SBES data and lead line readings are taken in shallow water with a flat bottom. Lead line comparison test results will be included in the Data Acquisition and Processing Report.

A lead line calibration report is included in Appendix I.

Innerspace Technology 455 Survey Depth Sounder on S3003

3.3 Side Scan Sonar

S3003 is equipped with a Klein System 3000 sonar system. The system includes:

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

Klein System 3000 Towfish on 3003

The horizontal beam widths for the low and high frequencies are 1° and 2° respectively. The vertical beam width is 40°. Maximum range scale is 150 meters using the high frequency, and 500 meters using the low frequency.

All SSS data collection is controlled using the SonarPro software operating in a Microsoft Windows NT environment on the WDCU. Control signals are sent to the towfish and data is received from the towfish via the TPU. Data is 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 the water depth. Lines are planned with a minimum of 25 meters of overlap with adjacent swaths.

Vessel speed is adjusted to ensure that an object one meter square in size would be detected and clearly imaged across the sonar swath. Typical SSS collection speeds are three to five knots. Confidence checks are performed by observing operation of the SSS along pier faces, and in areas with known targets.

High frequency is utilized as the primary frequency for data collection, with low frequency observed but not logged. The maximum range scale used is 100 meters, with operation on the 50 to 75 meter range scales more typical. Fish height is kept at eight to

twelve percent of the range scale, except in very shallow areas (< 6 meters) or in areas where rapidly changing terrain risks impacting the fish on the bottom.

S3003 is equipped with a Dynapar cable counter used to measures the length of towfish cable deployed by counting revolutions of the towing block on the J-frame. The length of cable deployed is computed automatically and output directly to the WDCU where it is used by the SonarPro software and logged in the SDF data format.

A certification test of the system for object detection and contact positioning was conducted in August, 2005 and the report is included in Appendix I.

3.4 Positioning and Orientation Equipment

Applanix POS MV Position and Orientation Sensor

Survey launch S3003 is equipped with a POS MV (Position and Orientation system for Marine Vessels) model 320 version 3. The system includes the following components:

- POS MV rack mounted POS Computer System (PCS)
- IMU-200 Inertial Measurement Unit (IMU)
- Two Identical GPS Antennas

POS MV System

The PCS contains two GPS receivers, primary and secondary, along with interface cards for communication and processing the IMU and GPS data. It also contains all ports for data output to peripheral survey equipment.

The IMU contains three solid-state linear accelerometers and gyros which work together with electronics to provide digital measurements of acceleration in three directions and motion around all three axes of the IMU.

The components work together to provide position, attitude, and heading information to the various survey systems on S3003.

Position and velocity information is provided by the primary GPS receiver using differential (RTCM) correctors received through the DIFF port on the PCS. The primary GPS receiver also provides the Pulse Per Second (PPS) strobe used to synchronize data output to Universal Time Coordinate (UTC) or GPS time.

Attitude data (heave, pitch, and roll) is computed by the PCS using data from the IMU. Heave is calculated by performing a double integration of the IMU sensed vertical accelerations. The POS MV controller heave filter is used for all data: a heave bandwidth between 10 and 20 seconds and a damping ration of 0.707 are used depending on the conditions at the time of data acquisition. Both roll and pitch measurements are computed by the IMU after sensor alignment and leveling.

Heading is computed by blending heading measurements calculated using two independent methods; dynamic heading alignment and GPS Azimuth Measurement Subsystem (GAMS). The dynamic heading alignment method uses data supplied by the IMU and the two GPS receivers. This measurement of heading is accurate under rapid changes in direction and varying forces of acceleration, and is relatively unaffected by noise, but will drift when the vessel remains on a steady course. The GAMS method determines heading by computing a geographic vector between the two fixed GPS antennas through carrier phase measurements of the satellite signals. This method is subject to error due to noise but exhibits no drift. The POS MV uses the advantages of each method to deliver a blended measurement of heading with an accuracy between 0.02 and 0.1 degrees RMS.

Position quality, heading and attitude are monitored in real time using the POS MV controller software. POS MV setup parameters are shown in Appendix III.

Trimble DSM212L DGPS Receiver

Survey launch S3003 is equipped with a Trimble DSM212L integrated 12-channel GPS receiver and dual-channel DGPS beacon receiver. The beacon receiver can simultaneously monitor two independent U.S. Coast Guard (USCG) DGPS beacons. 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. Additionally, the DSM212L can

accept differential correctors (RTCM messages) from an external source such as a user-established DGPS reference station.

The following parameters can be monitored in real-time through Trimble's TSIP Talker software to ensure position data quality: number of satellites used in the solution, horizontal dilution of precision (HDOP), latency of correctors and beacon signal strength. The DSM212L is configured in the auto-range mode to only use correctors from the nearest USCG beacon, to go off-line if the age of DGPS correctors exceeded 20 seconds and to exclude satellites with an altitude below 8°.

The DSM212L is used to supply differential correctors (RTCM) to the POS MV primary GPS receiver through the DIFF port on the POS MV PCS.

Trimble Backpack Unit

The Trimble backpack unit is used to collect DGPS data on fixed aids to navigation and to update high water features and natural shoreline.

The Trimble backpack unit consists of the following:

- Pro XRS 12 channel DGPS receiver
- Combined L1 GPS/Beacon/Satellite Differential Antenna
- TSCe data logger with Windows CE operating system

Trimble backpack unit

The ProXRS receiver is set to collect data using the following restrictions:

Minimum No. of satellites: 5
Maximum PDOP: 6
Minimum SNR: 6
Minimum Satellite elevation: 15 degrees

Data collection rates and times are:

Fixed aides to navigation:	One second data collected for ten minutes.
Other point features:	One second data collected for one minute.
Line features:	One second interval for length of line or single points collected at corners

Trimble's TerraSync software is used on the Trimble TSCe data logger to collect DGPS data in the field. A data dictionary created by NRT6 is used in the collection process to categorize and add metadata to features. Features are collected under one of three categories: fixed aids, structures or lines.

Line data is acquired on curved and/or complex structures where collecting discrete, multiple points would be confusing. In most cases, these DGPS line data positions are acquired by collecting a data point along the outside edge of a feature at an angle or intersection, then pausing data collection until the next angle or intersection is reached, at which point a new position is logged to the line. These steps would be repeated until the feature is completely defined. The Pathfinder software extrapolates between the points acquired to create a continuous line and clearly delineate the feature.

In some cases where shoreline changes are obvious, line data is collected while walking along the waterline to delineate the revised shoreline.

On bridges where walking is impractical, a line is obtained while driving a vehicle across the bridge (antenna positioned outside the passenger side window). An offset to the edge of the bridge is estimated and entered in the collection process to more accurately depict the structure.

All items are assigned position numbers based on the day number and order of collection in the format DDD.###, where DDD is the day number and ### is incremented with each data point, e.g., 301.001, 301.002, etc.

NRT6 is in the process of updating the data dictionary to one based on the IHO S-57 standard. It is expected to be in use before 2006 and will be included in the DAPR after final editing. For now a copy of the current data dictionary is included in Appendix IV.

3.5 Sound Velocity Profilers

NRT6 acquires water column sound velocity data using a Sea-Bird SBE19+ Conductivity, Temperature, and Depth (CTD) profiler. Temperature is measured directly. Salinity is calculated from measured electrical conductivity. Depth is calculated from strain gauge pressure. The SBE19+ was calibrated on June 11th, 2005. Calibration documents are located in Appendix II.

Sea-Bird SBE19+ on Survey Launch S3003

The ODOM Hydrographic Systems Digibar Pro is a real-time time-of-flight sea surface velocimeter, which calculates sound velocity using the two-way travel time of a pulse of sound sent from a transducer to a reflector. The Digibar Pro is mounted at the multibeam transducer head and is used by the EM3000 system for initial beam forming. The Digibar Pro was calibrated on October 6th, 2004. Calibration documents are located in Appendix II.

ODOM Hydrographic Systems Digibar Pro on Survey Launch S3003

A second Digibar is used as a backup for the Sea-Bird SBE19+. The second Digibar was calibrated on August 13th, 2003. Calibration documents are located in Appendix II.

3.6 Land Surveying Equipment

Optical elevation measurements are made using a Leica Automatic B1 and a fiberglass level rod. The rod is marked in one-centimeter intervals.

3.7 Hardware Inventory

Equipment	Model / Part	Serial Number	Vendor Calibration	Remarks
Kongsberg Simrad Multibeam Echosounder	EM3000 Processing Unit	1518	N/A	Installed 2003
	EM3000 Transducer Head	307	N/A	Installed 2003
Klein 3000 Side Scan Sonar	Workstation	23-372WS	N/A	Installed 2003
	TPU	351	N/A	Installed 2003
	Towfish	450	N/A	Installed 2003
Innerspace SB Echosounder	Model 455A	194	July 2004	Installed 2003
Applanix POS MV 320	PCS	676	N/A	Installed 2003
	IMU	307	N/A	Installed 2003
Trimble DGPS Receiver	DSM 212H	0220296441	N/A	Installed 2003
Seabird Seacat Profiler	SBE 19 Plus	19P37217-4676	9/03/2004	
Odom Digibar Pro	DB1200	98213	10/06/2004	On MB Head
Odom Digibar Pro	DB1200	98214	8/13/2003	Spare
Dynapar Cable Counter	Max Count II	Unknown	N/A	
Leica	Automatic B1	4592	N/A	

PC Hardware

Machine Name	Hardware Configuration					
	Make/Model	Serial number	Processor	RAM	Video Card	Video RAM
NRT6-1	Dell OptiPlex GX270	FKTT931	P4, 2.8 GHz	512 MB	NVIDIA GeForce FX5200	128 MB
NRT6-2	Dell OptiPlex GX270	3LTT931	P4, 2.8 GHz	512 MB	NVIDIA GeForce FX5200	128 MB
Hypack	HP Pavilion	MXP41302TQ	P4, 3.2 GHz	1 GB	NVIDIA GeForce FX5200	128 MB
Klein	Klein 3000	23-372WS	P3, 1.2 GHz	512 MB	Matrox Millenium G450	Unknown

4. Software Systems

Coastal Oceanographic's Hypack Max is used for vessel navigation and line tracking during all data acquisition.

Hypack Max's Survey program is used to log SBES data and is used in conjunction with Hypack Max's Hysweep Survey program to log MBES data. SBES and MBES data are logged in the Hypack "raw" format, with SBES data using the day number as an extension and MBES data using the .hsx extension. Both are ASCII text files. Setup parameters for Hypack Survey and Hysweep Survey are included in Appendix III.

Klein SonarPro software is used to monitor and log all side scan sonar data. Data is recorded in the Klein SDF format.

Caris HIPS/SIPS 6.0 is used on office workstation NRT6-1 and NRT6-2 for processing all MBES, SBES and SSS data.

4.1 Software Inventory

Computers and Operating Systems:

Machine Name	Date New	OS		
		Windows XP	SP1	SP2
NRT6-1	2003	2003	2003	2005
NRT6-2	2003	2003	2003	2005
Hypack	2003	2003	2003	Not Installed
Klein	2003	2003	2003	Not Installed

Acquisition Software:

Machine Name	Hypack Max	Klein SonarPro
	Ver. 4.3 Gold	Ver. 8.0
Hypack	23-May-05	n/a
Klein	n/a	25-Jun-05

Processing Software:

Machine Name	Pathfinder Office	MapInfo Pro		Hydro MI	Vertical Mapper
	Ver. 3.0	Ver. 6.5	Ver. 8.0	Ver. 5.4.1	Ver. 3.0
NRT6-1	2004	2004	Oct-05	2004	2004
NRT6-2	2004	2004	Oct-05	2004	2004

Machine Name	Caris GIS	HIPS/SIPS			Pydro		Velocwin	
	Ver 4.4 SP3	Ver. 5.4	SP1 HF 1-28	Ver. 6.0	5.3.3rc5	5.9.4	8.6	8.7.7
NRT6-1	2004	2004	2004	Sept-05	2005	Sept-05	2004	Sept-05
NRT6-2	2004	2004	2004	Sept-05	2005	Setp-05	2004	Sept-05

Support Software:

Machine Name	MS Office XP Professional SP2	NobelTec Tides and Currents
NRT6-1	2004	2005
NRT6-2	2004	2005

5. Personnel

Personnel	Position	Training					
		Small Boat Safety	Hydro	Tides	Basic Caris	Advanced Caris	Shallow Water Multibeam
Edmund Wernicke	Physical Science Technician	2005	N/A	N/A	2005	2005	2005
Julia Uhlendorf	Contractor	N/A	2005	2005	2005	2005	N/A

APPROVAL

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.

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

Approved and Forwarded: For: _____ July 7th, 2006

Edmund Wernicke, Physical Science Technician
Navigation Response Team Six

Appendix I

1. Pos MV and Vessel Offset Survey
2. Static Draft Report
3. Dynamic Draft Report
4. Side Scan Sonar Certification Report
5. Patch Test Calibration Report
6. Lead Line Calibration Report

NOAA Survey Launch S3003
POS MV and Vessel Offset Survey Field Report

Purpose

The purpose of the survey was to accurately determine the spatial relationship of various components of a POS MV navigation system, and determine vessel offsets used to correct position and depth measurements for NOAA survey launch S3003.

Instrumentation

Topcon ET-1 Total Station
A standard peanut prism

Personnel

Surveyor: Ash Harris (Resigned from NOAA)
Assisted by: Kurt Brown, Edmund Wernicke, Julia Uhlendorf

Project Details

This survey was conducted at a Keefe Kaplan Maritime boat works in Richmond, CA on November 9, 2004. The survey launch was on blocks and leveled according to the waterline (marked in ink on the port side of the launch), and the multibeam survey arm was lowered as shown in figure 1.

The total station was set up at the first control point (CP1), and a random point in the distance chosen for a back sight. From CP1 angle and distance measurements were taken to the following points:

- Centerline Bow
- Centerline Stern
- Trimble GPS Antenna
- Port and Starboard POS antennas
- SSS Tow Point at top of sheave
- Simrad Multibeam Transducer Head at center bottom

Figure 1.

A second control point (CP2) was then established on the opposite side of the launch and angle and distance measurements were taken to the following points:

- Singlebeam Transducer
- Center of POS IMU
- Vessel Reference Point (RP) – Approximate center of rotation
- Forward Port Waterline
- Aft Port Waterline

Establishing the Reference Frame

The vessel reference frame was established using two points shot fore and aft on the centerline (keel) of the vessel. To expedite the field measurements, the initial field survey was done using assumed coordinates with the z value for the reference frame points set to zero.

A baseline was later computed in a north/south orientation, and the vessel's reference frame points transformed to the baseline. All other points were then rotated to the baseline's orientation and the vessel RP was set as the origin. The coordinates of all points were calculated with respect to the RP.

Discussion

The positions for all GPS antenna are to the top center of the antenna. To correct the Z value of the primary POS MV antenna to the antenna phase center, 2.5 cm (obtained from Applanix product manual) was subtracted from the height. This value was entered into the POS MV installation parameters.

The following problems were found with the survey of S3003:

- Benchmarks were not recorded or marked on the vessel.
- Although raw data is available, full documentation on the process of converting the raw data to the final offset values is not available, as the surveyor is no longer with NOAA.
- No rigorous error analysis was done. Error values entered into Caris are based on manufacturer error estimates of the instrument.

In lieu of the above problems, a complete resurvey of S3003 is recommended, and will be undertaken as soon as possible. For the present, the offset measurements obtained in this survey will be used in data processing and have been verified as accurately as possibly with a steel tape measure. All offset values checked were within the error expected using the steel tape.

Final coordinates for all points taken are summarized in the following table.

Description	X	Y	Z
Reference Point	0	0	0
Centerline - Bow	0	3.3258	N/A
Centerline - Stern	0	-3.9928	N/A
Trimble GPS Antenna	-0.0133	-0.5163	-3.266
Stbd POS Antenna	0.7672	1.2712	-2.527
Port POS Antenna	-0.7621	1.262	-2.529
SSS Tow Point	0.5073	-4.0154	-2.422
SWMB Transducer	1.341	3.0209	1.232
SB Transducer	-0.1698	0.3505	0.353
IMU	0.1269	0.3109	0.118
Waterline Mark AFT	-1.1753	-1.9092	-0.055
Waterline Mark FWD	-1.1717	0.3623	-0.049

Error Estimates

Precise error estimates could not be obtained for the ET-1 total station. Error estimates are based on later model Topcon total stations. From manufacturer specifications:

Measurement Accuracy = (5mm + 2ppm x distance)

All shots were less than 100 meter in distance, reducing the measurement accuracy to 5mm (5 ppm at 100 meters add less than a mm to the value).

This value was entered into the Total Propagated Error section of the vessel configuration file.

NOAA Survey Launch S3003
Static Draft Report
Navigation Response Team Six

Background

The purpose of a static draft measurement is to correct for the distance from the waterline to the transducer face. In Caris software, the term draft is not used. The Z value of the transducer below the vessel reference point (RP) and waterline will give the draft.

Procedure

The static draft was measured by marking the waterline on the vessel with the vessel in the water and not listing. Marks were made fore and aft on the port side of the vessel. Both marks were shot in using a total station as part of the vessel offsets measurement process. The Z value for these two points was averaged and used as the value for distance between waterline and RP entered into the Caris vessel config file.

The values measured are summarized in the table below.

Offset Measurement	Z Value (meters)
RP to Fore Waterline fore	-.049
RP to Aft Waterline	-.055
RP to Singlebeam Transducer	.353
RP to Mulitbeam Transducer	1.23

Using the average waterline value of -0.052 meters drafts for the multibeam and singlebeam transducers are shown in the table below.

Transducer	Draft (meters)
Multibeam	1.28
Singlebeam	0.40

NOAA Survey Launch S3003
Dynamic Draft Report
Navigation Response Team Six

Background

The draft of a vessel changes as the speed changes, and is accounted for in CARIS using a table of speed-draft value pairs entered in the vessel config files. During the merge process, the difference between the instantaneous draft and the static draft is computed and the final depth is compensated.

These speed-draft value pairs are acquired by running speed trials and the settlement and squat procedure described in this report.

Date and Location

Dynamic draft data were acquired on June 16, 2005 in the Richmond Inner Harbor area of San Francisco Bay, CA.

Equipment

Leica Automatic B1 Optical Level – Serial Number 4592
Fiberglass 0.5 cm Level Rod

Procedure

Dynamic draft calculations were recorded twice: once with the multibeam arm in its stowed position, and once with the arm deployed. Draft readings were taken at various RPM levels covering the range of survey speeds for singlebeam and multibeam survey operations.

The level rod was placed as close to the position of the Inertial Motion Unit (IMU) as possible, which was at the aft cabin bulkhead on the centerline of the launch. The rod extended over the top of the launch cabin allowing readings to be taken from a fixed pier. At each desired RPM level, readings were taken as the launch was driven toward and away from the shore-side observer. Three readings were taken per pass and all readings were averaged to come up with one value at each RPM level. To account for tidal changes during the procedure, an average at rest reading was made prior to each new RPM level. For each RPM level, the difference between the average measured value and an at rest value interpolated between the two at rest values bracketing the run was computed to determine the change in draft. (Note: At 2800 RPM in the singlebeam procedure, a delay in the runs required the at rest value taken after the run be applied to the readings).

Speed trials were performed to determine the speed of the survey launch at each RPM level. Lines were run at each RPM level. The data was processed and speed values for each line were computed in Caris.

Results

The results of the speed trials and dynamic draft observations for multibeam and singlebeam operations are summarized in the tables below. The columns in blue show final speed-draft values entered into the Caris vessel configuration files. The values represent the draft relative to the initial zero draft value. Thus a positive value in the table represents an increase in the draft relative to the vessel at rest. Values in the table are added to the static draft in the merge process.

