2006 DAPR-NRT5

NOAA FORM 76-35A

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

Data Acquisition & Processing Report

NOAA Navigation Response Team 5

LOCALITY

Northeast Proper from New York to Maine

2006

CHIEF OF PARTY
LT. Jasper D. Schaer, NOAA

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DATE

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DATA ACQUISITION AND PROCESSING REPORT

For year 2006 Survey Operations
NOAA Navigation Response Team 5
LT Jasper D. Shaer, Team Leader

A. EQUIPMENT

All calibration data were acquired by Navigation Response Team 5 (NRT5) during the month of April, 2006. NRT5 data acquisition systems include side scan sonar (SSS) data, multibeam echosounder data (MBES), single beam echosounder (SBES) data, and sound velocity profiler (SVP). Vessel description and offset measurements are included in Appendix III of this report. Any unusual vessel configurations or problems will be addressed in the respective survey Descriptive Reports.

Methods and systems used to test and calibrate all equipment were determined by the Hydrographer and the Hydrographic Systems Technology Processing Branch-liaison in accordance with the Navigation Response Services Branch Standing Letter Instructions (forth coming), the Specifications and Deliverables (June, 2006), and the Field Procedures Manual (May, 2006). Other considerations included system performance limitations, limited time available, and ability of vessel to safely navigate a particular area.

A.1. Sounding Equipment

INNERSPACE ECHOSOUNDER

NRT5's Survey boat S-3002 is equipped with an Inner Space 455i single beam echosounder (SBES) (fig 1). The Inner space echosounder has a single-frequency digital-recording unit with a digital recorder. This unit transducer operates at 208 KHz with a circular beam footprint of 8° at the –12 dB point. If MBES data is collected, SBES data is then archived in raw form, but not generally processed.

Figure 1: Inner space single beam echosounder

MULTIBEAM ECHOSOUNDER

NOAA NRT5 Survey Boat S-3002 is equipped with a pole-mounted MBES (Fig 2). The Kongsber EM3000 is a 300 KHz system which measures two-way sound travel times across a 130° swath; each swath consisting of 127 beams individually formed 1.5° x 1.5° beams. This system is used to obtain full-bottom bathymetry coverage in depths generally up to 150 meters, depending on water depth and across-track slope.

Figure 2: Pole-mounted Kongsberg EM3000

The EM3000 sonar processor incorporates real time sound velocity measurements from a Digibar Pro Profiling Sound Velocimeter (section C.1). These measurements are used for initial beam forming and steering. Four adjustable parameters used to control the EM3000 from the EM3000 compact controller software include range scale, power, gain, and pulse width, however these are set to range scale = auto, power= 300 Khz, gain=80, pulse width=25 Hz. These parameters are adjusted as necessary to ensure best bottom tracking for bathymetry. Additionally, vessel speed is adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Main scheme MBES line plans generally run parallel to the contours at a line spacing approximately three to four times the water depth. For discrete item developments, line spacing is often reduced to two-times water depth to ensure least-depth determination by MBES near-nadir beams.

Diver Least Depth Gauge

Dive investigations are primarily for contact/AWOIS verification and/or least depth confirmation of selected contacts. NRT5 has not been issued Diver Least-Depth Gauges (DLDG) at this time.

Leadline

Leadlines are used for single beam and multibeam echosounder comparisons. Calibration reports for the leadlines are included in Appendix IV of this report.

A.2. Side Scan Equipment

General Operations

Line spacing for side scan sonar (SSS) operations is determined by the required range scale. Typically, to acquire 200% coverage, 40 meter line spacing is used at the 50 m range scale, 60 meter line spacing is used at the 75 m range scale, and 80 m line spacing is used at the 100 meter range scale.

The towfish altitude of eight to twenty percent of the range scale is maintained during data acquisition. SSS altitude for towed operations is adjusted by the amount of deployed tow cable, and to a lesser degree by vessel speed.

Confidence checks are performed daily by observing changes in linear bottom features extending to the outer edges of the digital side scan image, features on the bottom in survey area, and by passing aids to navigation.

Side Scan Sonar

The Klein System 3000 includes the Model 3210 tow fish, Transceiver Processing Unit (TPU), and Klein workstation. The Model 3210 tow fish (fig 3) operates at a frequency of 500/100 KHz and has a vertical beam angle of 40 degrees. Klein TPU contains a network card for transmission of the sonar data to the Klein acquisition computer. Acquisition software (SonarPro 9.6) used on the Klein computer saves the raw data in SDF format.

Figure 3: Klein 3000

Standard configuration for using the Klein System 3000 aboard NOAA S3002 has been determined by NRT5 during regular hydrographic survey operations. The Klein 3000 tow fish is deployed from a davit arm using a Dayton electric-hydraulic winch spooled with approximately 50 meters of armored coaxial cable off of the starboard stern of the vessel. Tow cable is lead from the winch upward along the davit arm through a series of snatch blocks and d-rings. The tow cable at the winch is connected to a deck cable through a slip ring assembly mounted coaxially on the winch. Cable-out is controlled by the wheel mounted at the end of the davit arm. Cable is run along the top edge of the wheel and outward toward the towfish. This sensor computes cable out by the number of revolutions of the wheel's sheave. The Dyna Pro cable counter provides a serial message to the **Hypack** acquisition computer. Message is parsed over delph-serial from Hypack to the Klein computer to be saved and included in the raw SDF format. Cable-out is adjusted to 2.0 meters before deployment of the towfish to account for the distance from the water surface to the wheel.

Klein System 3000 towed operations are typically limited to seven or eight knots, speed-over-ground aboard S3002. This is to allow an increased margin for safe navigation, to optimize vessel fuel consumption, minimize towing gear stress, and reduce "strumming" in the tow cable which can interfere with the side scan imagery. Turns to port require the towfish to be drawn in to prevent the tow cable from swinging into the dual outboard propellers.

A.3 Position Equipment

TRIMBLE DSM212L DGPS RECIEVERS

NRT5 ‘s Survey Boat S-3002 is equipped with a Trimble DSM212L DGPS receiver for reception of U.S. Coast Guard (USCG) differential GPS (DGPS) beacons, which are used for horizontal position control. The DSM212L is an integrated 12-channel GPS receiver and dual-channel differential beacon receiver. The beacon receiver can simultaneously monitor two USCG DGPS beacon stations. The Trimble DSM212L was configured in manual mode to allow reception of only one beacon station during data acquisition.

DSM212L parameters were configured using Trimble **TSIPTalker**. Configuration is checked frequently throughout the project period. Parameters set included number of visible satellites (4 SV’s), positional dilution of precision (PDOP < 8), maximum pseudo range corrector age (#30 sec), and satellite elevation mask (8 deg).

Position quality is monitored real time in the POS/MV controller software. The primary positional quality monitored is HDOP. Where HDOP exceeds 2.5, the data are examined during post-processing, and if necessary, positions interpolated or rejected**.** The Hypack pos.dll (NMEA message but for the POS/MV UDP port version) configuration includes a 500-ms update rate and a non-differential alarm in the acquisition window to alert the operator when the signal is lost.

TSS POS/MV POSITION AND ORIENTATION SENSOR

NRT5‘s Survey Boat S-3002 is equipped with a TSS POS/MV Model320 Version 4 (Position and Orientation System for Marine Vessels) to determine position. The POS/MV is an aided strap down inertial navigation system, which provides a composite position solution derived from both an Inertial Measurement Unit (IMU) and dual-frequency GPS receivers. The IMU and GPS receivers are complementary sensors; data from one are used to filter and constrain errors from the other resulting in high position accuracy. On NRT5‘s Survey Boat S-3002, the TSS POS/MV is used for MBES, SSS, and SBES position.

Position accuracy and quality are monitored in real time during data acquisition using the POS/MV Controller software to ensure positioning accuracy requirements in the NOS Hydrographic Surveys Specifications and Deliverables are met. The POS/MV Controller software provides clear visual indications whenever accuracy thresholds are exceeded.

A.4. Heading & Attitude Equipment

TSS POS/MV POSITION AND ORIETATION SYSTEM

NRT5's Survey Boat S-3002 is equipped with a TSS POS/MV Model 320Version 4 for vessel heading and attitude determination. This system replaced the older Version 3 in February, 2005 (See POS/MV Configuration Note, Appendix I). The POS/MV is an aided strap down inertial navigation system (INS), consisting of an Inertial Measurement Unit (IMU) sensor and two GPS receivers. The IMU senses linear acceleration and angular motion along the three major axes of the vessel. The POS/MV's two GPS receivers determine vessel heading using carrier-phase differential position measurements.

POS/MV Heading Computation

The POS Computer System (PCS) blends data from both the IMU and the two GPS receivers to compute highly accurate vessel heading. The IMU determines accurate heading during aggressive maneuvers and is not subject to short-period noise. However, IMU accuracy characteristically diminishes over time. The GPS receivers compute a vector between two fixed antennas and provide azimuth data using the GPS Azimuth Measurement Subsystem (GAMS). The GAMS calculation for the system was completed earlier this year and re-run when firmware was changed on v4. GPS heading data is accurate over time, but is affected by short-period noise. The POS/MV combines both heading measurement systems into a blended solution with accuracies greater than either system could achieve alone. On this platform, the TSS POS/MV was used for MBES, SBES, and SSS heading.

POS/MV Heave, Pitch, and Roll Computation

Heave is computed in the POS/MV by performing a double integration of the IMU-sensed vertical accelerations. The POS/MV v4 controller heave filter is used for all data aboard S-3002; a heave bandwidth between 10 and 20 seconds and heave damping ratio of 0.707 are used depending on the conditions at the time of data acquisition. Heave is collected by logging message 111 to a file for the operation for the day, then merged to the data set in CARIS post processing.

Both roll and pitch measurements are computed by the IMU after sensor alignment and leveling. The IMU mathematically simulates a gimbaled gyro platform and applies the sensed angular accelerations to this model to determine roll and pitch. Heave, pitch, and roll POS/MV was used for MBES & SBES.

A.5. Software

Coastal Oceanographic's **Hypack MAX** is used for vessel navigation and line tracking during acquisition of MBES, Side Scan Sonar, and SBES data. All SBES and MBES data are acquired in **Hypack** in the "RAW" format.

MBES data from NRT5's Survey Boat S-3002 Kongsberg EM3000 unit are acquired on the hypack computer via the hypack program **Hysweep**. The boat's offset configurations for the transducer and motion sensor were entered into the Caris Vessel Configuration File. Sound velocity and attitude data are not inputted directly at the transceiver unit, but are applied during post-processing.

Side scan, multibeam echosounder, and singlebeam data are processed using both Caris **HIPS and SIPS 6.0.sp2.** Caris software applies tide data, sound velocity corrections, true heave, merges the data, and then determines bias error values in calibration mode. Calculation of Total Propagated Error (TPE) was used during the field season for the creation of BASE (Bathymetry Associated with Statistical Error) surfaces.

All MB soundings, and side scan and MB features are analyzed during post-processing using **Pydro**. This program was created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the **Python 23** programming language to interface with the **HIPS** data directly.

Features are exported from **Pydro** in MIF/MID (**MapInfo** Interchange) format, and imported into **MapInfo**. Soundings are imported into **MapInfo** with a tool that takes soundings from the Preliminary Smooth Sheet created by **Pydro**. **MapInfo** is used for final data analysis and for creating final plots. **GeoZui** (UNH, Durham, NH) and **HIPS** are used for visualization and data comparisons.

Raw sound velocity data are processed using **Velocwin,** supplied by NOAA Hydrographic Systems and Technology Program (HSTP). **Velocwin** uses raw salinity, temperature, and pressure measurements to create a sound velocity profile.

A complete list of software and versions is included in Appendix I.

B. DATA PROCESSING AND QUALITY CONTROL

B.1. Multibeam Echosounder Data

Raw HSX multibeam data were converted to HDCS format in **HIPS 6.0 sp2**. Transformation parameters pertaining to the source of the attitude packet is stored in the Log File located in line directory of the **HIPS** data. After conversion, the Total Propagated Error (TPE) was calculated in **Caris HIPS and SIPS 6.0 sp2** to determine the quality of the multibeam data. TPE was calculated using the Caris implementation of the multibeam error model (Hare et al., 1995). Input parameters to the error model were entered into the HVF file (5.4 version of the VCF). A table of these values is provided in Appendix IV.

Vessel heading, attitude, and navigation data were reviewed and edited in line mode (viewed as time series data). Fliers or gaps in heading, attitude, or navigation data were manually rejected or interpolated for small periods of time. Sound velocity correction was applied in **HIPS**. Tide correction was applied to the data during “merge”, and dynamic draft corrections and sensor lever arms are applied in S3002’s MB VCF.

Heave is collected by the POS/MV into a log file (message 111) and post-processed in Caris HIPS. This is applied prior to the merging data via Process Load True Heave. The MBES’s VCF heave sensor has to be applied (check “YES”), in order to use this heave data.

Settlement and squat for a vessel this small is a problem. It was suggested by HSTP to proceed and trim the engines when hydro-operations are underway. On the trim/tilt indicator, it has been marked to insure the trim is set every time for survey operations.

TPE takes into account uncertainties in the measurements coming from each sensor (Heave, Pitch, Roll, Position, Heading, Sound Velocity, and Tide) and uncertainties in static measurements (Draft and Latency) to calculate the total uncertainty. **Caris HIPS and SIPS 6.0 sp2** uses the vertical uncertainty from TPE to produce a BASE (Bathymetry Associated with Statistical Error) surface. These BASE surface products (Depth, Uncertainty, Density, Standard Deviation, Mean, Shoal, and Deep) could then be used to demonstrate MBES coverage, and to further check for systematic errors such as tide, sound velocity, or attitude and timing errors. Sun-illumination is used to highlight the seabed features. **HIPS** gridded images were created as specified in the NOS Hydrographic Surveys Specifications and Deliverables.

The actual resolution chosen for finalized base surface for NRT5 is 0.75m. This was the recommendation by HSTP. Once the BASE surface has been finalized, they are inserted into Pydro. Bathymetry can be inserted into Pydro using the Insert Caris Lines or Insert HIPS Weighted grid functions. As the final product is a collection of BASE surface, chart comparison and least depths on the features are from the finalized BASE surfaces, not the Caris lines bathymetry.

B.2. Single-Beam Echosounder Data

SBES data are acquired concurrently with both MBES data and SSS data. When SBES data is not the primary source of bathymetry, i.e. MBES data is also acquired; SBES data is not routinely processed, but may be used for troubleshooting or confidence check purposes. In this case, the raw **Hypack** SBES data are submitted for archival purposes only. This data should not be used for the creation of any product.

When SBES data are the primary source of bathymetry, i.e. collected concurrently with SSS data, SBES data are processed, passed through quality control, and submitted for the purposes of product creation. Following acquisition, single-beam echosounder data are converted from **Hypack** “Raw” format to **HDCS** using **HIPS**.

Each line is viewed in **HIPS** Single Beam Editor against the digital trace of the SBES data. Selected soundings are scanned for missed depths. Additional selected soundings are inserted where necessary to define peaks and abrupt changes in slope.

After review and cleaning, **HIPS** is used to merge depth, position and attitude data with sound velocity, tide, vessel offset, and dynamic draft correctors to compute the corrected depth and position of each sounding. All soundings are reviewed again in **HIPS** Subset Mode. Data are compared with adjacent lines and crosslines for systematic errors such as tide or sound velocity errors.

B.3. Side Scan Sonar Data

Side scan sonar data were converted from *.SDF (SonarPro raw format) to **SIPS.** Side scan data were processed using **SIPS.**

Post-processing side scan data includes examining and editing fish height, vessel heading (gyro), and vessel navigation records. Fish navigation is recalculated using **SIPS**. Tow point measurements (C-frame and cable out), fish height, and depth are used to calculate horizontal layback.

After fish navigation is recalculated, side scan imagery data are slant-range corrected to 0.1m with beam pattern correction. Depending on the requirements for the survey as stated in the Hydrographic Survey Letter Instructions, one of two methods can be utilized for SSS operations. The first is to acquire 100% or 200% side scan sonar coverage. All significant contacts are then selected and investigated further at the discretion of the hydrographer. Investigation methods used to resolve SSS contacts includes diver investigations and MBES developments. The second method, where full MBES coverage has been obtained, is pick side scan sonar contacts only in areas of incomplete multibeam coverage, on man made features, and ambiguous features.

