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# Data Acquisition and Processing Report

**R/V Bay Hydro II**
Chief of Party: LT Megan R. Guberski
Year: 2012
Version: 1
Publish Date: 2012-01-02

# A Equipment

## A.1 Survey Vessels

### A.1.1 R/V Bay Hydro II

<table>
<tr><td>Name</td><td>R/V Bay Hydro II</td></tr>
<tr><td>Hull Number</td><td>S5401</td></tr>
<tr><td>Description</td><td>R/V BAY HYDRO II 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. Vessel configuration and offset measurements are included in Appendix 1 of this report.</td></tr>
<tr><td>Utilization</td><td>Three sonar systems (VBES, SWMB and SSS) were used to acquire data on this project. The methods and systems used to meet full-coverage was determined by the Hydrographer, and are in accordance with guidance provided in the Hydrographic Survey Project Instructions, NOAA's Hydrographic Surveys Specifications & Deliverables and NOAA's Field Procedures Manual. Bathymetric data were acquired using either VBES or SWMB systems. Side scan sonar was utilized for imagery and object detection.</td></tr>
<tr><td>Dimensions</td><td><table><tr><td>LOA</td><td>18 meters</td></tr><tr><td>Beam</td><td>6.33 meters</td></tr><tr><td>Max Draft</td><td>1.83 meters</td></tr></table></td></tr>
<tr><td>Most Recent Full Static Survey</td><td><table><tr><td>Date</td><td>2009-03-23</td></tr><tr><td>Performed By</td><td>H. Stewart Kuper Jr., NGS</td></tr><tr><td>Discussion</td><td>A NGS survey of R/V Bay Hydro II was performed on 23 March 2009 using optical levels.</td></tr></table></td></tr>
<tr><td>Most Recent Partial Static Survey</td><td>Partial static survey was not performed.</td></tr>
</table>

| | | |
|---|---|---|
| *Most Recent Full Offset Verification* | Full offset verification was not performed. | |
| *Most Recent Partial Offset Verification* | Partial offset verification was not performed. | |
| *Most Recent Static Draft Determination* | *Date* | 2011-01-04 |
| | *Method Used* | Steel Measuring Tape and Lead Line |
| | *Discussion* | Static draft was measured daily during MBES data acquisition. The value was calculated by:1) measuring from the benchmark on top of the multibeam strut, down to the waterline, then 2) subtracting the fixed distance from the benchmark to the reference point. The result is the distance from the reference point, to the water line. |
| *Most Recent Dynamic Draft Determination* | *Date* | 2011-10-06 |
| | *Method Used* | Echosounder Technique |
| | *Discussion* | Dynamic Draft values were determined on 6-Oct-2011, using the echo sounder technique outline in the Field Procedures manual section 1.4.2.1.2.1. See Appendix 3 for the full report. |

*Figure 1: R/V Bay Hydro II*

## A.2 Echo Sounding Equipment

## A.2.1 Side Scan Sonars

### A.2.1.1 L3 Klein 5000

| | |
|---|---|
| *Manufacturer* | L3 Klein |
| *Model* | 5000 |
| *Description* | The Klein High Speed, High Resolution Side Scan (SSS) Sonar system is a beam-forming acoustic imagery device that is towed behind the R/V Bay Hydro II via an armored cable and a hydraulic A-frame. The KLEIN 5500 towfish operates at a frequency of 455 kHz with a vertical beam angle of 40°, and can resolve up to 5 discreet received beams per transducer stave. The integrated system includes a KLEIN 5500 light weight towfish, a tow cable telemetry system, and a Transceiver/Processing Unit (TPU).<br><br>Positioning of the Towfish is calculated using CARIS SIPS, and is derived from the amount of cable out, the towfish depth (from the towfish pressure gage), the vessel's Course Made Good (CMG), and the vessels heading. Towfish altitude is maintained between 8% and 20% of the range scale. Vessel speed is adjusted during SSS acquisition to ensure that object detection density is met. Confidence checks are 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.<br>The resolution of the system is:<br>Along Track:<br>10cm out to 38 meters<br>20cm out to 75 meters<br>36 cm out to 150 meters<br>Across Track: 3.75 cm<br><br>Side Scan data from the Klein 5000 was used to provide object detection. |
| *Serial Numbers* | *Vessel Installed On*: 5401<br>*TPU s/n*: 139<br>*Towfish s/n*: 320 |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Specifications* | *Frequency* | 455 kilohertz | | | | |
| | *Along Track Resolution* | *Resolution* | 10 centimeters | 20 centimeters | 36 centimeters | |
| | | *Min Range* | 0 meters | 38 meters | 75 meters | |
| | | *Max Range* | | | | |
| | *Across Track Resolution* | 0.0375 meters | | | | |
| | *Max Range Scale* | 100 meters | | | | |
| *Manufacturer Calibrations* | Manufacturer calibration was not performed. | | | | | |

*Figure 2: Klein 5500 light weight towfish*

## A.2.2 Multibeam Echosounders

### A.2.2.1 RESON SeaBat 7125

| | |
|---|---|
| *Manufacturer* | RESON |
| *Model* | SeaBat 7125 |
| *Description* | The RESON SeaBat 7125 system is a single-frequency, digital recording Multibeam echo sounder, which is pole mounted on retractable arm. The integrated system includes a 400 kHz Projector unit, a Receiver unit, a Link Control Unit (LCU), and a topside 7-P Sonar Processor Unit (TPU). The projector and receiver are set up in |

| | |
|---|---|
| | a Mills Cross configuration, and the pole arm is deployed through a bomb bay door located on the center line of the vessel.<br><br>The 7-P Sonar Processor Unit has the following software versions installed:<br>7K Center: Version 3.7.7.9<br>7K IO: Version: 3.4.1.11<br>7K UI: Version 3.12.5.8<br><br>Bathymetric data from the RESON 7125 is used to provide least depths over features, and to provide object detection in areas of Complete Multibeam. |
| *Serial Numbers* | *Vessel Installed On*: 5401<br>*Processor s/n*: 2708006<br>*Transceiver s/n*: none<br>*Transducer s/n*: 51515<br>*Receiver s/n*: 0808037<br>*Projector 1 s/n*: 0908167<br>*Projector 2 s/n*: None |

**Specifications**

| | | |
|---|---|---|
| *Frequency* | 400 kilohertz | |
| *Beamwidth* | *Along Track* | 1.0 degrees |
| | *Across Track* | 0.5 degrees |
| *Max Ping Rate* | 50 hertz | |
| *Beam Spacing* | *Beam Spacing Mode* | Equidistant |
| | *Number of Beams* | 512 |
| *Max Swath Width* | 128 degrees | |
| *Depth Resolution* | 0.003 meters | |
| *Depth Rating* | *Manufacturer Specified* | 50 meters |
| | *Ship Usage* | 38 meters |

| | |
|---|---|
| *Manufacturer Calibrations* | Manufacturer calibration was not performed. |

**System Accuracy Tests**

| | | |
|---|---|---|
| *Vessel Installed On* | S5401 | S5401 |
| *Methods* | Comparison to Vertical Beam Echosounder | Patch Test |
| *Results* | On 4-Jan-2012, soundings from the RESON SeaBat 7125 were compared to soundings from the ODOM Vertical Beam Echo sounder. The average difference between depths was 4cm. | On 6-Oct-2011 the MBES system was patch tested, in order to resolve residual biases between the sonar reference frame, and the positioning system reference frame. |

| | |
|---|---|
| *Snippets* | Sonar has snippets logging capability. |

*Figure 3: Mills cross multibeam projector and receiver configuration on retractable arm*

## A.2.3 Single Beam Echosounders

### A.2.3.1 ODOM Echotrac CV 200 Vertical Beam Echosounder CV-200

| | |
|---|---|
| *Manufacturer* | ODOM Echotrac CV 200 Vertical Beam Echosounder |
| *Model* | CV-200 |
| *Description* | The Odom Echotrac CV-200 is a dual frequency digital recording echosounder, mounted to the starboard pontoon of the R/V bay Hydro II. |
| *Serial Numbers* | *Vessel*: 5401<br>*Processor s/n*: 003071<br>*Transducer s/n*: TR5444 |

| | | | | | |
|---|---|---|---|---|---|
| *Specifications* | *Frequency* | 200 hertz | | 24 kilohertz | |
| | *Beamwidth* | *Along Track* | 10 degrees | *Along Track* | 10 degrees |
| | | *Across Track* | 12 degrees | *Across Track* | 12 degrees |
| | *Max Ping Rate* | 20 hertz | | 20 hertz | |
| | *Depth Resolution* | 0.01 meters | | 0.01 meters | |
| | *Depth Rating* | *Manufacturer Specified* | 1220 meters | *Manufacturer Specified* | 1220 meters |
| | | *Ship Usage* | 38 meters | *Ship Usage* | 38 meters |
| *Manufacturer Calibrations* | Manufacturer calibration was not performed. | | | | |
| *System Accuracy Tests* | *Vessel Installed On* | S5401 | | | |
| | *Methods* | Comparison to Lead Line | | | |
| | *Results* | On 26-Jan-2012, soundings from the ODOM Vertical Beam Echo sounder were compared to soundings read off a leadline. The average difference between depths was 4cm. | | | |

*Figure 4: Starboard VBES Sonar*

## A.2.4 Phase Measuring Bathymetric Sonars

No phase measuring bathymetric sonars were utilized for data acquisition.

