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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey	**Basic Hydrographic / Navigable Area / Field Examination**
Project Nos.	**OPR-E349-BH-06 / OPR-E300-BH/SPOT-07 / OPR-E346-BH-08**
Time Frame	**January 2007 – May 2008**

LOCALITY

State/Territory	**Maryland and District of Columbia**
General Locality	**Central Chesapeake Bay / Central Potomac River / Baltimore Harbor**

2008

CHIEF OF PARTY
LT Michael C. Davidson, NOAA

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DATE

DATA ACQUISITION AND PROCESSING REPORT

NOAA R/V BAY HYDROGRAPHER
Chief of Party: Lieutenant Michael C. Davidson, NOAA

Effective Dates

January 2007- May 2008

Applicable Surveys

OPR-E349-BH-06
H11598 – South of Cedar Point
Central Chesapeake Bay, Maryland
Hydrographic Letter Instructions dated June 16, 2006

OPR-E300-BH/SPOT-07
H11693 – Central Potomac River
State of Maryland and the District of Columbia
Hydrographic Letter Instructions dated May 21, 2007

OPR-E346-BH-08
F00552 – Northwest Harbor
Baltimore Harbor, Maryland
Hydrographic Letter Instructions dated May 13, 2008

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A. EQUIPMENT

BAY HYDROGRAPHER was used for the acquisition and post-processing of all side scan-sonar (SSS) data, vertical-beam echo sounder (VBES) data, shallow-water multibeam (SWMB) data, sound speed profiles (SVP) and detached positions (DP's) unless otherwise noted in the Descriptive Report. Any unusual vessel configurations or problems encountered on these projects are as described in the individual projects' descriptive reports. Vessel configuration and offset measurements are included in Appendix III of this report.

Three different types of sonar systems (VBES, SWMB, and SSS) were utilized for these projects unless otherwise noted in the Descriptive Report. The methods and systems used to meet survey requirements for the projects were determined by the Hydrographer and are in accordance with guidance provided in the Hydrographic Survey Project Instructions, Field Procedures Manual, Hydrographic Surveys Specifications and Deliverables, and Hydrographic Surveys Technical Directives. Other considerations included system performance limitations, complexity of bathymetry, water depth, and ability of the vessel to safely navigate a particular area. Bathymetric data were acquired using either VBES or SWMB systems. Side scan sonar was utilized for imagery and object detection. These sonar systems are described individually in the following sections of this report.

A.1 SOUNDING EQUIPMENT

A.1.1 Vertical-Beam Echo Sounder (VBES)

BAY HYDROGRAPHER is equipped with an Odom Echotrac MKIII Precision Survey Echo Sounder. The Odom Echotrac is a dual frequency digital recording vertical-beam echo sounder with the capability to record water column data either via analog paper trace or into digital files. BAY HYDROGRAPHER's current configuration is to record water column data to digital *.bin files that can be viewed by a utility in the Pydro Post Acquisition Tools. Transducer frequencies utilized are 24 kHz and 100 kHz. Unless edited by the hydrographer, selected soundings were acquired in meters using high frequency. Vertical-beam echo sounder data were acquired in conjunction with SSS. In areas where 200% SSS revealed no point features requiring further investigation, VBES was determined adequate to define the natural depth contours of the area.

A.1.2 Shallow-Water Multibeam (SWMB)

BAY HYDROGRAPHER is equipped with Reson Seabat 7125 shallow water multibeam sonar. The system is installed on a retractable arm that deploys over the starboard side of the vessel. The Seabat 7125 is a 400 kHz system that measures relative water depths across a 130^o swath. The sonar utilizes 256 individual channels, each with a footprint of 1.0^o x 0.5^o with a maximum ping rate of 50 Hz. Upon conversion in post processing, the 256 soundings per ping are used to interpolate an additional 256 soundings for a total of 512 soundings per ping. The sensor head is mounted vertically (0^0 mount) at a depth of 5.6 feet (1.73 meters) below the water line. The SWMB system was used to develop significant contacts identified with SSS and to provide bathymetric data in areas as required.

Multibeam operations were limited to speed-over-ground of 5.5 knots to ensure the required along-track coverage for object detection as stated in the NOS Specifications and Deliverables and to minimize arm “wobble”. Line spacing for item investigations was set at two times the water depth, while main scheme SWMB sounding lines were generally run at three times the water depth. Multibeam echosounders were configured to acquire back-scatter imagery in snippet format. Snippets were sometimes used during processing of the multibeam depth data to aid in determining whether anomalous soundings were true features or noise.

A.1.3 Diver’s Least-Depth Gauge (DLDG)

No Diver’s Least-Depth Gauge (DLDG) was maintained aboard BAY HYDROGRAPHER during the effective dates of this report. No contacts were investigated using such equipment.

A.1.4 Lead Line

BAY HYDROGRAPHER does not maintain traditional lead lines. In lieu of this equipment, a fabricated lead line was used for sonar comparisons. A lead line comparison to the Odom Echotrac VBES and RESON 7125 was performed March 25, 2008 (DN 085) at Calvert Marina, Solomons, MD. For a detailed description of the fabricated lead line and the lead line calibration reports and echosounder comparison log, see Appendix IV of this report. Lead lines were not used to acquire depths over rocks and other features for during surveys covered by this report.