The slant-range corrected side scan imagery data are closely examined for any targets. Targets-of-interest are evaluated as potential contacts based on apparent shadow length and appearance; particularly targets which do not appear to be natural in origin. Contacts are selected and saved to a contact file for each line of SSS data. Contact selection includes measuring apparent height, selecting contact position, and creating a contact snapshot (*.tif) image.

C. CORRECTIONS TO ECHO SOUNDINGS

C.1. Sound Velocity

SBE19Plus Conductivity, Temperature, and Depth (CTD) profilers

Sound velocity profiles are acquired with Sea-Bird Electronics SeaCat SBE19Plus CTD profilers. Raw conductivity, temperature, and pressure data are processed using the program **Velocwin** which generates sound velocity profiles for **HIPS**. Sound velocity correctors are applied to MBES and SBES data in **HIPS** during post processing only. Calibration reports for the SBE19Plus CTD and Odom Digibar profilers are included in Appendix III of this report. A CTD and DQA comparison was performed on May 22nd 2006, the results of which are listed below. This DQA is produced by comparing our pole mounted Odom Digibar to a single cast made with the SBE19Plus.

CTD DQA test:
1/30/2006 COMPARISON TEST FOR SEACAT PASSED DQA
Digibar Depth (m) = 1.1   Digibar SV (m/sec)= 1460.1
File= sheet_Z.svp   Seacat SV (m/sec) = 1460.400

CTD side by side comparison test:
5/22/2006

digibar-head		digibar-hand	
1484.3	0.7	1485.6	0
1484.3	1	1485.5	0.8
1484.3	1.7	1485.5	1.1
1484.2	2.1	1485.6	1.8
1484.6	2.6	1485.4	2.1
1485.1	3.1	1486	2.7
1485.4	3.5	1485.5	3
		1484.4	3.5

Note: Detached digibar from MB head to conduct test.

Side by side comparison tests as outlined by FPM between the SeaBird 19 Plus and our Digibar are completed at least once a week, and often more frequently when MBES surveys are being conducted. We will continue to use DQA test to compare the Seabird to the head mounted Digibar.

Speed of sound through water is determined by a minimum of one cast every four to six hours of MBES data acquired, in accordance with the Standing Letter Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Casts were conducted more frequently when changing survey areas, or when it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles. Casts were conducted at least every four hours while collecting data with the EM3000 during the period, with the pole-mounted Odom Digibar also active.

Sound velocity casts are extended in **Velocwin** and applied to the Simrad MBES data in **HIPS** during post processing. See Appendix III for annual CTD quality report.

EM3000 Surface Sound Velocity System

NRT 5's Survey Boat S3002 is equipped with an Odom Digibar Pro surface sound velocity sensor. The sensor is used to measure sound velocity at the depth of the Simrad EM3000 transducer. Sensor is mounted next to the transducer on the pole mount. Weekly and monthly DQA's are performed to assure both the SBE19Plus and Digibar are working accurately. The DQA is done at the depth of the pole mounted digibar. Sound velocity is taken at this depth by both instruments and Velocwin runs a comparison between the two sets of data. This produces a passing or failing DQA.

C.2. Vessel offsets and Dynamic Draft Corrections

The following table lists each Vessel Configuration File.

VCF NAME	SURVEY SYSTEM
3002_mbes	Kongsberg Simrad EM3000 Multibeam Sonar System
3002_vbes	Innerspace 455i Vertical Beam Echo Sounder Odom Echotrac CV (Pending Installation)
3002sss100k	Klein 3000 Side Scan Sonar Low Frequency
3002sss500k	Klein 3000 Side Scan Sonar High Frequency

Static draft corrections for S3002 were measured April 20, 2006 (see results Appendix II-A).

Dynamic draft measurements for S3002 were made on April 18, 2006 (see results Appendix II-B).

No new hardware added to vessel. Vessel offset measurements were made by National Geodetic Survey on S3002 while in Norfolk, VA on February 17, 2004. The procedure and results are in the Offset Confirmation Report found in Appendix III.

The S3002 sensor offsets are stored in the **HIPS** Vessel Configuration File (3002_mbes & 3002_vbes) and are applied to MBES & SBES data acquired with S3002. All offsets and biases are duplicated in the **Caris HIPS and SIPS 6.0 sp2** Vessel Configuration File (HVF).

S3002 performed a SSS verification during survey operations April 18, 2006 (see Appendix IV). The Klein SSS offsets are stored in the Caris Vessel Configuration Files and are applied to side scan data during processing in **HIPS**.

C.3. Heave, Pitch, Roll, and Heave included biase and Navigation Timing Errors

Heave, pitch, roll, and navigation latency biases for S3002's Simrad EM3000 were determined during Patch Tests conducted on April 18, 2006 in Gravesend

Anchorage, just outside New York Harbor, south of the Verrazano Bridge. MBES vessel offsets, dynamic draft correctors, and system bias values are contained in **HIPS** Vessel Configuration Files (VCFs and HVFs), and were created using **HIPS** and **Caris HIPS and SIPS 6.0 sp2**. These offsets and biases are applied to the sounding data during processing in **HIPS**. The VCFs, HVFs and Patch Test data are included with the digital data. The Patch Test Report for S3002 can be found in Appendix IV. A Patch Test or verification of certain biases is also performed at the start of each project before acquiring MBES data in a new area.

C.4. Water Level Corrections

Soundings are reduced to Mean Lower-Low Water (MLLW) using verified tide data from the local, primary tide gauge obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site. For all projects, a simple predicted tide table is applied to MBES data in **HIPS** during the Merge process. A zone-corrected verified tide file is supplied by CO-OPS which is then reapplied to all MB data using **HIPS**.

D. APPROVAL SHEET

As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to 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, as updated for December 30, 2006.

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

Respectfully Submitted:

Bert S. Ho
Hydrographer

Vitad Pradith
Hydrographer

Approved and Forwarded:

LT Jasper D. Schaer, NOAA
Team Leader

APPENDIX I

a) Software

b) POS/MV Report

Appendix I-a: **SOFTWARE**

NOAA - NRT-5 SYSTEM CERTIFICATION SOFTWARE REPORT - 2006

PROCESSING SOFTWARE

CARIS HIPS and SIPS 6.0 Service Pack 2, HotFix 20 (Dec 2006)
PYDRO Version 6_10_Beta (Dec 2006)

DATA ACQUISITION SOFTWARE

HYPACK MAX Version 4.3 (2004)
SONARPRO Version 9.6 (March 2005)
Simrad EM Controller 1.0.28 (2003) no new updates, not support by simrad any more

POSITIONING SOFTWARE

POS/MV Controller Version 3.2.2, POS/MV controller 3.3.0.0
Trimble TERRASYNC Version 2.5

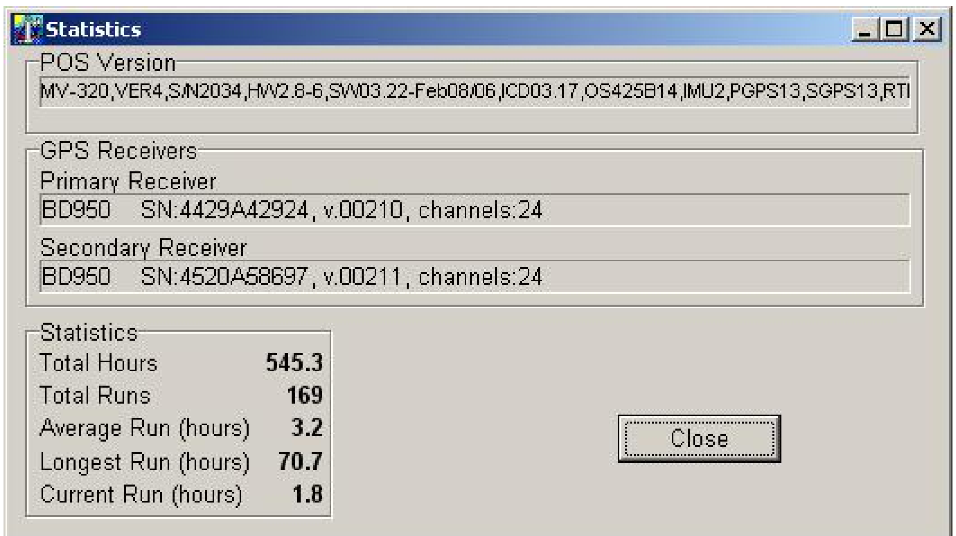
OTHER SOFTWARE

MAPINFO Version 8.5
SEATERM Version 1.3
VELCWIN Version 8.6
MICROSOFT OFFICE XP
GPS PATHFINDER OFFICE 3.1
FUGAWI 3.1.4.746

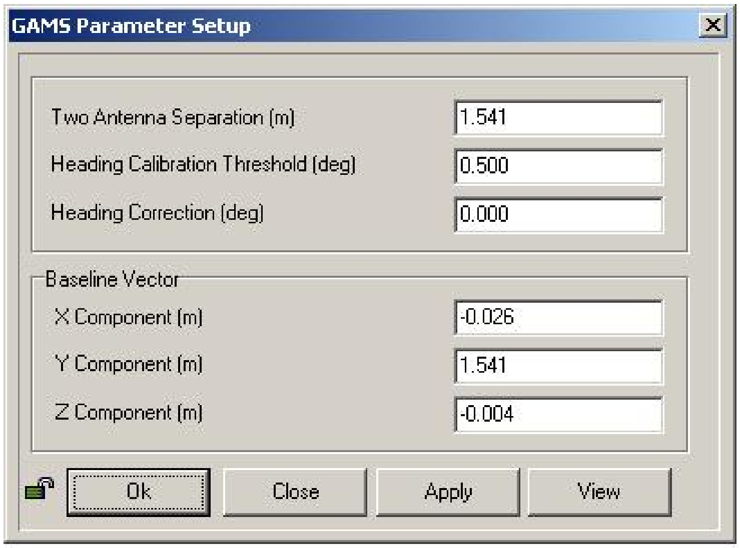
Appendix I-b: **POS/MV Report**

POS/MV Report

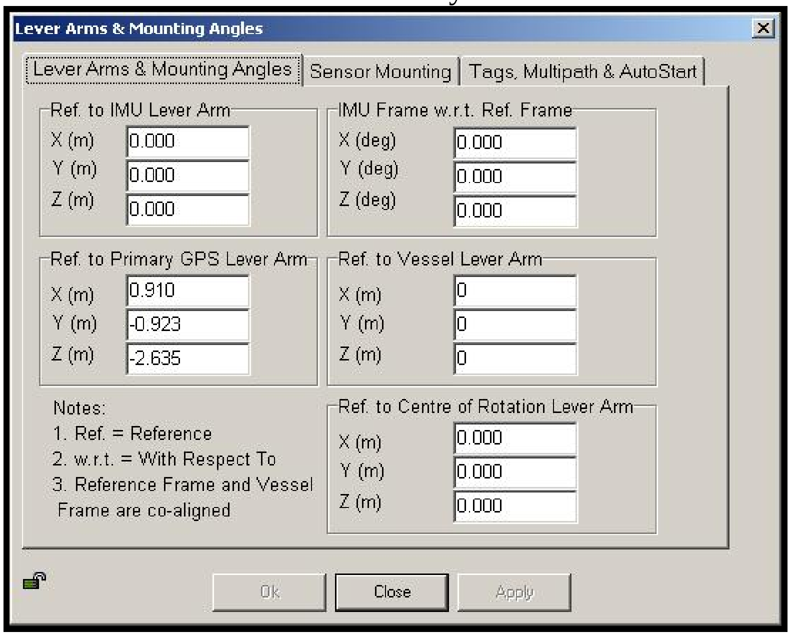
*no physical offset changes, just firmware upgrades
Stats of POS/MV 4.0 hardware upgrade



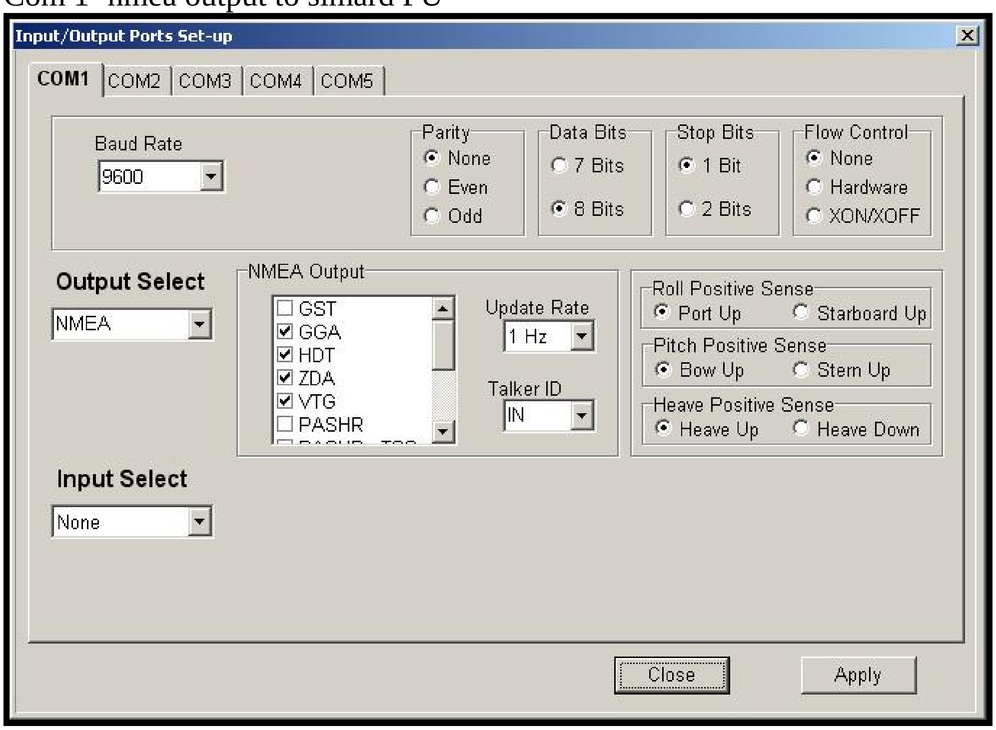
GAMS -Calibration conducted on April 18, 2006 (after new firmware upgrade).