Multibeam Results – Multibeam Arm Deployed

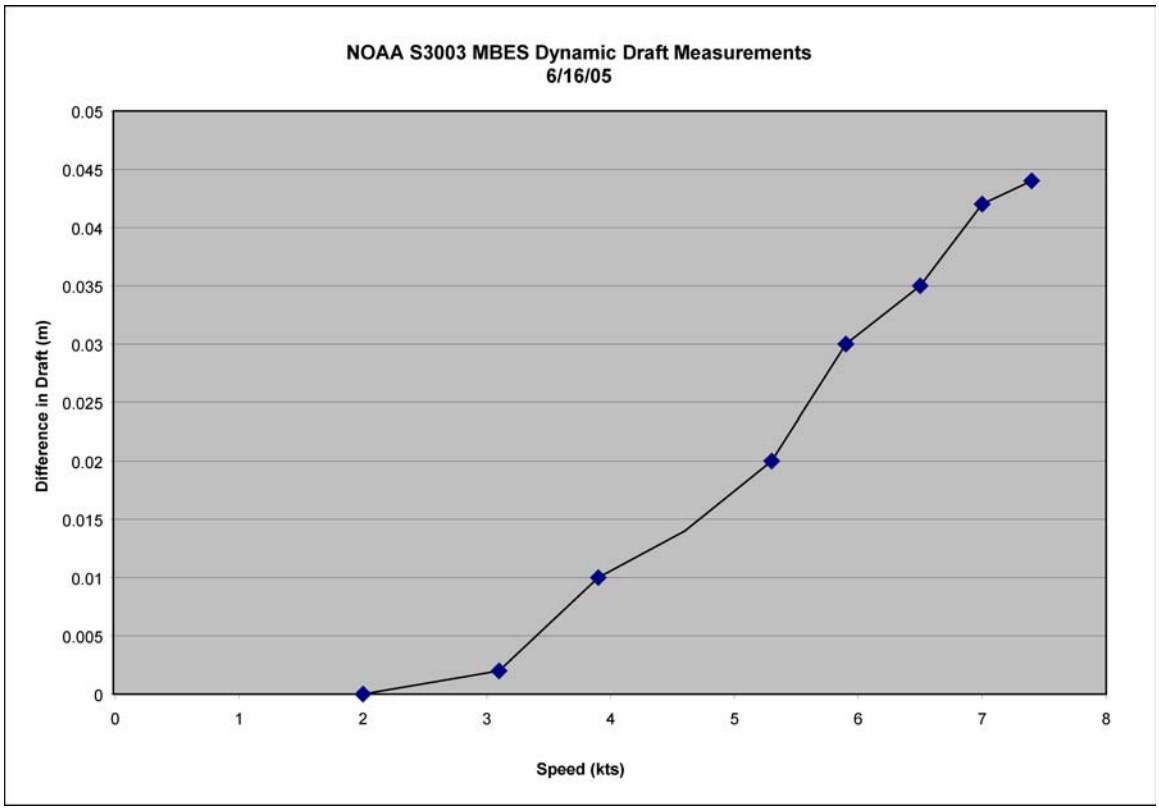
Speed Trials:

RPM	Speed
800	2.0
1000	3.1
1200	3.9
1400	4.6
1600	5.3
1800	5.9
2000	6.5
2200	7.0
2400	7.4

Dynamic Draft Readings:

RPM	Average Out	Average In	Average of both passes	Interpolated AT Rest Reading	Speed (kts)	Difference in Draft (m)
800	4.04	4.04	4.04	4.04	2.0	0
1000	4.042	4.042	4.042	4.04	3.1	.002
1200	4.046	4.046	4.046	4.04	3.9	.01
1400	4.06	4.058	4.059	4.045	4.6	.014
1600	4.075	4.074	4.075	4.055	5.3	.02
1800	4.098	4.092	4.095	4.065	5.9	.03
2000	4.112	4.108	4.11	4.075	6.5	.035
2200	4.125	4.128	4.127	4.085	7	.042
2400	4.142	4.133	4.134	4.09	7.4	.044

Graph of vessel speed versus observed difference in draft for multibeam operations:



Singlebeam Results

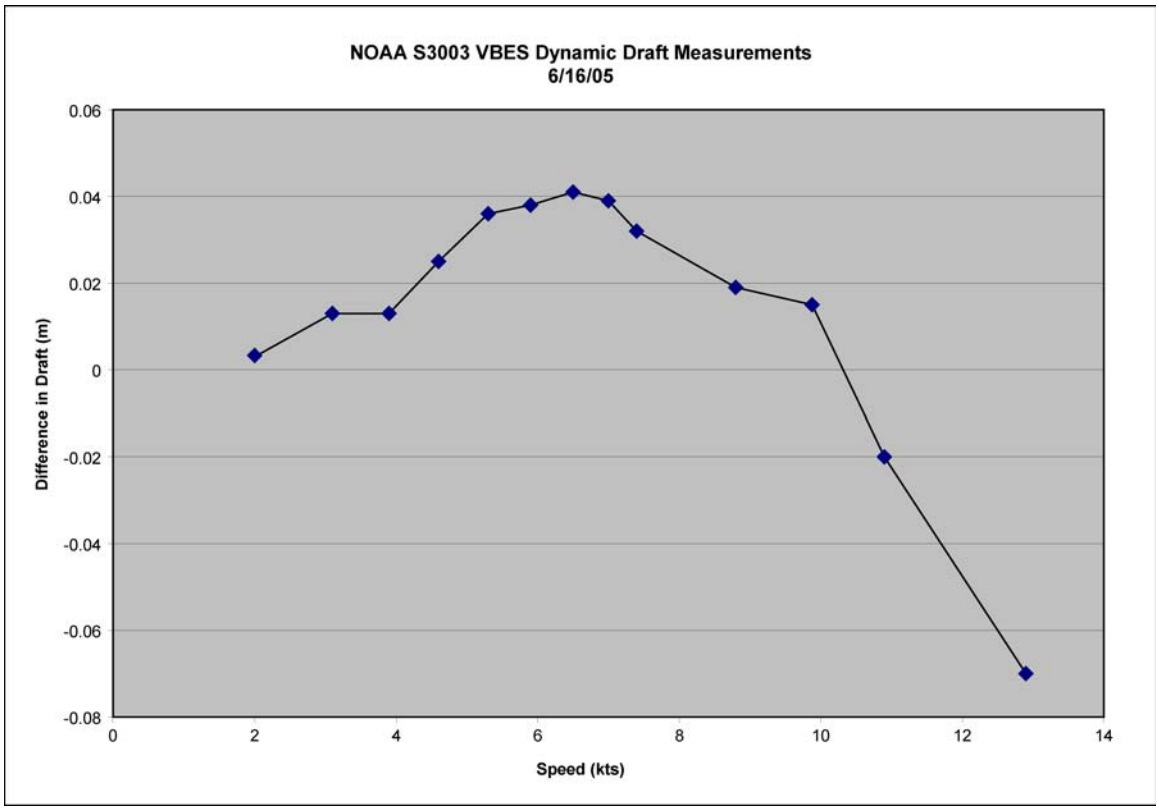
Speed Trials:

RPM	Speed
1000	4.1
1400	5.4
1800	6.6
2200	7.7
2600	8.8
3000	10.9
3200	12.9
3400	14.4
3600	16.0
3800	17.7
4000	20.1

Dynamic Draft Readings:

RPM	Average In	Average Out	Average of both passes	Interpolated AT Rest Reading	Speed (kts)	Difference in Draft (m)
800	3.471	3.368	3.47	3.467	2	.003
1000	3.47	3.487	3.479	3.466	3.1	.013
1200	3.488	3.485	3.487	3.474	3.9	.013
1400	3.51	3.517	3.514	3.489	4.6	.025
1600	3.52	3.527	3.24	3.488	5.3	.036
1800	3.53	3.523	3.527	3.489	5.9	.038
2000	3.545	3.54	3.543	3.502	6.5	.041
2200	3.548	3.545	3.547	3.508	7.0	.039
2400	3.537	3.543	3.54	3.508	7.4	.032
2600	3.535	3.528	3.532	3.513	8.8	.019
2800	3.55	3.55	3.55	3.535	9.9	.015
3000	3.507	3.532	3.52	3.54	10.9	-.02
3200	3.473	3.48	3.477	3.545	12.9	-.07

Graph of vessel speed versus observed difference in draft for singlebeam operations:



NOAA Survey Launch S3003
Side Scan Sonar Certification Report
Navigation Response Team 6

Introduction

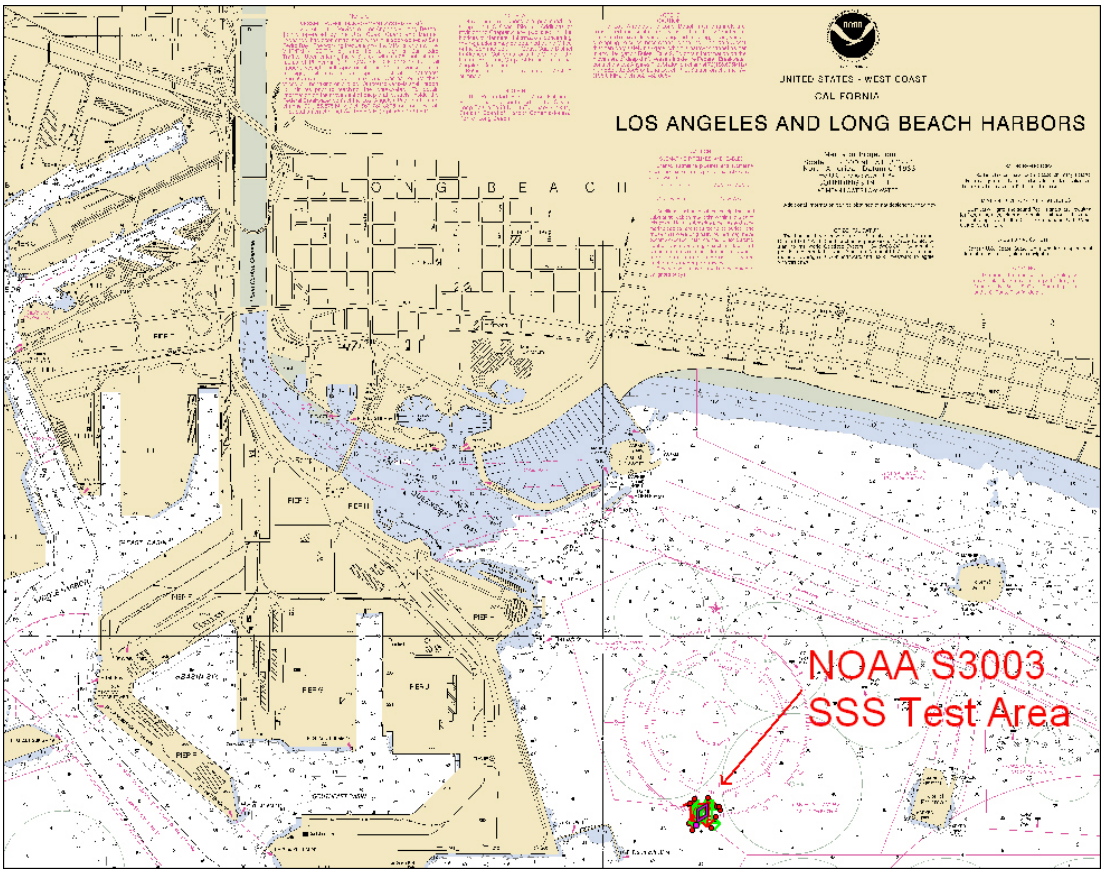
Survey launch S3003 is equipped with a Klein 3000 Side Scan Sonar. To check the performance of the system, multibeam and side scan sonar were used to acquire bathymetry and imagery of a buoy block to determine the target detect capability and positional accuracy of the Klein 3000 as configured on S3003. The exact size of the block is unknown. However, based on imagery collected, the block is approximately 1m x 1m x 1m.

Equipment

Klein System 3000 Side Scan Sonar
Simrad EM3000 Multibeam Echosounder

Location

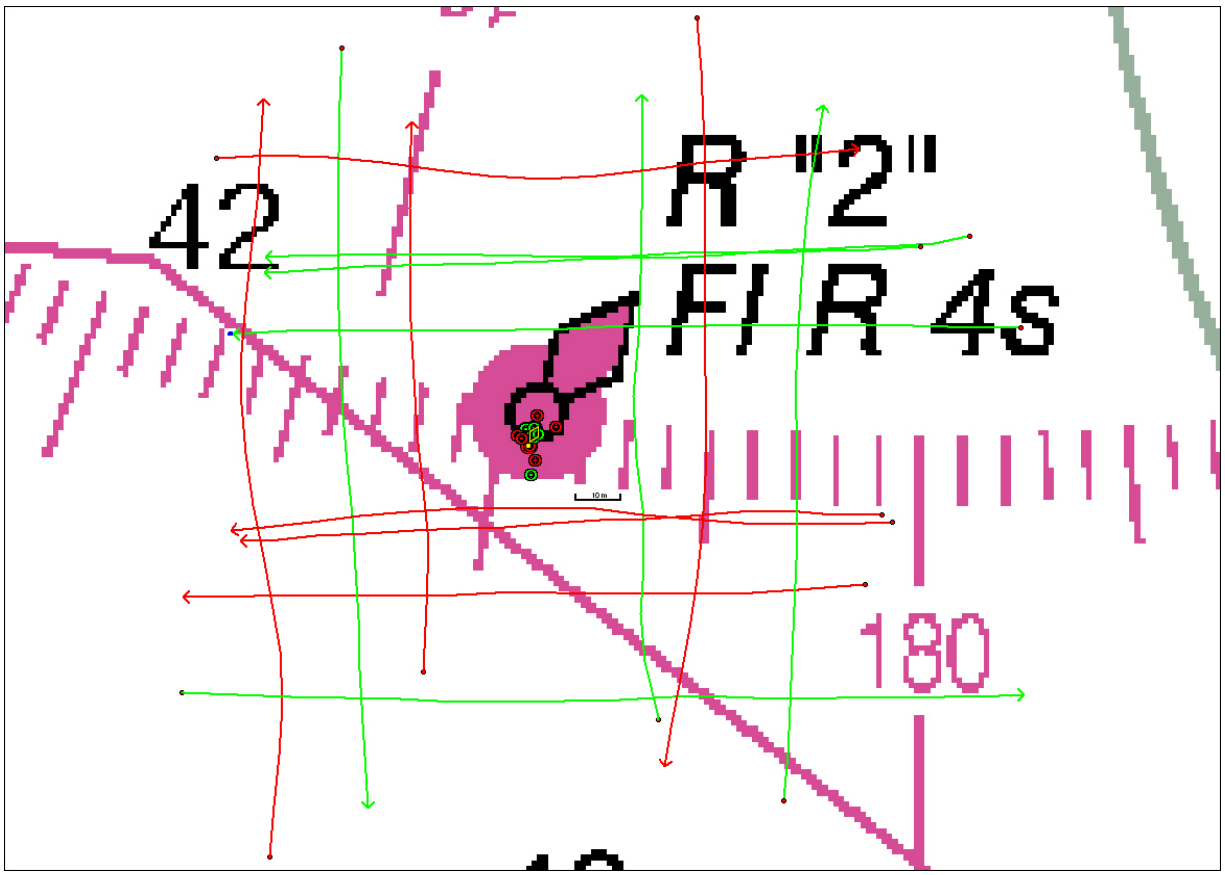
The test was performed using charted "Pier J Channel Lighted Buoy 2" which is located in the Long Beach Outer Harbor at an approximate location of 118° 10' 37" W 33°44' 26". The buoy's block was used for the testing of the system on August 2, 2005 and August 9, 2005 (DN 214, 221).



Location of S3003 side scan sonar certification test.

Running Procedure

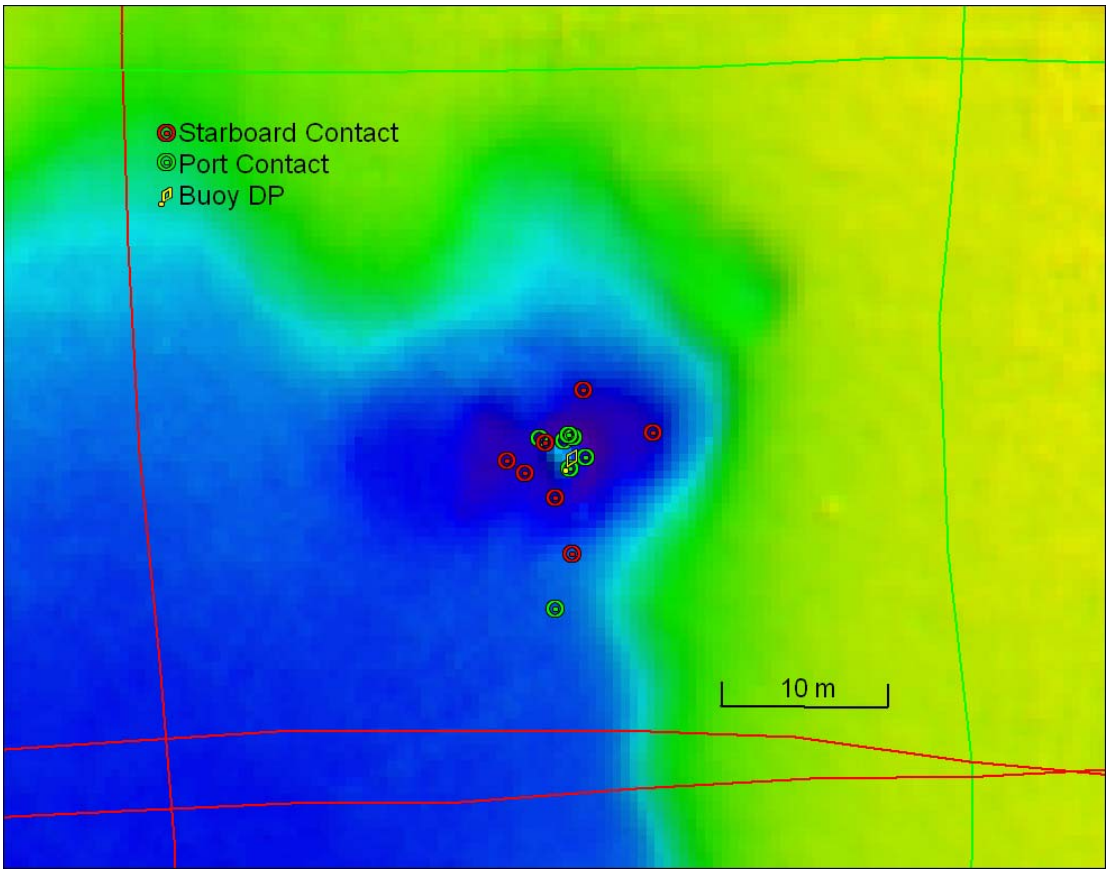
Side scan sonar imagery of the buoy block was acquired using a towed Klein System 3000 towfish (S/N 676). Fourteen passes were made at approximately 20, 40 and 60 meters from the target using a 75 meter range scale. Lines were run on all sides of the buoy and in four directions. This running method insured the ensonification of the buoy block on both the port and starboard channels of the fish, from different target distances, and from different directions. Contacts were picked from all fourteen lines. Twenty multibeam lines were run at varying distances from the buoy for comparison to the side scan positions and the data was used to obtain a DP on the block.



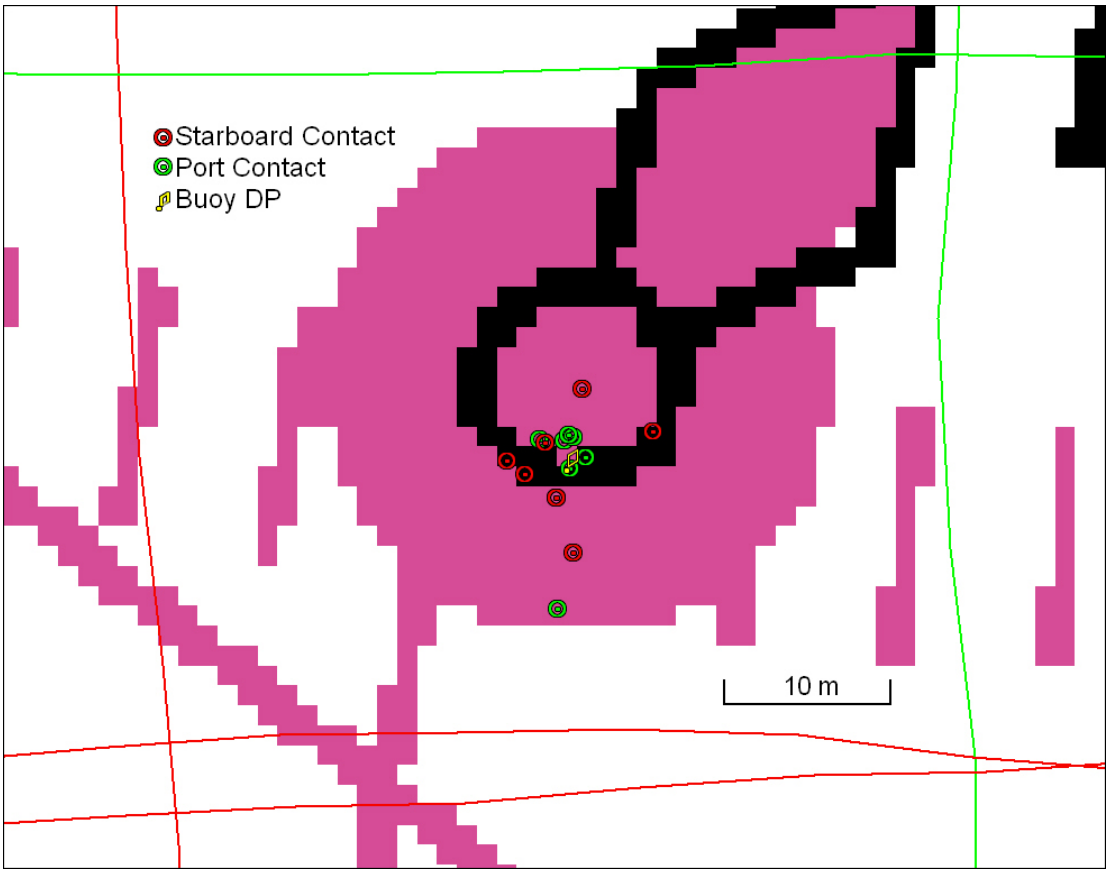
Side scan sonar test lines run. Red lines denote lines run with contact detected on starboard side. Green lines denote lines run with contact detected on port side. Arrows show the direction the line was run.

Processing Procedure

All test data was processed in CARIS using standard processing procedures and evaluated for positional accuracy of the system. A BASE surface with a resolution of 0.50 meters was computed from the multibeam data. Side scan contacts were picked from the side scan sonar imagery and compared to the BASE surface, DP and existing chart.



Side scan lines run and corresponding contacts picked compared to the 0.50 meter resolution multibeam BASE surface.