A.2 IMAGING EQUIPMENT

A.2.1 Side Scan Sonar (SSS)

BAY HYDROGRAPHER is equipped with a Klein System 5500 (S/N 184) High-Speed, High Resolution Side Scan Sonar (HSHRSSS) System. This integrated system includes the Model 5000 HSHRSSS towfish and the T5114 Transceiver Processing Unit (TPU). The Klein 5000 operates at a frequency of 455 kHz. The towfish contains transducers, sonar processing and control electronics, attitude and heading sensors, the down-link de-multiplexer (for control signals), and the uplink multiplexer (for sonar and auxiliary sensor data). The T5114 TPU contains electronics to de-multiplex the sonar signal from the towfish and multiplex the control signals transmitted to the towfish via a coaxial tow cable. The T5114 also contains a network card for transmission of the sonar data to the **ISIS** acquisition computer.

The Klein System 5500 is unique in that each transducer simultaneously forms five dynamically focused beams per side (channel), allowing increased resolution along track (20-75 cm) and across track (7.5 cm). The Klein System 5500 multibeam transducer technology also enables higher tow speeds of up to 10 knots.

The Klein towfish is deployed on a 100 meter armored cable via an Oceans Engineering model 1673-3 electric winch. The tow cable is fed from the winch drum to a stern mounted hydraulic A-frame and through a snatch block with a metered sheave. At the winch, the tow cable connects to a deck cable through a coaxial slip ring assembly mounted on the winch. Cable out is controlled remotely at the acquisition station (or locally at the winch) and is monitored using a McCartney MKII cable counter. This sensor computes cable out by the number of revolutions of the block’s sheave. The MKII cable counter provides a serial message to the **ISIS** acquisition computer. The cable-out value was checked prior to each SSS deployment and recalibrated if necessary. Throughout the 2006-2008 field seasons, the MKII cable counter experienced operating difficulty. BAY HYDROGRAPHER crewmembers used a steel tape and electrical tape to mark 1 meter increments on the side scan cable. When the MKII did not function correctly, the correct cable out was read directly from the cable and entered manually in **ISIS**.

Line spacing for SSS operations is determined as a function of the most suitable range scale. Typically when acquiring 100% SSS coverage, 70 meter (m) line spacing is used while operating at a 50 m SSS range scale, 120 meter line spacing is used with a 75 m range scale, and 150 m line spacing is used with a 100 meter range scale. For 200% coverage SSS coverage, the line spacing for each range scale is half the line spacing for 100% coverage. A sonar altitude of eight to twenty percent of the range scale was maintained during data acquisition whenever possible without endangering either vessel or equipment safety. SSS altitude for towed operations was maintained by a combination of adjusting both the amount of deployed tow cable and vessel speed.

Imagery was monitored in real time using the side scan sonar waterfall display window in the **ISIS** acquisition software or in Klein Sonar Pro. Vessel speed was adjusted during SSS acquisition to insure that along-track coverage for object detection, as required by the NOS Specifications and Deliverables, was met. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image and by verifying aids to navigation or other known features on the side scan record.

A.3 POSITIONING EQUIPMENT

A.3.1 Trimble DSM212L DGPS Receiver

BAY HYDROGRAPHER is equipped with a Trimble DSM212L to measure and calculate differential GPS (DGPS) position. The DSM212L is an integrated 12-channel GPS receiver and dual-channel differential beacon receiver. The beacon receiver can simultaneously monitor two U.S. Coast Guard (USCG) DGPS beacon stations. The Trimble DSM212L was configured in manual mode to allow reception of only one beacon station during data acquisition. Correctors for these projects were received from either the Annapolis, MD or Cape Henry, VA radio beacons, depending upon proximity and beacon status.

The DSM212L was configured using Trimble **TSIPTalker** version 2.0 software. The configuration was checked if problems were encountered throughout the project period. Parameters included a minimum allowable 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°).

The DSM212L was not used for survey positioning. The POS/MV feeds a GGA, ZDA, VTG data string to the KLEIN TPU as required for the calculation of number of beams to be used by the side scan sonar. The Trimble is also configured to provide DGPS beacon data to the POS/MV (see below) in the form of an RTCM message.

A.3.2 Applanix POS/MV Position and Orientation System

All survey positioning data were acquired using an Applanix POS/MV v 4 (S/N 2084) (Position and Orientation System for Marine Vessels). The POS/MV is a GPS-aided inertial positioning system that functions as an aided strap down inertial navigation system, providing 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. The POS/MV v.4 uses an algorithm known as "tightly coupled data." Instead of processing the GPS data and inertial motion data for positioning and then filtering the two, the version 4 uses the raw ranges to satellites and raw accelerations from the IMU to calculate a "tighter" solution.

Position accuracy and quality were monitored in real time using the MV-POSView Controller software to ensure positioning accuracy requirements in the NOS Hydrographic Surveys Specifications and Deliverables were met. The MV-POSView Controller software provides clear visual indications whenever accuracy thresholds are exceeded. However, because of the "tightly coupled" solution, the POS/MV can deliver DGPS quality positioning for up to 4 or 5 minutes after losing a differential beacon signal. The unit gives no indication that it is not receiving differential correctors until the positioning drops below the DGPS accuracy level. Therefore it is not possible to monitor the NOS Hydrographic Specification that (3.2.1): "The age of pseudo-range correctors used in position computation will not exceed 20 seconds . . ." At all times, the POS/MV position user accuracy parameter was set to 2.0 meters, and data were recollected if the accuracy exceeded 2.0 meters.

A.4 HEADING AND ATTITUDE EQUIPMENT

A.4.1 Applanix POS/MV Position and Orientation System

A.4.1.1 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 degrades over time. The GPS receivers compute a vector between two fixed antennas and provide azimuth data using the GPS Azimuth Measurement Subsystem (GAMS). 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. Heading accuracy in the POS/MV Controller software was set to 0.050°.