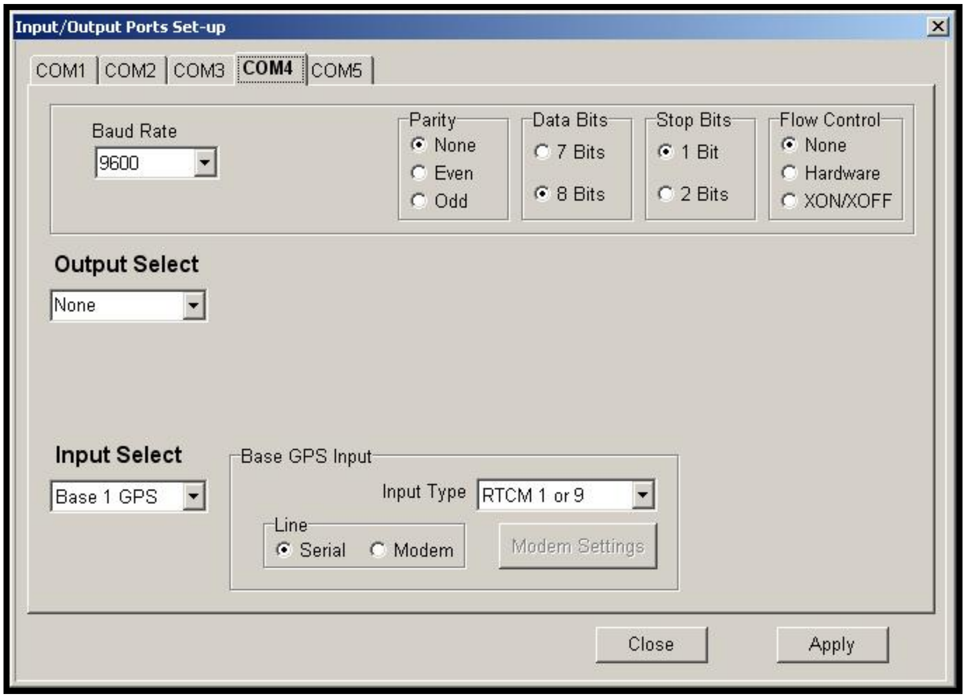
Lever arm offsets from NGS survey



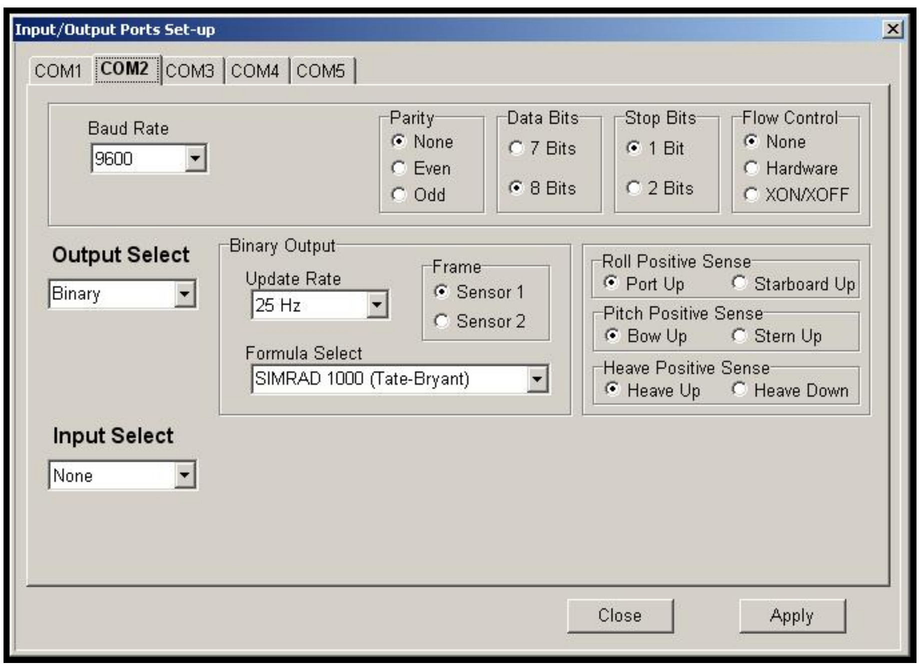
Com 1=nmea output to simard PU



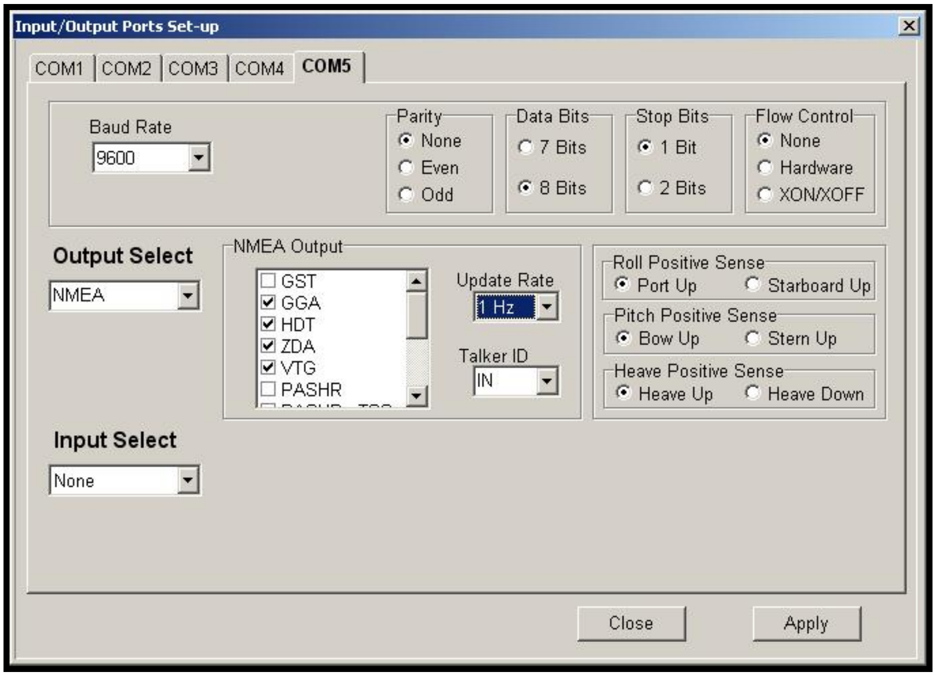
Com 4 = differential (rctm) input



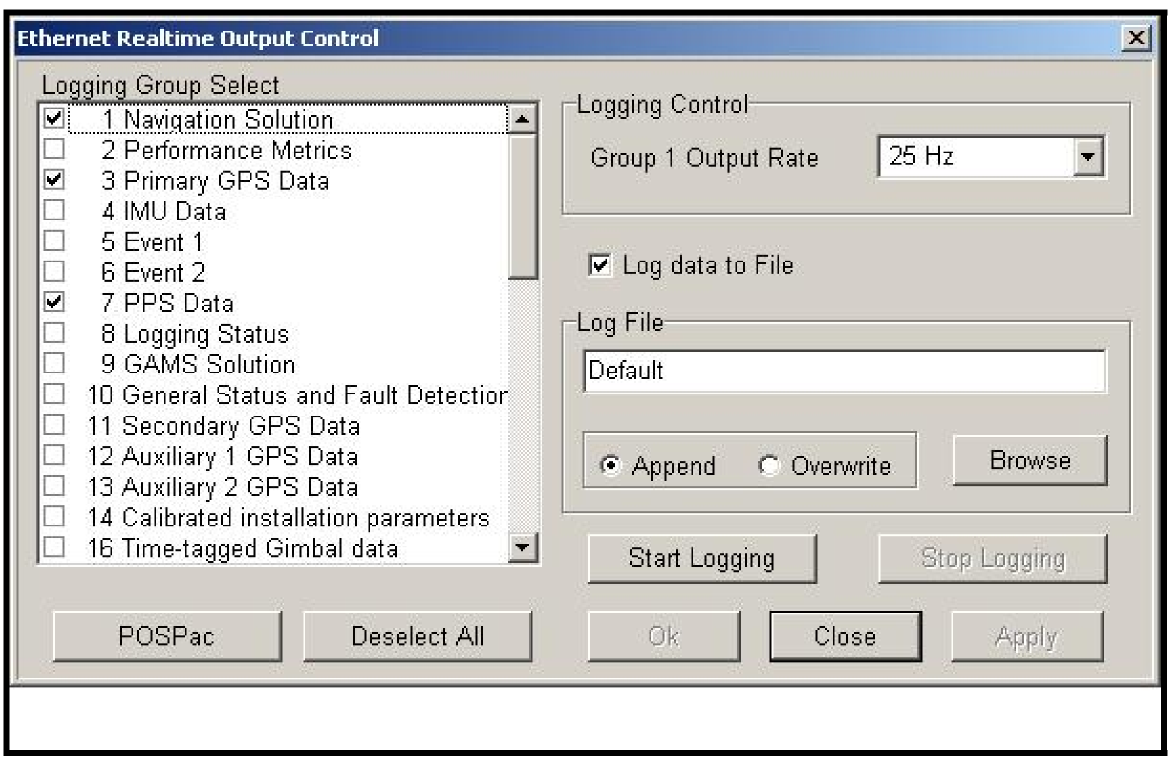
Com 2-attitude to simrad (change baud to 19200, 100 hz)



Com 5 =nmea to klein tpu



Output to hypack/hysweep over UDP 2601 port (message 1, 3, 7, 102, 111, 112, & 113) used with pss box in hypack program.



Note: Log a separate file and save as true-heave. Select message 111, (true heave data).

APPENDIX II

a) **Static Draft Report**
b) **Dynamic Draft Report**

Appendix I-a: **STATIC DRAFT REPORT**

Static Draft Report

Intro:

The Static Draft test was tested done in April 2006 by NRT 5 personnel. No changes to vessel's equipment.

Procedure:

Using a steel tape measure, the draft was measured to the waterline and referenced back to the IMU.

Result:

We calculated a -0.20m, identical to the previous year; VCF remains unchanged.

Appendix II-b: **DYNMANIC DRAFT REPORT**

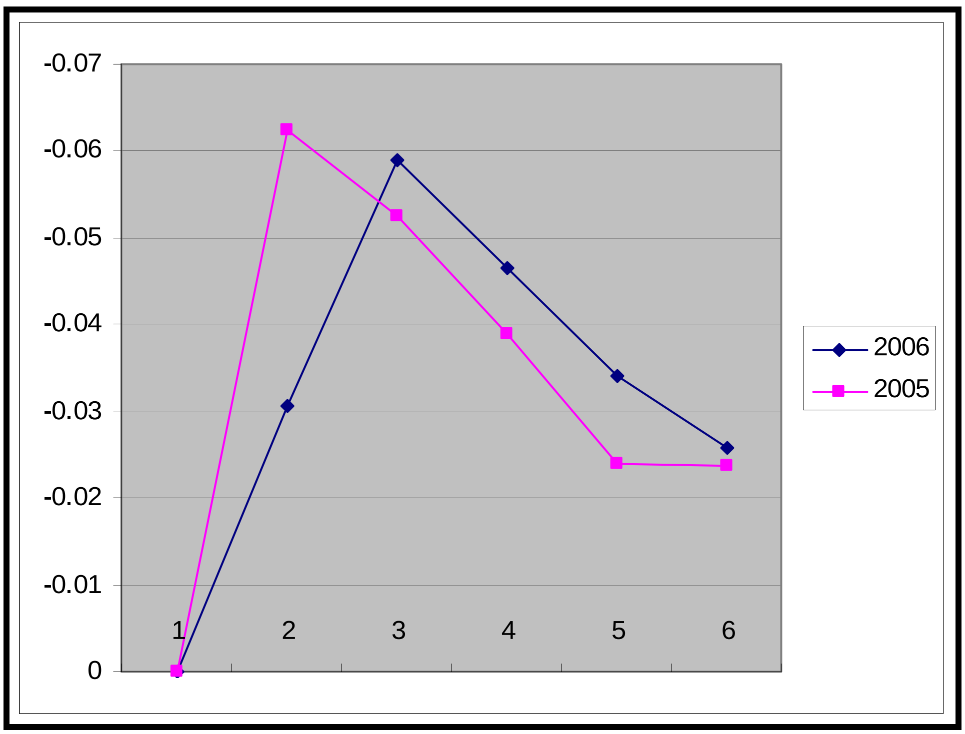
Dynamic Draft Report

Intro:

A Dynamic draft test was conducted by NRT5 on April 20, 2006 in New York Harbor.

Methods:

Measuring and recording depths at various speeds creates a model of the boat's draft as it rises initially and settles at survey speed. Based on these measurements, offsets are obtained and entered into the vessel configuration files to compensate for this added dimension.



Comparison between dynamic draft from 2005 and 2006 models

		MBES 3002(Dave Sinson method)		
line	4/20/2006	draft	speed	
1726	0	0	0	
1730	-0.0306	-0.0625	1.1	
1736	-0.059	-0.0525	3.2	
1738	-0.0465	-0.039	4.2	
1742	-0.034	-0.024	5.1	
1740	-0.0259	-0.0237	6.5	

2006		
Time	speed	depth
1726	0	0
1730	1.1	-0.0306
1736	3.2	-0.059
1738	4.2	-0.0465
1742	5.1	-0.034
1740	6.5	-0.0259

[illegible] Settlement Date april 20, 2006

line	rpms	speed				
1726	0	0.7	8.625	0		
1730	750	1.1		-.306		
1736	1200	3.2		-.59		
1738	1600	4.2		-.149		
1742	1800	5.1		-.34		
1740	2100	6.5		-.259		
1726vs1730				1726vs1742		
beam 55	8.887 - 8.881 [illegible]			beam 59	65 8.657	8.991
beam 55	8.910, 8.896			60	64 8.710	8.955
beam 57	9.022, 9.016			61	63 8.693	8.948
Avg. 8.931	-.306			Avg. 8.68	8.965 - .062	-.34
1726vs1736				1726vs1740		
beam 59	9.250 9.247			beam 64	8.901	
	9.142 9.154			63	8.911	
	9.265 9.245			62	8.841	
Avg. 9.215	-.59			Avg. 8.884	-.259	
1726vs1738			1726vs1738			
beam 30	8.617 8.683			1726	1738	
beam 30	8.645 8.646			8.937	9.056	
beam 69	8.644 8.659				9.100	
					9.103	
Avg. 8.653	-0.028				Avg. = 9.086	

-.149

1726 = 0 @ beam 63 = 8.625

H/1400

↳ squat_06

Session → squat_06

APPENDIX III

a) CTD Report
b) Offset Report
c) VCF Report
d) Vessel diagram

Appendix III-a: **CTD REPORT**

CTD Report –Digibar Currently mounted at the MBES Transducer last calibration.
July 22, 2006

Date:
Jun 06, 2006

Serial #:
98212-060606

DIGIBAR CALIBRATION REPORT

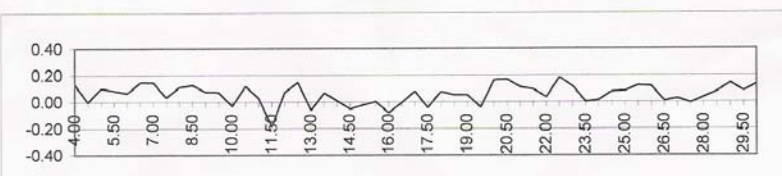
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5547.01	1421.75	0.13
4.50	1423.90	5555.25	1423.90	0.00
5.00	1426.15	5564.31	1426.26	0.10
5.50	1428.38	5572.79	1428.46	0.08
6.00	1430.58	5581.17	1430.64	0.07
6.50	1432.75	5589.83	1432.90	0.15
7.00	1434.90	5598.08	1435.04	0.15
7.50	1437.02	5605.80	1437.05	0.03
8.00	1439.12	5614.16	1439.23	0.11
8.50	1441.19	5622.17	1441.31	0.13
9.00	1443.23	5629.84	1443.31	0.08
9.50	1445.25	5637.59	1445.33	0.07
10.00	1447.25	5644.86	1447.22	-0.03
10.50	1449.22	5653.02	1449.34	0.12
11.00	1451.17	5660.15	1451.20	0.03
11.50	1453.09	5666.73	1452.91	-0.18
12.00	1454.99	5675.02	1455.07	0.07
12.50	1456.87	5682.51	1457.02	0.15
13.00	1458.72	5688.83	1458.66	-0.06
13.50	1460.55	5696.36	1460.62	0.07
14.00	1462.36	5703.08	1462.37	0.01
14.50	1464.14	5709.70	1464.09	-0.05
15.00	1465.91	5716.58	1465.88	-0.02
15.50	1467.65	5723.36	1467.65	0.00
16.00	1469.36	5729.63	1469.28	-0.08
16.50	1471.06	5736.44	1471.05	0.00
17.00	1472.73	5743.19	1472.81	0.08

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
17.50	1474.38	5749.06	1474.34	-0.04
18.00	1476.01	5755.78	1476.09	0.08
18.50	1477.62	5761.87	1477.67	0.05
19.00	1479.21	5767.97	1479.26	0.05
19.50	1480.77	5773.63	1480.73	-0.04
20.00	1482.32	5780.35	1482.48	0.16
20.50	1483.84	5786.23	1484.01	0.17
21.00	1485.35	5791.79	1485.46	0.11
21.50	1486.83	5797.43	1486.92	0.10
22.00	1488.29	5802.82	1488.33	0.03
22.50	1489.74	5808.94	1489.92	0.18
23.00	1491.16	5814.15	1491.28	0.12
23.50	1492.56	5819.11	1492.57	0.00
24.00	1493.95	5824.47	1493.96	0.01
24.50	1495.32	5829.97	1495.39	0.08
25.00	1496.66	5835.16	1496.74	0.08
25.50	1497.99	5840.42	1498.11	0.12
26.00	1499.30	5845.42	1499.41	0.12
26.50	1500.59	5849.96	1500.60	0.01
27.00	1501.86	5854.91	1501.88	0.03
27.50	1503.11	5859.60	1503.10	-0.01
28.00	1504.35	5864.50	1504.38	0.03
28.50	1505.56	5869.34	1505.64	0.08
29.00	1506.76	5874.19	1506.90	0.14
29.50	1507.94	5878.50	1508.02	0.08
30.00	1509.10	5883.16	1509.24	0.13



Odom Hydrographic Systems, Inc.
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Telephone: (225)-769-3051, Facsimile: (225)-766-5122
E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

Date:
Jun 06, 2006

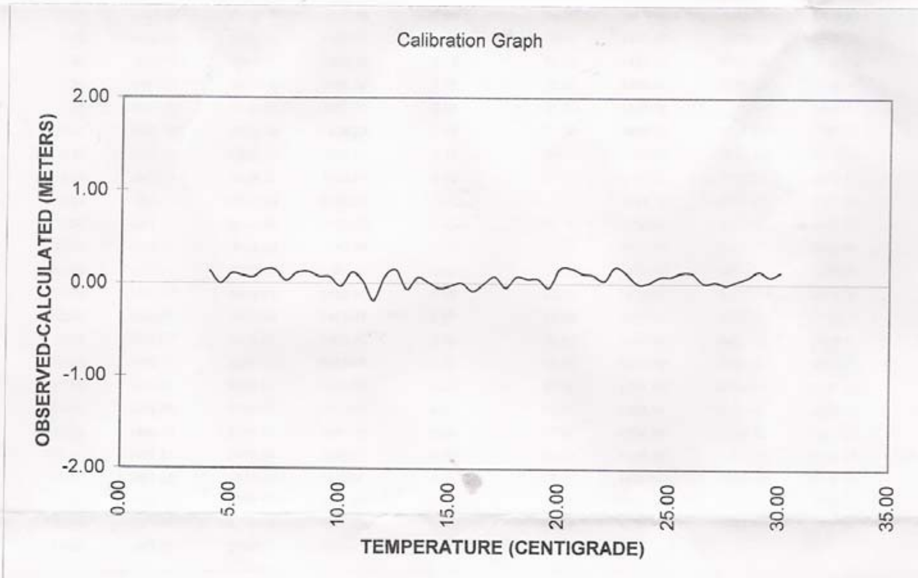
Serial #:
98212-060606

DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.