### A.2.5 Other Echosounders

No additional echosounders were utilized for data acquisition.

## A.3 Manual Sounding Equipment

### A.3.1 Diver Depth Gauges

No diver depth gauges were utilized for data acquisition.

### A.3.2 Lead Lines

<table>
<tr><td>Manufacturer</td><td colspan="2">N/A</td></tr>
<tr><td>Model</td><td colspan="2">N/A</td></tr>
<tr><td>Description</td><td colspan="2">The R/V Bay Hydro II is equipped with a non-traditional lead-line fabricated from Amsteel® brand line and an eight inch tall mushroom anchor. This lead line was newly fabricated on 16 June 2009 by LT Michael C. Davidson, and re-calibrated on 4 Jan 2011.</td></tr>
<tr><td>Serial Numbers</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="3">Calibrations</td><td>Serial Number</td><td>N/A</td></tr>
<tr><td>Date</td><td>2012-01-26</td></tr>
<tr><td>Procedures</td><td>The 8lbs mushroom anchor was removed, and replaced with an in-line scale. The line was then pulled taunt until a force of 8lbs registered on the in line scale. The graduations were then checked using a steel measuring tape. Performed 26-Jan-2012. See Appendix 2 for the full report.</td></tr>
<tr><td rowspan="3">Accuracy Checks</td><td>Serial Number</td><td>none</td></tr>
<tr><td>Date</td><td>2012-01-26</td></tr>
<tr><td>Procedures</td><td>On 26-Jan-2012, soundings from the leadline was compared to soundings from the ODOM Vertical Beam Echosounder. The average difference between depths was 4mm. See Appendix 2 forthe full report.</td></tr>
<tr><td>Correctors</td><td colspan="2">Correctors were not determined.</td></tr>
<tr><td>Non-Standard Procedures</td><td colspan="2">Non-standard procedures were not utilized.</td></tr>
</table>

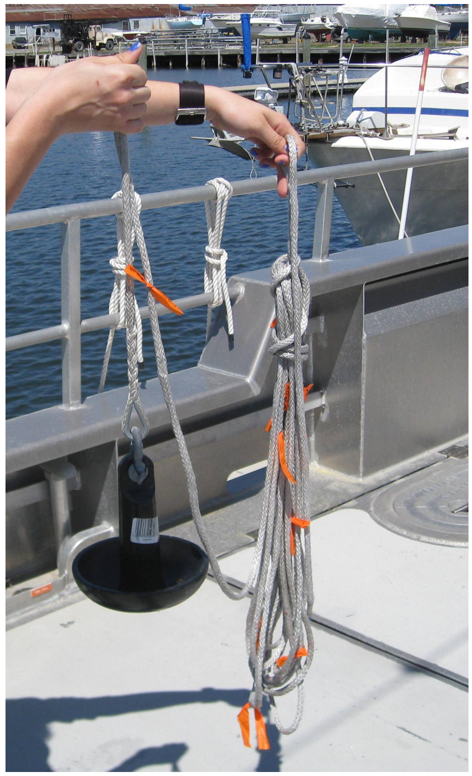


*Figure 5: Leadline with mushroom anchor*

### A.3.3 Sounding Poles

No sounding poles were utilized for data acquisition.

### A.3.4 Other Manual Sounding Equipment

No additional manual sounding equipment was utilized for data acquisition.

## A.4 Positioning and Attitude Equipment

### A.4.1 Applanix POS/MV

| | |
|---|---|
| *Manufacturer* | Applanix (a Trimble company) |
| *Model* | v.4 |
| *Description* | The POS M/V is a GPS-aided inertial positioning system that provides position and orientation data to external equipment. It is composed of an Inertial Measurement Unit, two GNSS receivers, and a POS Computing System (PCS) unit. Roll, pitch, and heave values are measured by the Inertial Measurement Unit (IMU). Position is |

<table>
<tr><td></td><td colspan="2">derived from the tightly-coupled GPS/IMU integration. Heading is determined by blending data from the GNSS antennas, with heading estimates by the IMU.</td></tr>
<tr><td rowspan="7">PCS</td><td>Manufacturer</td><td>Applanix (a Trimble company)</td></tr>
<tr><td>Model</td><td>v.4</td></tr>
<tr><td>Description</td><td>The PCS blends raw acceleration measurements from the IMU, with positional information from the GPS antennas and RTCM beacon, creating a tightly-coupled position and orientation solution. The PCS also provides the one Pulse Per Second (PPS) signal used by integrated systems to accurately time-stamp data.</td></tr>
<tr><td>Firmware Version</td><td>4.1-7</td></tr>
<tr><td>Software Version</td><td>3.4.0.0</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On: 5401</td></tr>
<tr><td>PCS s/n: 3954</td></tr>
<tr><td rowspan="6">IMU</td><td>Manufacturer</td><td>Applanix (a Trimble company)</td></tr>
<tr><td>Model</td><td>v4</td></tr>
<tr><td>Description</td><td>The POS M/V Inertial Measurement Unit (IMU) is used to record the amount of heave, pitch, and roll experienced by the vessel. The Unit is located at the vessel's central reference point, and is strapped down to the vessel. Since the IMU is fixed to the vessel, the motion experienced by the IMU is, by definition, the same motion experienced by the vessel. The IMU housing contains three orthogonally placed accelerometers, which sense acceleration in the x, y, and z directions. It also contains three orthogonally placed gyros, which sense angular rate of motion around the three axis. The measured amount of acceleration and rate of rotation is then used to find the degree of pitch, roll, and heave experienced by the vessel. Data from the IMU is also combined with data from the GNSS antennas to calculate vessel heading.</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On: 5401</td></tr>
<tr><td>IMU s/n: 1023</td></tr>
<tr><td>Certification</td><td>IMU certification report was not produced.</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| *Antennas* | *Manufacturer* | Applanix (A Trimble Company) | | |
| | *Model* | Zephyr Model 2 | | |
| | *Description* | The POS M/V system includes two GNSS antennas, each of which provides carrier phase level positioning information. In addition to providing robust positional information, the antenna's level of accuracy is also used to improve the system's heading accuracy. By using carrier phase level positioning, the system has enough resolution to position one antenna relative to the other. The positions are then used to calculate the North-East-Down vector between the Primary and the Secondary antennas. Combining the North-East-Down vector with the measured distance between antennas allows the system to resolve the IMU's heading. These heading estimates are blended with heading estimates made by the IMU, providing an extremely accurate heading solution. | | |
| | *Serial Numbers* | *Vessel Installed On* | S5401 | S5401 |
| | | *Antenna s/n* | 1440911819 | 1440918106 |
| | | *Port or Starboard* | Port | Starboard |
| | | *Primary or Secondary* | Primary | Secondary |
| *GAMS Calibration* | *Vessel* | S5401 | | |
| | *Calibration Date* | 2012-01-04 | | |
| *Configuration Reports* | *Vessel* | S5401 | | |
| | *Report Date* | 2012-03-27 | | |


*Figure 6: POS MV Topside Unit*

## A.4.2 DGPS

| | | | | |
|---|---|---|---|---|
| *Description* | Trimble | | | |
| *Antennas* | *Manufacturer* | Trimble | | |
| | *Model* | 27207-00 | | |
| | *Description* | This combined antenna features two elements, a L1 GPS antenna and a Beacon H-Field Loop antenna. The L1 GPS antenna is an active antenna element that filters out unwanted signals and amplifies the L1 signal. The Beacon H-field Loop antenna works as a preamplifier for filtering out interference an amplifies the Beacon signal. | | |
| | *Serial Numbers* | *Vessel Installed On* | S5401 | |
| | | *Antenna s/n* | 0220172421 | |
| *Receivers* | *Manufacturer* | Trimble | | |
| | *Model* | DSM212L | | |
| | *Description* | This DGPS receiver allows for submeter vessel positioning during hydrographic survey. | | |
| | *Firmware Version* | 1.32 242.11 | | |
| | *Serial Numbers* | *Vessel Installed On* | 5401 | |
| | | *Antenna s/n* | 0220177299 | |

## A.4.3 Trimble Backpacks

| | |
|---|---|
| *Manufacturer* | Trimble |
| *Model* | GeoExplorer 2008 Series GeoXH |
| *Description* | The Trimble backpack is used to collect geographic positions on shoreline features.The unit can use both an internal GPS antenna, as well as an external antenna. Both antennas receive GPS positions and carrier code data. Raw DGPS positions are recorded using the hand held, then differentially correct during post processing. |
| *Serial Numbers* | 4713435892 |

| | | |
|---|---|---|
| *Antennas* | *Manufacturer* | Trimble |
| | *Model* | Zephyr, Model 2 |
| | *Description* | The Zephyr is the optional external antenna. |
| | *Serial Numbers* | 1441132114 |
| *Receivers* | No receivers were installed. | |
| *Field Computers* | No field computers were utilized for data acquisition. | |
| *DQA Tests* | DQA test was not performed. | |


*Figure 7: Handheld GeoXH*

### A.4.4 Laser Rangefinders

| | |
|---|---|
| *Manufacturer* | Laser Technology Inc |
| *Model* | Impulse |
| *Description* | The Impulse uses sensors to measure distances and vertical angles, and menu-driven software to convert sensor readings to meaningful measurements. |

| | |
|---|---|
| *Serial Numbers* | ii08463 |
| *DQA Tests* | DQA test was not performed. |


*Figure 8: Impulse laser rangefinder*

## A.4.5 Other Positioning and Attitude Equipment

No additional positioning and attitude equipment was utilized for data acquisition.