A.4.1.2 POS/MV Heave, Pitch, and Roll Computation

The POS version 4 has two types of heave outputs: real-time heave and TrueHeave. Real-time heave is computed by performing a double integration on the IMU sensed vertical accelerations. A heave filter must be used for real-time heave to counteract minor noise that will eventually become significant due to the nature of mathematical integration. BAY HYDROGRAPHER's filter settings for 2006-2008 were set to a heave bandwidth of 6-20 seconds depending on sea state, and to a dampening ratio of 0.707 (critically damped). TrueHeave is a software option that is based on a two-way filter that analyzes both past and present vertical motion data to provide a more accurate heave solution. Because TrueHeave uses both future and past heave data to provide the best solution, the TrueHeave solution is only available three minutes after the data have been collected. The TrueHeave data are acquired in a separate raw file and applied in 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. Attitude accuracy parameters were set to 0.050° in the POS/MV Controller software.

B. SOFTWARE

All VBES data were acquired using **HYPACK** software, and processed with the **CARIS HIPS** Single Beam Editor. Detached positions (DPs) were also acquired with **HYPACK** in the format of target ("*.tgt") files and converted in **PYDRO** using the "Insert **HYPACK** DP" tool. **HYPACK** was also used for vessel navigation and line tracking during all data acquisition.

Shallow-water multibeam and side scan data, along with position and attitude data, were acquired using **TRITON IMAGING ISIS** software and logged in the Extended Triton Format (*.XTF). SWMB and SSS data were processed using **CARIS HIPS** and **SIPS** software.

All Detached Positions, SWMB and VBES soundings, and side scan and SWMB features were analyzed during post-processing using **PYDRO**. **PYDRO** is an extension package created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the Python programming language to interface with the **CARIS HDCS** data directly.

Soundings and features were exported from **PYDRO** by saving the Preliminary Smooth Sheet (PSS) and drawing into **MAPINFO** using the **HYDRO_MI** "Draw Pydro Data" function. **MAPINFO** was also used for creating initial line plans, development line plans, final data analysis, and for creating final plots. The **HYDRO_MI** application created by HSTP was used for drawing features, tracks, depths, and Preliminary Smooth Sheets.

Raw sound speed data were processed using **VELOCWIN** supplied by HSTP. **VELOCWIN** uses raw conductivity, temperature, and pressure measurements to create a sound speed profile using Wilson's Equation for the speed of sound.

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

C.1 DATA PROCESSING AND QUALITY CONTROL

C.1 SHALLOW WATER MULTIBEAM DATA

Shallow-water multibeam data were monitored in real-time using the 2-D and 3-D data display windows in **ISIS** and the on-screen display for the Reson Seabat sonar processor. Adjustable user parameters are range scale, power, gain, pulse width, swath width, spreading loss coefficient, and the absorption loss value. These parameters were adjusted as necessary to insure the best data quality. Additionally, vessel speed was adjusted as necessary, in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Following acquisition, shallow-water multibeam data were converted from raw .XTF files to **CARIS**' Hydrographic Data Cleaning System (HDCS) format using the **CARIS** convert utility. After conversion, the multibeam data were corrected with tide, sound speed, and Trueheave corrections and then merged with vessel position and orientation. The Total Propagated Error was also computed, and CUBE surfaces of appropriate resolution, as defined by the NOS Specifications and Deliverables, were created. The resulting spatially referenced data were then analyzed using **CARIS** HIPS editing tools in conjunction with the various CUBE layers. Data that did not contribute to a CUBE depth surface of appropriate resolution that adequately represents the probable sea floor were inspected using Caris subset, swath, or sidescan editing tools. “Flyers” were flagged as rejected. Systematic errors were corrected or addressed as noted in the Descriptive Report.

C.2 VERTICAL BEAM ECHO SOUNDER DATA

VBES data was acquired using **HYPACK** software. **CARIS HIPS** tools **HYPACK** converter were utilized for converting raw-data into readable digital format for **HIPS** Single Beam Editor. In addition, **HYPACK** created .bin files that digitally record the full water column data, in lieu of paper records; .bin files are viewed in PYDRO Post Acquisition Tools when necessary. All selected VBES soundings were combined with SWMB soundings, excessed using **PYDRO** and plotted in **MAPINFO** to compare the two types of bathymetric data with each other as well as with charted depths.

To produce the reduced, shoal-biased data set represented in the final field sheet, all non-rejected soundings that passed all other quality-assurance checks were imported into **PYDRO** using the "Insert **HIPS** Line Bathy" tool. Depths were inserted into **PYDRO** using a 15 meter bathymetry grid resolution and an over-plot removal character size of 1.5 millimeters at the scale of the survey.

Data processing flow diagrams are included in Appendix II of this report.

C.3 SIDE SCAN SONAR DATA

Side scan sonar data were acquired with the Klein 5500 Towfish using **ISIS**. Side scan sonar data were converted from .XTF and post-processed using **CARIS SIPS**.

Post-processing of side scan data consisted of first examining and editing fish height, heading (gyro), and vessel navigation records. Fish navigation was then recalculated using the **CARIS SIPS "**Recompute Towfish Navigation" sub-program. During "Recompute Towfish Navigation", tow point measurements (A-frame and cable out), fish height, and depth are used to calculate horizontal layback. Once fish navigation was re-calculated, side scan imagery data were slant-range corrected. The slant-range corrected side scan imagery was scanned, and check-scanned, for any significant contacts. Contacts in less than or equal to 20 meters of water were determined significant if their computed target height (based on shadow lengths obtained using SIPS) were at least one meter. In depths greater than 20 meters, contacts with computed target heights rising above the bottom at least ten percent of the depth were considered significant. Significant contacts were saved in a **CARIS** contact file, and contact snapshot (.tif) images were created to aid in analysis and contact classification in **PYDRO**.