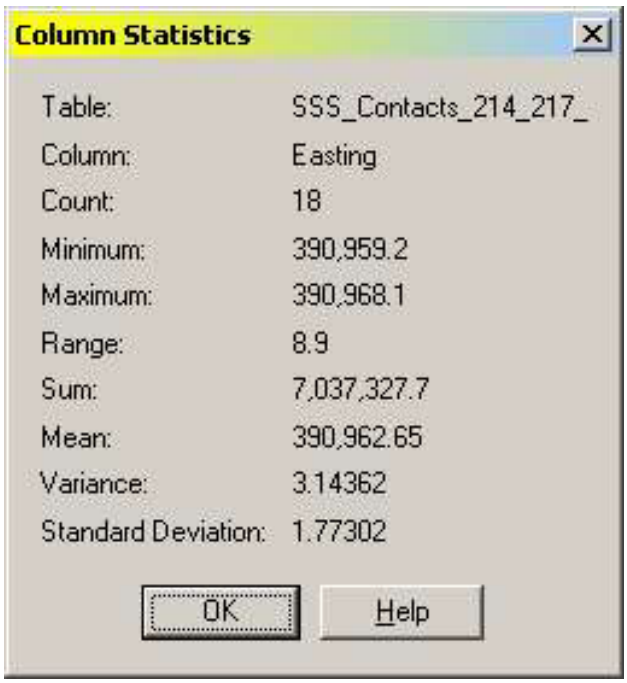


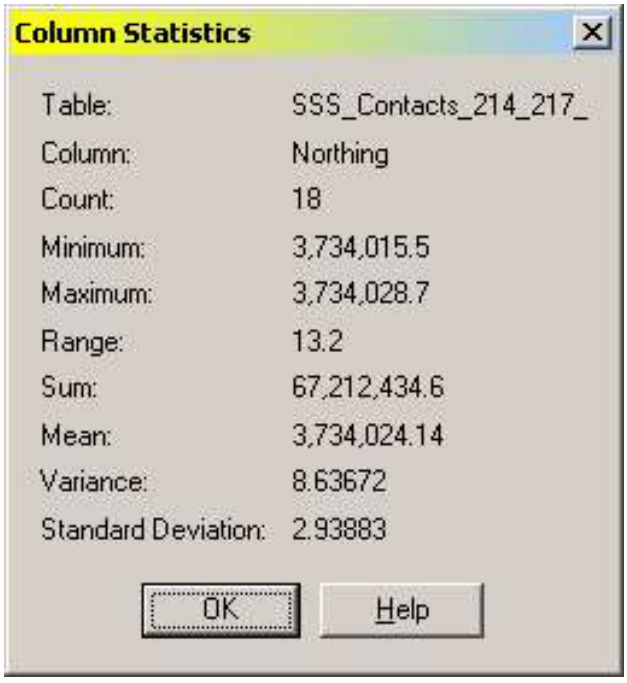
Side scan lines run and corresponding contacts picked compared to NOAA Chart 18751, Los Angeles and Long Beach Harbors.

Results

All contacts are within fractions of a second of a degree from each other and correlate with the location of the block as determined by multibeam. The maximum distance between any two contacts is 13.34 meters and is between two contacts on north-south lines. This could be due to the prevailing current running roughly north-south in the area at the time of the test. Despite the outlying position of some of the contacts, all of the contacts would be detected in a typical survey, where a survey search radius of 20 meters is used with lines are run over the target with 5 meter line spacing. This method provides a minimum of 200% coverage and ensures multiple ensonifications of each object being investigated.

All of the contacts picked were used to calculate standard deviations for Easting and Northing values in MapInfo. Those calculations are shown below in Figure Five. NRT6's Klein 3000 side scan sonar system is within acceptable limits for hydrographic surveying.





Statistics calculated in MapInfo for Easting and Northing of all contacts.

Side Scan Sonar Certification Report	
Vessel	NOAA Survey Launch S3003
Side Scan Sonar System	Klein 3000
Certification Date / DN	8-Aug-05, 9-Aug-05 (DN 214, 221)
Certifying Hydrographer	Kurt Brown, Team Leader NRT6
System Information	
TPU serial number	312
Towfish serial number	411
Cable type	Kevlar
Date of Most Recent EED / Factory Checkout	
Date of Most Recent Pressure Sensor Verification (if applicable)	
Vessel Information	
Sonar Configuration	Towed
Cable Measurement System (if applicable)	Dynapar Cable Counter
Date of Current Vessel Offset Measurement / Verification	10-Nov-04
Date of Current Cable Measurement / Verification (if applicable)	
Test Information	
Test Date(s) / DN(s)	8-Aug-05, 9-Aug-05 (DN 214, 221)
System Operator(s)	K. Brown, J. Uhlendorf, E. Wernicke
Wind / Seas	0-1 kts, NW
Locality	Los Angeles / Long Beach Harbors
Sub-Locality	San Pedro Bay
Description of Bathymetry	Flat
Bottom Type	Mud
Approximate Water Depth	14.5 meters
Description of Target	Buoy Block
Approximate Target Size	1m x 1m x 1m
Target Position	33° 44' 26.4012"N, 118° 10' 37.6392"W
Description of Positioning Method	POS MV DGPS
Estimated Target Position Error	5 meters
Approximate Survey Speed	3 kts.
Approximate Towfish Altitude	8 meters

NOAA Survey Launch S3003
Patch Test Calibration Report
Navigation Response Team Six

Background:

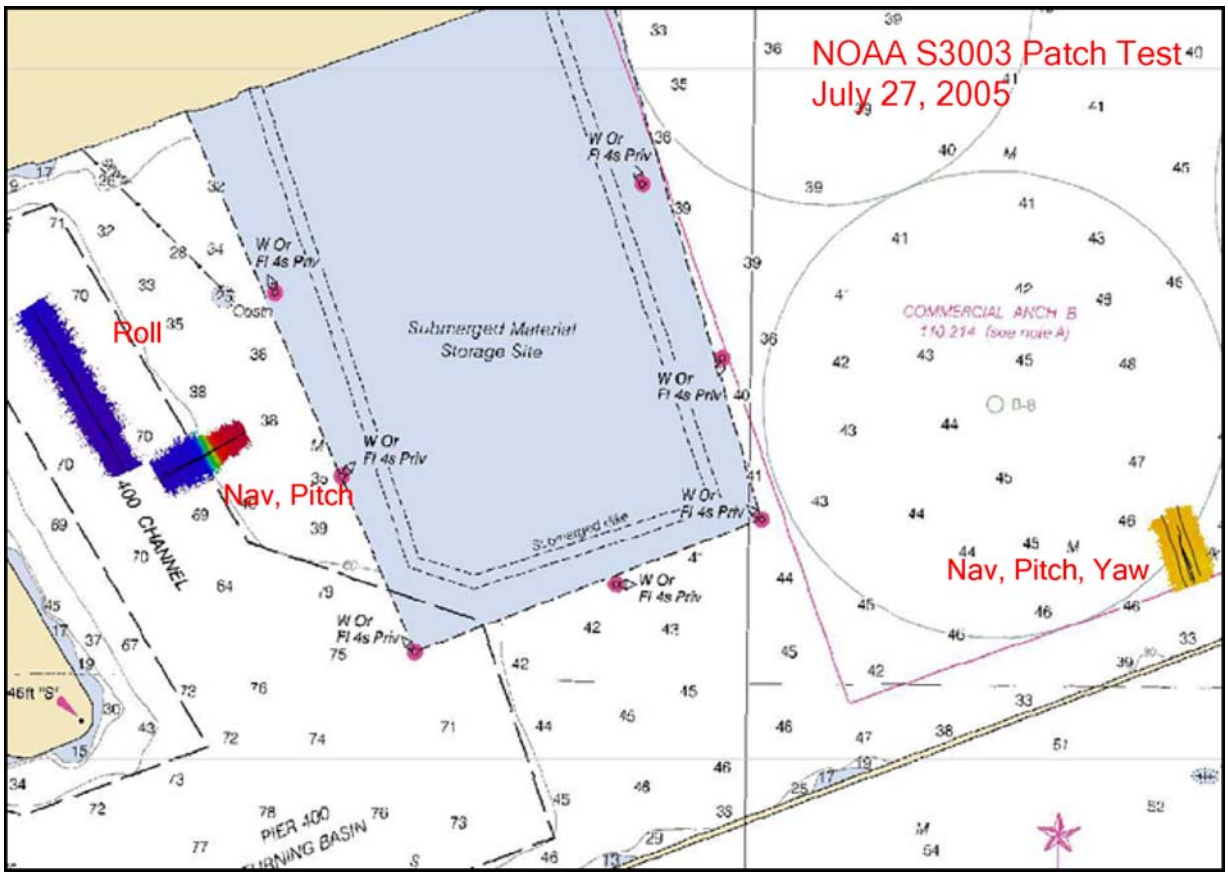
NOAA survey launch S3003 is a multi-purpose survey platform capable of acquiring multibeam bathymetry using a Kongsberg Simrad EM 3000 shallow-water multibeam echosounder system. The transducer is pole-mounted on the forward starboard deck of the launch. Biases due to misalignment of the sonar were assessed in Caris HIPS Calibration mode and entered into the Caris vessel configuration file NRT6_S3003_EM3000.

Location, Date and Personnel:

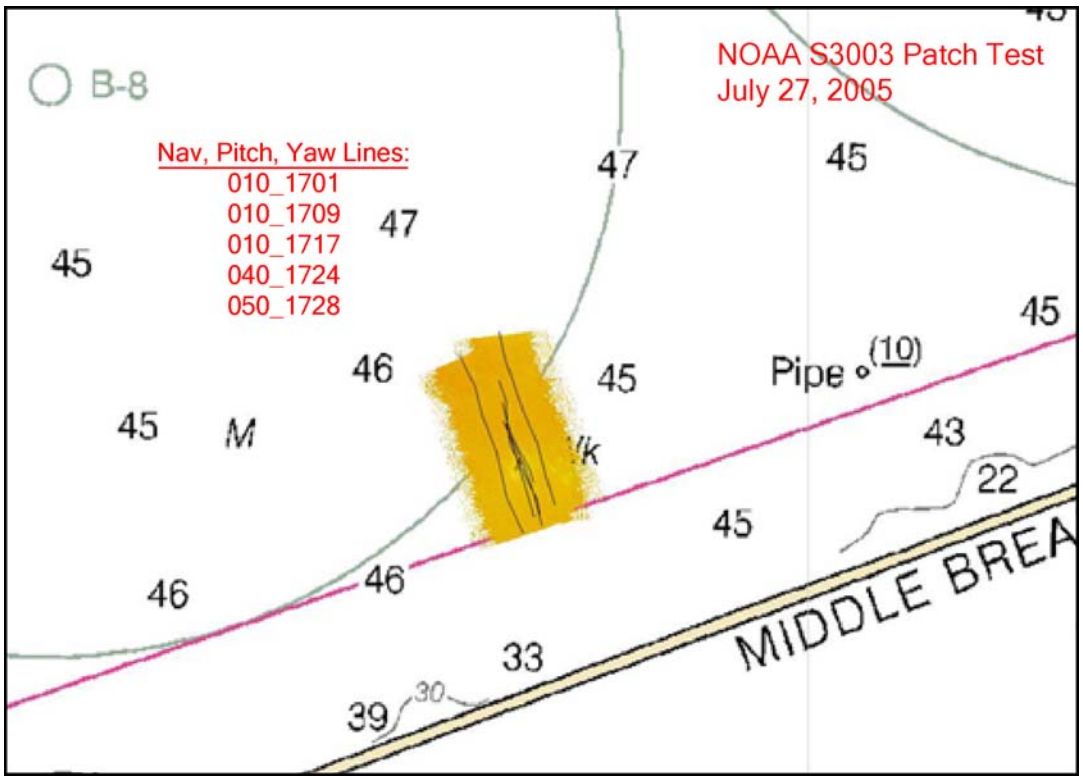
The patch test was performed near the Port of Los Angeles in San Pedro Bay, CA on July 27, 2005, DN 208 (approximate position: 118° 14’ 00.00”W 33° 43’ 00.00”N). Personnel included NRT6 team members Kurt Brown, Edmund Wernicke, and Julia Uhlendorf.

Reference surfaces included a charted wreck, a bounded slope and a flat area. The wreck was a distinctive feature rising off the bottom approximately one meter. The bounded slope was the edge of a dredged channel with an approximate slope of 23 degrees. The flat surface was the bottom of a dredged channel approximately 21 meters in depth.

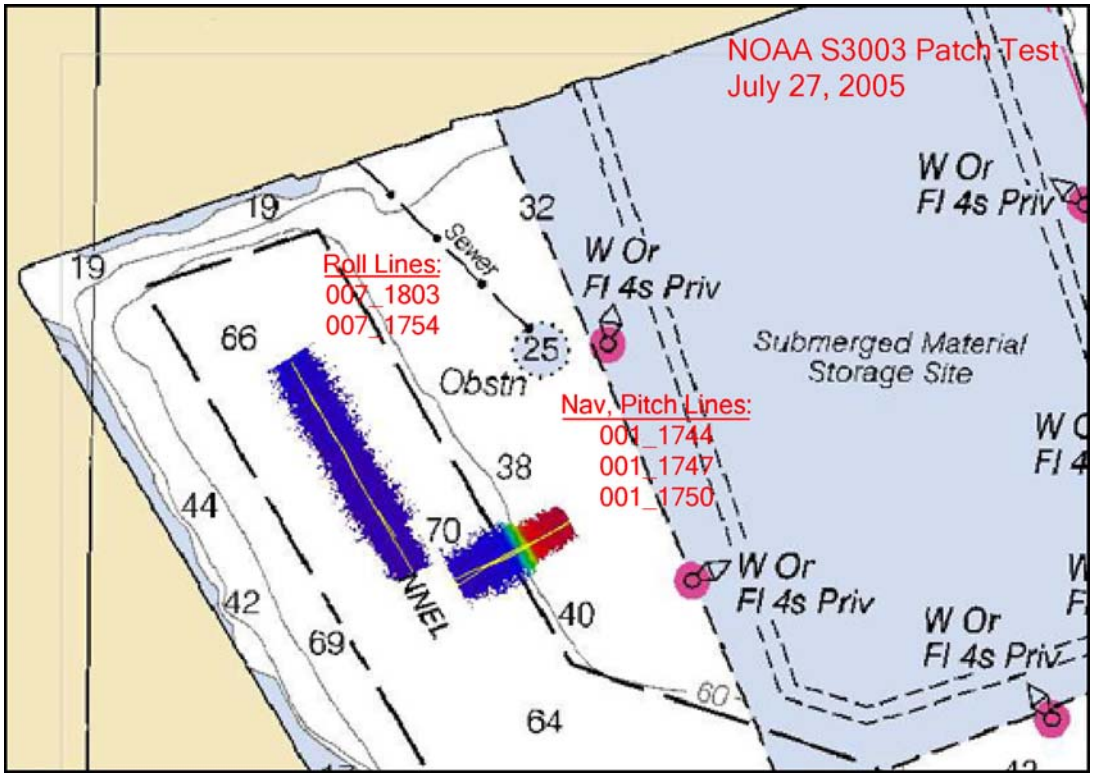
The locations of each test area are as follows:



Overall acquisition area for S3003 Patch Test



Charted wreck used for Navigation Time, Pitch and Yaw test



Bounded slope and flat area used for Navigation Time, Pitch, and Roll test

Equipment:

Kongsberg Simrad EM 3000 multibeam echosounder
Applanix POS MV 320 Inertial Measurement Unit
Trimble DSM 212H DGPS receiver
Seacat SBE19 Plus SV profiler

Procedure:

Lines for navigation time error and pitch were run in two separate areas to increase the accuracy in assessing these errors. Lines 010_1701 and 001_1744 were used for both navigation time and pitch error. One set of lines each were run for yaw and roll biases. The procedures for running lines are as follows.

Navigation Time Error: Two coincident lines were run in the same direction at two different speeds over the wreck and on the bounded slope. Lines were run at approximately 3 and 6 knots. The upper speed was limited by the maximum speed the survey launch could be driven without inducing vibration in the multibeam arm.

Pitch: Two coincident lines were run in opposite directions at the same speed over the wreck and on the bounded slope.

Roll: Two coincident lines were run in opposite directions at the same speed over the flat area approximately 21 meters deep.

Yaw: Two offset lines were run in the same direction and at the same speed approximately fifteen meters on either side of the wreck. The wreck was seen in the outer beams for both starboard and port sides.

The following table lists the lines run and area for each procedure.

Test Type	Lines Run					
	On Wreck		On Slope		On Flat	
Navigation/Time	010_1701	010_1709	001_1744	001_1750		
Pitch	010_1701	010_1717	001_1744	001_1747		
Roll					007_1754	007_1803
Yaw	040_1724	050.1728				

Processing procedures:

Data were processed twice by NRT6 personnel Kurt Brown and Julia Uhlendorf. Final offset values represent the average of these two procedures.
All biases were determined in the Caris calibration mode. Navigation time, pitch, roll and heading error values in the Caris vessel configuration file NRT6_S3003_EM3000 were

set to zero before the calibration process was started. After initially converting the data, tide and SVP were applied and the data was merged. The lines were then processed for error values in calibration mode in the following order: navigation time, pitch, roll and finally heading. Error values were entered into the vessel configuration file after each calibration procedure and lines were remerged before beginning the next calibration procedure.

Navigation Time: The lines run over the wreck and on the bounded slope were reviewed in Caris calibration mode at the nadir beams of the swath for an along track displacement of soundings. The data was reviewed in several different areas in both cases and the time error adjusted until no offset was noticed in the sounding data. Error values varied from 0.68 to 0.81 across both test areas and review by two people. A final average error value of 0.76 was computed.

Pitch: The lines run in opposite directions over the wreck and on the bounded slope were reviewed in Caris calibration mode at the nadir beams of the swath for an along track displacement of soundings. The data was reviewed in several different areas in both cases and the pitch error adjusted until no offset was noticed in the sounding data. Error values varied from 1.1 to 1.7 across both test areas and review by two people. A final average error value of 1.45 was computed.

Roll: The two lines run in opposite directions over the flat area were reviewed in Caris calibration mode at the outer beams of the swath for an across track displacement of soundings. The data was reviewed in several different areas and the roll error adjusted until no offset was noticed in the sounding data. Error values varied from .07 to .11 over the test areas and review by two people. A final average error value of .09 was computed.

Heading: The two heading bias lines run over the wreck were reviewed in Caris calibration mode for along track displacements of soundings. The data was reviewed in several different areas and the heading error adjusted until no offset was noticed in the sounding data. Error values varied from 3.4 to 3.8 over the test area and review by two people. A final average error value of 3.6 was computed.

Results:

The following table lists the final values obtained in the calibration process.

Bias Type	Final Error Value
Navigation Time	0.760
Pitch	1.450
Roll	0.090
Yaw	3.600

These values have been entered into the Caris vessel configuration file NRT6_S3003_EM3000.