Burn these numbers to EPROM:	Gradient	3332
	Intercept	219



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CTD Report –Digibar

125ft long cable digibar last calibrated May 19, 2006.

Date:
May 19, 2006

Serial #:
98214-051906

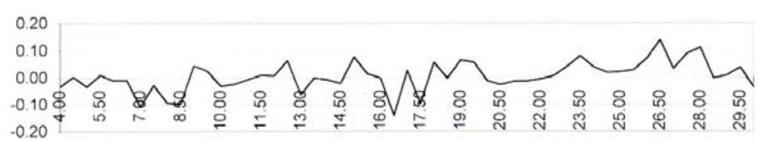
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc

STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5548.21	1421.59	-0.03
4.50	1423.90	5557.12	1423.90	0.00
5.00	1426.15	5565.64	1426.12	-0.03
5.50	1428.38	5574.37	1428.39	0.01
6.00	1430.58	5582.75	1430.57	-0.01
6.50	1432.75	5591.11	1432.74	-0.01
7.00	1434.90	5598.99	1434.79	-0.11
7.50	1437.02	5607.46	1436.99	-0.03
8.00	1439.12	5615.27	1439.02	-0.09
8.50	1441.19	5623.22	1441.09	-0.10
9.00	1443.23	5631.63	1443.28	0.04
9.50	1445.25	5639.33	1445.28	0.03
10.00	1447.25	5646.79	1447.22	-0.03
10.50	1449.22	5654.40	1449.20	-0.02
11.00	1451.17	5661.96	1451.16	-0.01
11.50	1453.09	5669.42	1453.10	0.01
12.00	1454.99	5676.72	1455.00	0.01
12.50	1456.87	5684.15	1456.93	0.06
13.00	1458.72	5690.79	1458.66	-0.06
13.50	1460.55	5698.07	1460.55	0.00
14.00	1462.36	5704.99	1462.35	-0.01
14.50	1464.14	5711.80	1464.12	-0.02
15.00	1465.91	5718.95	1465.98	0.08
15.50	1467.65	5725.40	1467.66	0.02
16.00	1469.36	5731.94	1469.36	0.00
16.50	1471.06	5737.92	1470.92	-0.14
17.00	1472.73	5745.00	1472.76	0.03
17.50	1474.38	5750.87	1474.28	-0.10
18.00	1476.01	5757.73	1476.07	0.06
18.50	1477.62	5763.69	1477.62	0.00
19.00	1479.21	5770.05	1479.27	0.07
19.50	1480.77	5776.04	1480.83	0.06
20.00	1482.32	5781.72	1482.30	-0.01
20.50	1483.84	5787.53	1483.82	-0.03
21.00	1485.35	5793.36	1485.33	-0.01
21.50	1486.83	5799.07	1486.82	-0.01
22.00	1488.29	5804.73	1488.29	0.00
22.50	1489.74	5810.33	1489.74	0.01
23.00	1491.16	5815.94	1491.20	0.04
23.50	1492.56	5821.49	1492.65	0.08
24.00	1493.95	5826.66	1493.99	0.04
24.50	1495.32	5831.83	1495.33	0.02
25.00	1496.66	5837.02	1496.68	0.02
25.50	1497.99	5842.15	1498.02	0.03
26.00	1499.30	5847.35	1499.37	0.07
26.50	1500.59	5852.57	1500.73	0.14
27.00	1501.86	5857.05	1501.89	0.03
27.50	1503.11	5862.08	1503.20	0.09
28.00	1504.35	5866.92	1504.46	0.11
28.50	1505.56	5871.16	1505.56	0.00
29.00	1506.76	5875.81	1506.77	0.01
29.50	1507.94	5880.46	1507.98	0.04
30.00	1509.10	5884.65	1509.07	-0.03



Odom Hydrographic Systems, Inc.
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E-mail: email@odomhydrographic.com, HTTP: www.odomhydrographic.com

Date:
May 19, 2006

Serial #:
98214-051906

DIGIBAR CALIBRATION REPORT

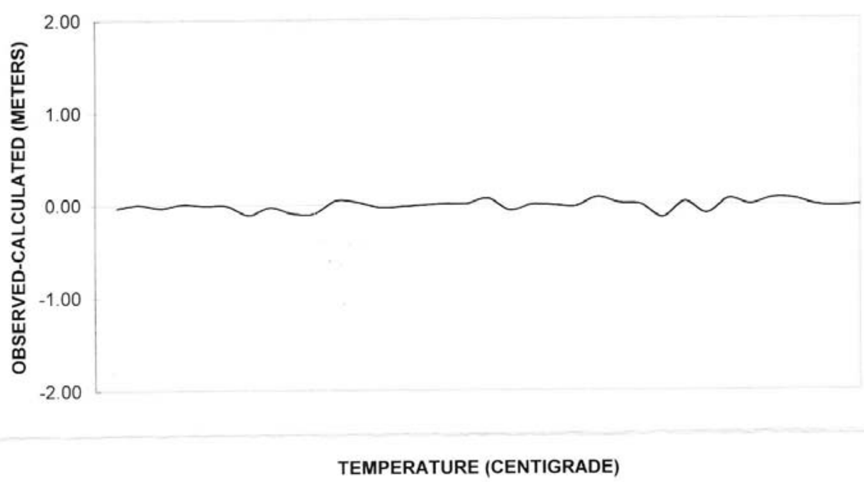
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc

Burn these numbers to EPROM:

	Gradient	**3329**
	Intercept	**211**

Calibration Graph



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CTD Report-Sea Bird CTD

SeaBird Sound Velocity Probe Calibration Date:07/11/2006

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: 4835
CALIBRATION DATE: 11-Jul-06

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

COEFFICIENTS:

```
g = -1.018083e+000
h =  1.319940e-001
i = -2.011500e-004
j =  3.178869e-005

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

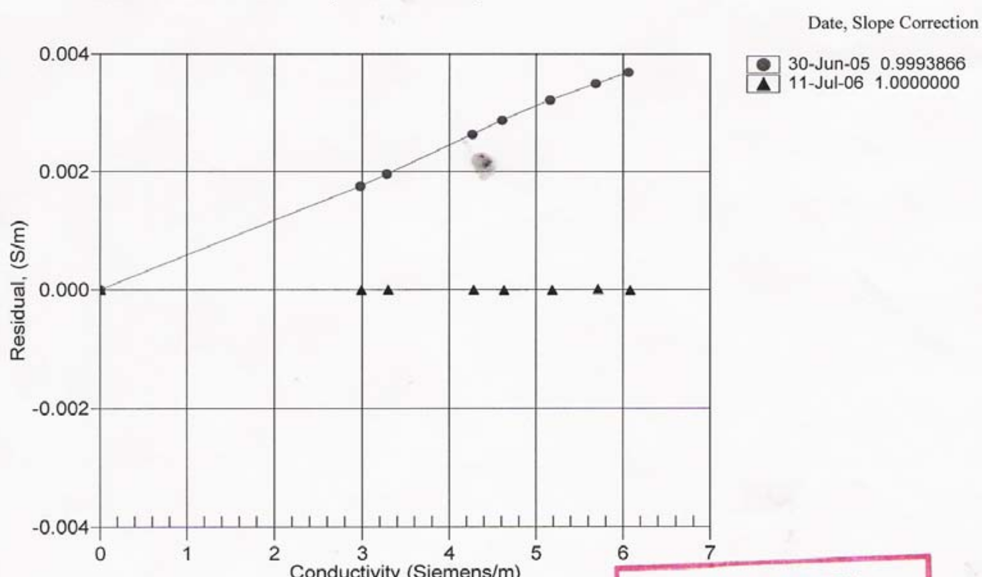
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2780.55	0.0000	0.00000
0.9999	34.9457	2.98596	5510.72	2.9860	-0.00000
4.5000	34.9255	3.29401	5718.10	3.2940	0.00000
15.0000	34.8837	4.27900	6335.02	4.2790	0.00000
18.5000	34.8748	4.62529	6537.79	4.6253	-0.00001
24.0000	34.8654	5.18512	6852.63	5.1851	-0.00000
29.0000	34.8604	5.70873	7134.19	5.7087	0.00001
32.5001	34.8579	6.08243	7328.32	6.0824	-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



POST CRUISE CALIBRATION

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: 4835
CALIBRATION DATE: 11-Jul-06

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.263807e-003
a1 = 2.606755e-004
a2 = 3.313828e-007
a3 = 1.414077e-007

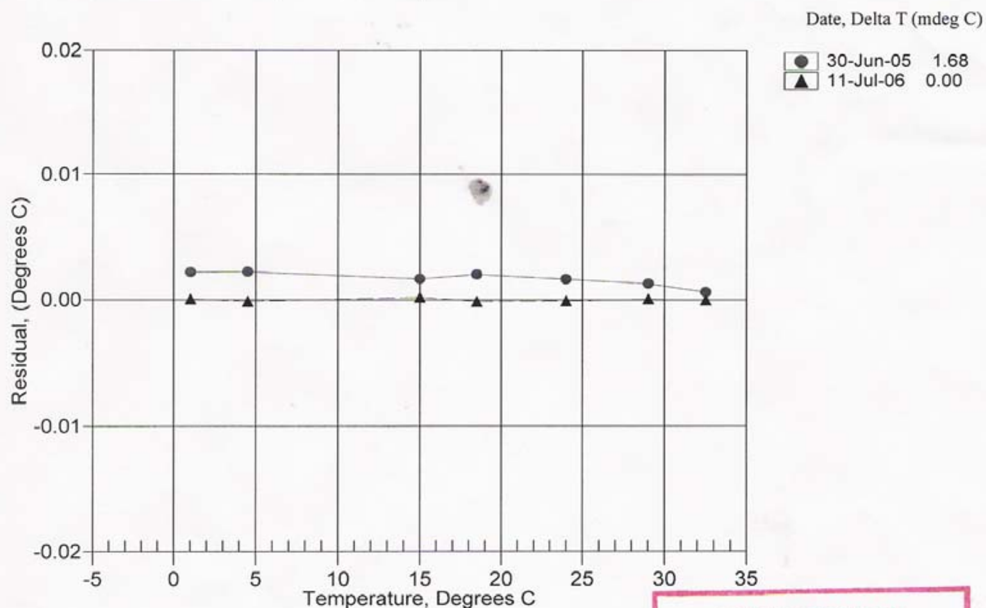
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	601006.373	1.0000	0.0001
4.5000	533123.729	4.4999	-0.0001
15.0000	365269.068	15.0002	0.0002
18.5000	320340.373	18.4999	-0.0001
24.0000	259417.220	23.9999	-0.0001
29.0000	213093.864	29.0001	0.0001
32.5001	185132.983	32.5001	-0.0000

MV = (n - 524288) / 1.6e+007

R = (MV * 2.900e+009 + 1.024e+008) / (2.048e+004 - MV * 2.0e+005)

Temperature ITS-90 = $1/\{a0 + a1[ln(R)] + a2[ln^2(R)] + a3[ln^3(R)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

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: 4835
CALIBRATION DATE: 07-Jul-06

SBE19plus PRESSURE CALIBRATION DATA
160 psia S/N tspan

COEFFICIENTS:

PA0 =	1.504874e-002	PTCA0 =	5.239214e+005
PA1 =	4.866425e-004	PTCA1 =	8.882021e-001
PA2 =	-3.481982e-012	PTCA2 =	2.256796e-002
PTEMPA0 =	-6.061920e+001	PTCB0 =	2.512200e+001
PTEMPA1 =	5.330373e+001	PTCB1 =	-2.000000e-003
PTEMPA2 =	1.160726e-002	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.78	554247.0	1.5	14.78	0.00
29.90	585300.0	1.5	29.91	0.00
59.89	646868.0	1.5	59.88	-0.01
94.89	718816.0	1.5	94.87	-0.01
124.88	780547.0	1.5	124.87	-0.01
159.88	852684.0	1.5	159.89	0.00
124.88	780580.0	1.5	124.88	0.01
94.88	718840.0	1.5	94.89	0.00
59.89	646899.0	1.5	59.90	0.01
29.89	585314.0	1.5	29.92	0.01
14.81	554257.0	1.5	14.79	-0.01

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.75	554542.39
29.00	1.68	554529.02
24.00	1.59	554531.41
18.50	1.48	554514.95
15.00	1.42	554503.47
4.50	1.22	554490.58
1.00	1.16	554493.36

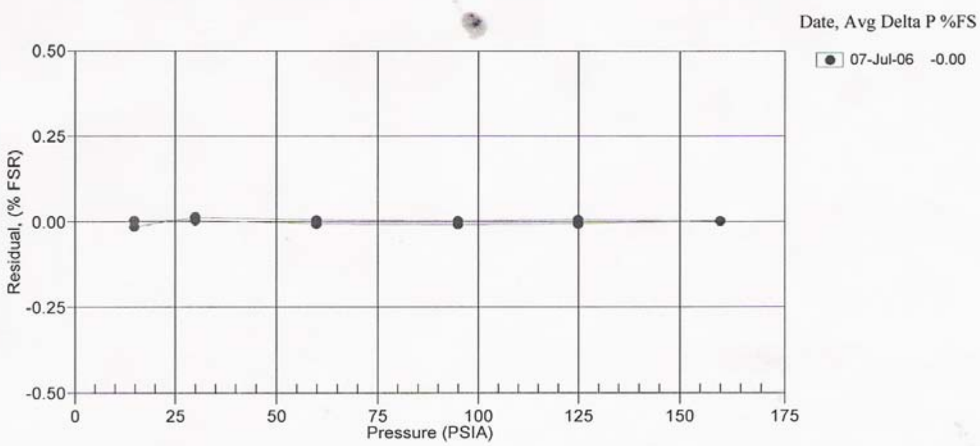
TEMP(ITS90)	SPAN(mV)
-5.00	25.13
35.00	25.05

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$



Appendix III-b: **OFFSET REPORT**

No changes were made to the previous year's offset report as determined by NGS.

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

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY
FIELD REPORT

Kendall L. Fancher
February 17, 2005

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

PURPOSE

The primary purpose of the survey was to accurately determine the spatial relationship of various components of a POS MV navigation system aboard the NOAA boat SS 3002. Additionally, various reference points (bench marks) and a GPS antenna used for navigation were established onboard the vessel to aid in future spatial surveys aboard the boat.

PROJECT DETAILS

This survey was conducted at the I & M Branch facility in Corbin, VA on the 16th of February. The weather was unusually mild with a steady breeze.

INSTRUMENTATION

The Leica (Wild) TC2002 precision total station was used to make all measurements.

Technical Data:

Angle Measurement

Resolution	0.03 seconds
Smallest unit in display	0.1 seconds

Standard Deviation

Horizontal angle	0.5 seconds
Vertical angle	0.5 seconds
Distance measurement	1mm + 1ppm

A standard "peanut" prism was used as a sighting target. This prism was configured to have a zero mm offset.

PERSONNEL

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

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

ESTABLISHING THE REFERENCE FRAME

A primary reference point, CL1, was set on the centerline of the boat and near the physical center of the boat. To conduct this survey a local coordinate reference frame was established where the X axis runs along the centerline of the boat and is positive from the primary reference point towards the bow of the boat. The Y axis is perpendicular to the centerline of the boat (X axis) and is positive from the primary reference point towards the right, when looking at the boat from the stern. The Z axis is positive in an upward direction from the primary reference point. In this reference frame CL1, the primary reference point, has the following coordinates;
X = 0.000(m)
Y = 0.000(m)
Z = 0.000(m)

A secondary reference point (CL2) was set on the centerline of the boat, near the stern. The Y value of the secondary reference point was assumed to be zero. Determination of the X value for CL2 was accomplished by measuring the horizontal distance from CL1. Determination of the Z value for CL2 was accomplished by trigonometric leveling from CL1. The determined coordinates for CL2 are;
X = -3.115(m)
Y = 0.000(m)
Z = -0.008 (m)

ESTABLISHING ALL OTHER POINTS

While occupying CL1, a bearing of 180.0000 was input into the instrument and CL2 was input for initialization. After initialization was conducted, angular and distance measurements were taken to establish the following points; BM2 and TP1. TP1 is a temporary point set off of the boat. The established coordinates for TP1 were then stored internally in the instrument.

While occupying TP1, the previously determined bearing to CL1 was recalled and initialization was conducted to CL1. After initialization was conducted, angular and distance measurements were taken to establish the following points; IMU, BM4, BM3, GPS, L1, L2, and TP2. TP2 is a temporary point set off of the boat. The established coordinates for TP2 were then stored internally in the instrument. During these observations, coordinate checks were made to the following previously established points;
BM2
X = 0.001(m)
Y = 0.003(m)
Z = 0.007(m)

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

CL2
X = 0.005(m)
Y = 0.000(m)
Z = 0.005(m)

While occupying TP02, the previously determined bearing to TP01 was recalled and initialization was conducted to TP01. After initialization was conducted, angular and distance measurements were taken to establish the following points; BM1, MB1, SB, and TP3. TP3 is a temporary point set off of the boat. The established coordinates for TP3 were then stored internally in the instrument. During these observations, coordinate checks were made to the following previously determined points;
CL1
X = -0.002(m)
Y = -0.003(m)
Z = 0.013(m)

IMU
X = 0.006(m)
Y = -0.010(m)
Z = 0.003 (m)

CL2
X = 0.001(m)
Y = 0.003(m)
Z = 0.007(m)

BM3
X = -0.002(m)
Y = -0.004(m)
Z = 0.000(m)

BM2
X = 0.003(m)
Y = -0.005(m)
Z = 0.003 (m)

GPS
X = 0.003(m)
Y = -0.005(m)
Z = 0.003(m)

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

L1
X = 0.003(m)
Y = -0.004(m)
Z = 0.003(m)

While occupying TP3, the previously determined bearing to TP2 was recalled and initialization was conducted to TP2. After initialization was conducted, angular and distance measurements were taken to establish the following points; BM1, MB1, SB, MB2, and MB3. During these observations, coordinate checks were made to the following previously determined points;

CL1
X = -0.002(m)
Y = 0.002(m)
Z = 0.013(m)

IMU
X = -0.004(m)
Y = 0.000(m)
Z = 0.005(m)

CL2
X = 0.008(m)
Y = -0.008(m)
Z = 0.002(m)

BM3
X = -0.002(m)
Y = 0.000(m)
Z = 0.005(m)

GPS
X = 0.005(m)
Y = 0.006(m)
Z = 0.003(m)

L1
X = 0.001(m)
Y = -0.003(m)
Z = 0.004(m)

NOAA BOAT S 3002
POS MV COMPONENTS SPATIAL RELATIONSHIP SURVEY

L2
X = -0.004(m)
Y = -0.002(m)
Z = 0.001 (m)

BM1
X = -0.001(m)
Y = 0.000(m)
Z = 0.003(m)

MB1
X = 0.003(m)
Y = -0.001(m)
Z = 0.002(m)

TP1
X = 0.000(m)
Y = 0.000(m)
Z = 0.007(m)
Points MB2 and MB3 were established for the purpose of determining a length for the Mulitbeam Sensor arm. A plumb bob was used to project the top center of the arm onto the deck. A plumb bob was also used to project the center of the bottom of the Multibeam Sensor can onto the deck. An inverse was computed between these two surveyed positions for a length value of 1.544(m).

DISCUSSION

All sensor/benchmark coordinates are contained in spreadsheet "S3002.xls. Included in this spreadsheet is the Multibeam Sensor arm length measurement and also an IMU GPS antenna separation value.

The positions given for all GPS antenna are to the top center of the antenna. To correct the Z value contained in the spreadsheet for each antenna to the electronic phase center, I recommend the following steps be taken;

1) Measure the total height of each antenna type. This information is probably located on the antenna or with equipment documentation.
2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This value may also be available at the NGS website for antenna modeling.

3) Subtract the total height of the antenna from the spreadsheet Z value for each antenna. This will give you a Z value for the antenna ARP (antenna reference point)
4) Then add to this value the electronic phase center offset value.

Appendix III-c: **VCF REPORT**

Vessel Configure

Vessel Name: 3002__mbes.hvf
Vessel modify: April 24, 2006