All contacts were imported into **PYDRO** using the "Insert **HIPS/SIPS** Line Features" tool. Contacts were arranged by day and line and could be selected in the data "Tree" window. Information concerning a specific contact was displayed in **PYDRO**'s "Editor Notebook Window", including contact position, AWOIS item positions, surrounding depths, contact cross references, and charting recommendations. Each contact was reviewed, and information flags were set accordingly. If there were multiple contacts for a single feature, then the one providing the best SSS image of the feature was chosen as "Primary". Any items that were to be addressed in the Item Investigation section of the Descriptive Report were flagged as "Chart". Items which had the "Chart" flag set could also be further designated for inclusion in the Danger To Navigation Report by choosing the "DTON" flag. "Snapshots" of contacts were displayed in

PYDRO's “Image Notebook Editor”. Contacts appearing significant were further investigated with SWMB. Final positioning and least depth determinations of significant items were accomplished using multibeam.

Side scan sonar coverage was verified using **CARIS SIPS** generated side scan mosaics imported into **MAPINFO** for analysis. Any deficiencies in the side scan sonar data were filled by completing a holiday line plan to meet the 200% requirement. Confidence checks were performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image and by correlating sonar contacts to known features such as aids to navigation. These checks were performed in real time during data acquisition each day.

C.4 PRELIMINARY SMOOTH SHEET

Once all sounding data and features were reviewed and analyzed using **PYDRO**, the data was saved into a Preliminary Smooth Sheet (PSS). The PSS is a working file that does not actually contain data, but contains links to the data with specific path information as well as ancillary data flag information which is not supported in the **HDCS** file structure. The PSS was then imported into **MAPINFO** via the **HYDRO_MI** “Draw Pydro data” function. Final field analysis of the PSS was performed in **MAPINFO**.

D. CORRECTIONS TO ECHO SOUNDINGS

D.1 SOUND SPEED CORRECTION

Sound speed profiles were acquired with a SeaBird Electronics SeaCat SBE19+ Conductivity, Temperature, and Depth (CTD) profiler 19P37217-4677. Raw conductivity, temperature, and pressure data were processed using the program **VELOCWIN** that generates sound speed profiles for **CARIS**. Sound speed correctors were applied to SWMB and VBES soundings in **CARIS HIPS** during post processing. CTD calibration reports and dates are included in Appendix IV of this report.

The speed of sound through water was determined by a minimum of one cast every four hours of SWMB acquisition, and one cast every week for VBES acquisition, in accordance with the Standing Project Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Additional casts were conducted when changing survey areas or if it was judged that conditions, such as a change in weather, tide, or current, would warrant additional sound speed profiles.

In order to correctly form its beams, the RESON Seabat 7125 requires a surface sound speed input. BAY HYDROGRAPHER uses an ODOM Digibar Pro to provide surface sound speed to the multibeam. Calibrations for the Odom Digibar Pro can be found in Appendix 4 of this report.

D.2 VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

A separate HIPS Vessel File (HVF) was created for each type of survey required. Some of the HVFs are redundant, e.g. the HVF for 100% and 200% side scan coverage have the exact same offsets, but are kept separate to facilitate ease of processing. The following table lists each HIPS Vessel File.

HVF NAME	SURVEY SYSTEM
BH_S5501_KLEIN5000_SSS100	Side scan configuration for 100% Side Scan Lines
BH_S5501_KLEIN5000_SSS200	Side scan configuration for 200% Side Scan Lines
BH_S5501_RESON7125	Multibeam configuration file
BH_S5501_SB	Standard VBES configuration
BH_S5501_XL_LINES	Standard VBES configuration for Cross Lines
BH_S5501_DP	Used for detached positions only, vertically corrected

Vessel offsets were measured on September 14 and 15, 2004, by Kendall Facher of the National Geodetic Survey. A Leica TC2002 Total Precision Station was used to measure offsets to GPS antennae, sonar transducers, the POS IMU, and various vessel benchmarks. A report from this survey is included in Appendix 3. Vessel waterline was measured on March 10, 2005 by taking the top off the vessel's moon pool and using a steel ruler to directly measure to the waterline. A value of 3.4 cm below the reference point was found. All offsets are included in the HIPS Vessel file reports included in Appendix 3.

Settlement and squat correctors for BAY HYDROGRAPHER were determined on April 9, 2008 and were run using the echosounder technique outlined in FPM sec 1.4.2.1.6. The vessel ran a series of reciprocal courses at varying speeds. The data was then processed to yield a negligible vertical change versus time and speed table.

Sensor offsets and dynamic draft values are stored in the **CARIS** HVFs and were applied to VBES, SWMB and SSS data in **CARIS** during post-processing. The Reference Point (RP) used in all HVFs is the small divot in the moon pool in BAY HYDROGRAPHER's middle hold. Vessel offset diagrams are included in Appendix III of this report. The HIPS Vessel Files have been submitted with the digital processed data.

D.3 HEAVE, PITCH, ROLL AND HEADING,
INCLUDING BIASES AND NAVIGATION TIMING ERRORS

BAY HYDROGRAPHER is configured for the "Precise Timing" setup for SWMB operations. In this method of minimizing timing errors, a UTC serial time stamp is output from the POS/MV and received by the ISIS PC and the RESON processing unit. All data (navigation, heave, pitch, roll, and bathymetry) are time stamped according to this string at acquisition, as opposed to upon arrival at ISIS. Because these data are time-stamped at acquisition and the time stamp is honored in post-processing, the timing errors between navigation, heave, pitch, and roll are minimized. For more detailed information on this setup, see the Field Procedures Manual.