## A.5 Sound Speed Equipment

## A.5.1 Sound Speed Profiles

### A.5.1.1 CTD Profilers

#### A.5.1.1.1 Sea-Bird Electronics CTD SBE 19 Plus 05M

| | |
|---|---|
| *Manufacturer* | Sea-Bird Electronics CTD |
| *Model* | SBE 19 Plus 05M |
| *Description* | The R/V Bay Hydro II uses a Sea-Bird Electronics SeaCat SBE19+ Conductivity, Temperature, and Depth (CTD) profiler to collect sound velocity profiles. Temperature is measured directly. Salinity is calculated from measured electrical conductivity. Depth is calculated from strain gauge pressure. |
| *Serial Numbers* | *Vessel Installed On*: S5401<br>*CTD s/n*: 19P37217-4677 |
| *Calibrations* | *CTD s/n*: 19P37217-4677<br>*Date*: 2012-01-12<br>*Procedures*: Calibration performed by SEABIRD Electronics |

*Figure 9: CTD SBE 19 Plus*

### A.5.1.2 Sound Speed Profilers

No sound speed profilers were utilized for data acquisition.

## A.5.2 Surface Sound Speed

**A.5.2.1 DIGIBAR PRO 1.12**

| | | |
|---|---|---|
| *Manufacturer* | DIGIBAR PRO | |
| *Model* | 1.12 | |
| *Description* | The Digibar Pro is a sing-around transducer, measuring the speed of sound in water by finding the time needed for a ping of sound to travel a known distance. | |
| *Serial Numbers* | *Vessel Installed On* | S5401 |
| | *Sound Speed Sensor s/n* | 98376-121610 |
| *Calibrations* | *Sound Speed Sensor s/n* | 98376-121610 |
| | *Date* | 2012-12-27 |
| | *Procedures* | Performed by Teledyne ODOM |

*Figure 10: Digibar Pro 19+*

## A.6 Horizontal and Vertical Control Equipment

### A.6.1 Horizontal Control Equipment

No horizontal control equipment was utilized for data acquisition.

### A.6.2 Vertical Control Equipment

No vertical control equipment was utilized for data acquisition.

## A.7 Computer Hardware and Software

### A.7.1 Computer Hardware

<table>
<tr><td>Manufacturer</td><td colspan="2">Dell</td></tr>
<tr><td>Model</td><td colspan="2">Precision T3400</td></tr>
<tr><td>Description</td><td colspan="2">Hypack Computer using an Intel Core2 Quad CPU Q6700 that processes at 2.66 GHz and has 3 GB of RAM.  This computer is used to operate the HyPack/HySweep interface, as well as to view the POS M/V interface during acquisition.</td></tr>
<tr><td rowspan="3">Serial Numbers</td><td>Computer s/n</td><td>7FH43H1</td></tr>
<tr><td>Operating System</td><td>Microsoft Windows XP Professional, Version 2002 Service Pack 3</td></tr>
<tr><td>Use</td><td>Acquisition</td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td colspan="2">Dell</td></tr>
<tr><td>Model</td><td colspan="2">Precision T3400</td></tr>
<tr><td>Description</td><td colspan="2">Sonar Pro Computer (OCS-W-NSD716681) using an Intel Core2 Quad CPU Q6600 that processes at 2.40 GHz and has 3.25 GB of RAM.  This computer is used for the SonarPro interface.</td></tr>
<tr><td rowspan="3">Serial Numbers</td><td>Computer s/n</td><td>4HJRTK1</td></tr>
<tr><td>Operating System</td><td>Microsoft Windows XP Professional, Version 2002 Service Pack 3</td></tr>
<tr><td>Use</td><td>Acquisition</td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td colspan="2">Dell</td></tr>
<tr><td>Model</td><td colspan="2">Precision T3500</td></tr>
<tr><td>Description</td><td colspan="2">OCS-W-001772559 uses an Intel Xeon CPU that processes at 3.07GHz and has 6.00GB of RAM.  This computer is used for post-processing and development of deliverables, using the following programs: CARIS HIPS/SIPS, CARIS Bathy DataBASE , Pydro, Velocipy, and the full Microsoft Office Suite.</td></tr>
<tr><td rowspan="3">Serial Numbers</td><td>Computer s/n</td><td>HJ9KYQ1</td></tr>
<tr><td>Operating System</td><td>Microsoft Windows 7, Service Pack 1</td></tr>
<tr><td>Use</td><td>Processing</td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td>Dell</td></tr>
<tr><td>Model</td><td>Precision T3500</td></tr>
<tr><td>Description</td><td>OCS-W-001670305 uses an Intel Xeon CPU that processes at 3.07GHz and has 6.00GB of RAM.. This computer is used for post-processing and development of deliverables only, using the following programs: CARIS HIPS/SIPS, CARIS Bathy DataBASE, Pydro, Velocipy, and the full Microsoft Office Suite.</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Computer s/n</td><td>C3SMZQ1</td></tr>
<tr><td>Operating System</td><td>Microsoft Windows 7, Service Pack 1</td></tr>
<tr><td>Use</td><td>Processing</td></tr>
</table></td></tr>
</table>

## A.7.2 Computer Software

| | |
|---|---|
| *Manufacturer* | HYPACK, Inc |
| *Software Name* | Hypack 2011 |
| *Version* | 11.0.1.54 |
| *Service Pack* | none |
| *Hotfix* | none |
| *Installation Date* | 2011-01-03 |
| *Use* | Acquisition |
| *Description* | HYPACK Hypack is used to acquire VBES data in a *.raw format, and detached positions, in a *.tgt format. It is also used for vessel navigation during data acquisition. HYSWEEP Hysweep is a module for Hypack used to acquire RESON 7125 MBES data in a *.HSX format. It receives input from The Reson 7125, the Digibar Pro, and the Applanix POS/MV systems. |

| | |
|---|---|
| *Manufacturer* | Applanix |
| *Software Name* | POSVIEW |
| *Version* | 5.1.0.2 |
| *Service Pack* | none |
| *Hotfix* | none |
| *Installation Date* | 2011-05-05 |
| *Use* | Acquisition |
| *Description* | POSVIEW is used to monitor positional accuracy and log positional and inertial data while displaying the attitude accuracy details |

| | |
|---|---|
| *Manufacturer* | Applanix |
| *Software Name* | MMS |

| | |
|---|---|
| *Version* | 5.3.3838.25021 |
| *Service Pack* | 3 |
| *Hotfix* | none |
| *Installation Date* | 2011-01-05 |
| *Use* | Processing |
| *Description* | POSPac MMS is used to process POSPac files, which are recorded in a .000 format. |

| | |
|---|---|
| *Manufacturer* | Caris |
| *Software Name* | HIPS and SIPS |
| *Version* | 7.1 |
| *Service Pack* | 1 |
| *Hotfix* | 1 |
| *Installation Date* | 2012-02-26 |
| *Use* | Processing |
| *Description* | CARIS HIPS (Hydrographic Information Processing System) is used for the initial processing of Multibeam and singlebeam echosounder data. The program applies vessel offsets to the raw sonar data, corrects for tide and sound velocity, and calculates a Total Propagated Uncertainty (TPU) for each sounding. Individual soundings are then processed into CUBE (Combined Uncertainty and Bathymetry Estimator) grids. CARIS SIPS (Side-Scan Information Processing System) is used for processing of side-scan sonar imagery, including cable layback correction, slant range correction, contact selection, tow point entry, and mosaic generation. |