```
<HIPSVesselConfig Version="2.0">
  <VesselShape>
    <PlanCoordinates>
      <Entry X="-1.350000" Y="-4.150000"/>
      <Entry X="1.340000" Y="-4.150000"/>
      <Entry X="1.340000" Y="1.850000"/>
      <Entry X="-0.005000" Y="4.970000"/>
      <Entry X="-1.350000" Y="1.850000"/>
      <Entry X="-1.350000" Y="-4.150000"/>
    </PlanCoordinates>
    <ProfileCoordinates>
      <Entry Y="-4.150000" Z="0.890000"/>
      <Entry Y="-4.150000" Z="-0.500000"/>
      <Entry Y="1.850000" Z="-0.500000"/>
      <Entry Y="4.970000" Z="0.890000"/>
      <Entry Y="-4.150000" Z="0.890000"/>
    </ProfileCoordinates>
    <RP Length="4.150000" Width="1.340000" Height="0.500000"/>
  </VesselShape>
  <DepthSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Comment value="imu to mbes"/>
      <Latency value="0.000000"/>
      <SensorClass value="Swath"/>
      <TransducerEntries>
        <Transducer Number="1" StartBeam="1" Model="em3000">
          <Manufacturer value="Kongsberg"/>
          <SerialNumber value=""/>
          <Offsets X="1.174000" Y="2.600000" Z="1.342000"
Latency="0.000000"/>
          <MountAngle Pitch="-4.800000" Roll="1.985000"
Azimuth="3.000000"/>
        </Transducer>
      </TransducerEntries>
    </TimeStamp>
    <TimeStamp value="2005-305 00:00:00">
      <Latency value="0.000000"/>
      <SensorClass value="Swath"/>
      <TransducerEntries>
        <Transducer Number="1" StartBeam="1" Model="em3000">
          <Manufacturer value="Kongsberg"/>
          <Offsets X="1.174000" Y="2.600000" Z="1.342000"
Latency="0.000000"/>
          <MountAngle Pitch="-4.455000" Roll="1.875000"
Azimuth="2.830000"/>
        </Transducer>
      </TransducerEntries>
    </TimeStamp>
  </DepthSensor>
  <DraftSensor>
    <TimeStamp value="2004-240 00:00:00">
```

```
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <DraftEntries>
        <Entry Speed="0.000000" Draft="0.000000"/>
        <Entry Speed="2.000000" Draft="0.030000"/>
        <Entry Speed="3.500000" Draft="0.030000"/>
        <Entry Speed="5.000000" Draft="-0.016000"/>
        <Entry Speed="6.400000" Draft="-0.027000"/>
        <Entry Speed="7.200000" Draft="-0.040000"/>
      </DraftEntries>
      <Comment value="recal"/>
    </TimeStamp>
    <TimeStamp value="2004-306 00:00:00">
      <Comment value=""/>
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <DraftEntries>
        <Entry Speed="0.000000" Draft="0.000000"/>
        <Entry Speed="2.000000" Draft="-0.063000"/>
        <Entry Speed="3.500000" Draft="-0.053000"/>
        <Entry Speed="4.500000" Draft="-0.040000"/>
        <Entry Speed="6.000000" Draft="-0.024000"/>
        <Entry Speed="7.500000" Draft="-0.024000"/>
      </DraftEntries>
    </TimeStamp>
    <TimeStamp value="2005-305 00:00:00">
      <Comment value="recal 06"/>
      <Latency value="0.000000"/>
      <ApplyFlag value="Yes"/>
      <DraftEntries>
        <Entry Speed="0.000000" Draft="0.000000"/>
        <Entry Speed="1.098272" Draft="-0.031000"/>
        <Entry Speed="3.199568" Draft="-0.059000"/>
        <Entry Speed="4.198704" Draft="-0.046000"/>
        <Entry Speed="5.098704" Draft="-0.034000"/>
        <Entry Speed="6.498272" Draft="-0.026000"/>
      </DraftEntries>
    </TimeStamp>
  </DraftSensor>
  <GyroSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <Comment value="(null)"/>
      <Manufacturer value="(null)"/>
      <Model value="(null)"/>
      <SerialNumber value="(null)"/>
    </TimeStamp>
    <TimeStamp value="2005-305 00:00:00">
      <Comment value=""/>
      <Latency value="0.000000"/>
      <Manufacturer value=""/>
      <Model value=""/>
      <SerialNumber value=""/>
      <ApplyFlag value="No"/>
    </TimeStamp>
  </GyroSensor>
```

```
<HeaveSensor>
  <TimeStamp value="2004-240 00:00:00">
    <Latency value="0.000000"/>
    <ApplyFlag value="Yes"/>
    <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
    <Comment value="(null)"/>
    <Manufacturer value="(null)"/>
    <Model value="(null)"/>
    <SerialNumber value="(null)"/>
  </TimeStamp>
  <TimeStamp value="2005-305 00:00:00">
    <Comment value=""/>
    <Latency value="0.000000"/>
    <Manufacturer value=""/>
    <Model value=""/>
    <SerialNumber value=""/>
    <ApplyFlag value="Yes"/>
    <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
  </TimeStamp>
</HeaveSensor>
<NavSensor>
  <TimeStamp value="2004-240 00:00:00">
    <Comment value=""/>
    <Latency value="-0.100000"/>
    <Manufacturer value=""/>
    <Model value=""/>
    <SerialNumber value=""/>
    <Ellipse value="NA83"/>
    <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
  </TimeStamp>
  <TimeStamp value="2005-305 00:00:00">
    <Comment value=""/>
    <Latency value="0.035500"/>
    <Manufacturer value=""/>
    <Model value=""/>
    <SerialNumber value=""/>
    <Ellipse value="NA83"/>
    <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
  </TimeStamp>
</NavSensor>
<PitchSensor>
  <TimeStamp value="2004-240 00:00:00">
    <Latency value="0.000000"/>
    <ApplyFlag value="No"/>
    <Offsets Pitch="0.000000"/>
    <Comment value="(null)"/>
    <Manufacturer value="(null)"/>
    <Model value="(null)"/>
    <SerialNumber value="(null)"/>
  </TimeStamp>
  <TimeStamp value="2005-305 00:00:00">
    <Comment value=""/>
    <Latency value="0.000000"/>
    <Manufacturer value=""/>
    <Model value=""/>
    <SerialNumber value=""/>
    <ApplyFlag value="No"/>
```

```
      <Offsets Pitch="0.000000"/>
    </TimeStamp>
  </PitchSensor>
  <RollSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="Yes"/>
      <Offsets Roll="0.000000"/>
      <Comment value="(null)"/>
      <Manufacturer value="(null)"/>
      <Model value="(null)"/>
      <SerialNumber value="(null)"/>
    </TimeStamp>
    <TimeStamp value="2005-305 00:00:00">
      <Comment value=""/>
      <Latency value="0.000000"/>
      <Manufacturer value=""/>
      <Model value=""/>
      <SerialNumber value=""/>
      <ApplyFlag value="Yes"/>
      <Offsets Roll="0.000000"/>
    </TimeStamp>
  </RollSensor>
  <SVPSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <DualHead value="Yes"/>
      <Offsets X="1.174000" Y="2.600000" Z="1.342000" X2="0.000000"
Y2="0.000000" Z2="0.000000"/>
      <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000" Pitch2="0.000000" Roll2="0.000000"
Azimuth2="0.000000"/>
      <Comment value="(null)"/>
    </TimeStamp>
    <TimeStamp value="2005-305 00:00:00">
      <Latency value="0.000000"/>
      <DualHead value="No"/>
      <Offsets X="1.174000" Y="2.600000" Z="1.342000"/>
      <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000"/>
    </TimeStamp>
    <TimeStamp value="2006-111 00:00:00">
      <Latency value="0.000000"/>
      <DualHead value="No"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
      <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000"/>
    </TimeStamp>
  </SVPSensor>
  <WaterlineHeight>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <WaterLine value="-0.205000"/>
      <ApplyFlag value="Yes"/>
      <StdDev Waterline="0.000000"/>
      <Comment value="recal"/>
    </TimeStamp>
```

```
  </WaterlineHeight>
  <TPEConfiguration>
    <TimeStamp value="2004-240 00:00:00">
      <Comment value="values for pos ver 4"/>
      <Latency value="0.000000"/>
      <Offsets>
        <MRUtoTransducer X="0.020000" Y="0.020000" Z="0.020000"
X2="0.000000" Y2="0.000000" Z2="0.000000"/>
        <NavigationToTransducer X="0.020000" Y="0.020000"
Z="0.020000" X2="0.000000" Y2="0.000000" Z2="0.000000"/>
        <Transducer Roll="0.020000" Roll2="0.000000"/>
        <Navigation Latency="0.000000"/>
      </Offsets>
      <StandardDeviation>
        <Motion Gyro="0.050000" HeavePercAmplitude="5.000000"
Heave="0.050000" Roll="0.020000" Pitch="0.020000"
PitchStablized="0.000000"/>
        <Position Navigation="0.500000"/>
        <Timing Transducer="0.100000" Navigation="0.010000"
Gyro="0.010000" Heave="0.010000" Pitch="0.010000" Roll="0.010000"/>
        <SoundVelocity Measured="0.050000" Surface="0.050000"/>
        <Tide Measured="0.010000" Zoning="0.100000"/>
        <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
        <MRUAlignment Gyro="0.000000" Pitch="0.000000"
Roll="0.000000"/>
        <Vessel Speed="0.000000" Loading="0.000000" Draft="0.030000"
DeltaDraft="0.000000"/>
      </StandardDeviation>
    </TimeStamp>
  </TPEConfiguration>
</HIPSVesselConfig>
```


Vessel Name: 3002__vbes.hvf
Vessel modify: April 21, 2005


```
<HIPSVesselConfig Version="2.0">
  <VesselShape>
    <PlanCoordinates>
      <Entry X="-1.350000" Y="-4.150000"/>
      <Entry X="1.340000" Y="-4.150000"/>
      <Entry X="1.340000" Y="2.050000"/>
      <Entry X="-0.005000" Y="4.970000"/>
      <Entry X="-1.350000" Y="2.050000"/>
      <Entry X="-1.350000" Y="-4.150000"/>
    </PlanCoordinates>
    <ProfileCoordinates>
      <Entry Y="-4.150000" Z="0.870000"/>
      <Entry Y="-4.150000" Z="-0.500000"/>
      <Entry Y="2.050000" Z="-0.500000"/>
      <Entry Y="4.970000" Z="0.870000"/>
      <Entry Y="-4.150000" Z="0.870000"/>
    </ProfileCoordinates>
    <RP Length="4.150000" Width="1.340000" Height="0.500000"/>
  </VesselShape>
  <DepthSensor>
```