Patch tests were conducted throughout the year after any removal and replacement of the RESON 7125 SWMB head due to the test and evaluation mission of the BAY HYDROGRAPHER. These patch tests are designed to find any roll, pitch, and yaw, and remaining time offset between the MB reference frame and the navigation reference frame. Results of the patch tests are included in the Hips Vessel Files (HVF) reported in Appendix 3. All HVFs are digitally submitted with project data.

As per the Specifications and Deliverables, pitch and roll are not applied to VBES soundings.

D.4 WATER LEVEL CORRECTION

Soundings were reduced to Mean Lower-Low Water (MLLW) using final, approved zoned tide data (unless otherwise noted in the DR) from each tide station applicable for a specific survey sheet. All tide data were obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site https://tidesandcurrents.noaa.gov/olddata. These data were used to create a CARIS HIPS Tide file (.tid). Refer to individual Descriptive Reports for further information regarding water levels specific to each survey.

BAY HYDROGRAPHER personnel installed no tide gauges in conjunction with the survey projects referenced in this report.

E. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were utilized in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables.

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

LT Michael C. Davidson

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Ocean Service
National Geodetic Survey
Geodetic Services Division
Instrumentation & Methodologies Branch

NOAA Launch- Bay Hydrographer
POS Components Spatial Relationship Survey
Field Report

Kendall Fancher
September 14th & 15th, 2004

NOAA Launch-Bay Hydrographer
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 launch Bay Hydrographer. Additionally, various recoverable Reference Points were established onboard the vessel to aid in future spatial surveys aboard the ship.

PROJECT DETAILS

This survey was conducted on the 14th and 15th of September at Solomon's Island, Maryland while the ship was in dry dock. The weather on the 14th was partly sunny and mild. The weather on the 15th was cool with light to moderate rain throughout the morning and intermittently during the afternoon. Reconnaissance was conducted on the 14th, with the aid of Holly Dehart (Launch Captain), Charles Yoos, and Dave Pritchard to determine exactly what point was to be positioned on each sensor and where the Reference Points were to be established. Data collection was conducted on the 15th, once the rain had stopped in the early afternoon.

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	

Two standard "peanut" prisms were used as sighting targets and for distance measurement during this project. These prisms are of the same model and have an offset of 30 mm. The prism offset was accounted for during data collection.

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 Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

SURVEY PROCEDURES

Establishing the IMU Coordinates

A dimple, located in the top center of the Moon Pool (CL01) was deemed to be on the centerline of the vessel during reconnaissance. At this same time, a mark was established on the back portion of the keel of the vessel that was also deemed to be on the centerline of the vessel. From these two points was established Temporary Point (TP01), directly in line with CL01 and the mark established on the keel. The following coordinates were assumed for TP01; easting of 1000.000m, northing of 1000.000m, and up of 1000.000m. While occupying TP01, a zero bearing was input into the instrument and CL01 was used for initialization. After initialization was conducted, angular measurements and distances were taken to establish Temporary Point 2 (TP02).

TP02 was occupied and TP01 was used for initialization. Angular measurements and distances were taken to establish a predefined point on the IMU. After establishing coordinates for the IMU, angular measurements and distances were taken to CL01 to determine an azimuth check. The azimuth check revealed a closure of 0.001m in the easting, 0.002m in the northing, and 0.004m in the up component.

Establishing all Other Points

While occupying TP01, a zero bearing was input into the instrument and CL01 was used for initialization. After initialization was conducted, angular measurements and distances were taken to establish the following points; two Centerline Reference Points (CL02 and CL03), The DGPS antenna (DGPS), The Multi Beam Sensor phase center (MBPC), a Multi Beam Bench Mark (MBBM), and Temporary Point 3 (TP03). Angular measurements and distances were taken to CL01 to determine an azimuth check. The azimuth check revealed a closure of 0.000m in the easting, 0.000m in the northing, and 0.001m in the up component.