| | |
|---|---|
| *Manufacturer* | NOAA OCS HSTP |
| *Software Name* | PYDRO |
| *Version* | v12.1 |
| *Service Pack* | r3761 |
| *Hotfix* | |
| *Installation Date* | 2012-03-01 |
| *Use* | Processing |
| *Description* | HSTP PYDRO is a program for the classification of side-scan sonar and Multibeam bathymetry contacts, and for the creation of preliminary smooth sheets. Multibeam contacts (designated soundings), side-scan sonar contacts, and detached position contacts are analyzed, grouped, and assigned S-57 classifications. The bathymetric grid is imported for comparison between surveyed and charted depths, and to the side scan contacts. The sounding selection interval is dependent on the survey scale. The final product is a Preliminary Smooth Sheet file (PSS), which is delivered to the Atlantic Hydrographic Branch as part of the final submission package. PYDRO is also used for chart comparisons, generation of chartlets, generation of Danger to |

| | |
|---|---|
| | Navigation reports, generation of appendices to the Descriptive Report, compilation of survey statistics, and generation of standard NOAA forms such as the Descriptive Report cover sheet. |

| | |
|---|---|
| *Manufacturer* | NOAA OCS HSTP |
| *Software Name* | VELOCIPY |
| *Version* | v12.1 |
| *Service Pack* | r3761 |
| *Hotfix* | |
| *Installation Date* | 2012-03-01 |
| *Use* | Processing |
| *Description* | HSTP VELOCIPY is a program used for processing sound velocity casts. This program converts the hexadecimal SeaCat data into ASCII data, then converts the ASCII data into a depth-binned sound velocity file. The resulting .svp files are applied to MBES and VBES data during post processing to correct for sound velocity variation within the water column |

| | |
|---|---|
| *Manufacturer* | PitneyBowes |
| *Software Name* | MAPINFO Professional |
| *Version* | 11 |
| *Service Pack* | |
| *Hotfix* | |
| *Installation Date* | 2012-02-16 |
| *Use* | Acquisition |
| *Description* | MapInfo is the Geographic Information System (GIS) software package used to plan survey lines, review hydrographic data, and create preliminary chartlet plots. HYDRO_MI is a OCS HSTP product and exists as a set of tools that aid hydrogrpahic aquisition planning. |

## A.8 Bottom Sampling Equipment

## A.8.1 Bottom Samplers

### A.8.1.1 Unknown Unknown

| | |
|---|---|
| *Manufacturer* | Unknown |
| *Model* | Unknown |
| *Description* | Ponar-type grab sampler is used to verify assigned charted seafloor bottom type |

# B Quality Control

## B.1 Data Acquisition

## B.1.1 Bathymetry

### B.1.1.1 Multibeam Echosounder

All Multibeam data is logged using Hypack Hysweep in the .HSX format. During acquisition, the hydrographer:

· Monitors the Reson SeaBat interface for errors and data quality;

· Adjusts range scale, power, gain, pulse width, swath width, absorption, spreading, and gates to ensure maximum data quality;

. Monitors the Hysweep interface using the following sub-windows: 3-D sounding points, Multibeam Waterfall-Solid TIN, and Profile Window-Beam Pattern;

· Monitors vessel speed and adjusted as necessary to ensure density specifications.

### B.1.1.2 Single Beam Echosounder

All Vertical Beam Data is logged using Hypack Hysweep in the .bin and .RAW formats. During acquisition, the hydrographer:

· Monitors real-time data in Odom's eChart interface;

· Adjusts gain and power as needed to ensure data quality.

#### B.1.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

### B.1.2 Imagery

#### B.1.2.1 Side Scan Sonar

All Side Scan Sonar data is logged using Klein SonarPro, in the .SDF format. During acquisition, the hydrographer:

- Monitors: range, fish height, heading, pitch, roll, latitude, longitude, speed, pressure, and temperature;
- Adjust towfish height, in accordance with Field Procedures Manual, and manually record in Sonar Pro.

#### B.1.2.2 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not acquired.

### B.1.3 Sound Speed

#### B.1.3.1 Sound Speed Profiles

All Sound velocity profiles are acquired using a Sea-Bird SeaCat SBE19+ CTD. Casts are acquired once per week for VBES acquisition, and once every 2 - 4 hours for MBES. Profiles are collected more frequently when transiting more than 1 nautical mile between survey areas, or when current and weather conditions warrant. Sound velocity casts are applied to all bathymetric data during post processing.

The Sea-Bird CTD is sent for factory calibration annually. Calibration Reports can be found in Separate II of this report.

*Figure 11: Sound Speed Profiling Device*

#### B.1.3.2 Surface Sound Speed

An ODOM Digibar Pro is used to find sound speed values at the transducer face.Accuracy of the transducer is checked against the data point closest to the transducer depth on every CTD cast.

The Digibar Pro is sent for factory calibration annually. Calibration Reports can be found in Separate II of this report.

### B.1.4 Horizontal and Vertical Control

#### B.1.4.1 Horizontal Control

The Bay Hydro II uses DGPS to establish horizontal position, using an assigned U.S. Coast Guard Maritime DGPS Services beacon. The frequency of the assigned beacon is programmed into the Trimble DGPS receiver using the program TSIP Talker. The minimum number of satellites, their minimum elevation above the horizon, and the age of pseudo range corrects are also set in TSIPs Talker.

During acquisition, differential correctors are sent to the Applanix POS M/V via serial connection. Total positional accuracy is then monitored inside the MV-POSView window.

#### B.1.4.2 Vertical Control

During data acquisition, bathymetric data is initially reduced to Mean Lower-Low Water (MLLW) using preliminary (observed) water level data. Water level stations and zone files, or TCARI grids, are assigned by the Center for Operational Oceanographic Products and Services (CO-OPS). Preliminary water levels are downloaded though the CO-OPS website in six-minute intervals and applied to the data at the end of each day. After acquisition is complete, preliminary tide levels and zoning are examined for veracity by CO-OPS, and all bathymetric data is then re-reduced to the verified levels.

## B.1.5 Feature Verification

The following work flow is used to develop features:

· The locations of all potentially significant features are exported to MapInfo. Any indication of shoaling found in the VBES data is also noted, and the area outlined in MapInfo;

· A development line plan is created using MapInfo, creating line spacing that will ensonify all features with nadir beams;

· Object Detection level MBES data is collected over all SSS contacts, VBES designated soundings, and all possible shoals. Quality of data is controlled through:

- Real time monitoring during acquisition to ensure that all features are covered by nadir beams;
- Post Processing inspection of the CUBE surface's Density and Uncertainty layers;

· All developments are examined for significance. Objects found to be significant are flagged with a designated sounding, and imported into HSTP Pydro for reporting.

## B.1.6 Bottom Sampling

Bottom Samples are collected according to the sample diagram contained in the Project Instructions. A Van veen grab sampler is used to take samples.

## B.1.7 Backscatter

Backscatter data were not acquired.

## B.1.8 Other

No additional data were acquired.

# B.2 Data Processing

## B.2.1 Bathymetry

### B.2.1.1 Multibeam Echosounder

Convert MBES data using CARIS HIPS,

· Apply True Heave; correct for tide and speed of sound; compute Total Propagated Error

· Uncertainty values in the HVF follow recommendations of FPM, Appendix 4,
    · With the exception of MRU alignment uncertainties, which are calculated using the standard deviation of all angular biases found during a patch test;
    · For tidal zoning and speed of sound error modeling, refer to section B.2.2 of the Descriptive Report;

· Scan Navigation and Attitude data, flagging erroneous data as rejected;

· Initial data cleaning using Swath Editor to reject gross flyers;

· Create CUBE grids.

Grid resolution is dictated by the type of coverage required (Complete Coverage vs. Object Detection) and the depth of the water. Disambiguation method is NOAA Cube Parameters 2010. Compliance with HSSD gridding requirements is strictly observed,

· Review the CUBE grids for holidays;

· Create an initial holiday line plan;

· Review the uncertainty layer of the each CUBE grid. Address each area where uncertainly falls outside of the standards set by HSSD;

· Review the density layer of each CUBE grid for compliance with HSSD specified density requirements,
    · Add areas of rarefaction to the holiday line plan;

· Examine all surfaces for erroneous surface designation and evidence of systematic errors, for features, and for evidence shoaling,

· Significant features are flagged ‘designated’, forcing the CUBE algorithm honor the depth of the sounding

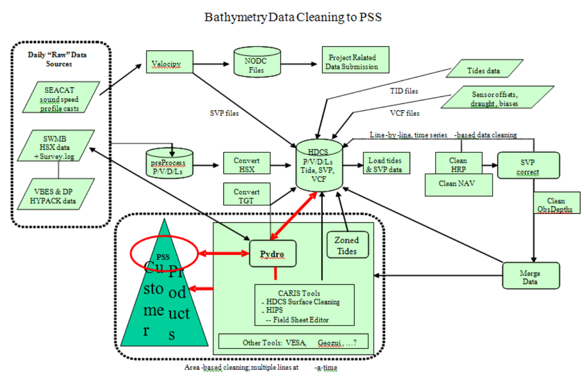



*Figure 12: Bathymetry Data Cleaning to PSS*

### B.2.1.2 Single Beam Echosounder

VBES Data

· Convert VBES data using CARIS HIPS;

· Scan Navigation and Attitude data, flagging erroneous data as rejected;

· Apply tide and speed of sound corrections, compute Total Propagated Uncertainty Uncertainty values in the HVF follow recommendations of NOAA Field Procedures Manual (FPM), Appendix 4,

· With the exception of MRU alignment uncertainties, which are calculated using the standard deviation of all angular biases found during a patch test;

· For tidal zoning and speed of sound error modeling, refer to section B.2.2 of the Descriptive Report;

· Clean data using CARIS Single Beam Editor, flagging data from the water column and sub-bottom returns as rejected;

· When definition of the true bottom is ambiguous, the full water column data can be inspected by viewing the HYPACK created .bin files;

· Create CARIS BASE Uncertainty Weighted Grids at 4 meter resolution;

· Analyze grids for features and for areas of shoaling, flagging them for development by a Multibeam sonar.