NOAA Survey Launch S3003
Lead Line Calibration Report
Navigation Response Team Six

Lead Line & Sounding Pole Calibration Report		
Lead Line / Sounding Pole Identification Number: (Unique Identifier, with equipment type, date made, etc.) #1		
Date of Calibration: 10/5/05		
Method of Calibration: ☑ Steel tape ☐ Permanent graduation marks ☐ Other		
Location: Long Beach, CA		
Platform, Vessel, or Party: S3003, NRT6		
Chief of Party: ☐ Commanding Officer ☑ Team Leader ☐ Lead Hydrographer Kurt Brown		
Lead Line / Sounding Pole Unit of Measure: Meters (This should always be meters!)		
Measured by: Ed Wernicke	Recorded by: Julia Uhlendorf	Checked by: Julia Uhlendorf
Graduated Marking (a)	Calibration Measurement (b)	Lead Line Corrector (c = b - a)
0.00	0.00	0.00
1.00	1.00	0.00
2.00	1.99	-0.01
3.00	2.98	-0.02
4.00	3.97	-0.03
5.00	4.96	-0.04
6.00	5.95	-0.05
7.00	6.94	-0.06
7.50	7.44	-0.06

Appendix II

1. Sea-Bird Electronics SBE 19+ CTD Profiler Serial No. 4676 – Calibration Report
2. Odom Digibar Pro Serial No. 98213 – Calibration Report
3. Odom Digibar Pro Serial No. 98214 – Calibration Report

Sea-Bird Electronics SBE 19+ CTD Profiler Serial No. 4676- Calibration Report

FROM : FAX NO. : Jul. 11 2005 03:41PM P2

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: 4676
CALIBRATION DATE: 03-Sep-04

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.252205e-003
a1 = 2.641777e-004
a2 = -1.553069e-007
a3 = 1.591276e-007

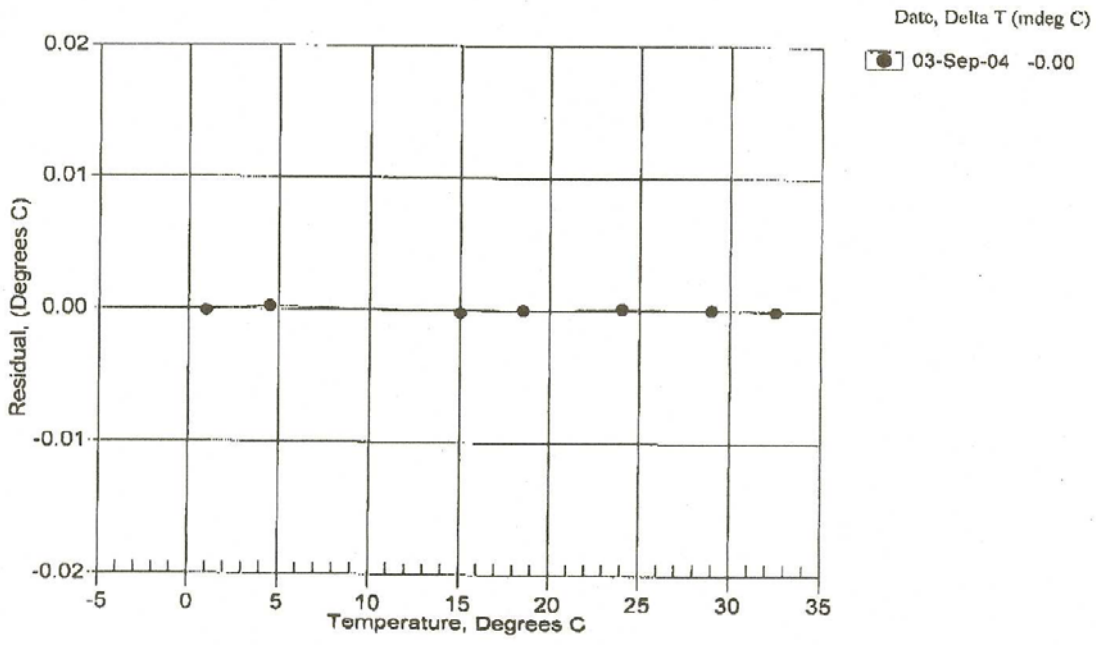
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	610669.279	0.9999	-0.0001
4.5000	541966.502	4.5002	0.0002
15.0000	371806.046	14.9998	-0.0002
18.5000	326185.323	18.5000	-0.0000
24.0000	264295.417	24.0001	0.0001
29.0000	217217.702	29.0000	0.0000
32.5000	188793.425	32.4999	-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 = $1/\{a0 + a1[ln(R)] + a2[ln^2(R)] + a3[ln^3(R)]\} - 273.15$ (°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: 4676
CALIBRATION DATE: 03-Sep-04

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

COEFFICIENTS:

g = -1.044412e+000
h = 1.334792e-001
i = -1.527031e-004
j = 2.857296e-005

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

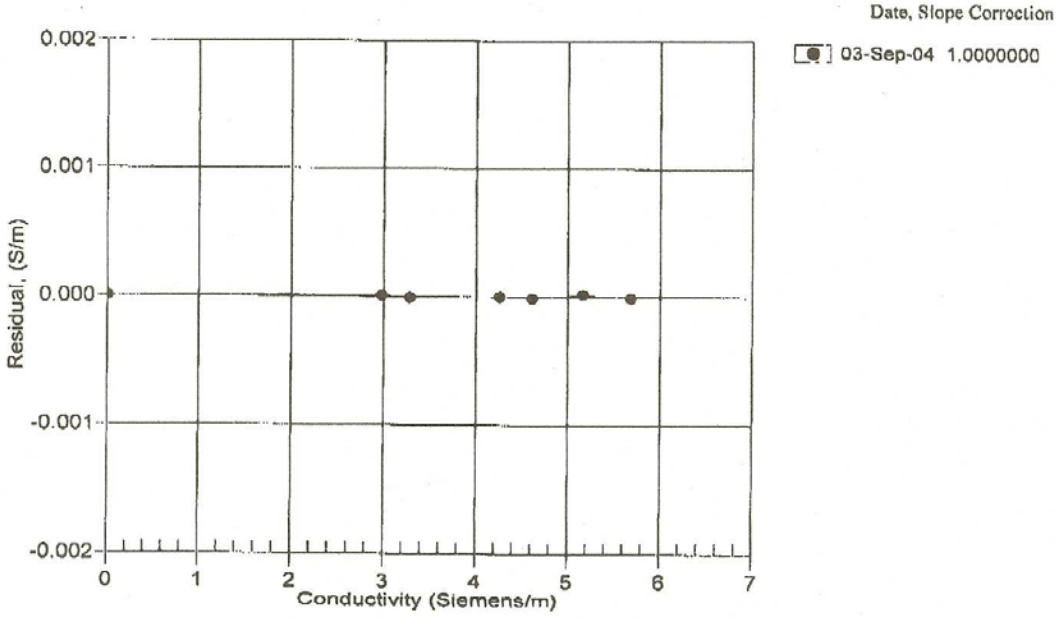
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2799.37	0.0000	0.00000
1.0000	34.7690	2.97231	5485.22	2.9723	0.00001
4.5000	34.7490	3.27900	5690.06	3.2790	-0.00001
15.0000	34.7054	4.25945	6299.68	4.2594	0.00000
18.5000	34.6962	4.60415	6500.15	4.6041	-0.00001
24.0000	34.6860	5.16138	6811.50	5.1614	0.00002
29.0000	34.6804	5.68256	7089.99	5.6826	-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: 4676
CALIBRATION DATE: 09-Sep-04

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 6134

COEFFICIENTS:

PA0 =	3.372359e-002	PTCA0 =	5.154841e+005
PA1 =	1.542930e-003	PTCA1 =	3.028947e+000
PA2 =	6.247656e-012	PTCA2 =	-1.022479e-001
PTEMPA0 =	-7.582059e+001	PTCB0 =	2.441038e+001
PTEMPA1 =	4.802333e+001	PTCB1 =	-1.925000e-003
PTEMPA2 =	-2.454645e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.62	524930.0	2.1	14.61	-0.00
99.73	579980.0	2.1	99.72	-0.00
199.73	644622.0	2.1	199.70	-0.00
299.72	709232.0	2.1	299.69	-0.01
404.71	777036.0	2.1	404.69	-0.00
504.70	841594.0	2.1	504.70	-0.00
404.71	777070.0	2.1	404.74	0.01
299.72	709264.0	2.1	299.75	0.00
199.72	644652.0	2.1	199.75	0.01
99.72	579987.0	2.1	99.73	0.00
14.62	524951.0	2.1	14.64	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.28	525143.93
29.00	2.21	525154.32
24.00	2.10	525169.22
18.50	1.98	525173.69
15.00	1.91	525175.73
4.50	1.69	525164.22
1.00	1.61	525157.11

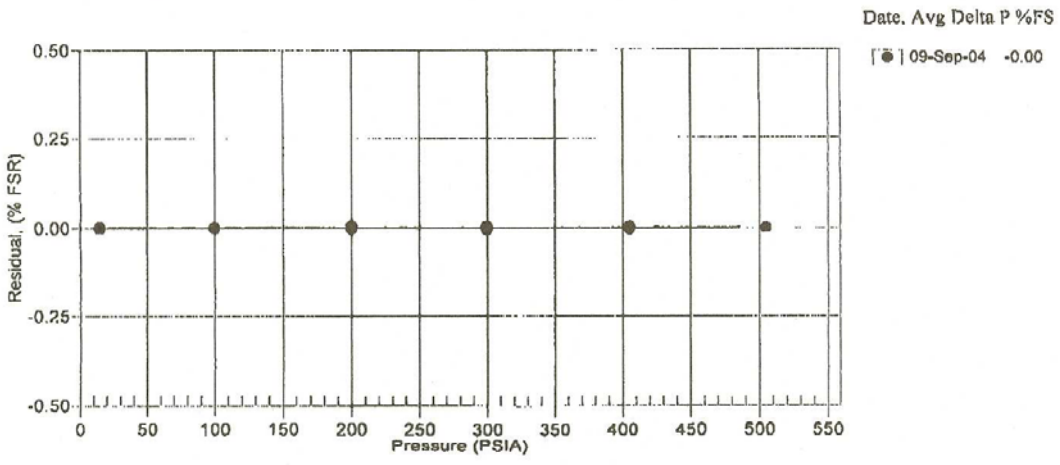
TEMP(ITS90)	SPAN(mV)
-5.00	24.42
35.00	24.34

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



Odom Digibar Pro Serial No. 98213-Calibration Report

Date:
Oct 06, 2004

Serial #:
SN:98213-100604

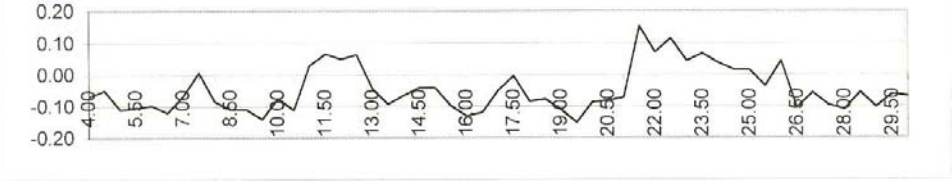
DIGIBAR CALIBRATION REPORT

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	5551.10	1421.55	-0.07	17.50	1474.38	5752.10	1474.38	0.00
4.50	1423.90	5559.84	1423.85	-0.05	18.00	1476.01	5757.99	1475.93	-0.08
5.00	1426.15	5568.18	1426.04	-0.11	18.50	1477.62	5764.14	1477.54	-0.08
5.50	1428.38	5576.67	1428.27	-0.10	19.00	1479.21	5770.05	1479.09	-0.11
6.00	1430.58	5585.07	1430.48	-0.10	19.50	1480.77	5775.85	1480.62	-0.15
6.50	1432.75	5593.25	1432.63	-0.12	20.00	1482.32	5781.98	1482.23	-0.09
7.00	1434.90	5601.63	1434.83	-0.07	20.50	1483.84	5787.80	1483.76	-0.08
7.50	1437.02	5609.98	1437.03	0.01	21.00	1485.35	5793.56	1485.27	-0.07
8.00	1439.12	5617.61	1439.03	-0.08	21.50	1486.83	5800.06	1486.98	0.15
8.50	1441.19	5625.39	1441.08	-0.11	22.00	1488.29	5805.32	1488.36	0.07
9.00	1443.23	5633.18	1443.12	-0.11	22.50	1489.74	5810.98	1489.85	0.11
9.50	1445.25	5640.75	1445.11	-0.14	23.00	1491.16	5816.13	1491.20	0.04
10.00	1447.25	5648.60	1447.18	-0.07	23.50	1492.56	5821.56	1492.63	0.07
10.50	1449.22	5655.96	1449.11	-0.11	24.00	1493.95	5826.72	1493.99	0.04
11.00	1451.17	5663.91	1451.20	0.03	24.50	1495.32	5831.83	1495.33	0.02
11.50	1453.09	5671.37	1453.16	0.07	25.00	1496.66	5836.95	1496.68	0.01
12.00	1454.99	5678.54	1455.05	0.05	25.50	1497.99	5841.81	1497.95	-0.04
12.50	1456.87	5685.73	1456.94	0.06	26.00	1499.30	5847.09	1499.34	0.04
13.00	1458.72	5692.37	1458.68	-0.04	26.50	1500.59	5851.43	1500.48	-0.11
13.50	1460.55	5699.15	1460.46	-0.09	27.00	1501.86	5856.45	1501.80	-0.06
14.00	1462.36	5706.13	1462.30	-0.06	27.50	1503.11	5861.07	1503.01	-0.10
14.50	1464.14	5713.01	1464.10	-0.04	28.00	1504.35	5865.71	1504.23	-0.11
15.00	1465.91	5719.71	1465.87	-0.04	28.50	1505.56	5870.55	1505.51	-0.06
15.50	1467.65	5726.11	1467.55	-0.10	29.00	1506.76	5874.93	1506.66	-0.10
16.00	1469.36	5732.52	1469.23	-0.13	29.50	1507.94	5879.58	1507.88	-0.06
16.50	1471.06	5739.01	1470.94	-0.12	30.00	1509.10	5883.98	1509.04	-0.07
17.00	1472.73	5745.64	1472.68	-0.05					



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

Date:
Oct 06, 2004

Serial #:
SN:98213

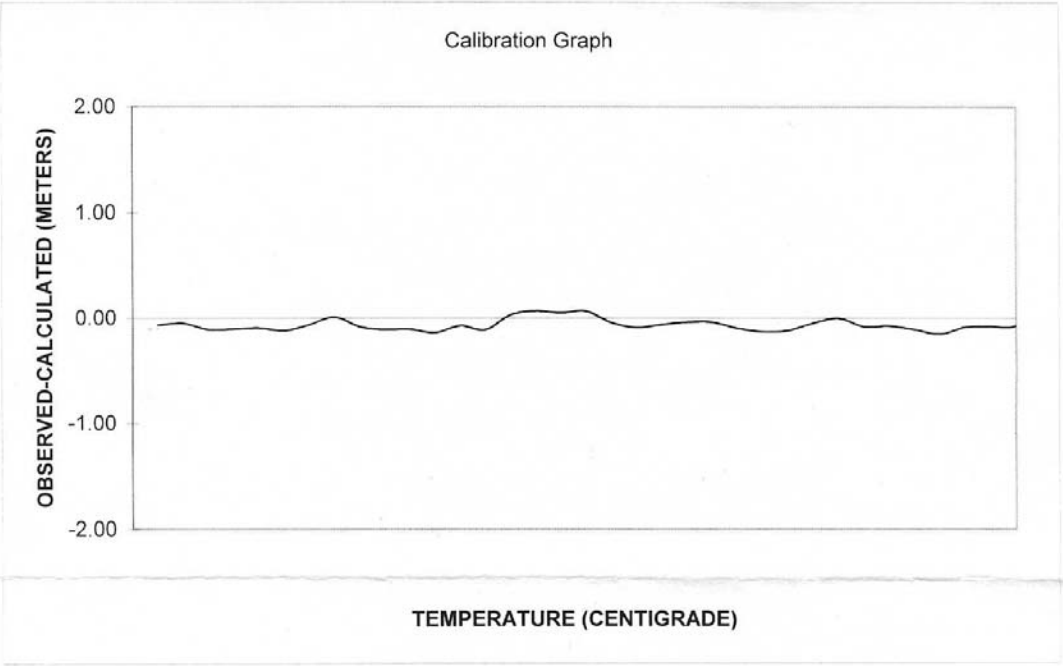
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

Burn these numbers to EPROM:

Gradient	**3364**
Intercept	**373**



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

Odom Digibar Pro Serial No. 98214-Calibration Report

NRT-6

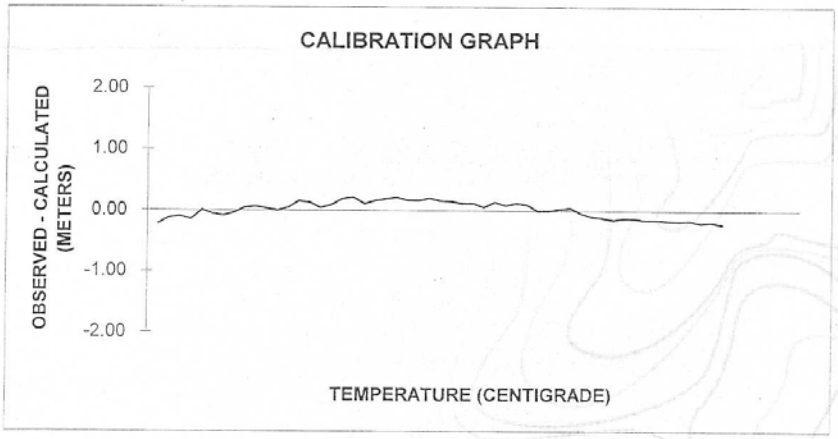
odom
HYDROGRAPHIC SYSTEMS

1450 Seaboard Avenue • Baton Rouge, Louisiana 70810-6261 USA
E-mail: email@odomhydrographic.com • http://www.odomhydrographic.com
Telephone: (225) 769-3051 • Facsimile: (225) 766-5122

8/13/2003 STANDARD DEL GROSSO H2O SERIAL# 98214-081103

TEMP	VELOCITY	MEASURED FREQUENCY	RES VEL	OBS-CAL	TEMP	VELOCITY	MEASURED FREQUENCY	RES VEL	OBS-CAL
4.0	1421.62	5539.9	1421.4	-0.22	17.5	1474.38	5746.5	1474.5	0.15
4.5	1423.90	5549.2	1423.8	-0.12	18.0	1476.01	5752.7	1476.1	0.12
5.0	1426.15	5558.0	1426.1	-0.10	18.5	1477.62	5759.0	1477.7	0.12
5.5	1428.38	5566.5	1428.2	-0.15	19.0	1479.21	5764.9	1479.3	0.05
6.0	1430.58	5575.6	1430.6	0.01	19.5	1480.77	5771.4	1480.9	0.14
6.5	1432.75	5583.9	1432.7	-0.05	20.0	1482.32	5777.2	1482.4	0.09
7.0	1434.90	5592.1	1434.8	-0.08	20.5	1483.84	5783.2	1484.0	0.12
7.5	1437.02	5600.5	1437.0	-0.04	21.0	1485.35	5789.0	1485.4	0.10
8.0	1439.12	5609.0	1439.2	0.05	21.5	1486.83	5794.3	1486.8	0.00
8.5	1441.19	5617.1	1441.3	0.06	22.0	1488.29	5800.1	1488.3	0.00
9.0	1443.23	5625.0	1443.3	0.03	22.5	1489.74	5805.8	1489.8	0.03
9.5	1445.25	5632.7	1445.3	0.00	23.0	1491.16	5811.4	1491.2	0.05
10.0	1447.25	5640.6	1447.3	0.05	23.5	1492.56	5816.5	1492.5	-0.03
10.5	1449.22	5648.7	1449.4	0.16	24.0	1493.95	5821.7	1493.9	-0.09
11.0	1451.17	5656.2	1451.3	0.13	24.5	1495.32	5826.9	1495.2	-0.11
11.5	1453.09	5663.3	1453.1	0.04	25.0	1496.66	5832.0	1496.5	-0.14
12.0	1454.99	5670.9	1455.1	0.10	25.5	1497.99	5837.3	1497.9	-0.12
12.5	1456.87	5678.6	1457.1	0.19	26.0	1499.30	5842.3	1499.2	-0.13
13.0	1458.72	5685.9	1458.9	0.22	26.5	1500.59	5847.3	1500.4	-0.15
13.5	1460.55	5692.6	1460.7	0.11	27.0	1501.86	5852.2	1501.7	-0.15
14.0	1462.36	5699.8	1462.5	0.16	27.5	1503.11	5857.1	1503.0	-0.16
14.5	1464.14	5706.9	1464.3	0.19	28.0	1504.35	5861.8	1504.2	-0.17
15.0	1465.91	5713.8	1466.1	0.22	28.5	1505.56	5866.6	1505.4	-0.16
15.5	1467.65	5720.4	1467.8	0.17	29.0	1506.76	5871.1	1506.6	-0.20
16.0	1469.36	5727.1	1469.5	0.16	29.5	1507.94	5875.7	1507.8	-0.18
16.5	1471.06	5733.8	1471.3	0.20	30.0	1509.10	5880.1	1508.9	-0.22
17.0	1472.73	5740.2	1472.9	0.16					

constants: 3292 32



Appendix III

1. S3003 Vessel Offset Measurements
2. S3003 Systems Setup Diagrams

S3003 Vessel Offset Measurements

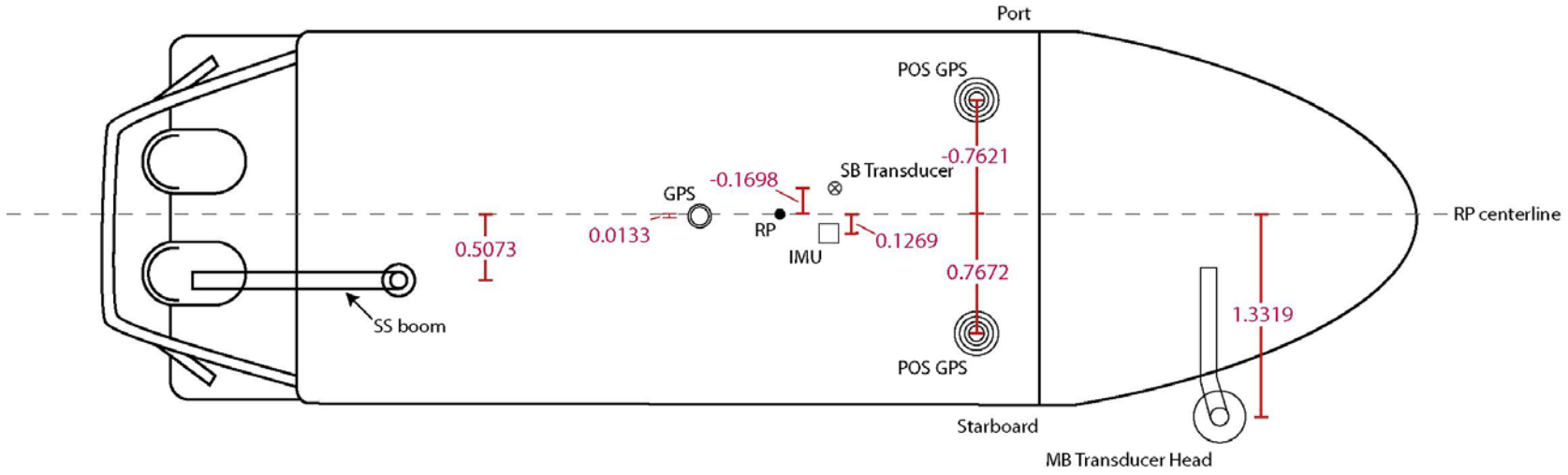
Top View

S3003 Vessel Offset Measurements

11/10/2004

Description: Aluminum Sea Ark VC Commander Survey Launch
Vessel Length: 27 feet
LOA: 32 feet