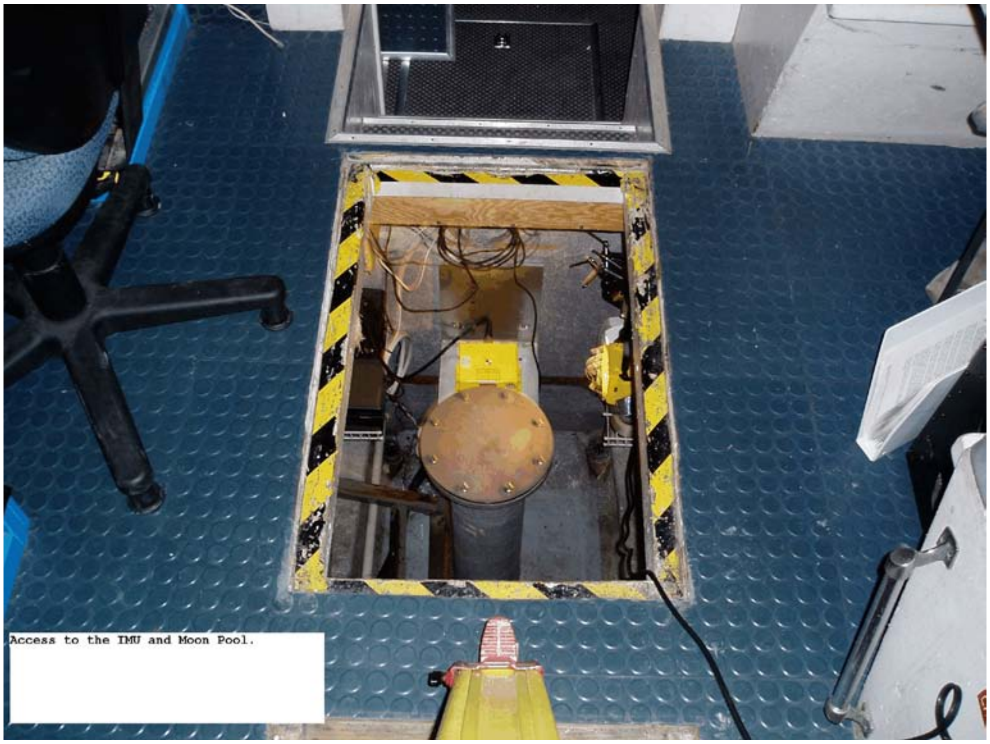
While occupying TP03, TP01 was used for initialization. After initialization was conducted, angular measurements and distances were taken to establish the following points; a Centerline Reference Point (CL04), Two GPS antenna (GPS1 and GPS2), a Multi Beam Support Bracket Reference Point (MBSP), and the Single Beam Sensor phase center (SBPC). Angular measurements and distances were taken to CL03 to determine an azimuth check. The azimuth check revealed a closure of 0.001m in the easting, 0.000m in the northing, and 0.003m in the up component. Angular measurements and distances were also taken to TP03 to determine an azimuth check. The azimuth check revealed a closure of 0.001m in the easting, 0.001m in the northing, and 0.001m in the up component.

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

Field Notes

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

Moon Pool




Moon Pool, View looking from above, the reference point (CL01) is the dimple in the top center of the plate.

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

Single Beam Sensor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SBPC-point determined during the survey for the single beam sensor located on the bottom of the ship's hull. No reference point was set, the point determined was the center of the sensor located closest to the bow of the ship.

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

CL04


CL04

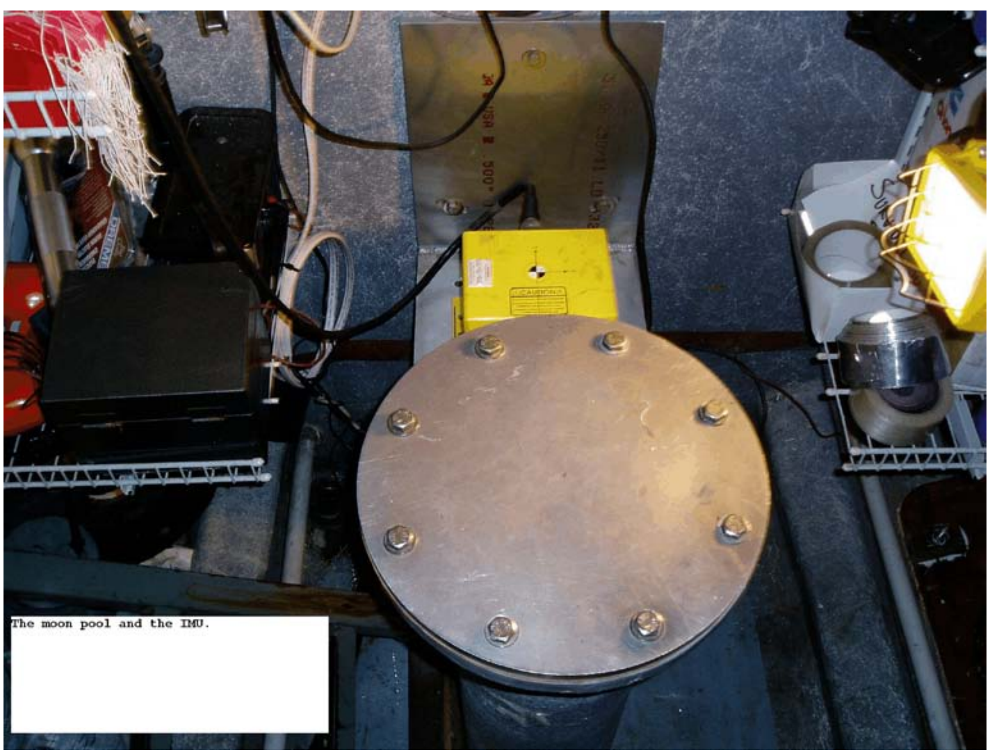
CL02

CL02-reference point established along the centerline, and near the stern, of the ship for future surveys. The reference point is a punch mark set in the metal support for a metal access cover.