```
    <TimeStamp value="2004-240 00:00:00">
      <Comment value="rp to sb-trans"/>
      <Latency value="0.000000"/>
      <SensorClass value="Swath"/>
      <TransducerEntries>
        <Transducer Number="1" StartBeam="1" Model="Unknown">
          <Manufacturer value=""/>
          <SerialNumber value=""/>
          <Offsets X="-0.130000" Y="0.305000" Z="0.389000"
Latency="0.000000"/>
          <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000"/>
        </Transducer>
      </TransducerEntries>
    </TimeStamp>
  </DepthSensor>
  <DraftSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="Yes"/>
      <DraftEntries>
        <Entry Speed="0.000000" Draft="0.000000"/>
        <Entry Speed="2.500000" Draft="0.067000"/>
        <Entry Speed="4.000000" Draft="0.087000"/>
        <Entry Speed="5.000000" Draft="0.109000"/>
        <Entry Speed="6.500000" Draft="0.114000"/>
        <Entry Speed="8.000000" Draft="0.095000"/>
        <Entry Speed="10.000000" Draft="0.014000"/>
      </DraftEntries>
      <Comment value=""/>
    </TimeStamp>
  </DraftSensor>
  <GyroSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
    </TimeStamp>
  </GyroSensor>
  <HeaveSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
      <Comment value="(null)"/>
      <Manufacturer value="(null)"/>
      <Model value="(null)"/>
      <SerialNumber value="(null)"/>
    </TimeStamp>
  </HeaveSensor>
  <PitchSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <Offsets Pitch="0.000000"/>
      <Comment value="(null)"/>
      <Manufacturer value="(null)"/>
      <Model value="(null)"/>
```

```
      <SerialNumber value="(null)"/>
    </TimeStamp>
  </PitchSensor>
  <RollSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="No"/>
      <Offsets Roll="0.000000"/>
      <Comment value="(null)"/>
      <Manufacturer value="(null)"/>
      <Model value="(null)"/>
      <SerialNumber value="(null)"/>
    </TimeStamp>
  </RollSensor>
  <SVPSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <DualHead value="Yes"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000" X2="0.000000"
Y2="0.000000" Z2="0.000000"/>
      <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000" Pitch2="0.000000" Roll2="0.000000"
Azimuth2="0.000000"/>
      <Comment value="(null)"/>
    </TimeStamp>
  </SVPSensor>
  <WaterlineHeight>
    <TimeStamp value="2004-240 00:00:00">
      <Latency value="0.000000"/>
      <WaterLine value="-0.140000"/>
      <ApplyFlag value="Yes"/>
      <StdDev Waterline="0.000000"/>
      <Comment value="recal"/>
    </TimeStamp>
  </WaterlineHeight>
  <NavSensor>
    <TimeStamp value="2004-240 00:00:00">
      <Comment value="imu to rp"/>
      <Latency value="0.000000"/>
      <Manufacturer value=""/>
      <Model value=""/>
      <SerialNumber value=""/>
      <Ellipse value="NA83"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
    </TimeStamp>
  </NavSensor>
</HIPSVesselConfig>
```


Vessel Name: 3002__sss500k.hvf
Vessel modify: April 21, 2005

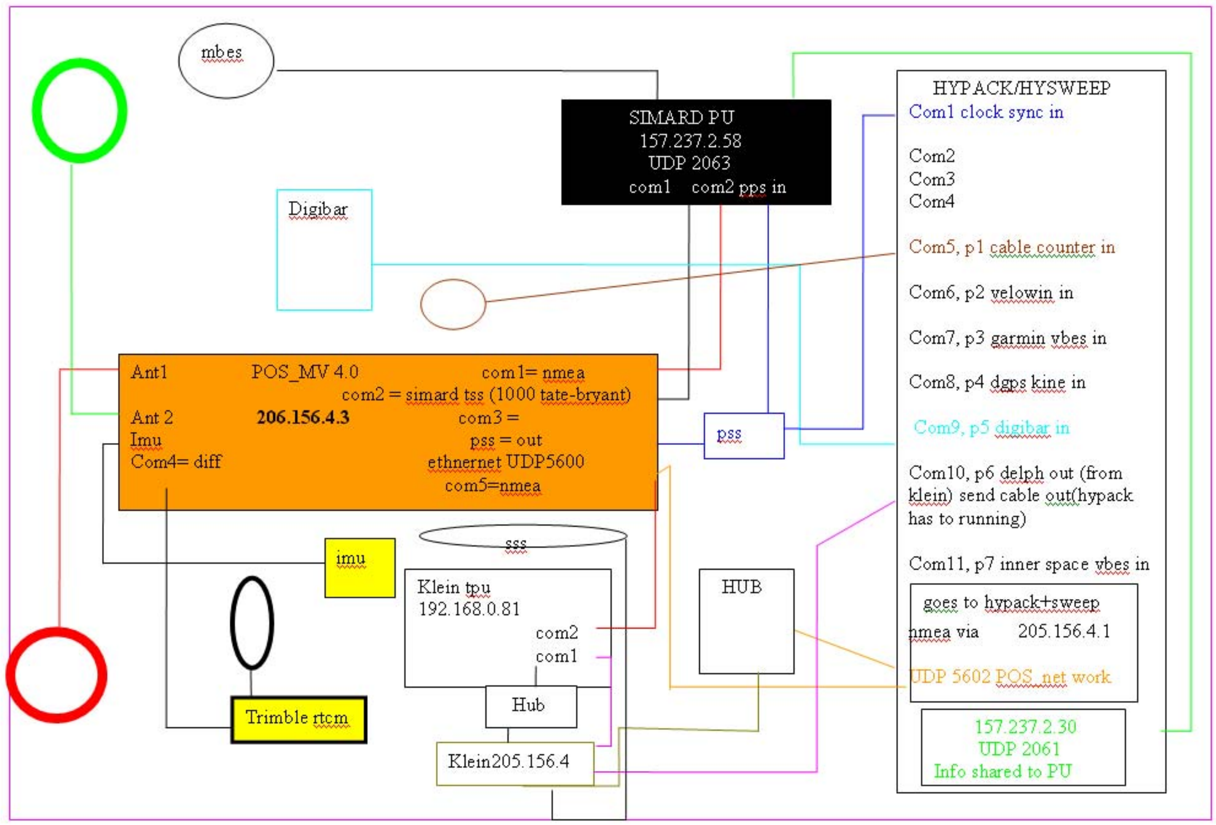

```
HIPSVesselConfig Version="2.0">
  <VesselShape>
    <PlanCoordinates>
      <Entry X="-1.350000" Y="-4.150000"/>
```

```
      <Entry X="1.340000" Y="-4.150000"/>
      <Entry X="1.340000" Y="1.850000"/>
      <Entry X="-0.005000" Y="4.970000"/>
      <Entry X="-1.350000" Y="1.850000"/>
      <Entry X="-1.350000" Y="-4.150000"/>
    </PlanCoordinates>
    <ProfileCoordinates>
      <Entry Y="-4.150000" Z="0.890000"/>
      <Entry Y="-4.150000" Z="-0.500000"/>
      <Entry Y="1.850000" Z="-0.500000"/>
      <Entry Y="4.970000" Z="0.890000"/>
      <Entry Y="-4.150000" Z="0.890000"/>
    </ProfileCoordinates>
    <RP Length="4.150000" Width="1.340000" Height="0.500000"/>
  </VesselShape>
  <DepthSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <SensorClass value="Swath"/>
      <TransducerEntries>
        <Transducer Number="1" StartBeam="1" Model="448">
          <Manufacturer value="Innerspace"/>
          <SerialNumber value="187"/>
          <Offsets X="0.000000" Y="0.000000" Z="0.000000"
Latency="0.000000"/>
          <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000"/>
        </Transducer>
      </TransducerEntries>
    </TimeStamp>
  </DepthSensor>
  <DraftSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Comment value="(null)"/>
      <Latency value="0.000000"/>
      <ApplyFlag value="Yes"/>
      <DraftEntries>
        <Entry Speed="0.000000" Draft="0.000000"/>
        <Entry Speed="4.100000" Draft="0.010000"/>
        <Entry Speed="6.000000" Draft="0.030000"/>
        <Entry Speed="8.400000" Draft="0.050000"/>
        <Entry Speed="11.400000" Draft="0.000000"/>
        <Entry Speed="15.400000" Draft="-0.080000"/>
        <Entry Speed="24.500000" Draft="-0.010000"/>
      </DraftEntries>
    </TimeStamp>
  </DraftSensor>
  <GyroSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <ApplyFlag value="Yes"/>
      <Offsets>
        <Gyro>
          <Entry Azimuth="0.000000" Offset="0.000000"/>
        </Gyro>
      </Offsets>
    </TimeStamp>
```