Top View



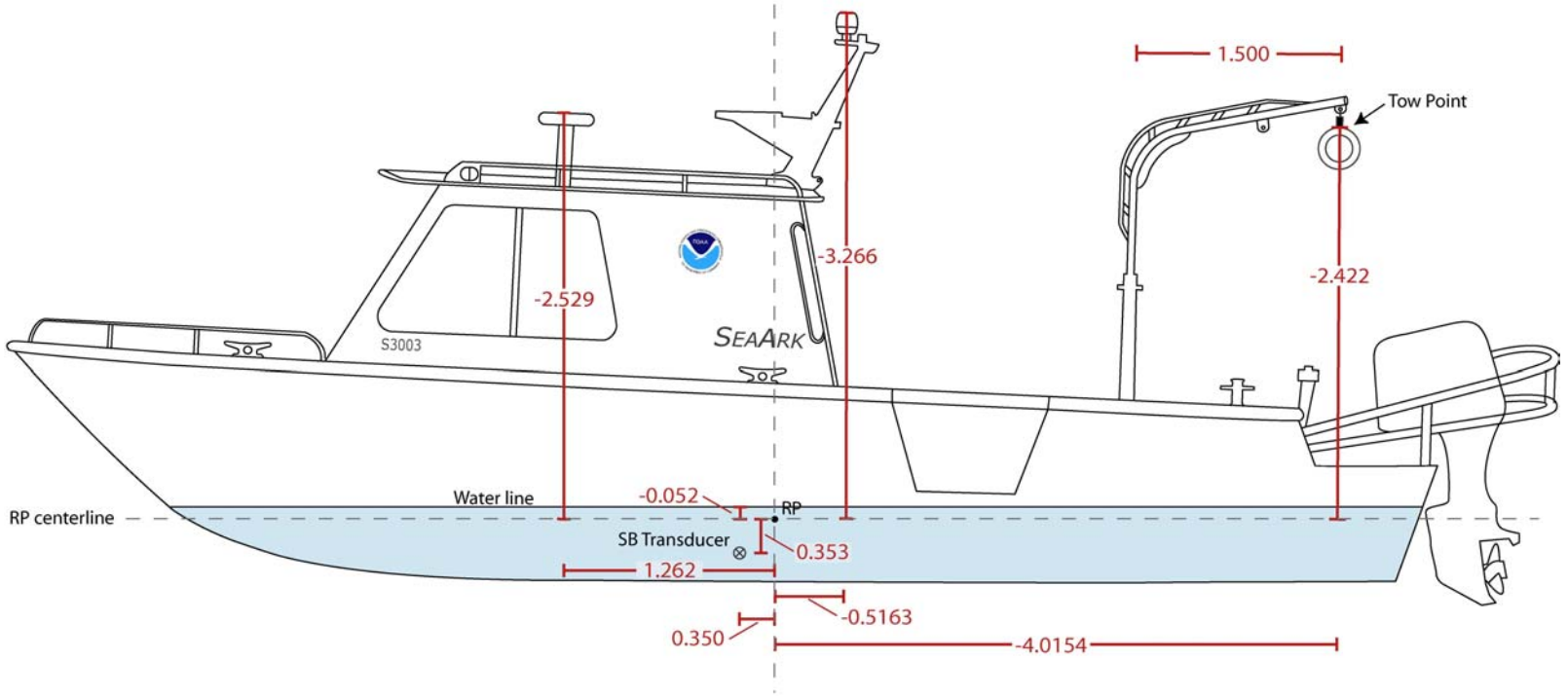
Port Side View

S3003 Vessel Offset Measurements

Port Side Singlebeam & Sidescan Sonar Systems

11/10/2004

Description: Aluminum Sea Ark VC Commander Survey Launch
Vessel Length: 27 feet
LOA: 32 feet



	meters		
	X	Y	Z
Main GPS Antenna	0.0133	-0.5163	-3.266
Port POS GPS	-0.7621	1.262	-2.529
Tow Point	0.5073	-4.0154	-2.422
Singlebeam Transducer	-0.1698	0.3505	0.353
Waterline			-0.052

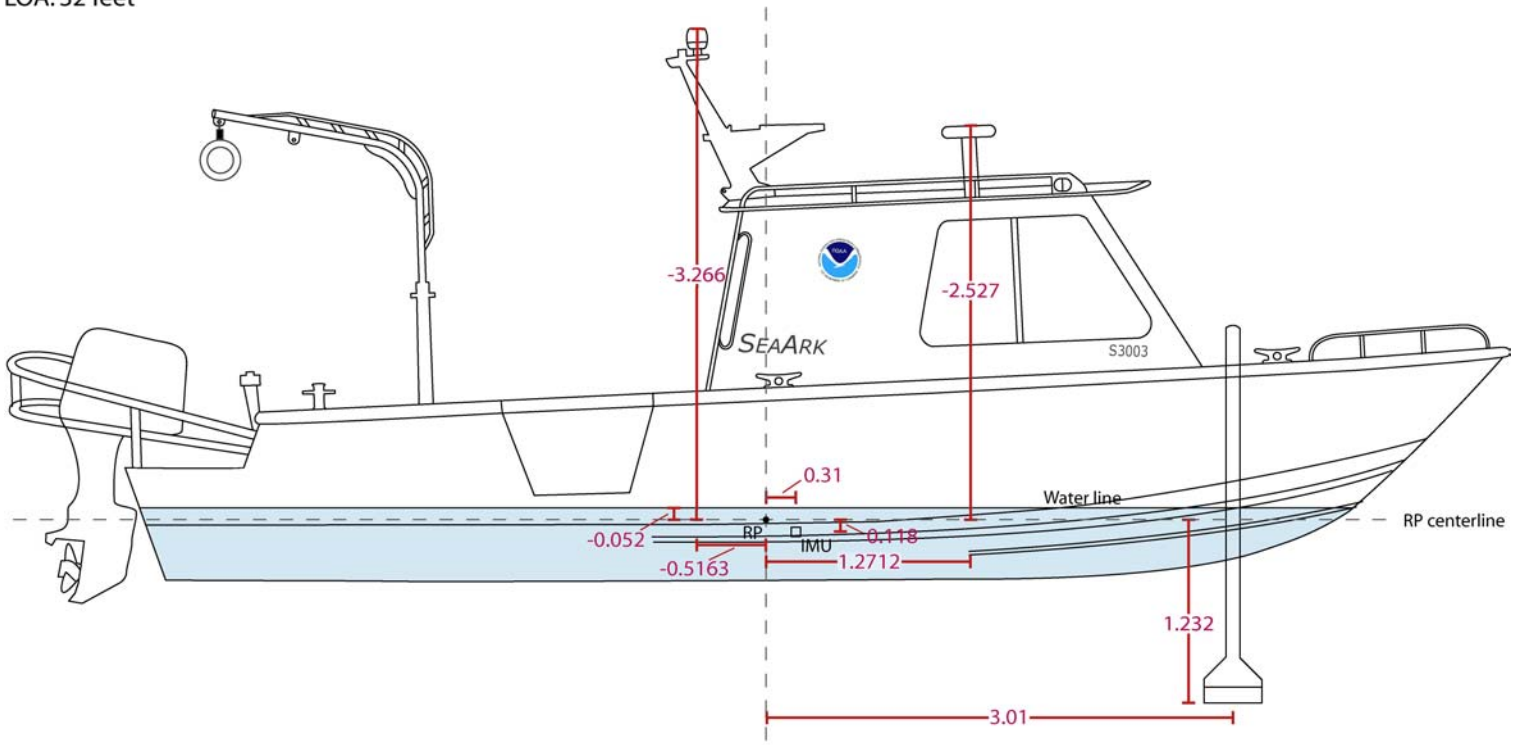
Starboard Side View

S3003 Vessel Offset Measurements

Starboard Side Multibeam System

11/10/2004

Description: Aluminum Sea Ark VC Commander Survey Launch
Vessel Length: 27 feet
LOA: 32 feet



			meters
	X	Y	Z
Main GPS Antenna	0.0133	-0.5163	-3.266
Starboard POS GPS	0.7672	1.2712	-2.527
IMU	0.1269	0.3109	0.118
SWMB Transducer	1.3319	3.0143	1.232
Waterline			-0.052