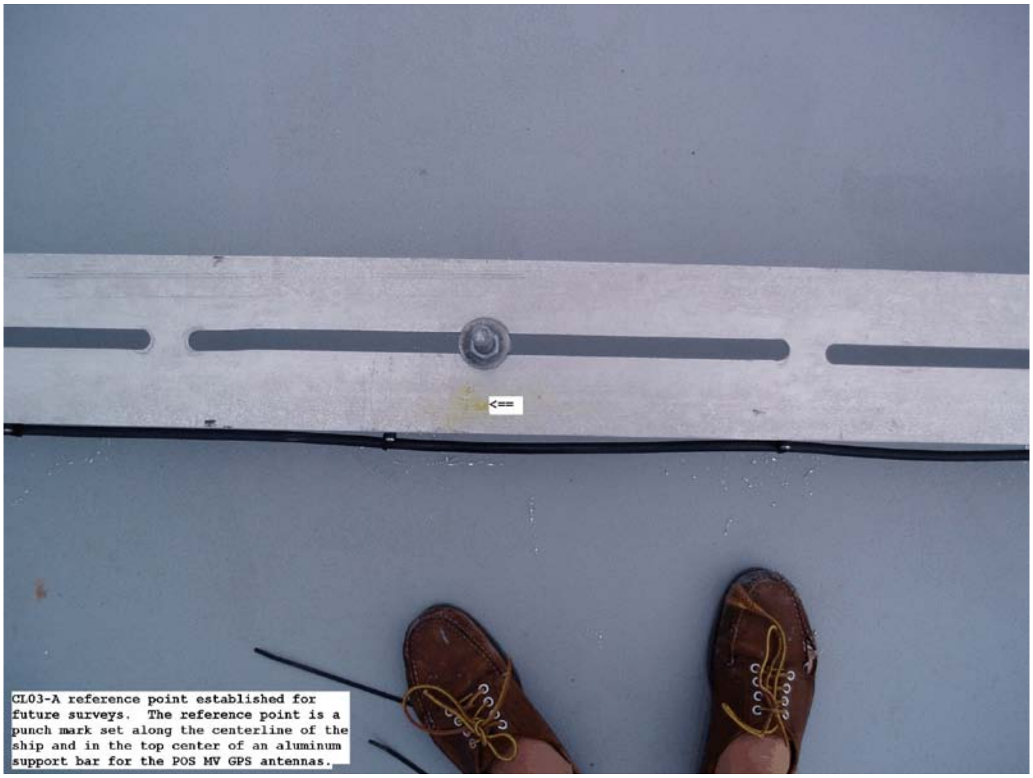
Closeup view of CL02.

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

IMU/Moonpool



CL03


<==
CL03-A reference point established for future surveys. The reference point is a punch mark set along the centerline of the ship and in the top center of an aluminum support bar for the POS MV GPS antennas.

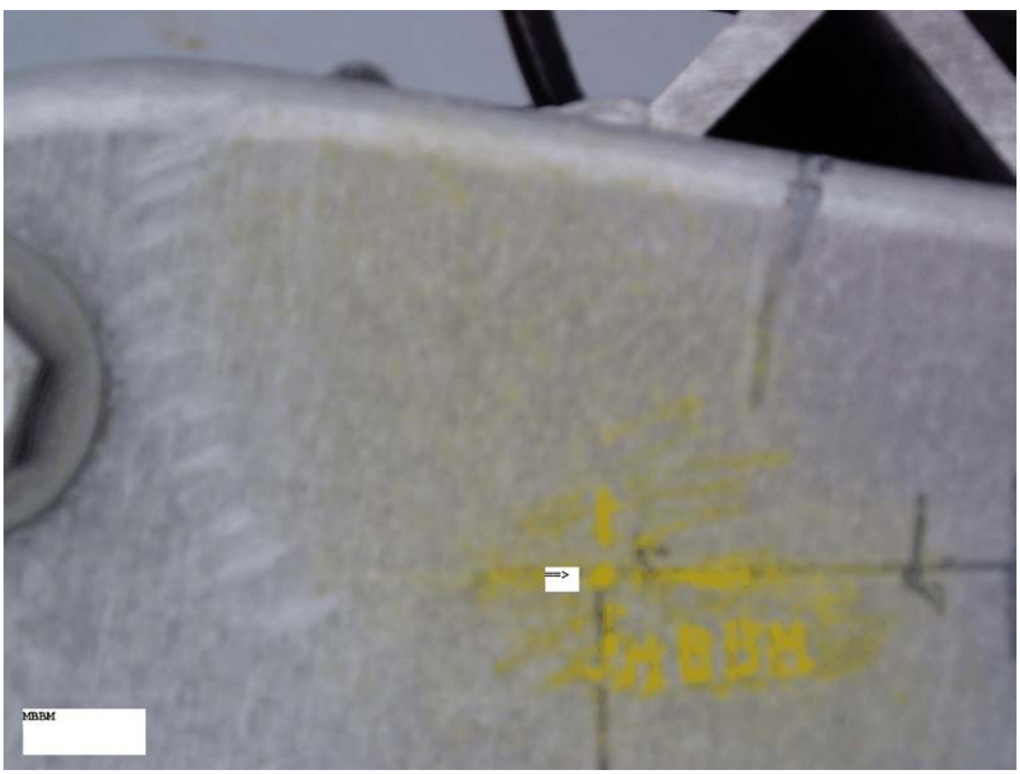

==>
CL03

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

MBBM

NOAA Launch-Bay Hydrographer
POS MV Components Spatial Relationship Survey

MBSB



==>
MBSB. Top view of a reference point set in top of a support bracket for the multi Beam sensor. The reference point is a punch mark set in the top of the plate.