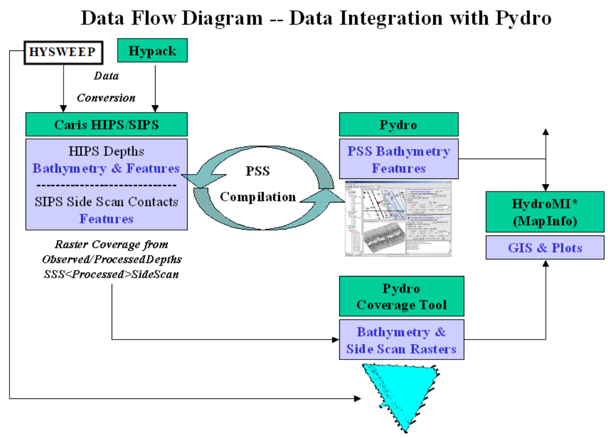



*Figure 13: Data Flow Diagram*

### B.2.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not processed.

### B.2.1.4 Specific Data Processing Methods

#### B.2.1.4.1 Methods Used to Maintain Data Integrity

All bathymetric data is moved through the CARIS HIPS processing pipeline using a step-by-step method. No scripts or batch files are used. Data integrity is maintained through the use of processing logs, which tracks: Conversion of the data; Examination of ancillary sensor(navigation and attitude); and Application of heave, tides, SVP, and TPU.

#### B.2.1.4.2 Methods Used to Generate Bathymetric Grids

After initial processing the bathymetric data is gridded into BASE surfaces.

VBES data is gridded using an Uncertainty Weighted algorithm, set to 4 meter resolution. This type of grid calculates an horizontal and vertical uncertainty for each sounding, derived from the combined uncertainty from each of the sensors that contributes data to the sounding (e.g water levels, tide zoning, attitude sensor error, navigation sensor horizontal position error, and sound velocity profile error). Individual soundings are then propagated to grid nodes, which takes on a depth value as well as an uncertainty value based on all the soundings that contribute to the node. The influence of a sounding on a grid node is limited to 0.707 times the grid resolution.

MBES data is gridded using the CUBE algorithm. Resolution is dictated by the Project Instructions, as well as section 5.2.2 of the HSSD. The disambiguation method used is always Density and Local. The settings used for Capture Distance Scale, Horizontal Error Scaler, and Capture Distance Minimum are those listed in section 4.2.1.1.1.1 of the FPM.

After creation, Uncertainty and CUBE grids go through a quality control process. During this process, the Depth, Uncertainty, and Density child layers are examined for compliance with NOAA specifications. After the grids passes quality control, they are finalized. Uncertainty values for finalized surface come from the greater of either Uncertainty, or Standard Deviation.

#### B.2.1.4.3 Methods Used to Derive Final Depths

| | |
|---|---|
| *Methods Used* | Cleaning Filters<br>Gridding Parameters<br>Surface Computation Algorithms |
| *Description* | Gridding parameters are dictated by section |

## B.2.2 Imagery

### B.2.2.1 Side Scan Sonar

SSS Data
· Convert SSS data using CARIS SIPS;

· Scan Navigation and Attitude data, flagging erroneous data as rejected;

· Re-Compute towfish navigation. This is when tow point offsets and horizontal layback is applied to the data;

· Slant Range correct each line of data;

· A primary reviewer scans each line for significant contacts,

· A secondary reviewer makes an independent check-scan of all lines, verifying contacts and checking for missed contacts;

· If the Project Instructions call for 200% Side Scan coverage, the scanners check for correlation of contacts between 100% and 200% coverage;

· Correlation is also used to reveal systematic errors, particularly if a contact shows up on lines collected in opposite or orthogonal directions;

· Create individual mosaics for 100% and 200% coverage. Examine for coverage,

· If necessary, create a holiday line plan.

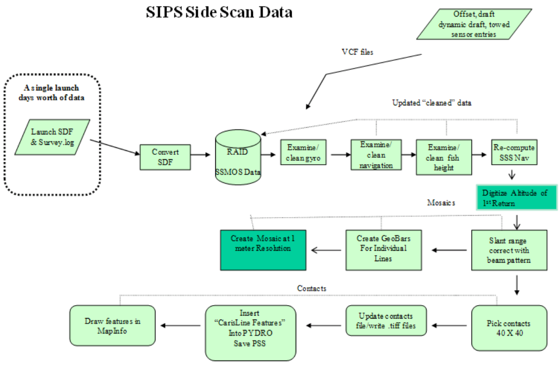



*Figure 14: Side Scan Sonar Workflow*

### B.2.2.2 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not processed.

### B.2.2.3 Specific Data Processing Methods

#### B.2.2.3.1 Methods Used to Maintain Data Integrity

Daily confidence checks were completed to insure integrity of data. These checks were completed by ensonifing a target in the outer limits of the range scale on either side of towfish. When this target was seen on the trace within ten meters of the targets actual position (the positional accuracy of a towed system), is was understood that data integrity was maintained.

#### B.2.2.3.2 Methods Used to Achieve Object Detection and Accuracy Requirements

R/V BAY HYDRO II achieved object detection and accuracy requirements by limiting vessel speed to insure that a minimum of three independent pings occurred per meter traveled in the along track direction, as well as by insuring the towfish was position between eight and twenty of the range scale off of the bottom.

#### B.2.2.3.3 Methods Used to Verify Swath Coverage

Mosaics were created after SSS acquisition was completed. These mosaics were placed onto a brightly colored background in the CARIS window so that holidays were easily visible. If holidays were found to exist, a new line plan was created to address them.

#### B.2.2.3.4 Criteria Used for Contact Selection

R/V BAY HYDRO II followed the contact height of one meter in twenty meter water depth criteria as set forth in the HSSD section 6.3.2.

#### B.2.2.3.5 Compression Methods Used for Reviewing Imagery

No compression methods were used for reviewing imagery.

## B.2.3 Sound Speed

### B.2.3.1 Sound Speed Profiles

Sound speed profiles were acquired with a SeaBird Electronics SeaCat SBE19plus profiler. Raw conductivity, temperature, and pressure data were processed using Velocipy, which generates sound speed profiles in a format readable by CARIS HIPS/SIPS. Sound speed correctors were applied to MBES and VBES data in CARIS HIPS during post processing.

The speed of sound through the water column was determined by a minimum of one cast every 2-4 hours of MBES acquisition, and one cast every week for VBES acquisition.

#### B.2.3.1.1 Specific Data Processing Methods

##### B.2.3.1.1.1 Caris SVP File Concatenation Methods

All SVP casts are processed using HSTP Velocipy. are concatenated into a project master file.

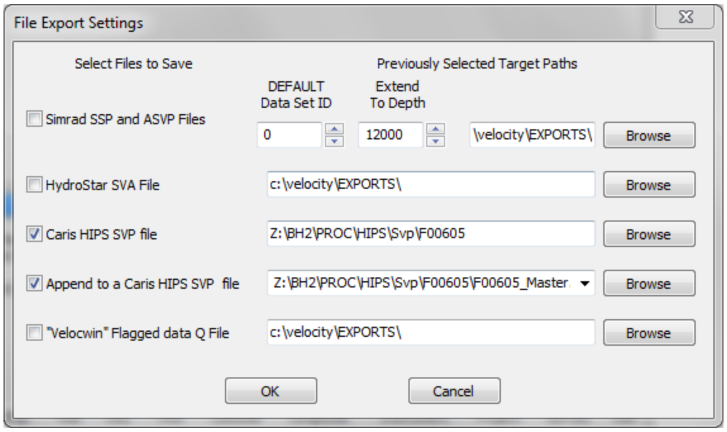



*Figure 15: Velocipy GUI*

#### B.2.3.2 Surface Sound Speed

Surface sound speed data were not processed.