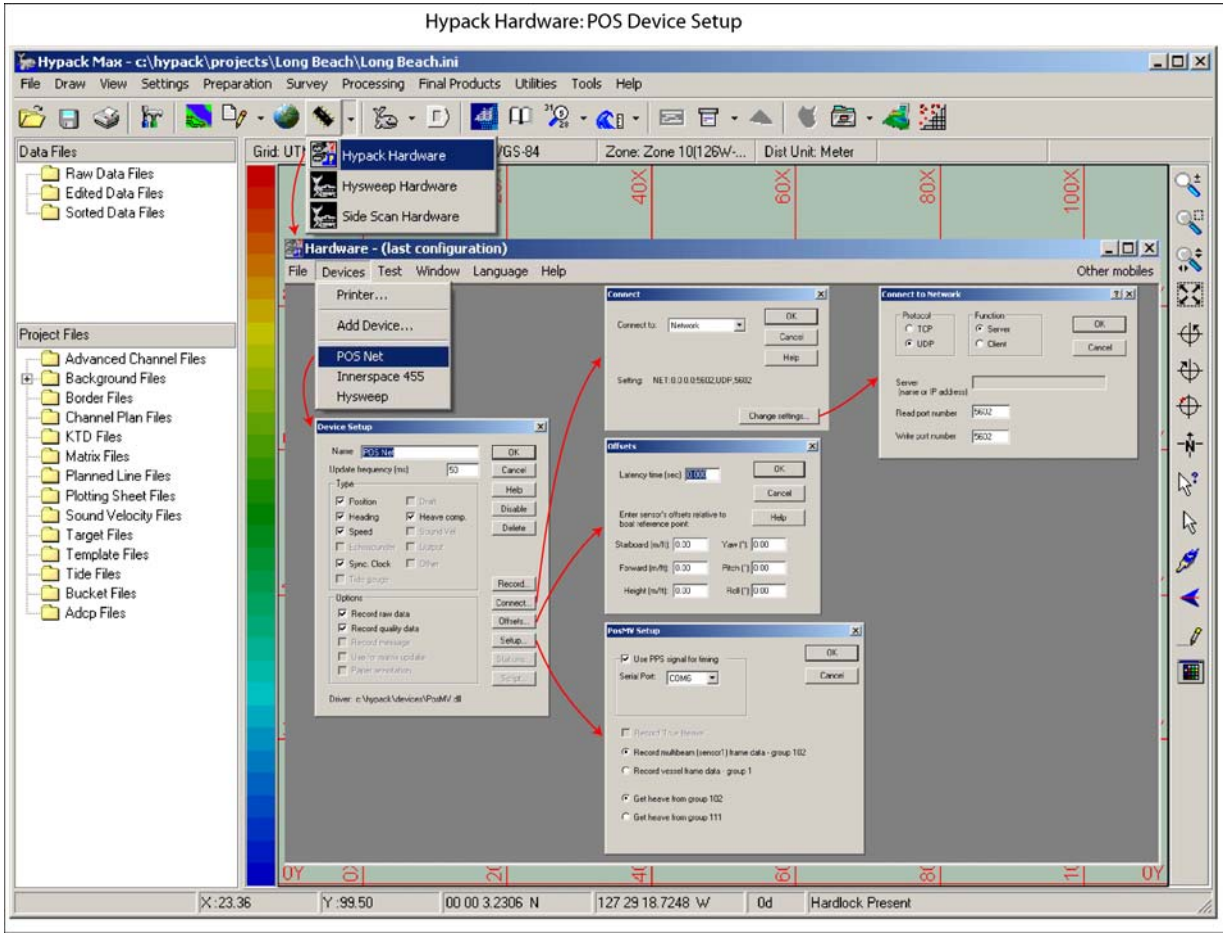
S3003 Systems Setup Diagrams

Hypack Max

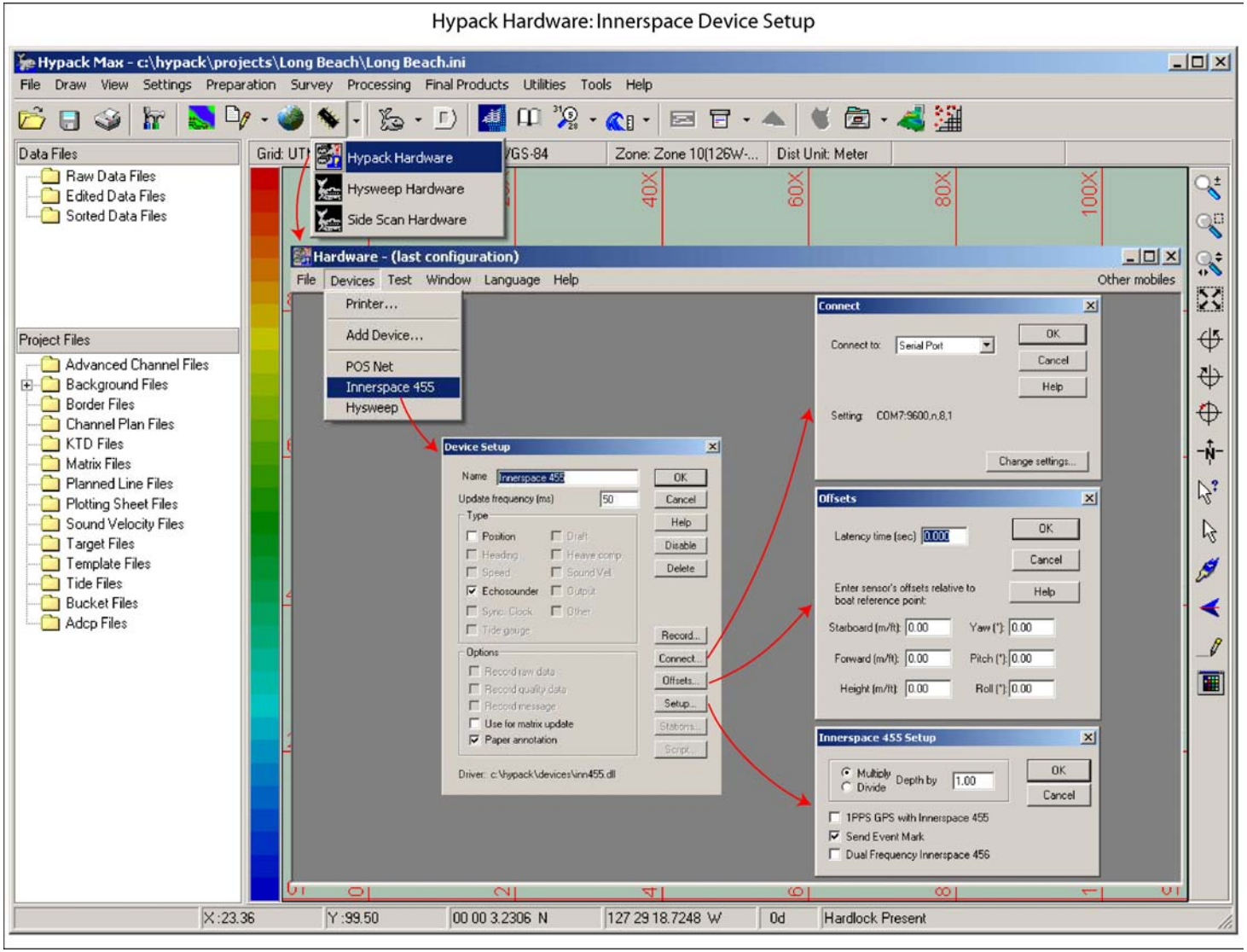
Hypack Hardware

POS Net

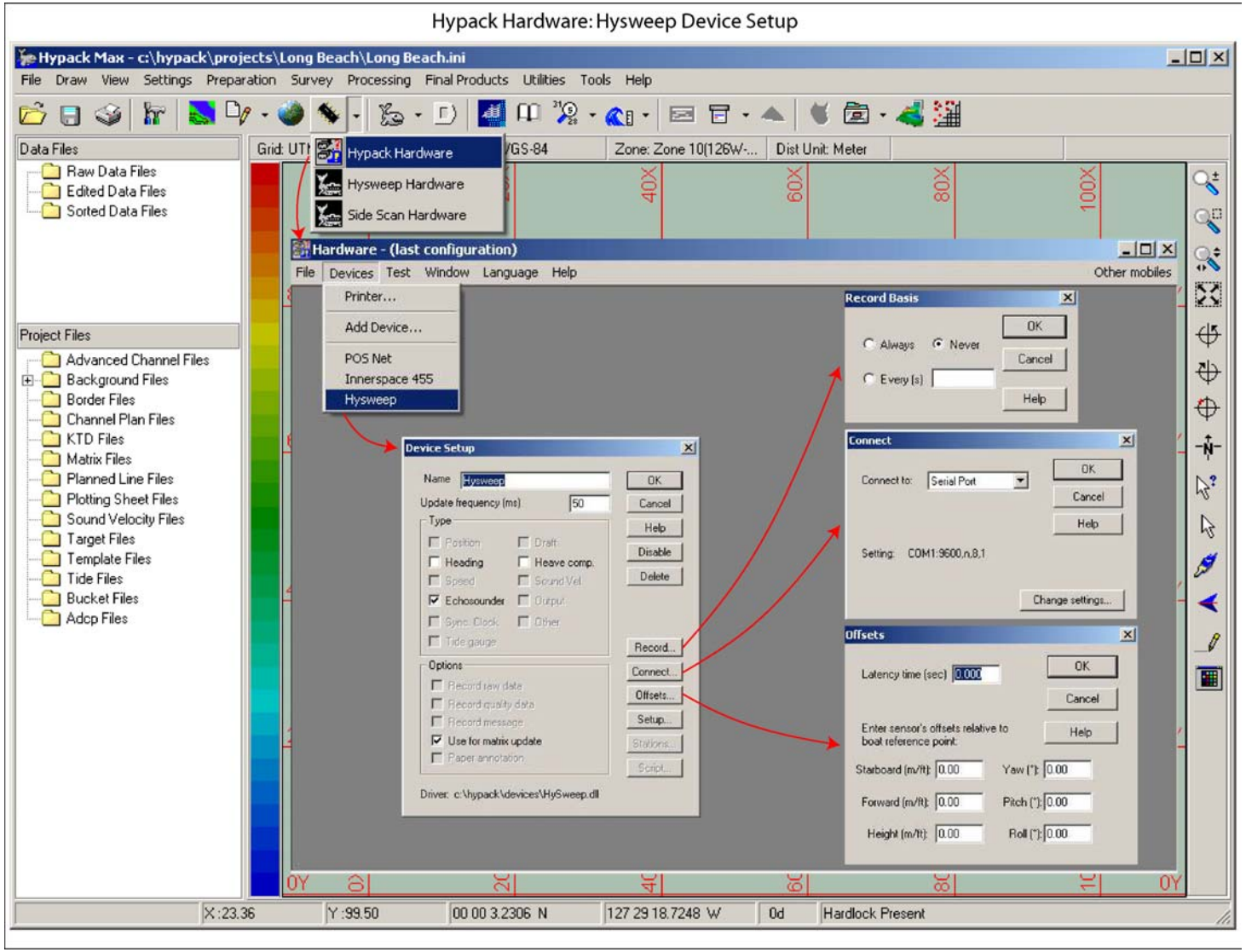
Hypack Hardware: POS Device Setup



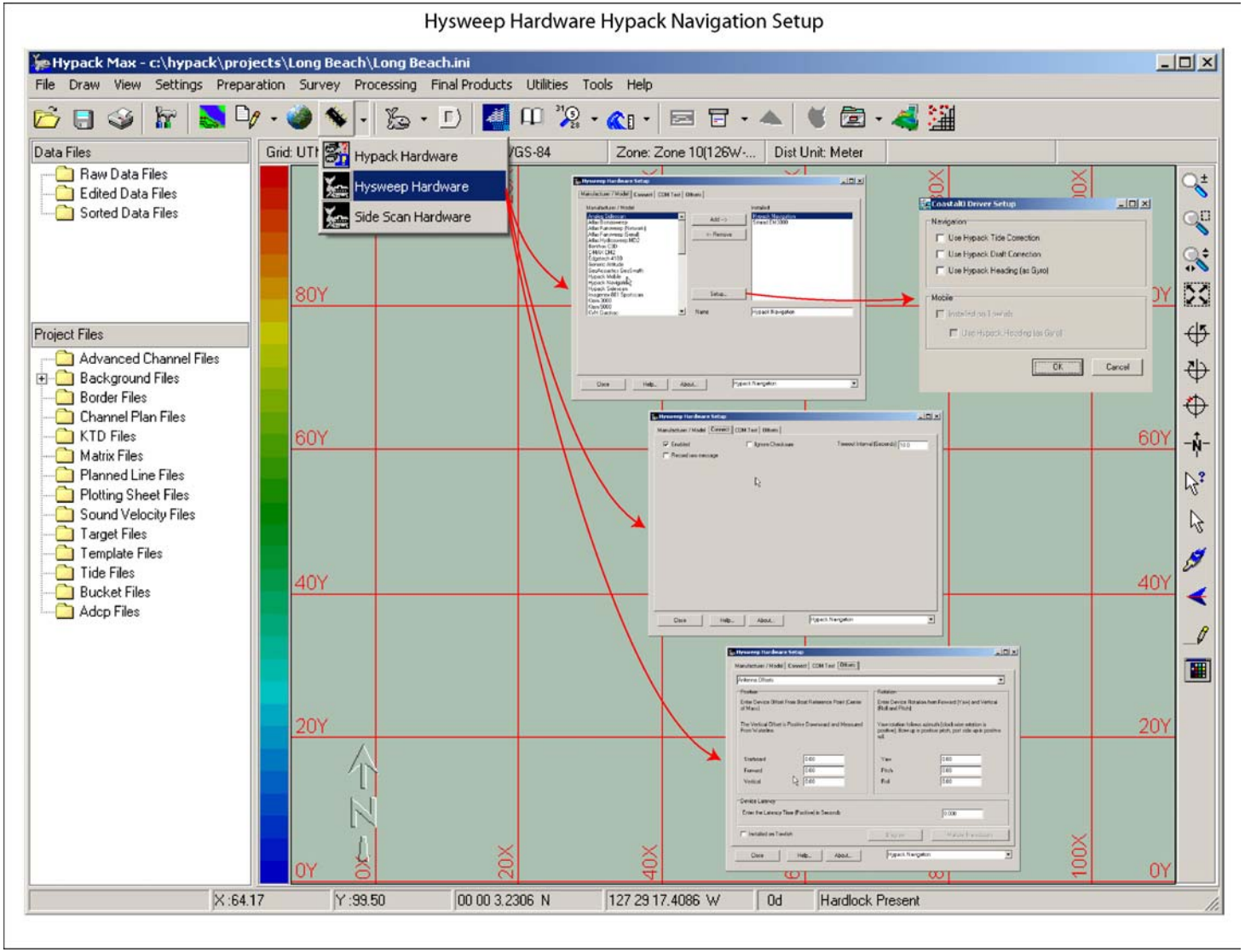
Hypack Hardware
Innerspace 455



Hypack Hardware
Hysweep

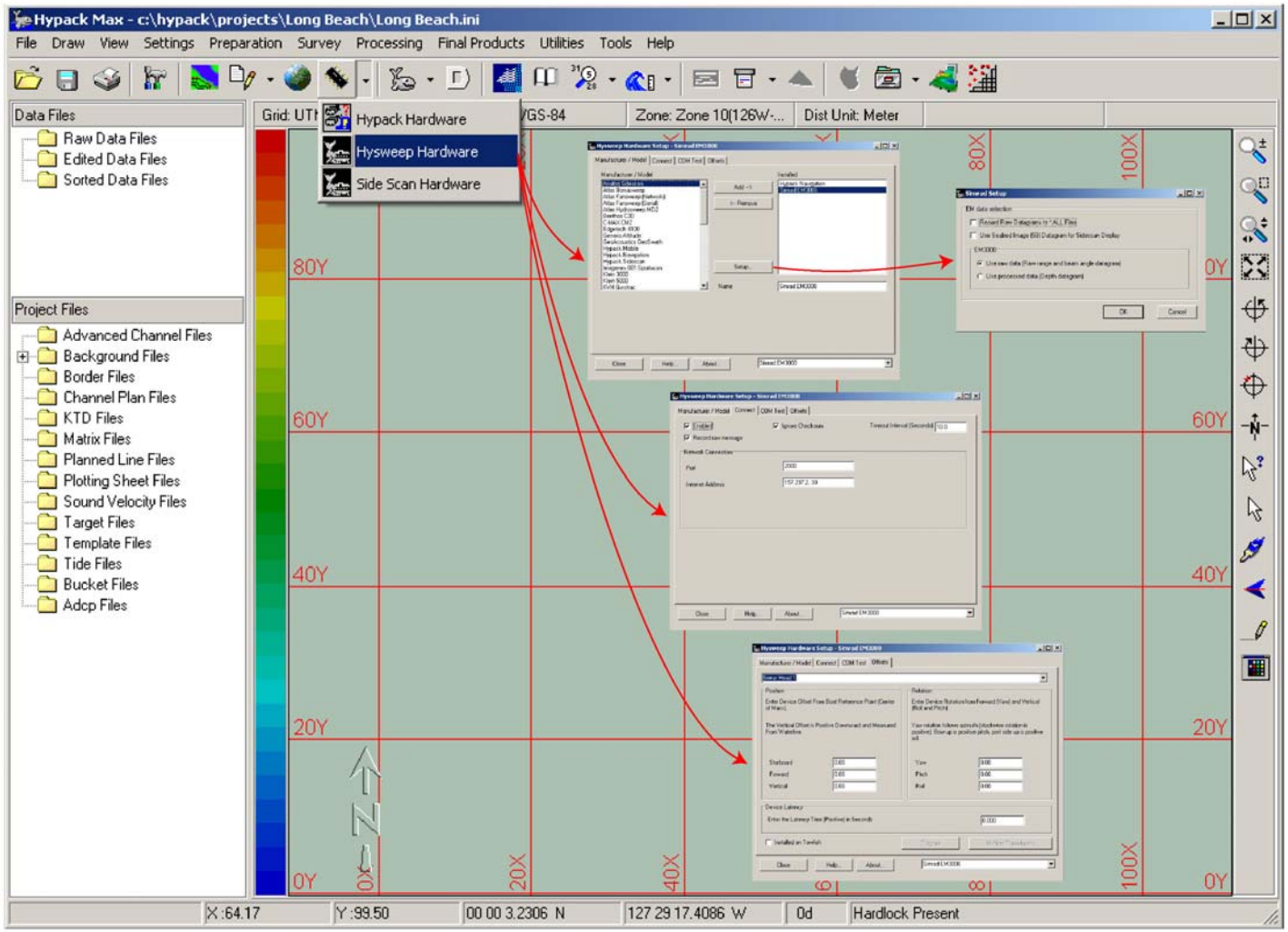


Hysweep Hardware
Hypack Navigation



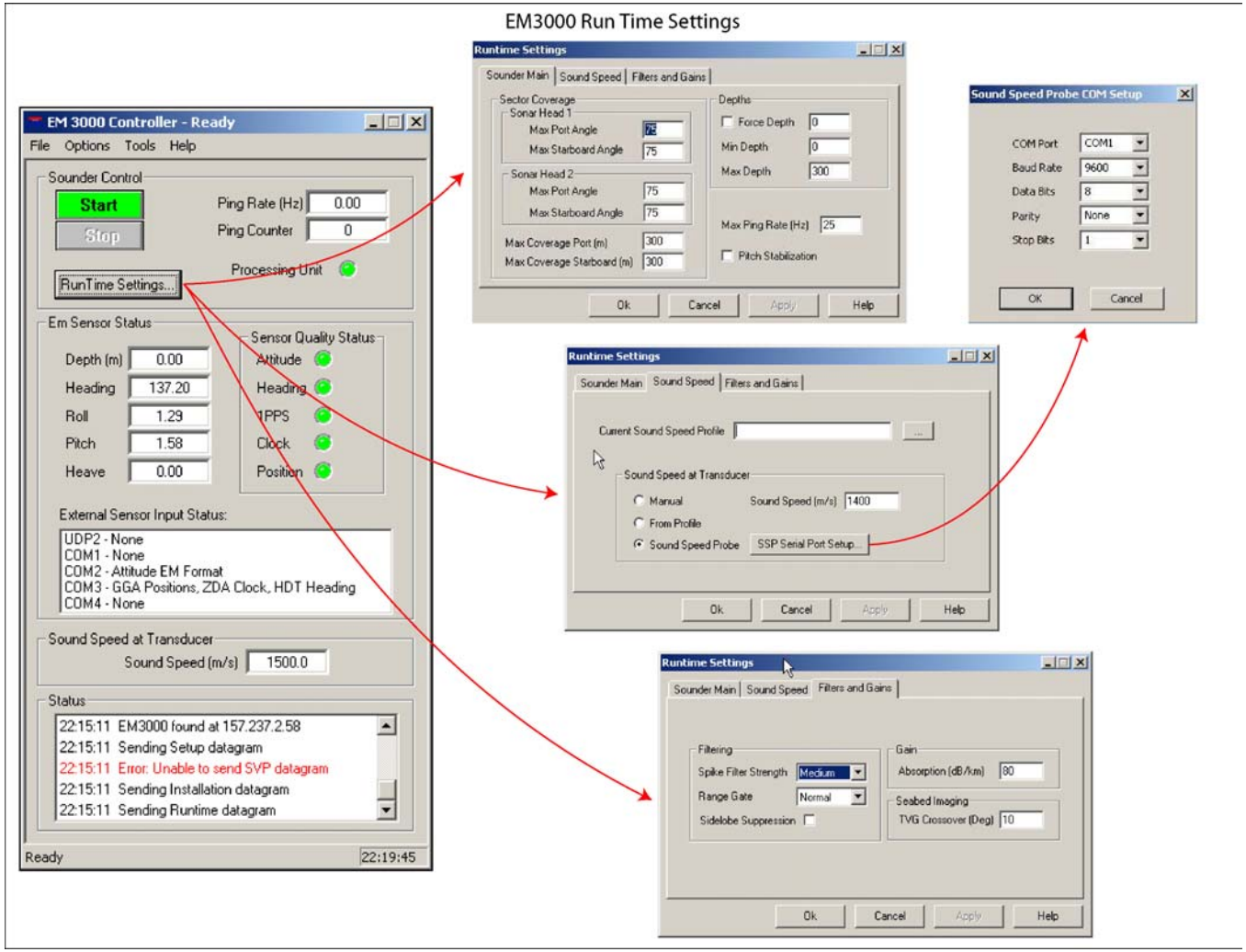
Hysweep Hardware
Simrad

Hysweep Hardware Simrad EM3000 Setup

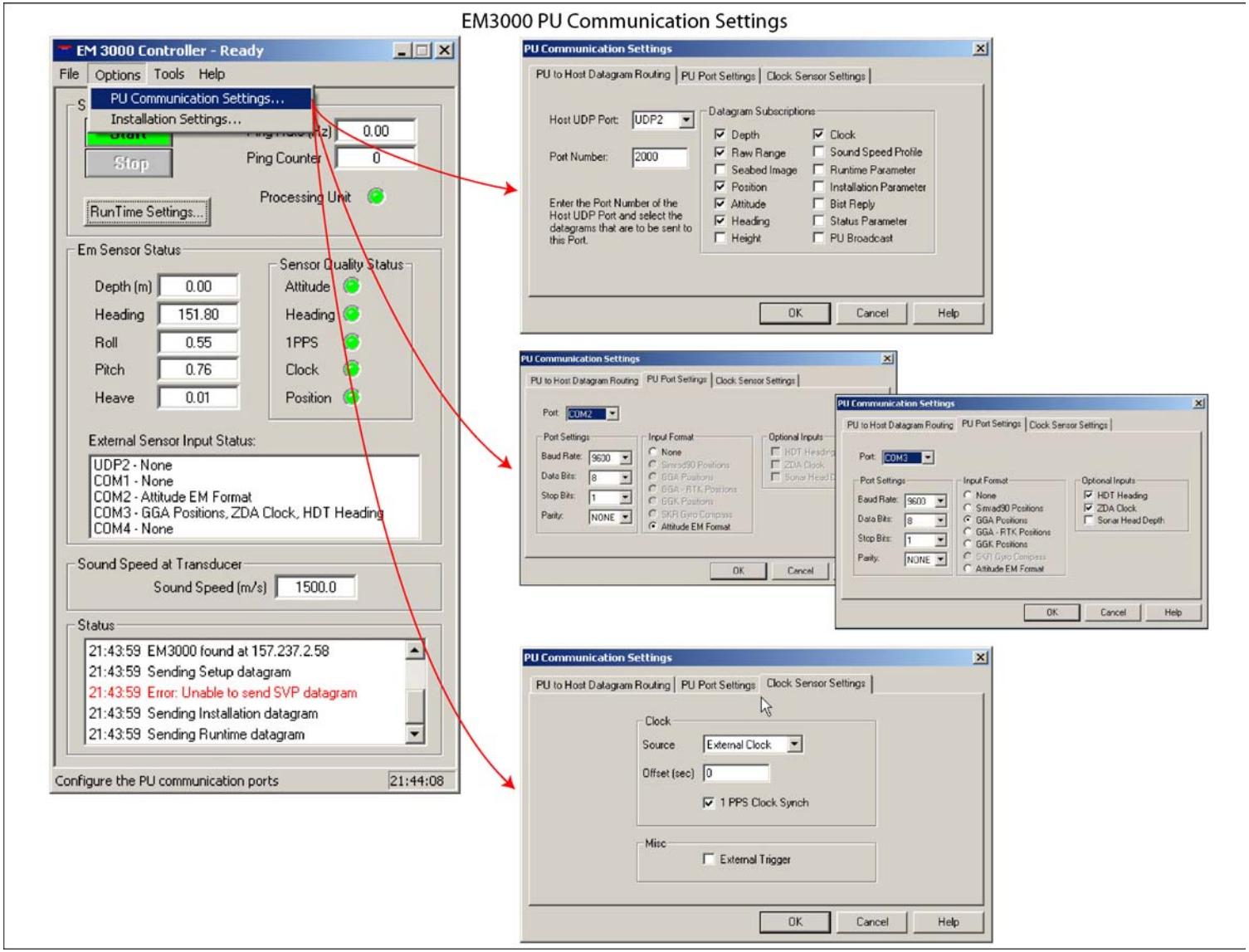


Simrad EM3000