```
  </GyroSensor>
  <NavSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <Manufacturer value=""/>
      <Model value=""/>
      <SerialNumber value=""/>
      <Ellipse value="WG84"/>
      <Offsets X="0.133000" Y="0.283000" Z="0.097000"/>
      <Comment value="imu to rp"/>
    </TimeStamp>
    <TimeStamp value="2004-306 00:00:00">
      <Comment value="do not imu to rp"/>
      <Latency value="0.000000"/>
      <Manufacturer value=""/>
      <Model value=""/>
      <SerialNumber value=""/>
      <Ellipse value="NA83"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000"/>
    </TimeStamp>
  </NavSensor>
  <SVPSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <DualHead value="Yes"/>
      <Offsets X="0.000000" Y="0.000000" Z="0.000000" X2="0.000000"
Y2="0.000000" Z2="0.000000"/>
      <MountAngle Pitch="0.000000" Roll="0.000000"
Azimuth="0.000000" Pitch2="0.000000" Roll2="0.000000"
Azimuth2="0.000000"/>
    </TimeStamp>
  </SVPSensor>
  <TowedSensor>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <Manufacturer value="Dynapar"/>
      <Offsets X="2.180000" Y="-2.820000" Z="-2.640000"
Layback="0.000000"/>
      <Comment value="(null)"/>
      <Model value="(null)"/>
      <SerialNumber value="(null)"/>
    </TimeStamp>
    <TimeStamp value="2004-306 00:00:00">
      <Comment value="redone config"/>
      <Latency value="0.000000"/>
      <Manufacturer value="dynapar"/>
      <Model value=""/>
      <SerialNumber value=""/>
      <Offsets X="1.535000" Y="-3.031000" Z="-2.310000"
Layback="0.000000"/>
    </TimeStamp>
  </TowedSensor>
  <WaterlineHeight>
    <TimeStamp value="2002-079 00:00:00">
      <Latency value="0.000000"/>
      <WaterLine value="-0.200000"/>
      <ApplyFlag value="Yes"/>
```

<StdDev Waterline="0.000000"/>
<Comment value="(null)"/>
</TimeStamp>
</WaterlineHeight>
</HIPSVesselConfig>

Appendix III-d: **VESSEL DIAGRAM**


mbes
SIMARD PU
157.237.2.58
UDP 2063
com1 com2 pps in
HYPACK/HYSWEEP
Com1 clock sync in
Com2
Com3
Com4
Com5, p1 cable counter in
Com6, p2 velowin in
Com7, p3 garmin vbes in
Com8, p4 dgps kine in
Com9, p5 digibar in
Com10, p6 delph out (from klein) send cable out(hypack has to running)
Com11, p7 inner space vbes in
goes to hypack+sweep
nmea via 205.156.4.1
UDP 5602 POS net work
157.237.2.30
UDP 2061
Info shared to PU
Digibar
Ant1
POS_MV 4.0
com1= nmea
com2 = simard tss (1000 tate-bryant)
Ant 2
206.156.4.3
com3 =
Imu
pss = out
Com4= diff
ethnernet UDP5600
com5=nmea
pss
imu
sss
Klein tpu
192.168.0.81
com2
com1
HUB
Hub
Trimble rtcm
Klein205.156.4

APPENDIX IV

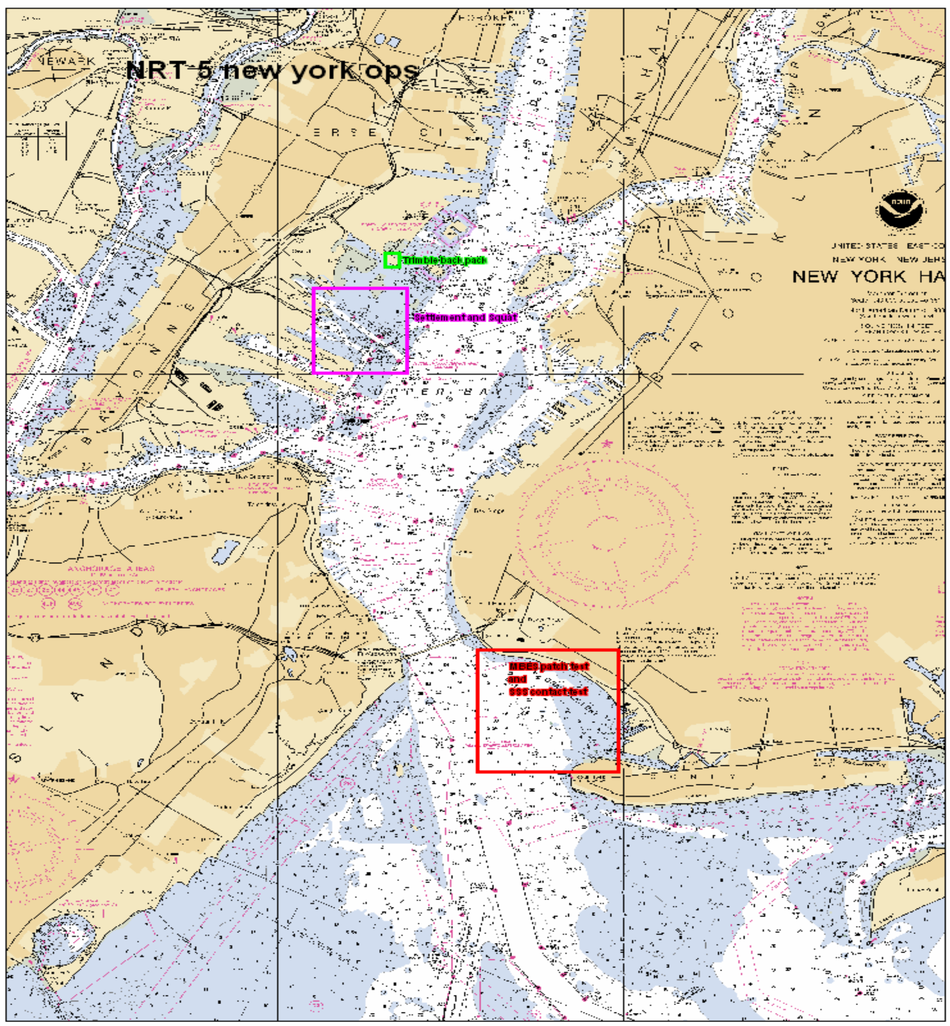
a) Patch Test Report
b) SSS Test Report
c) Leadline Test Report
d) GPS Back Pack Report

Appendix IV-a: **PATCH TEST REPORT**

Patch Test Report

Background:

Prior to the beginning of Survey Operations, certification of the boat equipment and procedures must be performed and submitted to the branch. This document addresses only the Simrad Em3000 certification. At this point it is a fluid document. The Hardware Acceptance Test (HAT) and the System Acceptance Test (SAT) are lengthy check off sheets and at this time it is unknown whether this is to be incorporated into the Certification process. Preliminary tests for Hat, SAT and Pos/MV antenna calibration were performed April 9, 2006 here in New York Harbor. Patch tests must be completed consistently and offsets must be accurate; this report addresses our methods of acquiring those offsets. All other calibrations from the patch test are addressed in the Caris offsets.



Equipment:

Simrad EM3000 multibeam echo-sounder

TSS POS/MV 4 Inertial Motion sensor
Trimble DSM 212L DGPS receiver
2 Trimble GPS Antennas
Seacat SBE19Plus sound velocity profiler

Procedure:

The following is a list of key items that must be covered for SimradEm3000 Certification

Offset Confirmation with date accomplished

- ☐ **3/9 /2005 Horizontal Vertical (Changes)**
- ☐ **3/9 /2005** Sounders
- ☐ **3/9 /2005**SSS
- ☐ **3/9 /2005** Antenna
- ☐ P-Check
- ☐ **4/18 /2006** Static Draft Bubble
- ☐ **04/18/2006** Lead Line Comparison
- ☐ Processing Run Through

Pos/MV Gams Calibration

- ☐ **1/3/2006** The site will be in vicinity of the 2006 patch test for the boat.

Patch test

- ☐ **4/18/2006** Line Plan
- ☐ **3/9 /2005** Forms
- ☐ **2/2004** Hypack setup

EM3000

- ☐ **2/2004** Em3000 Install Parameters
- ☐ Certification/ Calibration Note
- ☐ **2/2004** Confirm Transfer Data Transfer Data
- ☐ **1/2006** Time Set UTC

PATCH TEST CALIBRATION

Location:

A patch test was conducted April 18, 2006 in the Gravesend Anchorage using methods dictated within the FPM. CARIS was utilized for data post processing with the results amending any previous calibration values. Two independent observers were used to verify the calibration values and subsequently applied to the Vessel Configuration File for use during the upcoming field season (see figures 3 & 4).

2006 Values:

Timing: 0.0355
Pitch: -4.455
Roll: 1.875
Yaw: 2.83

Procedure

Navigation Time delay: two pair of coincident lines run at different speeds and same direction. One pair up the slope and one down the slope, each line within a pair run at 3 and 7 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Pitch: two pair of coincident lines run at same speed and different direction. One pair up slope and one down slope, each line run at 5 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Roll: one pair of coincident lines, run at same speed and different direction in depths of 45 to 50 feet. One checkline run perpendicular to the pair of lines at the same speed for outer beam comparison. The pair of lines was reviewed in CARIS calibration mode for an average across track displacement of soundings. The checkline was reviewed with the pair of coincident lines and averaged with the overall roll bias.

Yaw- one pair of lines offset approximately 15 meters to either side of a charted wreck, run at same speed in opposite direction. The pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Deep water lines use the same procedures for pitch and roll. An outer beam roll offset was also acquired. This calibration accounts for the deterioration of the outer coating of the Simrad transducer. These are run perpendicular to each other and the Roll offset tool is used. A notice from Simrad indicated their documentation had the incorrect sign for outer beam offset.

Further assurance checks were made between our Innerspace 455i single beam echo sounder and the soundings obtained with the EM3000. The difference between soundings obtained from both sensors was less than 5cm over the actual shipwreck.

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Patch Test Report

PATCH TESTS **Project** H11400 **Vessel** 3002 **DN**______ **Date** 20 April 2006

Consult Caris Field Procedures for Calibration of MBES by Andre Godin 02/96 in the Patch Test Log

Test 1) Position Time	Running Attributes 500-1000m, Tool 3-5 Slices along Slope10-20° Perpendicular to contour, all 4; 1 pair inshore at different speed, angular beam spacing; 1 pair offshore at different speed, run same Line, — Use Pitch, X-Line over, Use Equi			1st Scan: Initials JP Observed Error	2nd scan: Initials BH Observed Error	Avg	Remarks
006_1518	Inbound Slow Line Name	Dir: →	Speed: 3.5 knots	① -0.07 ② -0.08 ③ -0.10 ④ -0.09	1 .06 2 -.01 3 -.02	V=-.0825 =-.01	total V avg = -0.086
006-1514 Comparison 1	Inbound Fast Line Name	Dir: →	Speed: 6.5 knots				
006_1522	Outbound Slow Line Name	Dir: ←	Speed: 3.5 knots	-0.09 -0.08 -0.10 -0.09	1 -.01 2 .04 3 .09	V=-0.09 =.04	B=.015
006_1516 Comparison 2	Outbound Fast Line Name	Dir: ←	Speed: 6.5 knots				

Time Ave = +0.355

Test 2) Pitch	Running Attributes 500-1000m, Tool 3-5 Slices along Slope10-20° Perpendicular to contour, or **Feature** all 4; 1 pair inshore at different speed, run same line, angular beam spacing; 1 pair offshore at different speed, run same Line, Add time delay from Position time test if pitch >1deg redo — Use Pitch, X-Line over, Use Equi			1st Scan: Initials JP Observed Error	2nd scan: Initials BH Observed Error	Avg	Remarks
006-1518	Inshore Slow Line Name	Dir: →	Speed: 3.5 knots	-4.91 -4.93 -4.90 -4.92	-4.2 -4.1	V=-4.915 -4.2	V total = -4.91
006-1514 Comparison 1	OffShore Slow Line Name	Dir: →	Speed: 6.5 knots				
006-1522	Inshore Fast Line Name	Dir: ←	Speed: 3.5 knots	-4.90 -4.92 -4.91 -4.89	-3.9	V=-4.905	-4.0
006-1516 Comparison 2	Offshore Fast Line Name	Dir: ←	Speed: 6.5 knots				

Pitch Ave = -4.455

Test 3) Roll	Running Attributes 500-1000m, Speed(use calculation), Bottom Type Flat, 50-250m deep roll bias shows up better — 1 pair opposite dir Same, 3-5 Slices Across, Use Roll Tool Roll			1st Scan: Initials JP Observed Error	2nd scan: Initials BH Observed Error	Avg	Remarks
002_1500	Line Name	Dir: ↑	Speed: 6.5k knots	1.99	1.85	V=1.92	V = 1.94
003_1502 Comparison	Line Name	Dir: ↓	Speed: 6.5knots				

Patch Test Report

003-1503	Line Name	Dir: ↑	Speed: 6.5 knots	1.99	1.67		B=1.76
002-1509 Comparison 2	Line Name	Dir: ↓	Speed: 6.5 knots				

Roll Ave 1.875

Test 4 Yaw, AZ or Heading	Running Attributes Two pair: 1st pair adjacent parallel lines same Dir. To be run normal to a prominent bathymetric feature such as a shoal or channel side slope, Do not use a feature with sharp edges such as wrecks since there is more ambiguity in the interpretation. 5% overlap. Same Speed 3-5 Slices along (center of overlap) Roll Tool blue line is center beam take 4 reading adjustments and avg			1st Scan: Initials (VP) Observed Error	2nd scan: Initials ZH Observed Error	Avg	Remarks
002-1500 Comparison 1	Line Name	Dir: ↑	Speed: 6.5 knots	2.99	2.2 1.8 2.5	E: 2.17	V=2.99 B=2.67
both at 090 e.g. 003-1503	Line Name	Dir: ↑	Speed: 6.5 knots				
003-1502 Comparison 2	Line Name	Dir: ↓	Speed: 6.5 knots	2.99	2.6 3.1 2.3	B: 2.67	
both at 180 e.g. 002-1505	Line Name	Dir: ↓	Speed: 6.5 knots				

Select Lines then corridor watch mouse button sequence (middle button)

Yaw Ave 2.83

Outer Beam offset (for Simrad transducer surface) Optional	Running Perpendicular NOTE: This Test is Typically for Simrad type systems only. The key to the calibration is not necessarily pulling the lines together (though they coulbe) But to get the depths of the outside wings of the beams parallel to the comparison line. Two perpendicular lines same speeed			1st Scan: Initials_____ Observed Error	2nd scan: Initials_____ Observed Error	Avg	Remarks which line is nadir
Comparison 1	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				

Comparison 2	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				
Comparison 3	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				
Comparison 4	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				
Comparison 5	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				
Comparison 6	Line Name	Dir:	Speed:				
	Line Name	Dir:	Speed:				

Remarks: Take a slice of the along the nadir line. Use the roll tool to make one wing of the swath parrallel to the nadir line but not intersecting.. The arm should be about 1/3