### B.2.4 Horizontal and Vertical Control

#### B.2.4.1 Horizontal Control

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.

*Figure 16: Real Time HORCON Monitoring Interface*

#### B.2.4.2 Vertical Control

Heave 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. Water level control were provided by CO-OPS.

*Figure 16: Real Time Vertical Control Monitoring Interace*

### B.2.5 Feature Verification

Features were verified using MBES. Shoreline features were collected using detached positions. The vessel's position was recorded using Hypack, and the range to the object found using a laser range finder. Position, range, and azimuth were then input into Pydro.


*Figure 17: Trimble GeoXH used to take detached positions*

### B.2.6 Backscatter

Backscatter data were not processed.

### B.2.7 Other

No additional data were processed.

## B.3 Quality Management

Prior to each Field Season the R/V Bay Hydro II performs an Annual Systems Preparation, during which all Multibeam sonars, Side Scan Sonars, lead lines, sound speed measuring devices, and positioning systems are calibrated. Additionally, a comparison is made between depths found by lead line, VBES, and the MBES.

During daily acquisition, a hydrographer monitors the cumulative uncertainties in position and attitude data, watches incoming data for errors, and compares the surface sound speed against full water column data for each CTD cast.

During post processing, Navigation and Attitude data is scanned using Caris HIPS & SIPS. Side Scan data is then scanned for significant features by two separate individuals. Multibeam data is binned into a BASE surface using the CUBE algorithm, then undergoes directed editing using the Standard Deviation, Depth, Uncertainty, and Hypothesis Count child layers. The Uncertainty layer is also used to ensure the data complies with IHO uncertainty standards.

## B.4 Uncertainty and Error Management

TPU is computed for each sounding using the CUBE algorithm, using the NOAA specified CubeParams_2010 values. TPU for sound speed is set to 2 m/s for Measured, and is generally set to 0.20 m/s for Surface. However, if the hydrographer observes a significant halocline near the depth of the multibeam head, Surface TPU can be increased up to 2 m/s.

## B.4.1 Total Propagated Uncertainty (TPU)

### B.4.1.1 TPU Calculation Methods

TPU is computed using the CUBE algorithm in CARIS HIPS. The contributing estimates are pulled from Appendix 4 of the Field Procedures Manual, with the exception of MRU alignment. Those values are estimated by calculating the standard deviation of a large sample of angular bias values resolved with a patch test.

### B.4.1.2 Source of TPU Values

Field Procedures Manual: Appendix 4

### B.4.1.3 TPU Values

| | |
|---|---|
| *Vessel* | R/V BAY HYDRO II |
| *Echosounder* | Reson SeaBat 7125 400 kilohertz |

| | | | |
|---|---|---|---|
| *TPU Standard Deviation Values* | *Motion* | *Gyro* | 0.020 degrees |
| | | *Heave* | 5.0 % Amplitude<br>0.050 meters |
| | | *Pitch* | 0.020 degrees |
| | | *Roll* | 0.020 degrees |
| | *Navigation Position* | 1.0 meters | |
| | *Timing* | *Transducer* | 0.005 seconds |
| | | *Navigation* | 0.005 seconds |
| | | *Gyro* | 0.005 seconds |
| | | *Heave* | 0.005 seconds |
| | | *Pitch* | 0.005 seconds |
| | | *Roll* | 0.005 seconds |
| | *Offsets* | *x* | 0.002 meters |
| | | *y* | 0.002 meters |
| | | *z* | 0.002 meters |
| | *MRU Alignment* | *Gyro* | 0.000 degrees |
| | | *Pitch* | 0.000 degrees |
| | | *Roll* | 0.000 degrees |
| | *Vessel* | *Speed* | 0.257 meters/second |
| | | *Loading* | 0.100 meters |
| | | *Draft* | 0.020 meters |
| | | *Delta Draft* | 0.020 meters |

## B.4.2 Deviations

There were no deviations from the requirement to compute total propagated uncertainty.

# C Corrections To Echo Soundings

## C.1 Vessel Offsets and Layback

## C.1.1 Vessel Offsets

### C.1.1.1 Description of Correctors

An NGS survey of R/V BAY HYDRO II was performed on 23 March 2009 using optical levels. The survey established the vessel's Reference Point (RP), then found the X, Y, and Z distances for the GNSS antennas and mulitbeam sonar. On 26 February 2010 the crew surveyed in the Tow Point for the side scan sonar. On 18 March 2010 the crew surveyed in the vessel's singlebeam transducers.

### C.1.1.2 Methods and Procedures

This original Sensor Components Spatial Relationship Survey was conducted using the TOPCON GPT 3002LW Series Total Station, and a SECO 25mm Mini Prism System. The vessel's Tow Point was established using a laser level and measuring tape. The singlebeam transducers were also surveyed using a level and measuring tape.

### C.1.1.3 Vessel Offset Correctors

<table>
<tr><td>Vessel</td><td colspan="3">R/V BAY HYDRO II</td></tr>
<tr><td>Echosounder</td><td colspan="3">Teledyne Odom Hydrographic Odom Echotrac CV-200 200 kilohertz</td></tr>
<tr><td>Date</td><td colspan="3">2010-03-18</td></tr>
<tr><td rowspan="14">Offsets</td><td rowspan="6">MRU to Transducer</td><td>x</td><td>2.294 meters</td></tr>
<tr><td>y</td><td>3.406 meters</td></tr>
<tr><td>z</td><td>2.143 meters</td></tr>
<tr><td>x2</td><td></td></tr>
<tr><td>y2</td><td></td></tr>
<tr><td>z2</td><td></td></tr>
<tr><td rowspan="6">Nav to Transducer</td><td>x</td><td>0.0 meters</td></tr>
<tr><td>y</td><td>0.0 meters</td></tr>
<tr><td>z</td><td>0.0 meters</td></tr>
<tr><td>x2</td><td></td></tr>
<tr><td>y2</td><td></td></tr>
<tr><td>z2</td><td></td></tr>
<tr><td rowspan="2">Transducer Roll</td><td>Roll</td><td>0.000 degrees</td></tr>
<tr><td>Roll2</td><td></td></tr>
<tr><td>Vessel</td><td colspan="3">R/V BAY HYDRO II</td></tr>
<tr><td>Echosounder</td><td colspan="3">Reson SeaBat 7125 400 kilohertz</td></tr>
<tr><td>Date</td><td colspan="3">2010-03-02</td></tr>
</table>

| | | | |
|---|---|---|---|
| *Offsets* | *MRU to Transducer* | *x* | 0.110 meters |
| | | *y* | -1.066 meters |
| | | *z* | 2.507 meters |
| | | *x2* | |
| | | *y2* | |
| | | *z2* | |
| | *Nav to Transducer* | *x* | -0.043 meters |
| | | *y* | -1.217 meters |
| | | *z* | 2.342 meters |
| | | *x2* | |
| | | *y2* | |
| | | *z2* | |
| | *Transducer Roll* | *Roll* | 0.000 degrees |
| | | *Roll2* | |

## C.1.2 Layback

### C.1.2.1 Description of Correctors

Layback on the R/V BAY HYDRO II is the offset from the Reference Point (RP), to the point where the tow cable departs the sheave at the top of the A-frame.

### C.1.2.2 Methods and Procedures

During acquisition the amount of side scan cable out is visually observed, and the value is entered into the SonarPro acqusition program. The number is then included in the .sdf file. Actual positioning of the Towfish is calculated during post processing, using CARIS SIPS.

### C.1.2.3 Layback Correctors

| | | | |
|---|---|---|---|
| *Vessel* | R/V BAY HYDRO II | | |
| *Echosounder* | L3 Communications / Klein Associates, Inc. 5000HSHRSSS Towfish, T5114 Transceiver Processing Unit (TPU) 455 kilohertz | | |
| *Date* | 2010-02-26 | | |
| *Layback* | *Towpoint* | *x* | -0.011 meters |
| | | *y* | -9.979 meters |
| | | *z* | -4.01 meters |
| | *Layback Error* | 0.00 meters | |

# C.2 Static and Dynamic Draft

## C.2.1 Static Draft

### C.2.1.1 Description of Correctors

Static draft is measured daily, and entered into the HVF file.

### C.2.1.2 Methods and Procedures

Once the multibeam strut has been deployed, the distance from the benchmark to the waterline is measured using the vessel's lead line, and a steal measuring tape. The Z-axis difference between the benchmark and the RP is subtracted to get the true static draft. The new measurement is inserted into the HVF file for the Reson 7125 multibeam under that day number in the Waterline Height section.

## C.2.2 Dynamic Draft

### C.2.2.1 Description of Correctors

Change in draft measurement are used on the R/V BAY HYDRO II to account for the natural "settlement and squat" the vessel undergoes while changing speed while acquiring SWMB data.