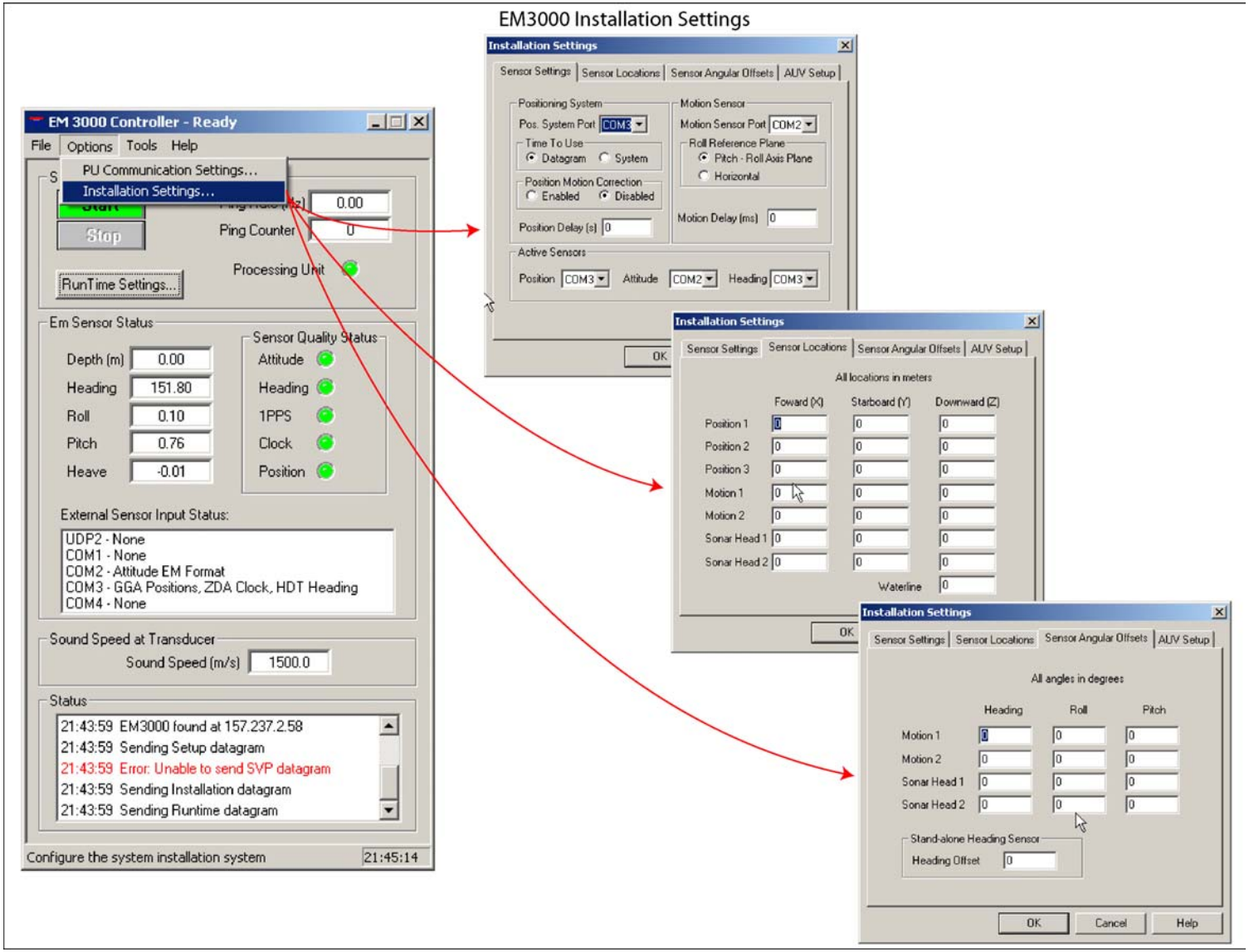
Run Time Settings



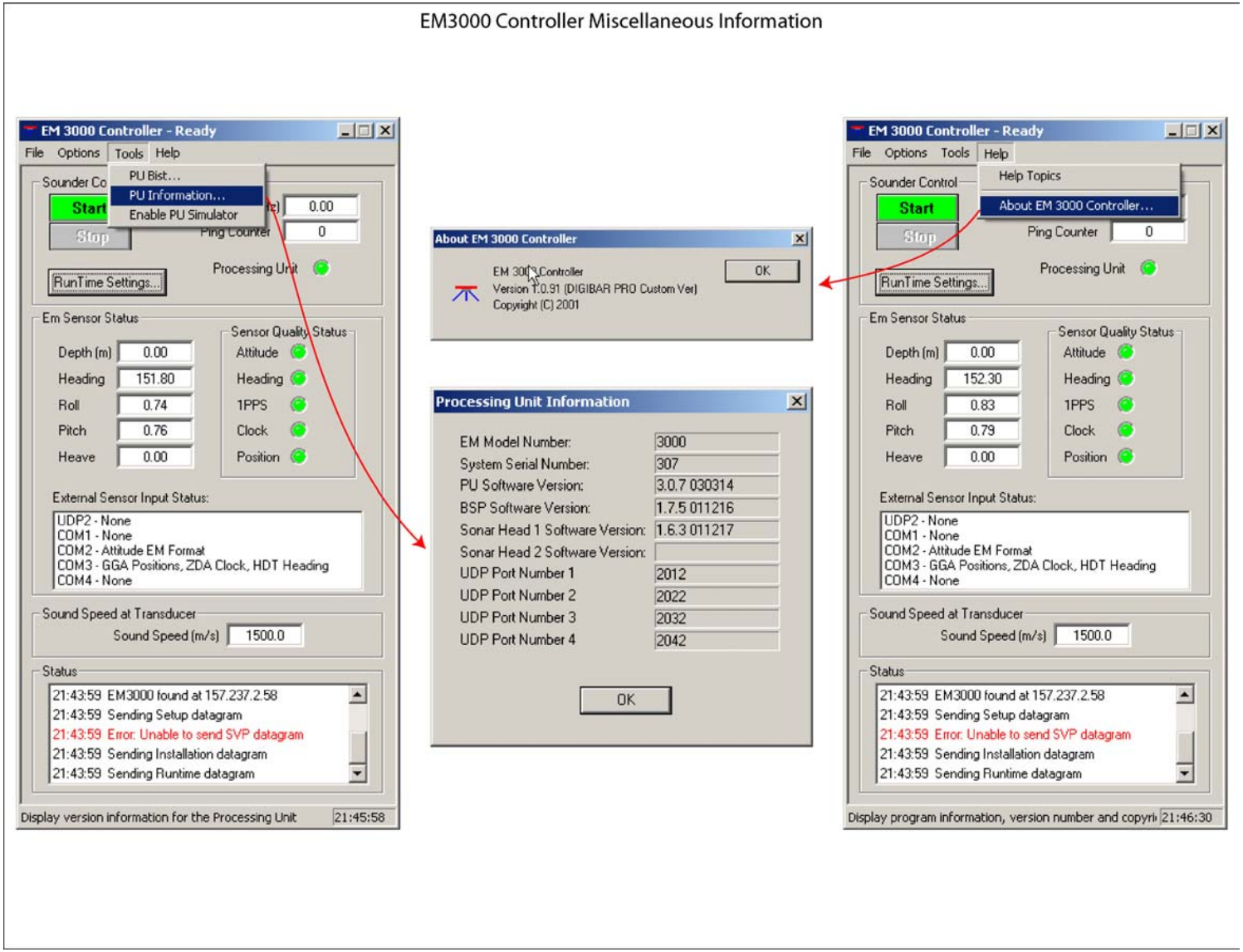
Processing Unit Communication Settings



Sensor Installation Settings

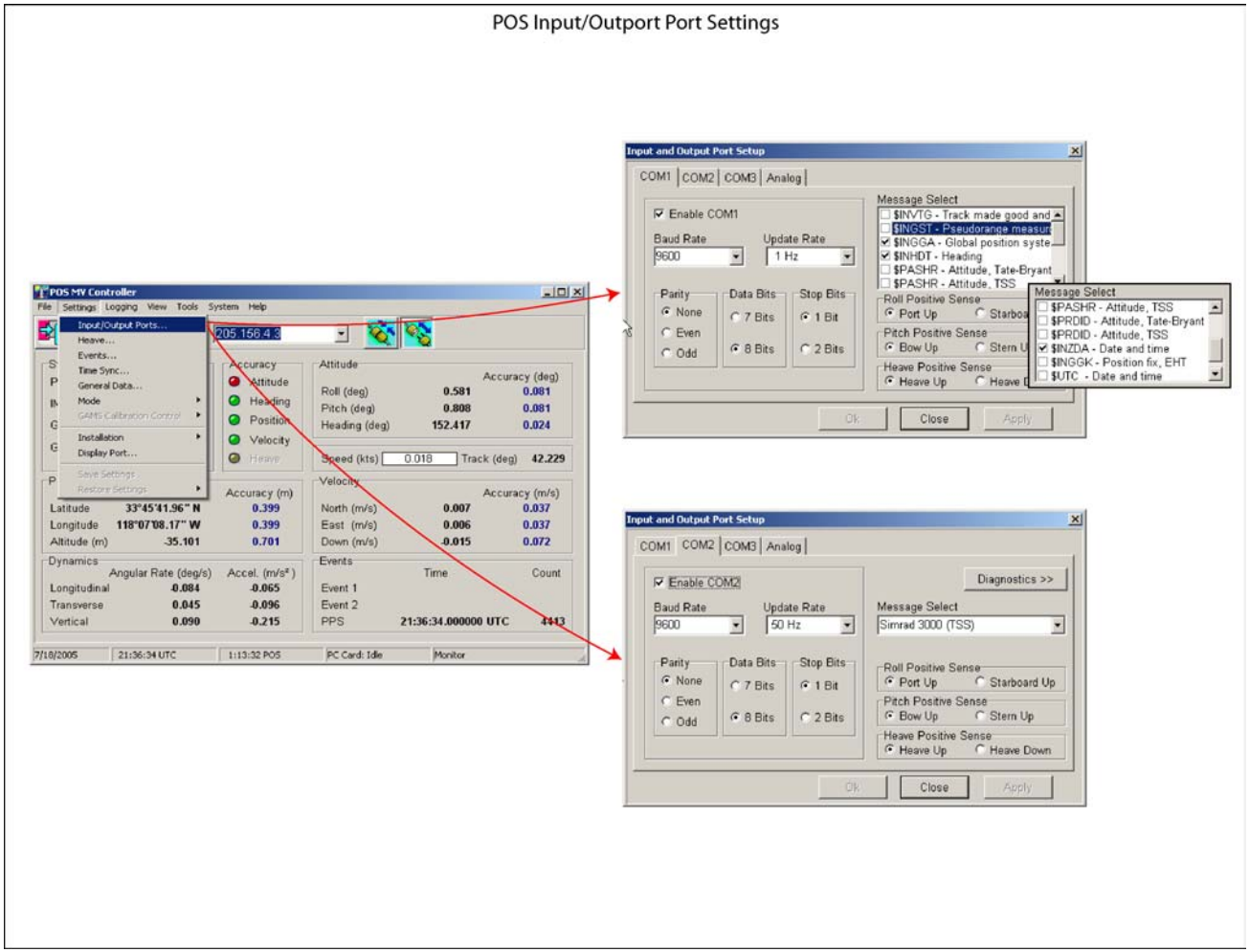


PU & Controller Misc. Information



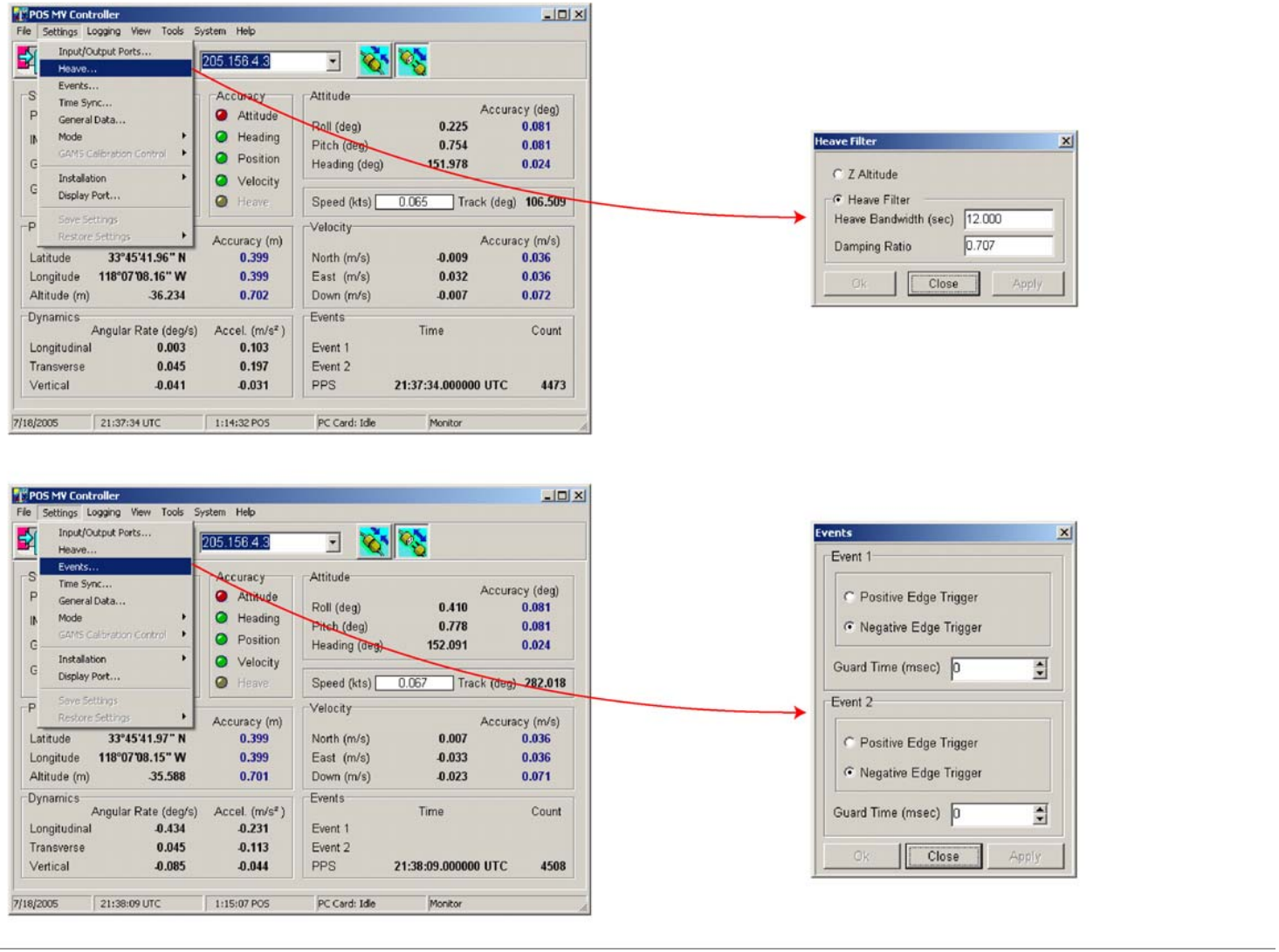
Applanix POS/MV 320

Settings
Input/Output Ports



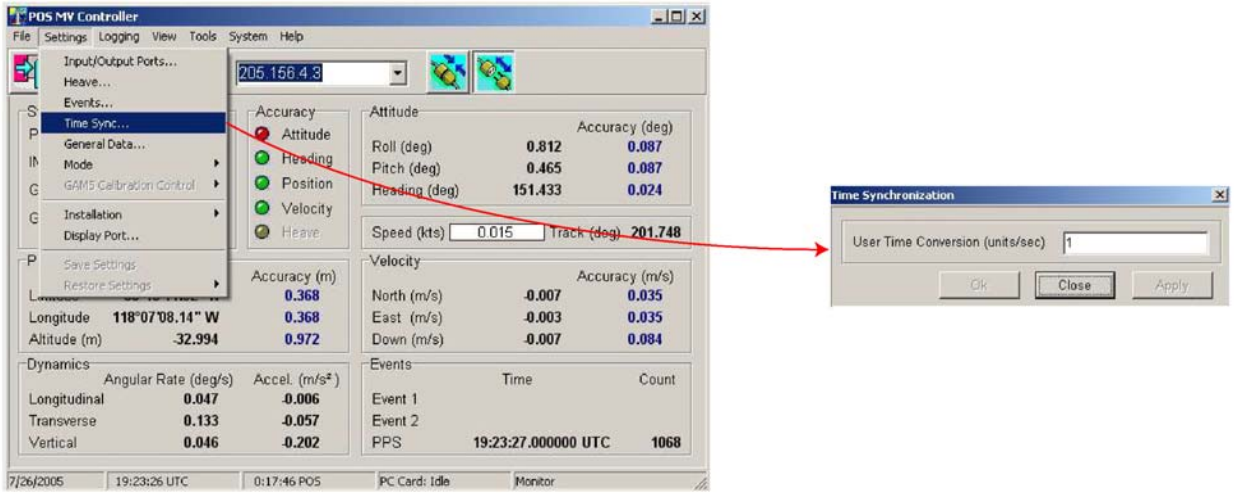
Heave & Events

POS Heave and Events Settings



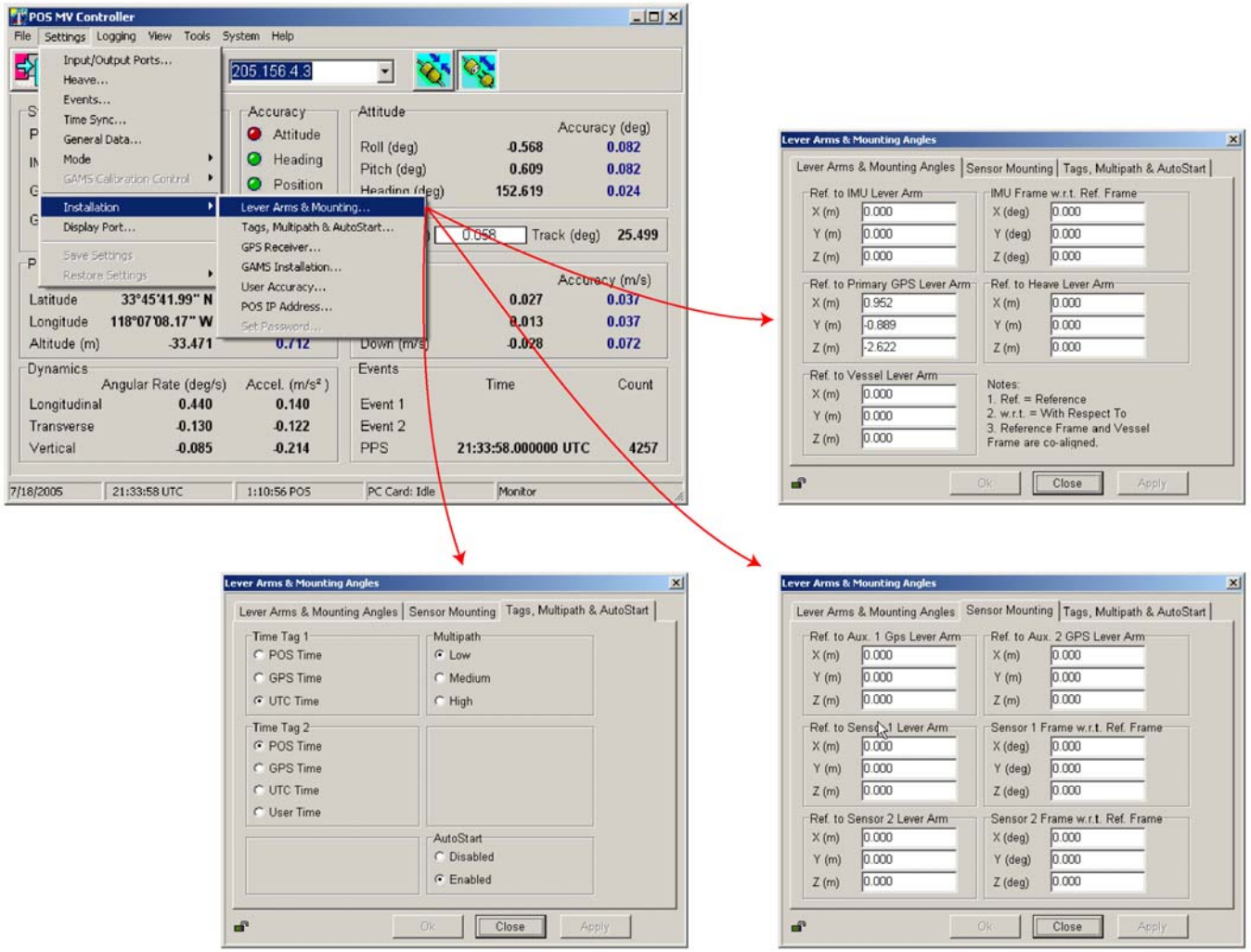
Time Sync

POS Time Sync Settings



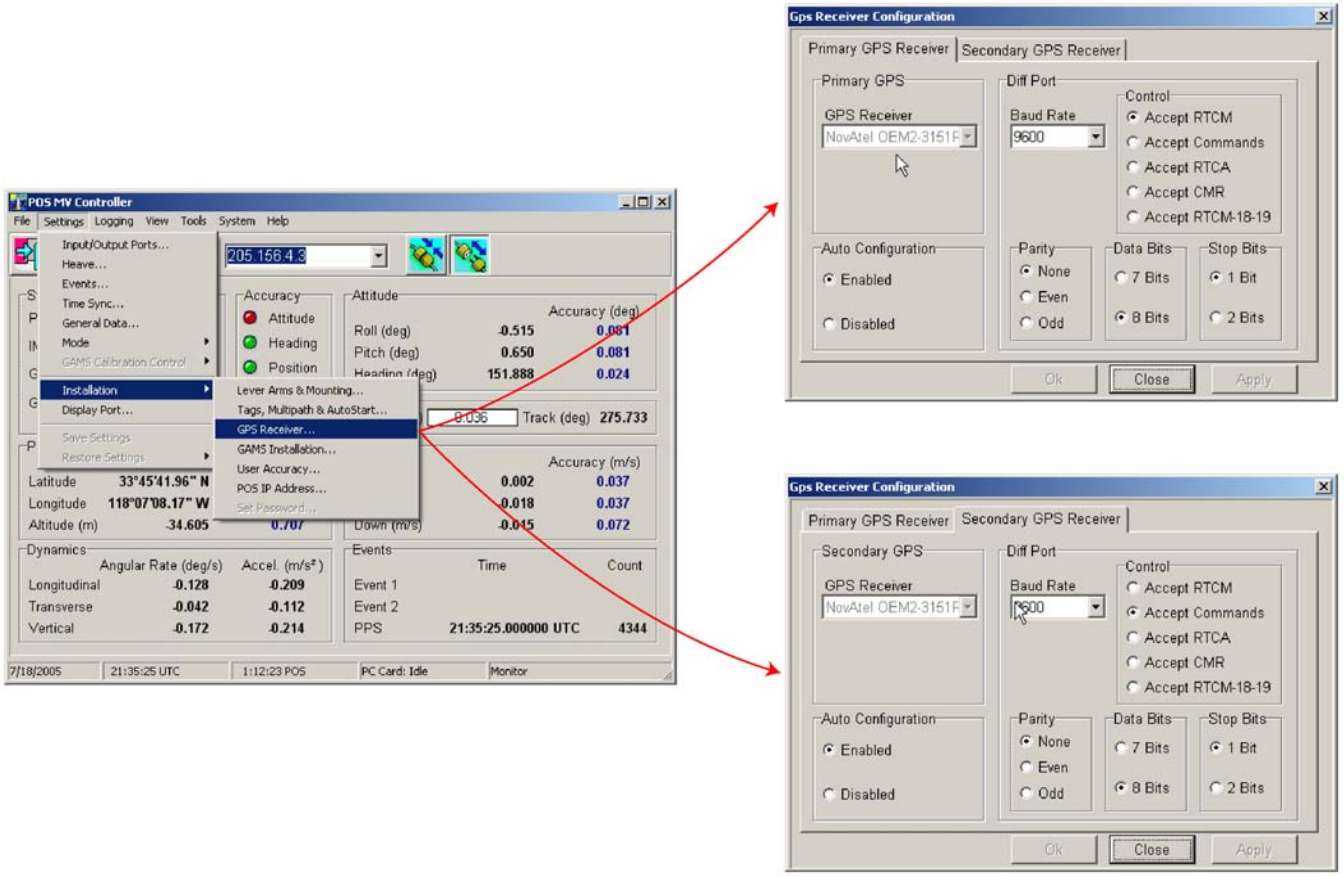
Installation-Lever Arms, Sensor Mounting & Tags