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POS MV Components Spatial Relationship Survey

MBPC/DGPS


The Multi Beam sensor. The reference point is the center of the vertical face of the black can.
<==

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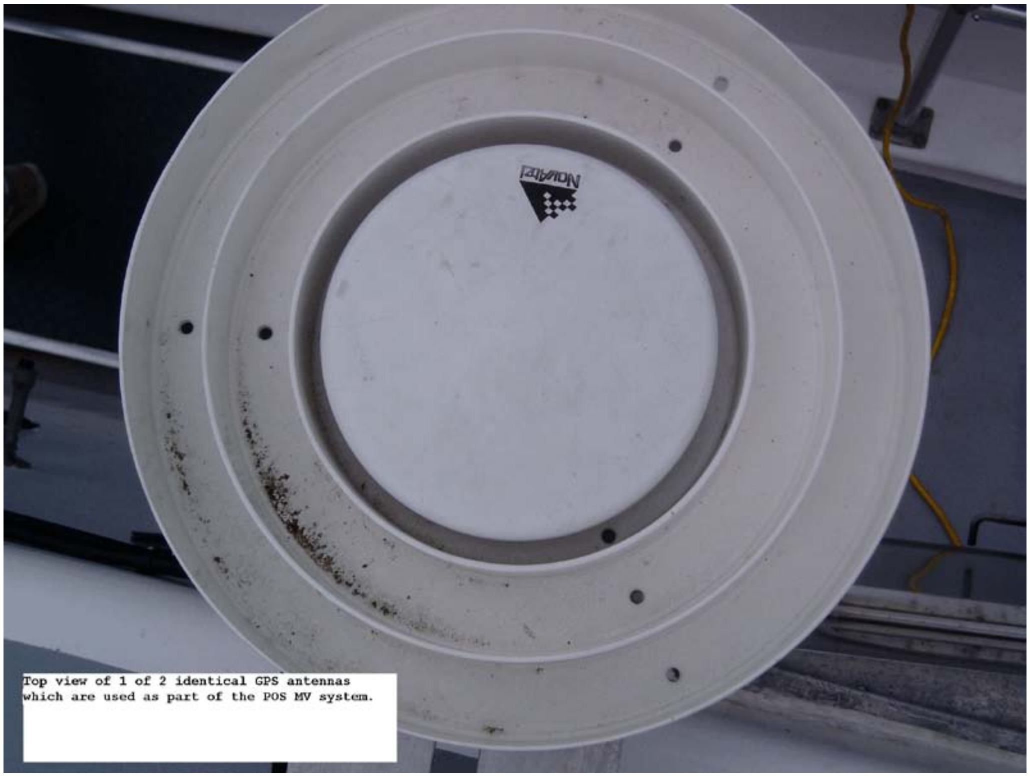
POS MV Components Spatial Relationship Survey

GPS1



Top view of 1 of 2 identical GPS antennas which are used as part of the POS MV system.

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POS MV Components Spatial Relationship Survey

GPS1-The top center of the antenna fastening bolt was positioned. The approriate corrections were then applied to account for the electronic phase center of the antenna with choke ring accessory.


S5501
BAY HYDROGRAPHER
National Geodetic Survey
CHEVROLET
C-18729
8yd

BAY HYDROGRAPHER										
		Observed Position			Δ Reference Point Moon Pool			Δ Reference Point IMU		
POINT	Name	e (m)	n (m)	u (m)	Δx (m)	Δy (m)	Δz (m)	Δx (m)	Δy (m)	Δz (m)
TP01	Temp point 1	1000.000	1000.000	1000.000	-32.734	0.000	-1.462	-33.080	0.002	-1.325
TP02	Temp point 2	1000.002	1030.326	1002.390	-2.408	0.002	0.928	-2.754	0.004	1.065
TP03	Temp point 3	1006.991	1053.097	1000.055	20.363	6.991	-1.407	20.017	6.993	-1.270
CL01	Moon Pool	1000.000	1032.734	1001.462	0.000	0.000	0.000	-0.346	0.002	0.137
IMU	IMU	999.998	1033.080	1001.325	0.346	-0.002	-0.137	0.000	0.000	0.000
CL02	Ref Point CL Stern	999.999	1024.904	1002.287	-7.830	-0.001	0.825	-8.176	0.001	0.962
CL03	Ref Point CL GPS Mount Bar	1000.001	1034.878	1005.234	2.144	0.001	3.772	1.798	0.003	3.909
CL04	Ref Point CL Bow	1000.029	1040.635	1003.716	7.901	0.029	2.254	7.555	0.031	2.391
GPS1	Top Center of Bolt GPS Ant (Port)	998.379	1034.915	1005.261	2.181	-1.621	3.799	1.835	-1.619	3.936
GPS1	GPS Ant Phase Center (Port)	998.379	1034.915	1005.304	2.181	-1.621	3.842	1.835	-1.619	3.979
GPS2	Top Center of Bolt GPS Ant (Starboard)	1001.653	1034.935	1005.259	2.201	1.653	3.797	1.855	1.655	3.934
GPS2	GPS Ant Phase Center (Starboard)	1001.653	1034.935	1005.302	2.201	1.653	3.840	1.855	1.655	3.977
DGPS	Top Center of Bolt DGPS Ant Mount	999.533	1032.189	1008.165	-0.545	-0.467	6.703	-0.891	-0.465	6.840
Single Beam	Single Beam Phase Center	1000.757	1032.948	1000.586	0.214	0.757	-0.876	-0.132	0.759	-0.739
MBSP	Multibeam Support	1002.225	1027.807	1002.225	-4.927	2.225	0.763	-5.273	2.227	0.900
MBBM	Multibeam Bench Mark	1003.731	1027.114	1002.035	-5.620	3.731	0.573	-5.966	3.733	0.710
MBPC	Multibeam Phase Center	1003.775	1026.958	999.778	-5.776	3.775	-1.684	-6.122	3.777	-1.547
MBPC2	Multibeam Phase Center under Stress	1003.765	1026.921	999.784	-5.813	3.765	-1.678	-6.159	3.767	-1.541

Azimuth check to IMU X 0.002(m) Y0.001(m) Z 0.004(m)

Azimuth check to remaining objects X 0.000(m) Y0.001(m) Z 0.003(m)

Temp Points are not permanently monumented