Appendix IV-b: **SSS Test Report**

SSS Report

SURVEY VESSEL 3002
CERTIFICATION REPORT KLEIN SSS 3000

Background:

Daily confidence checks are conducted by observing side scan imagery in the vicinity of known contacts, such as buoy blocks or charted wrecks at the operating frequencies of 100/500kHz. Imagery is considered satisfactory if the selected contacts are distinguishable throughout the entire range of the side scan record.

Equipment:

Klein 3000 Side Scan Sonar

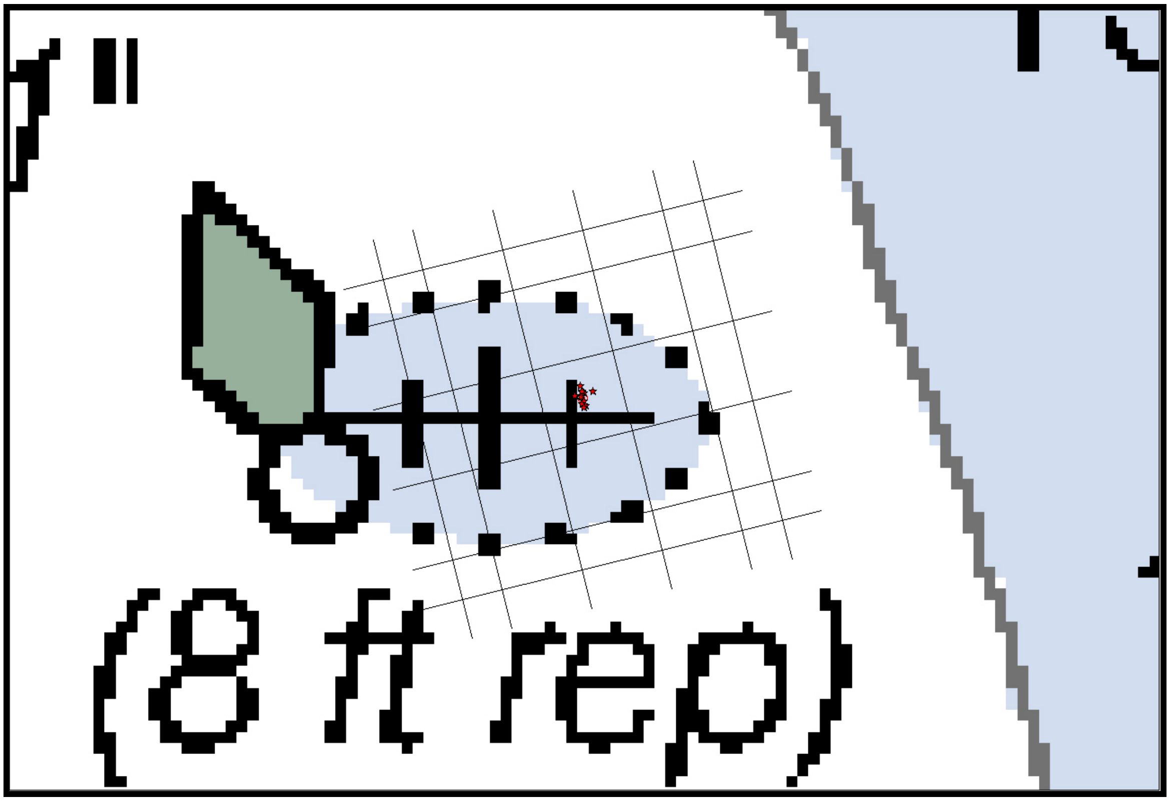
Location:

New York Harbor, Gravesend Anchorage.
Liberty State Park, Jersey City, NJ

Procedure:

A SSS certification evaluation was performed on April 18, 2006 (see fig1&5). Gravesend Anchorage, located just outside of New York Harbor, is a deep-water vessel anchorage located just south of the Verrazano-Narrows Bridge. The evaluation used a 75 meter operating range scale with thirteen passes near the contact. Line plans were drawn with opposing azimuths to provide for both port and starboard side transducer exposure, and drawn to different scales of 15, 45, and 60 meters away from the known contact.

Targeted contact(s) was selected using Multibeam data, ensuring a higher confidence in the positional accuracy of the object. Contact selected was a charted wreck adjacent to a green navigation buoy. SSS evaluation was conducted according to FPM section 1.2.8.1(see figure 5). The most reliable and accurate passes were used for calculation with the “Calculate Statistics” tool of MapInfo 8.0, and produced standard deviation values of 1.58 for Easting and 2.29 for Northing at a 98% confidence level (see figure 6 & 7).



Results:

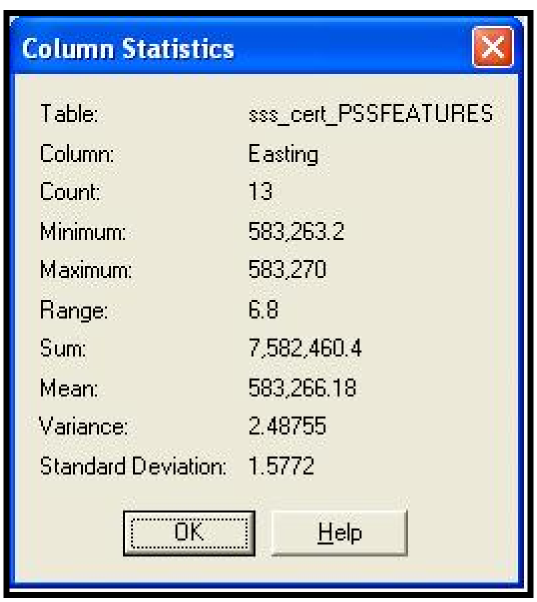


Table:	sss_cert_PSSFEATURES
Column:	Easting
Count:	13
Minimum:	583,263.2
Maximum:	583,270
Range:	6.8
Sum:	7,582,460.4
Mean:	583,266.18
Variance:	2.48755
Standard Deviation:	1.5772

fig 6, Easting calculations

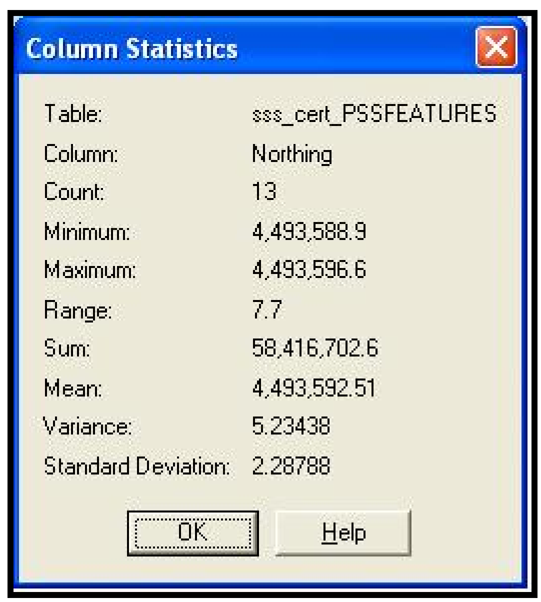


Table:	sss_cert_PSSFEATURES
Column:	Northing
Count:	13
Minimum:	4,493,588.9
Maximum:	4,493,596.6
Range:	7.7
Sum:	58,416,702.6
Mean:	4,493,592.51
Variance:	5.23438
Standard Deviation:	2.28788

fig7, Northing calculations

Appendix IV-c: **LEADLINE TEST REPORT**

Lead Line Test Report

Background:

A comparison test for the lead line and single beam echo sounder (sbes) was conducted in New York Harbor on 20 April 2006. These values are depicted in the table below. A 2 cm difference was determined between the sbes and lead line values and is within the currently accepted error budget guidelines of the FPM. No update to the sbes vessel configuration file is needed at this time (see table 2).

	leadline-std		leadline-port		sbes		
	3.255	3.055			3.305		
	3.265	3.065			3.205		
	3.255	3.055			3.305		
	3.275	3.075			3.305		
			3.275	3.075	3.305		
			3.255	3.055	3.305		
			3.255	3.055	3.305		
			3.275	3.075	3.305		
ave	**3.2625**		**3.265**		**3.2925**		
leadline ave	3.26375			sbes	3.2925	**difference**	**0.02875m**

Table 2. SBES vs Lead line

Procedure:

One member of NRT5 read the SBES digital trace, while another member read the lead line simultaneously. An average of the outside readings came from both port and starboard.

These values were tabulated and analyzed.

Result: Difference in leadline and SBES trace was found to be 0.02875m or less than 3cm.

Appendix IV-d: **GPS Trimble ProXRS TEST REPORT**

GPS Backpack Report

Background:

On April 19, 2006, an evaluation of the Trimble ProXRS was conducted on a known NGS benchmark labeled “KV6856” located inside Liberty State Park of Jersey City, NJ (see figure 8). Data acquisition consisted of a one-second logging interval for the duration of 5 minutes as outlined by FPM 3.4.4. Acquired data were then post-processed in Trimble’s Pathfinder Office 3.00 using a NGS *Continuously Operating Reference Station (CORS)* site located on the Campus of the New Jersey Institute of Technology of Newark, NJ. Of the 321 points acquired, a filtered set of 106 points were accepted by the C/A code post processing algorithm. Using Standard Deviation Values at the 95% confidence level, the horizontal accuracy of our unit was determined to be 0.6 meters (see figure 9, 10 & 11).

USACE bench mark KV6856

Fig 8, bench mark

First Order Horizontal Benchmark Used. (See NGS Data Sheet below for benchmark information)

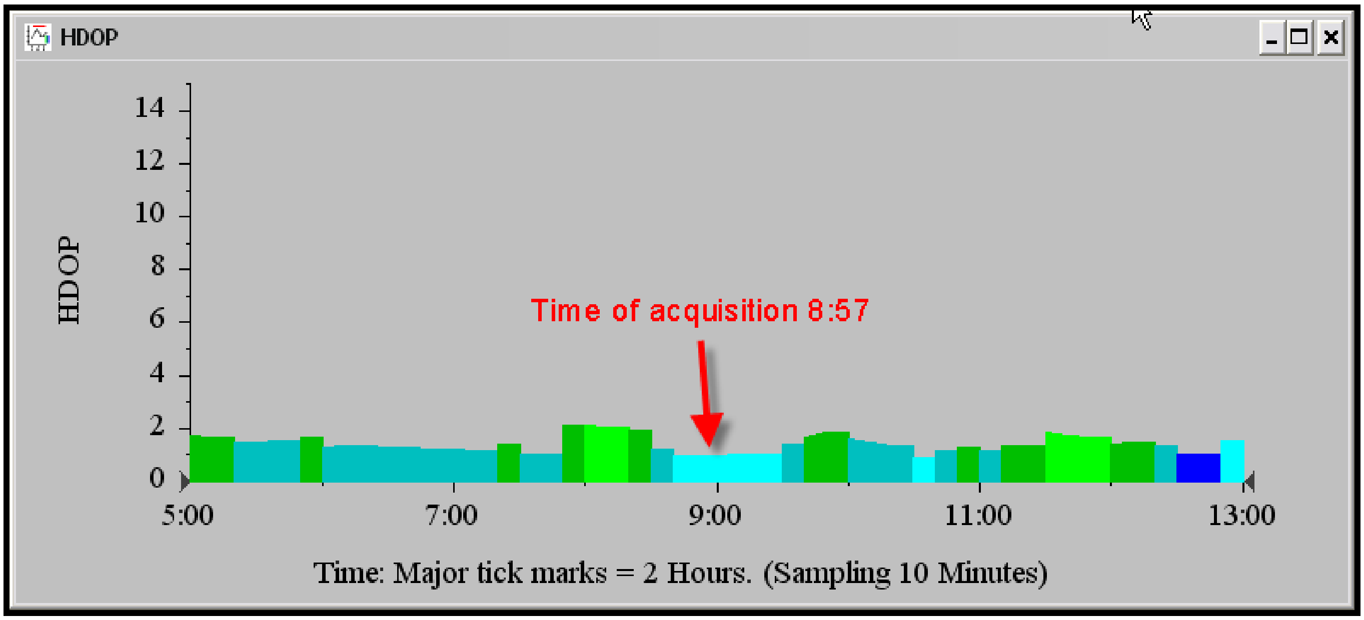


fig 9. Time of collection to reduce HDOP error.

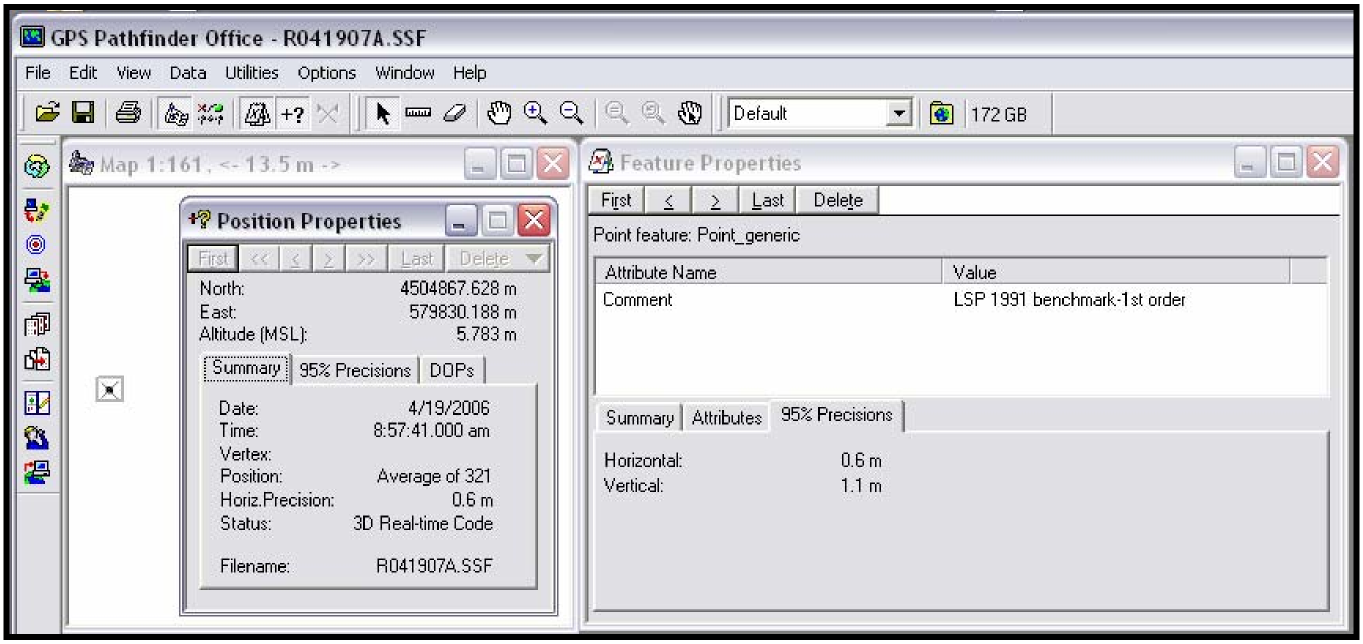


fig 10, Raw Statistics.

POST PROCESSED – using a Coarse Acquisition (C/A) Code from a CORS site.

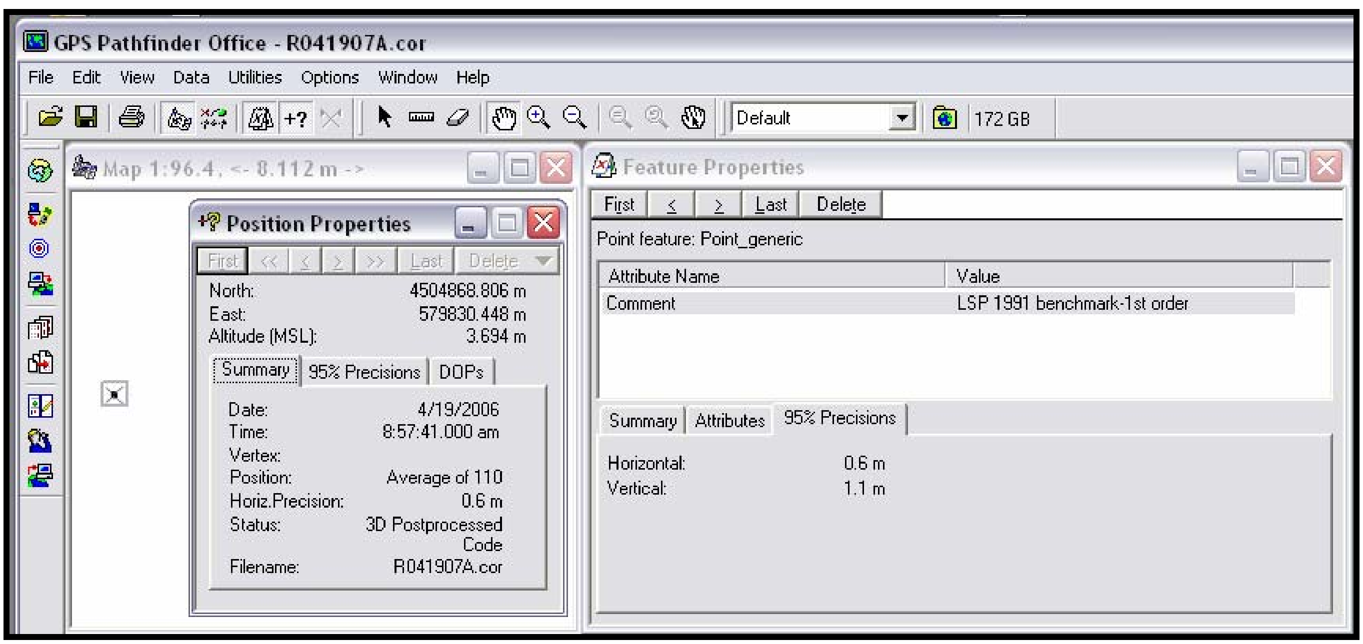


fig 11, Processed Statistics.

The NGS Data Sheet for bench mark used

See file dsdata.txt for more information about the datasheet.

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.35
1        National Geodetic Survey,   Retrieval Date = APRIL 18, 2006
 KV6856 ***********************************************************************
 KV6856  DESIGNATION -  LSP SOUTH
 KV6856  PID         -  KV6856
 KV6856  STATE/COUNTY-  NJ/HUDSON
 KV6856  USGS QUAD   -  JERSEY CITY (1981)
 KV6856
 KV6856                         *CURRENT SURVEY CONTROL
 KV6856  ___________________________________________________________________
 KV6856* NAD 83(1996)-  40 41 27.03865(N)    074 03 18.68737(W)     ADJUSTED
 KV6856* NAVD 88     -         2.7    (meters)       9.     (feet)  GPS OBS
 KV6856  ___________________________________________________________________
 KV6856  X          -   1,330,432.940 (meters)                    COMP
 KV6856  Y          -  -4,656,695.851 (meters)                    COMP
 KV6856  Z          -   4,136,432.710 (meters)                    COMP
 KV6856  LAPLACE CORR-           4.99  (seconds)                  DEFLEC99
 KV6856  ELLIP HEIGHT-         -29.33  (meters)         (10/23/02) GPS OBS
 KV6856  GEOID HEIGHT-         -31.98  (meters)                   GEOID03
 KV6856
 KV6856  HORZ ORDER  -  FIRST
 KV6856  ELLP ORDER  -  FOURTH    CLASS I
 KV6856
 KV6856.The horizontal coordinates were established by GPS observations
 KV6856.and adjusted by the National Geodetic Survey in May 1999..
 KV6856
 KV6856.The orthometric height was determined by GPS observations and a
 KV6856.high-resolution geoid model.
 KV6856
 KV6856.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 KV6856
 KV6856.The Laplace correction was computed from DEFLEC99 derived deflections.
 KV6856
 KV6856.The ellipsoidal height was determined by GPS observations
 KV6856.and is referenced to NAD 83.
 KV6856
 KV6856.The geoid height was determined by GEOID03.
 KV6856
 KV6856;                    North         East     Units Scale Factor Converg.
 KV6856;SPC NJ       -   206,314.091   187,594.708   MT  0.99991739   +0 17 24.0
 KV6856;SPC NY L     -    58,209.109   295,334.878   MT  0.99999874   -0 02 10.0
 KV6856;SPC NY L     -   190,974.39    968,944.51   sFT  0.99999874   -0 02 10.0
 KV6856;SPC NY E     -   206,314.091   187,594.708   MT  0.99991739   +0 17 24.0
 KV6856;SPC NY E     -   676,882.15    615,466.97   sFT  0.99991739   +0 17 24.0
 KV6856;UTM  18      - 4,504,867.899   579,830.555   MT  0.99967844   +0 36 57.7
 KV6856
 KV6856!             -  Elev Factor  x  Scale Factor =   Combined Factor
 KV6856!SPC NJ       -  1.00000460  x   0.99991739  =   0.99992199
 KV6856!SPC NY L     -  1.00000460  x   0.99999874  =   1.00000334
 KV6856!SPC NY E     -  1.00000460  x   0.99991739  =   0.99992199
 KV6856!UTM  18      -  1.00000460  x   0.99967844  =   0.99968304
```

```
KV6856
KV6856                    SUPERSEDED SURVEY CONTROL
KV6856
KV6856  ELLIP H (05/14/99)  -29.32   (m)                  GP(       ) 4 1
KV6856  NAD 83(1996)-  40 41 27.03859(N)    074 03 18.68742(W) AD(       ) 1
KV6856  NAD 83(1996)-  40 41 27.03774(N)    074 03 18.68818(W) AD(       ) 1
KV6856  NAD 83(1992)-  40 41 27.03675(N)    074 03 18.68962(W) AD(       ) 1
KV6856  NAD 83(1986)-  40 41 27.03687(N)    074 03 18.68962(W) AD(       ) 1
KV6856
KV6856.Superseded values are not recommended for survey control.
KV6856.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KV6856.See file dsdata.txt to determine how the superseded data were derived.
KV6856
KV6856_U.S. NATIONAL GRID SPATIAL ADDRESS: 18TWL7983104868(NAD 83)
KV6856_MARKER: DD = SURVEY DISK
KV6856_SETTING: 4 = OBJECT SURROUNDED BY MASS OF CONCRETE
KV6856_SP_SET: SURROUNDED BY MASS OF CONCRETE
KV6856_STAMPING: LSP SOUTH 1991
KV6856_MARK LOGO: USE
KV6856_MAGNETIC: N = NO MAGNETIC MATERIAL
KV6856_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
KV6856_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KV6856+SATELLITE: SATELLITE OBSERVATIONS - April 26, 2004
KV6856
KV6856  HISTORY     - Date     Condition        Report By
KV6856  HISTORY     - 1991     MONUMENTED       USE
KV6856  HISTORY     - 19920306 GOOD             NJGS
KV6856  HISTORY     - 19950920 GOOD             NJGS
KV6856  HISTORY     - 20010902 GOOD             NJDEP
KV6856  HISTORY     - 20040426 GOOD             PORANY
KV6856
KV6856                    STATION DESCRIPTION
KV6856
KV6856'DESCRIBED BY NEW JERSEY GEODETIC SURVEY 1992
KV6856'THE STATION IS LOCATED IN THE CITY OF JERSEY CITY ON THE GROUNDS OF
KV6856'LIBERTY STATE PARK AT THE SOUTHERN MOST POINT OF THE MONUMENT
KV6856'OVERLOOK.  TO REACH THE STATION FROM THE NEW JERSEY TURNPIKE EXIT
KV6856'14B, GO 0.9 MI (1.4 KM) SOUTHEAST ON MORRIS PESIN DRIVE TO THE
KV6856'LIBERTY STATE PARK VISITORS CENTER.  ACCESS TO THE OVERLOOK AND
KV6856'PERMISSION TO OCCUPY THE STATION MUST BE OBTAINED FROM RANGER CHUCK
KV6856'SARY, PHONE 201 915 3401 WHO REQUESTS A ONE WEEK ADVANCE NOTICE SO
KV6856'THAT HE CAN DETERMINE IF ANY SPECIAL EVENTS WILL TAKE PLACE DURING
KV6856'OUR OBSERVATION PERIOD.  HE ALSO REQUESTS THAT OUR VEHICLES KEEP OFF
KV6856'THE LAWNS DUE TO A SHALLOW SPRINKLER SYSTEM.  THE STATION IS 0.6 M
KV6856'(2.0 FT) NORTHEAST FROM THE SOUTHWEST CONCRETE WALL, 6.5 M (21.3 FT)
KV6856'NORTHWEST FROM THE BOTTOM STEP LEADING TO THE BRICK OBSERVATION AREA,
KV6856'11.5 M (37.7 FT) SOUTH FROM THE SOUTHERN MOST WOOD LAMP POST NUMBER
KV6856'1918, 16.3 M (53.5 FT) SOUTH FROM THE CENTER OF AN INLET IN THE LAWN
KV6856'AND 10.0 M (32.8 FT) WEST FROM THE WESTERN MOST OF THREE LIGHT POLES
KV6856'ON THE BRICK OBSERVATION AREA.  THE STATION IS SET FLUSH IN A FLUSH
KV6856'MOUNTED CONCRETE RETAINER FOR THE BRICK PAVED WALKWAY SURROUNDING THE
KV6856'BRICK OBSERVATION DECK.
KV6856
KV6856                    STATION RECOVERY (1995)
KV6856
KV6856'RECOVERY NOTE BY NEW JERSEY GEODETIC SURVEY 1995 (FAC)
```

KV6856'REECOVERED AS DESCRIBED.
KV6856
KV6856 STATION RECOVERY (2001)
KV6856
KV6856'RECOVERY NOTE BY NJ DEPT OF ENVIR PRO 2001 (BMC)
KV6856'CONTACT NOW IS PARK SUPERINTENDENT STEVE ELLIS. ELEVATION TRANSFERRED
KV6856'FROM KV0611, +8.75 FEET NAVD 88.
KV6856
KV6856 STATION RECOVERY (2004)
KV6856
KV6856'RECOVERY NOTE BY PORT AUTHORITY OF NY + NJ 2004 (SSZ)
KV6856'NEW CONTACT INFORMATION AS FOLLOWS. CONTACT SUPERINTENDENT OR CHIEF
KV6856'RANGER AT 201-915-3403 AT LEAST A WEEK IN ADVANCE.

*** retrieval complete.
Elapsed Time = 00:00:01