### C.2.2.2 Methods and Procedures

Using the Echosounder method, as described in the FPM section 1.4.2.1.2.1, a delta draft survey was conducted on 5 January 2011. A total of sixteen 1000m lines were run in opposite directions for each of eight different RPM's on the vessel's main engines. The initial two lines were run using a single engine, in order to maintain the slowest speed possible. The remaining fourteen lines were run using both engines. The evolution was completed by acquiring three drift lines, run orthogonal to the azimuth of the main lines. All multibeam data was processed using CARIS HIPS/SIPS 7.0 and then analyzed using the following methods: 20m X20m subset was defined at each drift line/main line intersection, all sounding inside subset were queried for depth, the median depth for lines run at the same RPM were calculated at each drift line reference area, the median depth of each drift line was calculated, and the delta draft at each line couplet at each reference point was calculated by subtracting the lines median depth from the median drift depth. The delta draft found at typical survey speeds was inserted into the Reson 7125 HVF under "TPU values, Standard Deviation, Delta Draft (m)".

### C.2.2.3 Dynamic Draft Correctors

| | |
|---|---|
| *Vessel* | R/V BAY HYDRO II |
| *Date* | 2011-01-05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Dynamic Draft Table* | *Speed* | 1.029 meters/second | 2.6424 meters/second | 3.087 meters/second | 3.498 meters/second | 3.807 meters/second | 4.064 meters/second | 4.476 meters/second | 5.093 meters/second |
| | *Draft* | -0.002 meters | -0.007 meters | -0.007 meters | 0.002 meters | 0.015 meters | 0.031 meters | 0.041 meters | 0.042 feet |

## C.3 System Alignment

### C.3.1 Description of Correctors

R/V BAY HYDRO II is configured for the "Precise Timing" setup for MBES operations. In this method of minimizing timing errors, a UTC serial time stamp is output from the POS/MV and received by Hysweep and the Reson processing unit. All data (navigation, heave, pitch, roll, and bathymetry) are time stamped according to this string at acquisition. 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.

### C.3.2 Methods and Procedures

Patch tests were conducted throughout the year after any removal and replacement of the Reson 7125 MBES head due to the test and evaluation mission of the R/V BAY HYDRO II, These patch tests are designed to find any roll, pitch, and yaw biases and remaining time offset between the MB reference frame and the navigational reference frame. These Patch Tests are conducted in accordance with the Hydrographic Specifications and Deliverables section 5.2.4.1. In order to insure the highest quality of testing, the lines are post-processed and the CARIS Calibration Utility is performed by all R/V BAY HYDRO II crew members. The results of the three trials are averaged together and recorded in the Reson 7125 HVF under the appropriate columns in Swath 1 for the specific day number.

## C.3.3 System Alignment Correctors

| | | |
|---|---|---|
| *Vessel* | R/V BAY HYDRO II | |
| *Echosounder* | Reson SeaBat 7125 400 kilohertz | |
| *Date* | 2011-01-05 | |
| *Patch Test Values* | *Navigation Time Correction* | 0.0 seconds |
| | *Pitch* | 2.1 degrees |
| | *Roll* | 0.10 degrees |
| | *Yaw* | 0.40 degrees |
| | *Pitch Time Correction* | 0.00 seconds |
| | *Roll Time Correction* | 0.00 seconds |
| | *Yaw Time Correction* | 0.00 seconds |
| | *Heave Time Correction* | 0.00 seconds |
| *Vessel* | S5401 | |
| *Echosounder* | Reson SeaBat 7125 400 kilohertz | |
| *Date* | 2011-01-31 | |

| | | |
|---|---|---|
| *Patch Test Values* | *Navigation Time Correction* | 0.0 seconds |
| | *Pitch* | -2.0 degrees |
| | *Roll* | 0.10 degrees |
| | *Yaw* | 0.45 degrees |
| | *Pitch Time Correction* | 0.00 seconds |
| | *Roll Time Correction* | 0.00 seconds |
| | *Yaw Time Correction* | 0.00 seconds |
| | *Heave Time Correction* | 0.00 seconds |
| *Vessel* | S5401 | |
| *Echosounder* | Reson SeaBat 400 kilohertz | |
| *Date* | 2011-05-09 | |
| *Patch Test Values* | *Navigation Time Correction* | 0.0 seconds |
| | *Pitch* | 2.20 degrees |
| | *Roll* | 0.10 degrees |
| | *Yaw* | 1.70 degrees |
| | *Pitch Time Correction* | 0.00 seconds |
| | *Roll Time Correction* | 0.00 seconds |
| | *Yaw Time Correction* | 0.00 seconds |
| | *Heave Time Correction* | 0.00 seconds |

**Additional Discussion**

The Bay Hydro II's MBES system was originally patched on 5 Jan 2011. A potential navigation timing error was found, and the system was re-patched on 31 Jan 2011. In May 2011, the POS M/V system was upgraded, and the MBES was repatched.

## C.4 Positioning and Attitude

### C.4.1 Description of Correctors

Applying positioning and attitude data to Raw MBES and VBES data.

### C.4.2 Methods and Procedures

The blended positional solution from the POS/MV is recorded to the "C" drive of the Hypack acquisition computer. This file is merged with the Raw data file in CARIS SIPS using the "Load True Heave" utility.

# C.5 Tides and Water Levels

### C.5.1 Description of Correctors

Sounding 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.

### C.5.2 Methods and Procedures

All tide data were obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) program Fetchtides.py. These data were used to create a CARIS HIPS Tide file (.tid) and were applied to MBES and VBES data within CARIS HIPS. Refer to individual Descriptive Reports for further information regarding water levels specific to each survey.

# C.6 Sound Speed

## C.6.1 Sound Speed Profiles

### C.6.1.1 Description of Correctors

Speed of sound measurements in the water column are used to correct for the effects of salinity, temperature, and conductivity changes within the water column.

### C.6.1.2 Methods and Procedures

CTD casts taken using the SeaBird CTS and are processed using HSTP's VELOCIPY software. The Profile created is then applied to MBES, SSS, and VBES data in CARIS HIPS using the Sound Velocity Corrections utility.

## C.6.2 Surface Sound Speed

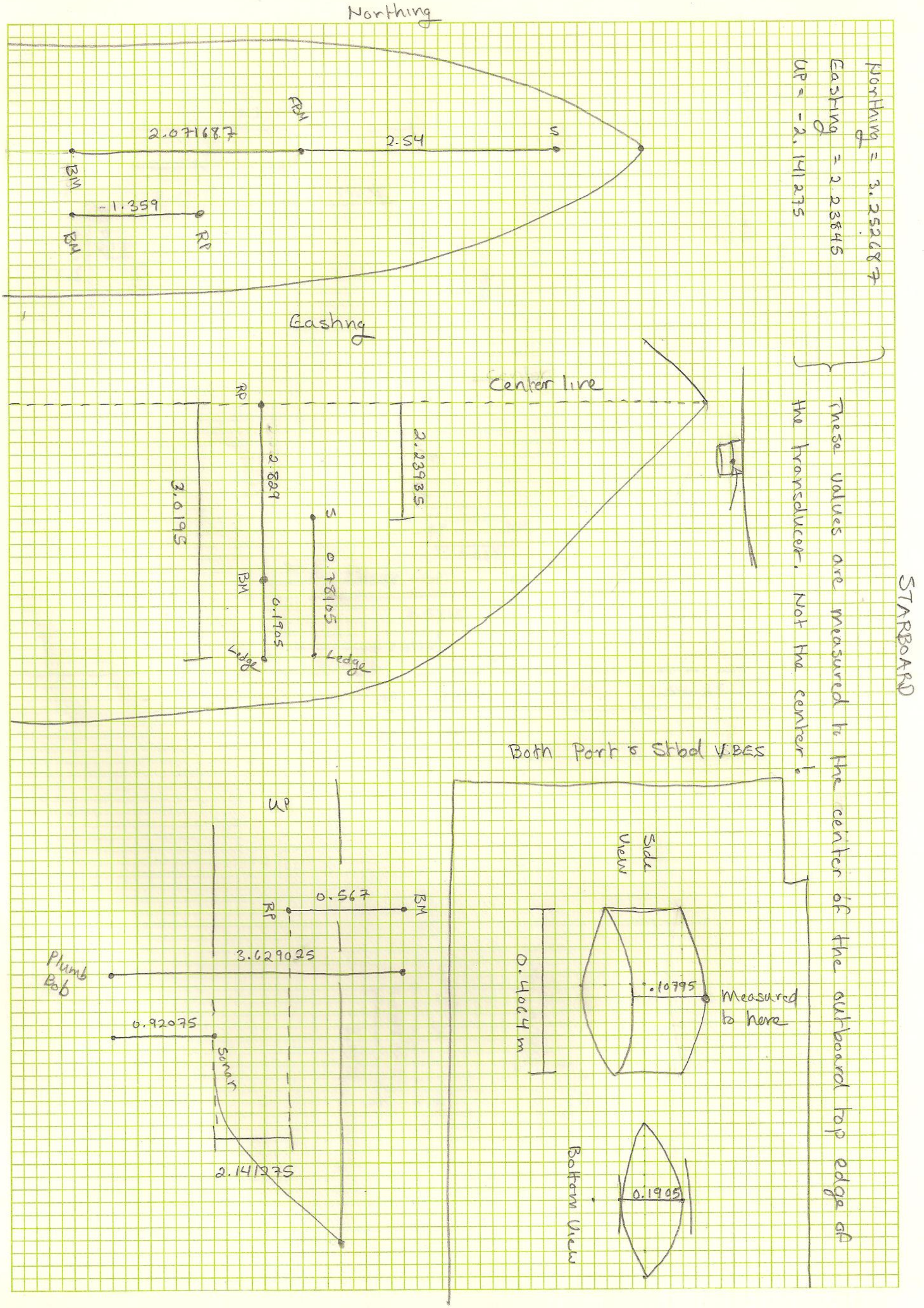
### C.6.2.1 Description of Correctors

Speed of sound measurements at the Reson 7125 transducer face are used by the unit to correctly form it's beams.