POS Lever Arms, Sensor Mounting and Tags Installation Settings



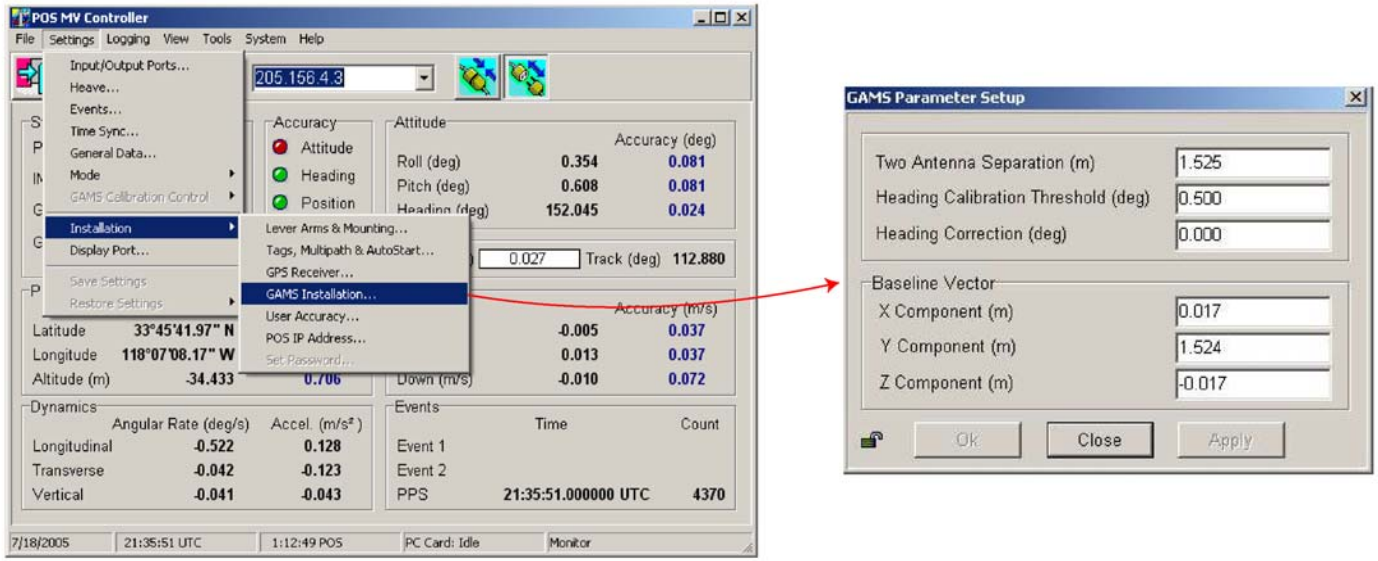
Installation-GPS Receiver Configuration

POS GPS Receiver Installation Settings



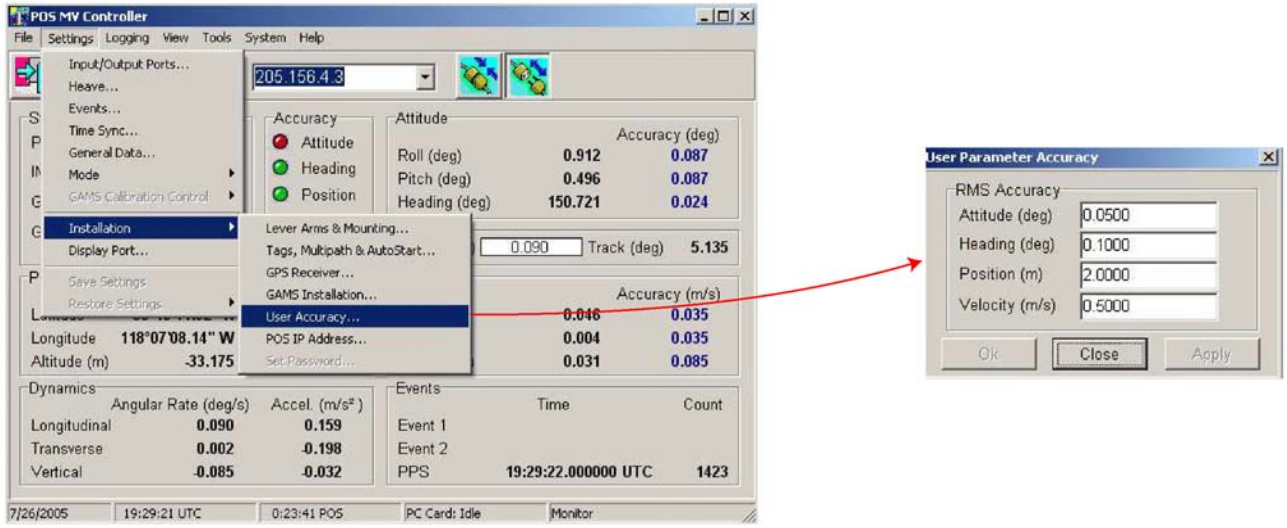
Installation-GAMS

POS GAMS Installation Settings



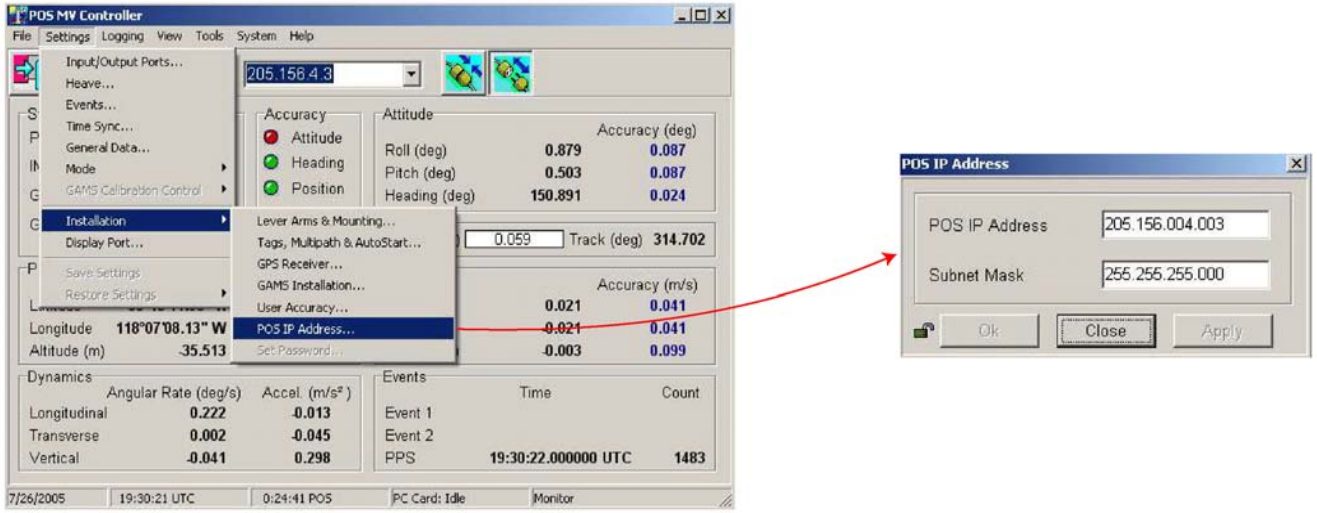
Installation-User Accuracy

POS User Accuracy Settings

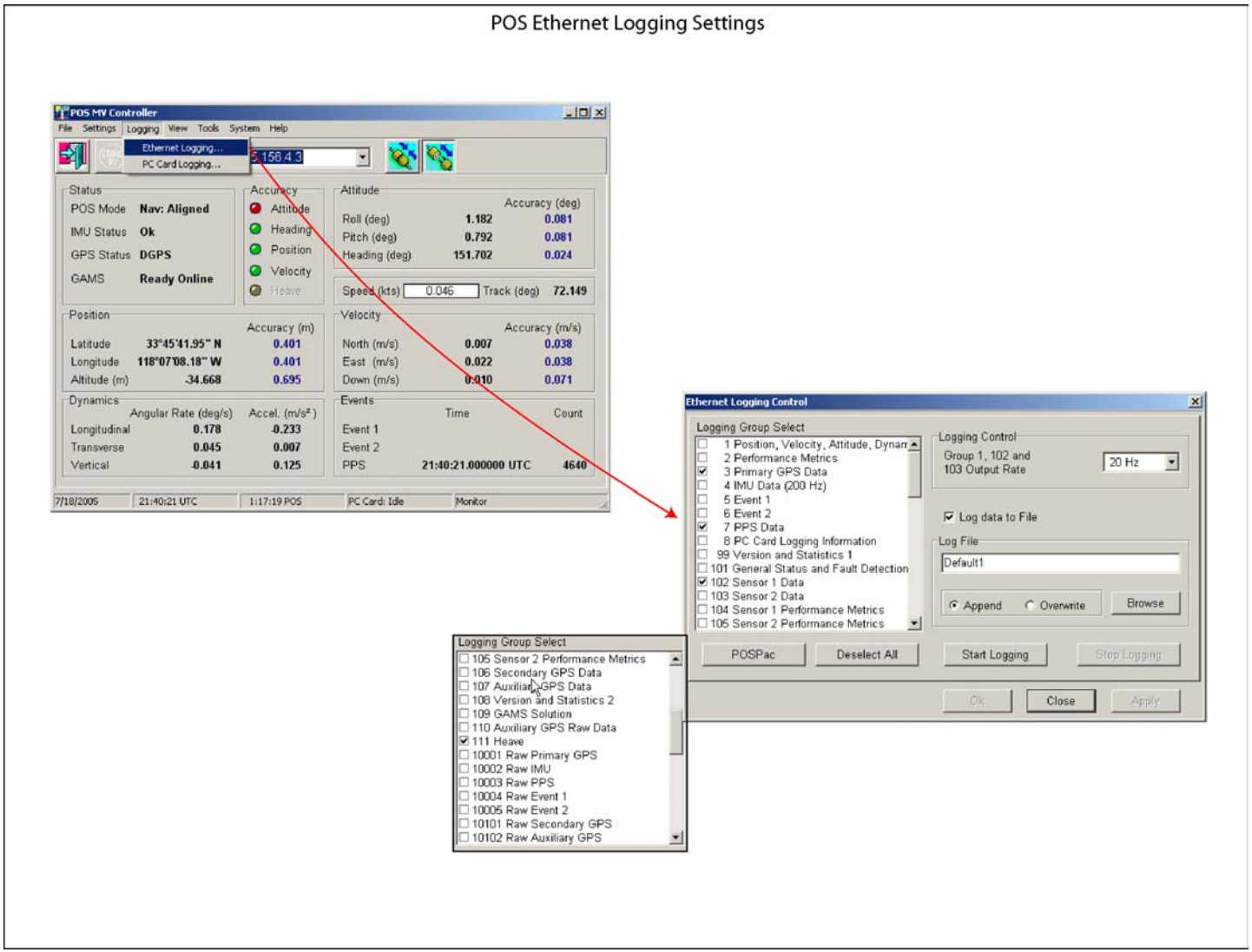


Installation-IP Address

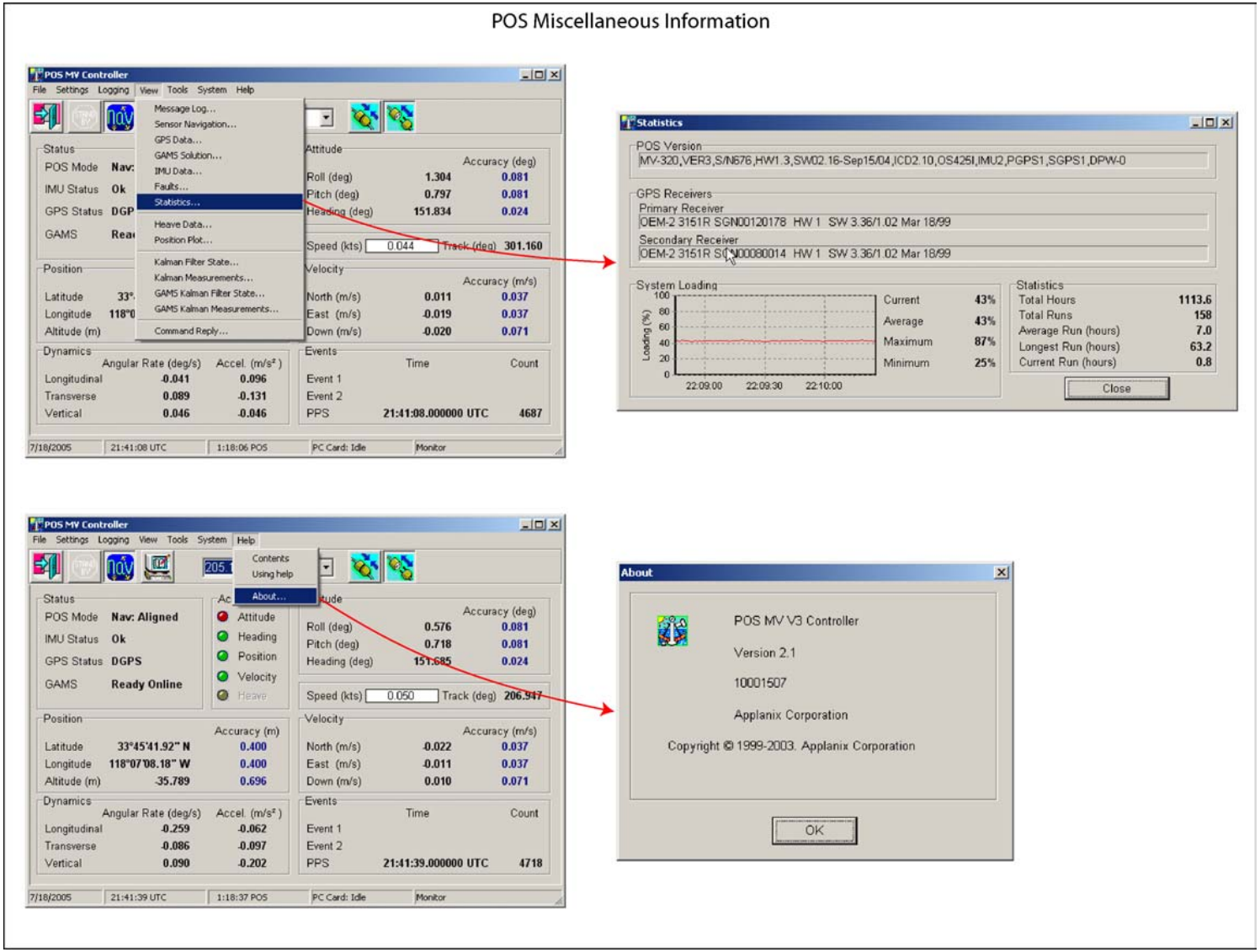
POS IP Address Settings



Logging
Ethernet Logging



Statistics & About Controller



Appendix IV

1. S3003 Vessel Configuration Files
2. NRT6 Trimble Data Dictionary

S3003Vessel Configuration Files

S3003 Innerspace 455 SBES Vessel Config File

```
Vessel Name: NRT6_S3003_SB.hvf
Vessel created: July 14, 2005


Depth Sensor:

      Sensor Class:      Swath
      Time Stamp:  2004-240 00:00

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

      DeltaX:     -0.169
      DeltaY:     0.350
      DeltaZ:     0.353

      Manufacturer:
      Model:             Unknown
      Serial Number:     Innerspace 455 - s/n 194

_____________________________________________________________
Navigation Sensor:

      Time Stamp:  2004-240 00:00

      Comments RP to IMU
      Latency 0.000
      DeltaX:     0.127
      DeltaY:     0.310
      DeltaZ:     0.118

      Manufacturer:      Applanix
      Model:             POSMV Ver 3
      Serial Number:     676

_____________________________________________________________
Gyro Sensor:

      Time Stamp:  2004-240 00:00

      Comments
      Latency 0.000

_____________________________________________________________
Heave Sensor:

      Time Stamp:  2004-240 00:00
```

Comments
Apply Yes
Latency 0.000
DeltaX: 0.000
DeltaY: 0.000
DeltaZ: 0.000

Manufacturer:
Model:
Serial Number:

Pitch Sensor:

Time Stamp: 2004-240 00:00

Comments
Apply Yes
Latency 0.000
Pitch offset: 0.000

Manufacturer:
Model:
Serial Number:

Roll Sensor:

Time Stamp: 2004-240 00:00

Comments
Apply Yes
Latency 0.000
Roll offset: 0.000

Manufacturer:
Model:
Serial Number:

Draft Sensor:

Time Stamp: 2004-240 00:00

Apply Yes
Comments
Entry 1) Draft: 0.000 Speed: 0.000
Entry 2) Draft: 0.003 Speed: 2.000
Entry 3) Draft: 0.013 Speed: 3.100
Entry 4) Draft: 0.013 Speed: 3.900
Entry 5) Draft: 0.025 Speed: 4.600
Entry 6) Draft: 0.036 Speed: 5.300
Entry 7) Draft: 0.038 Speed: 5.900
Entry 8) Draft: 0.041 Speed: 6.500
Entry 9) Draft: 0.039 Speed: 7.000
Entry 10) Draft: 0.032 Speed: 7.400

```
      Entry 11) Draft: 0.019  Speed: 8.800
      Entry 12) Draft: 0.015  Speed: 9.900
      Entry 13) Draft: -0.020 Speed: 10.900
      Entry 14) Draft: -0.070 Speed: 12.900
```

```
Svp Sensor:

      Time Stamp:  2004-240 00:00

      Comments (null)
      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:     -0.169
      DeltaY:     0.350
      DeltaZ:     0.353
```

```
WaterLine:

      Time Stamp:  2004-240 00:00

      Comments rp-waterline
      Apply Yes
      WaterLine -0.052
      WaterLineStdDev 0.000
```

S3003 Simrad EM3000 MBES Vessel Config File

```
Vessel Name: NRT6_S3003_EM3000.hvf
Vessel created: July 14, 2005


Depth Sensor:

      Sensor Class:      Swath
      Time Stamp:  2005-143 00:00

      Transduer #1:
      -------------
      Pitch Offset:     1.450
      Roll Offset:      0.090
      Azimuth Offset:   3.600

      DeltaX:     1.332
      DeltaY:     3.014
      DeltaZ:     1.232

      Manufacturer:      Simrad
      Model:             em3000
      Serial Number:     1518

_____________________________________________________________
Navigation Sensor:

      Time Stamp:  2005-143 00:00

      Comments RP to IMU
      Latency 0.760
      DeltaX:     0.127
      DeltaY:     0.310
      DeltaZ:     0.118

      Manufacturer:      Applanix
      Model:             POSMV Ver. 3
      Serial Number:     676

_____________________________________________________________
Gyro Sensor:

      Time Stamp:  2005-143 00:00

      Comments
      Latency 0.000

_____________________________________________________________
Heave Sensor:

      Time Stamp:  2005-143 00:00

      Comments RP to IMU
      Apply Yes
```

Latency 0.000
DeltaX: 0.127
DeltaY: 0.310
DeltaZ: 0.118

Manufacturer: Applanix
Model: POSMV Ver. 3
Serial Number: 676

Pitch Sensor:

Time Stamp: 2005-143 00:00

Comments (null)
Apply Yes
Latency 0.000
Pitch offset: 0.000

Manufacturer: Applanix
Model: POSMV Ver. 3
Serial Number: 676

Roll Sensor:

Time Stamp: 2005-143 00:00

Comments (null)
Apply Yes
Latency 0.000
Roll offset: 0.000

Manufacturer: Applanix
Model: POSMV Ver. 3
Serial Number: 676

Draft Sensor:

Time Stamp: 2005-143 00:00

Apply Yes
Comments (null)
Entry 1) Draft: 0.000 Speed: 0.000
Entry 2) Draft: 0.002 Speed: 3.100
Entry 3) Draft: 0.010 Speed: 3.900
Entry 4) Draft: 0.014 Speed: 4.600
Entry 5) Draft: 0.020 Speed: 5.300
Entry 6) Draft: 0.030 Speed: 5.900
Entry 7) Draft: 0.035 Speed: 6.500
Entry 8) Draft: 0.042 Speed: 7.000
Entry 9) Draft: 0.044 Speed: 7.400

TPE

Time Stamp: 2005-143 00:00

```
      Comments
      Offsets

      Motion sensing unit to the transducer 1
            X Head 1 1.205
            Y Head 1 2.700
            Z Head 1 1.114
      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 1.205
            Y Head 1 2.700
            Z Head 1 1.114
      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: 0.005
      Motion sensing unit alignment errors
      Gyro:0.000  Pitch:0.000 Roll:0.000
      Gyro measurement error: 0.020
      Roll measurement error: 0.020
      Pitch measurement error: 0.020
      Navigation measurement error: 4.000
      Transducer timing error: 0.000
      Navigation timing error: -0.170
      Gyro timing error: 0.000
      Heave timing error: 0.000
      PitchTimingStdDev: 0.000
      Roll timing error: 0.000
      Sound Velocity speed measurement error: 0.500
      Surface sound speed measurement error: 0.300
      Tide measurement error: 0.010
      Tide zoning error: 0.100
      Speed over ground measurement error: 0.250
      Dynamic loading measurement error: 0.000
      Static draft measurement error: 0.010
      Delta draft measurement error: 0.010
_____________________________________________________________
Svp Sensor:

      Time Stamp:  2005-143 00:00

      Comments RP to SV Probe
      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:     1.332
      DeltaY:     3.014
      DeltaZ:     1.232
```

```
WaterLine:

      Time Stamp:  2005-143 00:00

      Comments RP to WL
      Apply Yes
      WaterLine -0.050
      WaterLineStdDev 0.000
```

S3003 Klein System 3000 SSS Vessel Config File

```
Vessel Name: NRT6_S3003_Klein3000_SSS100.hvf
Vessel created: July 14, 2005


Navigation Sensor:

      Time Stamp:  2005-195 00:00

      Comments rp to IMU
      Latency 0.000
      DeltaX:     0.127
      DeltaY:     0.310
      DeltaZ:     0.118

      Manufacturer:      POSMV
      Model:             Ver 3
      Serial Number:     676

_____________________________________________________________
Gyro Sensor:

      Time Stamp:  2005-195 00:00

      Comments
      Latency 0.000

_____________________________________________________________
Tow Point:

      Time Stamp:  2005-195 00:00

      Comments Fish SN
      Latency 0.000
      DeltaX:     0.507
      DeltaY:     -4.015
      DeltaZ:     -2.422

      Manufacturer:      Klein
      Model:             3000
      Serial Number:     450

_____________________________________________________________
WaterLine:

      Time Stamp:  2005-195 00:00

      Comments RP to WL
      Apply No
      WaterLine -0.050
      WaterLineStdDev 0.000
_____________________________________________________________
```

NRT6 Trimble Data Dictionary

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C:\Pfdata\NRT6.ddf                                                    10/06/2005
NRT6-DDF
7/2004

Fixed Aids                 Point Feature, Label 1 = ID No. (DDD.###), Label 2 = Light
List Number
                           Lights, Daymarkers, Ranges
       ID No. (DDD.###)    Numeric, Decimal Places = 3
                           Minimum = 1, Maximum = 367, Default Value = 1
                           Normal, Normal
       Light List Number   Text, Maximum Length = 30
                           Normal, Normal
       Height        Numeric, Decimal Places = 2
                           Minimum = -1000, Maximum = 1000, Default Value = 0
                           Normal, Normal
       Light               Menu, Normal, Normal
              red
              white
              green
              orange
              yellow
              blue
              other
       Range               Menu, Normal, Normal
              front
              rear
       Location            Menu, Normal, Normal
              on pier
              on wharf
              on pile
              on dol
              on tower
              on breakwater
              on bridge fender
              on bulkhead
              on building
       Dayboard            Menu, Normal, Normal
              TR
              SG
              NR
              NG
              NB
              RG - red over green
              GR - green over red
              NW - danger
              KRB
              KBR
              KWB
              KBW
              KWR
              KRW
              KGW
              KWG
              KGR
              KRG
              KGB
              KBG
       Remarks             Text, Maximum Length = 100
                           Normal, Normal
```

```
Points              Point Feature, Label 1 = ID No. (DDD.###), Label 2 = Type of
Structure
       ID No. (DDD.###)    Numeric, Decimal Places = 3
                           Minimum = 0, Maximum = 367, Default Value = 0
                           Normal, Normal
       Height       Numeric, Decimal Places = 2
                           Minimum = -1000, Maximum = 1000, Default Value = 0
                           Normal, Normal
       Type of Structure   Menu, Normal, Normal
              pier
              floating pier
              wharf
              dolphin
              pile
              platform
              breakwater
              wingdam
              drydock
              bridge fender
              building
              shoreline
              other
       Point Location             Menu, Normal, Normal
              offshore end
              outside corner
              inside corner
              along edge
              end
              inshore tie
              at catwalk
              attached dol
              detached dol
              along shore
       Condition                  Menu, Normal, Normal
              active
              inactive
              in ruins
       Construction        Menu, Normal, Normal
              concrete
              wood
              metal
              riprap
       Light ?                    Menu, Normal, Normal
              red
              green
              white
              yellow
              orange
              violet
              blue
              other
       Remarks                    Text, Maximum Length = 100
                                  Normal, Normal

Line Features              Line Feature, Label 1 = ID No. (DDD.###), Label 2 = Line
type
       ID No. (DDD.###)           Numeric, Decimal Places = 3
                                  Minimum = 0, Maximum = 367, Default Value = 0
                                  Normal, Normal
       Line type                  Menu, Normal, Normal
              shoreline
              structure
```

```
       Remarks                    Text, Maximum Length = 100
                                  Normal, Normal

Other Features                    Point Feature, Label 1 = ID No. (DDD.###), Label 2 =
Remarks
       ID No. (DDD.###)           Numeric, Decimal Places = 3
                                  Minimum = 0, Maximum = 367, Default Value = 0
                                  Normal, Normal
       Height              Numeric, Decimal Places = 2
                                  Minimum = -1000, Maximum = 1000, Default Value = 0
                                  Normal, Normal
       Remarks                    Text, Maximum Length = 100
                                  Normal, Normal
```