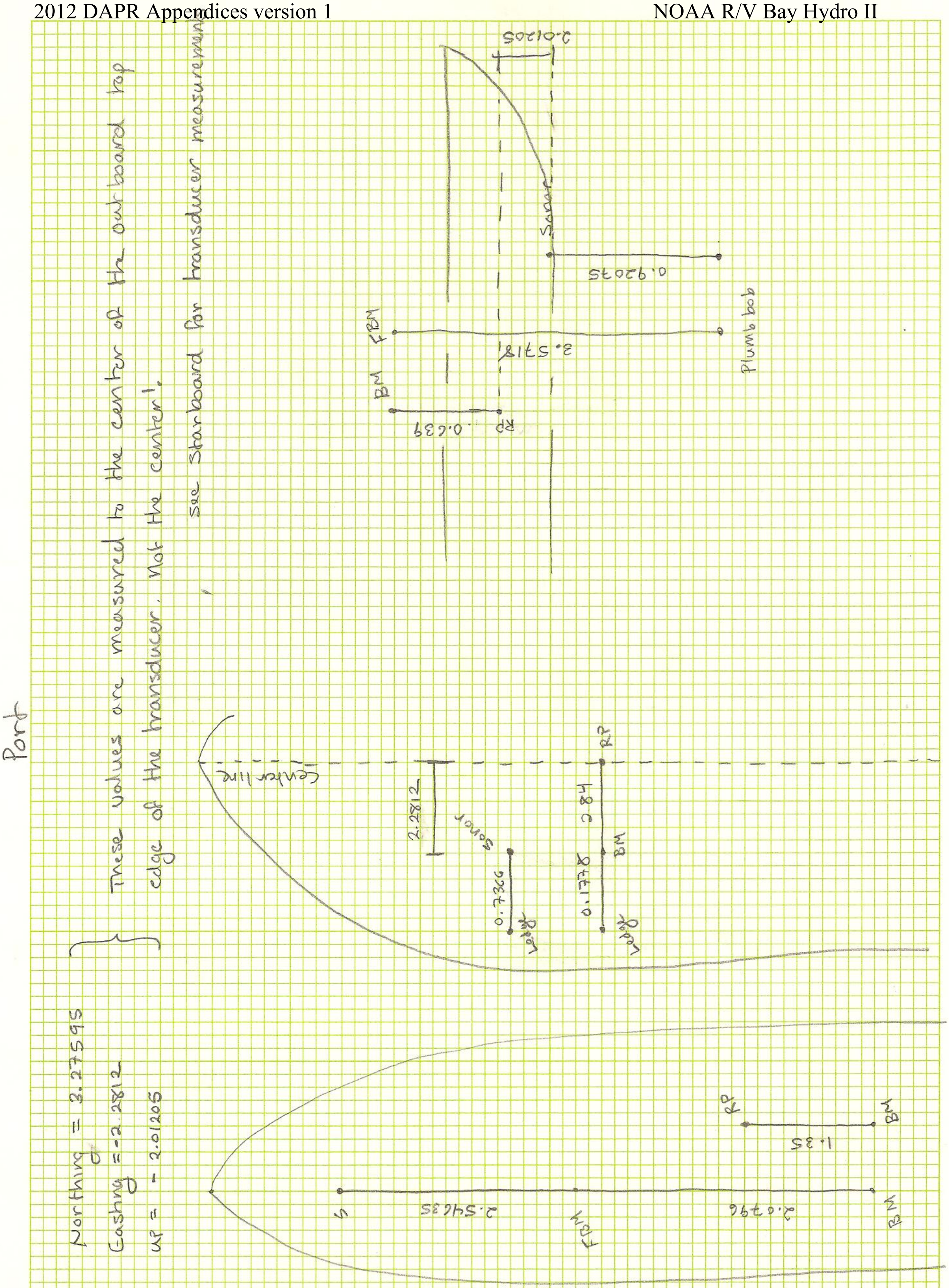
### C.6.2.2 Methods and Procedures

The R/V BAY HYDRO II use the Digibar Pro to acquire speed of sound at the face of the RESON 7125 transducer, and the data is sent real time to the RESON processor unit

# ! LJLJŜyŘƛȄ м
# Vessel Reports



Northing
2.071687
2.54
BM
FBM
S
-1.359
RP
Northing = 3.252687
Easting = 2.23845
UP = -2.141275
These values are measured to the center of the outboard top edge of the transducer. Not the center!
Easting
Center line
RP
2.809
3.0195
2.23935
S
0.78105
BM
0.1905
Ledge
STARBOARD
Both Port & Stbd VBES
UP
Side View
0.567
RP
BM
3.629025
Plumb Bob
0.92075
Sonar
0.4064 m
.10795
Measured to here
2.141275
Bottom View
0.1905


Northing = 3.27595
Easting = -2.2812
UP = -2.01205
These values are measured to the center of the outboard top edge of the transducer. Not the center!
See Starboard for transducer measurements
Port
2.01205
Sonar
0.92075
FBM
BM
3.5718
Plumb bob
RP
0.639
center line
RP
2.2812
Sonar
2.84
BM
0.1778
Ledge
0.7366
Ledge
RP
1.35
BM
S
2.54635
FBM
2.0796
BM
Northing

Method: Begin @ port BM

snap a line from BM, forward to a point that clears the rub rail
this is the 'fake bench mark'

Run a blump bob from FBM to near ground

Run another blumb bob as far fwd as possible, off the same BM to FBM line

on ground: snap a line, level horizontaly, that touches both plumb bobs. This is in the longitudnal plane of the boat

Run a blump bob from sonar to near ground

on ground: snap a line, level horizontaly that touches the sonar blumb bob & crosses the longitudnal line @ 90°. This is in the transverse frame of the boat.

Measure from

BM to FBM horizontaly

FBM to intersect w/ longitudnaly horizontal line

to intersect w/ transversly horizontal line

to intersect w/ sonar blump bob

up to sonar.

# U.S. Department of Commerce
## National Oceanic & Atmospheric Administration
National Ocean Service
National Geodetic Survey
Observation and Analysis Division
Field Operations Branch

NOAA Vessel – Bay Hydro II
Sensor Components Spatial Relationship Survey
Field Report

H. Stewart Kuper Jr.
March 23, 2009

NOAA Vessel – Bay Hydro II
Sensor Components Spatial Relationship Survey

## PURPOSE

The purpose of this survey was to accurately position the Inertial Measuring Unit (IMU), associated components, and sensors on the new NOAA Vessel – Bay Hydro II S5401.

## PROJECT DETAILS

This survey was conducted on March 23, 2009 at the OCEAN MARINE YACHT CENTER in Portsmouth, Virginia while the vessel was in dry dock. The weather was clear - sunny, cold, and windy on the day of the survey. This was an original Sensor Components Spatial Relationship Survey. LT Michael Davidson was consulted regarding points to survey. Recoverable benchmarks were established for future use this survey.

## INSTRUMENTATION

The TOPCON GPT 3002LW Series Total Station (S/N: 4G0533) was used to make all measurements. The instrument used was in excellent adjustment and had been recently cleaned and calibrated in an authorized shop on March 4, 2009.

A SECO 25 mm Mini Prism System with a 30mm offset was used as target sighting and distance measurements.

## SOFTWARE AND DATA COLLECTION

ADL Ver. 2.0.0 was used for data collection

ForeSight DXM Ver. 3.4.0 was used for post processing.

## PERSONNEL

Perky Falconer NOAA/NOS/NGS/Field Operations Branch 757-441-3603

Kevin Jordan NOAA/NOS/NGS/Field Operations Branch 757-441-3603

H. Stewart Kuper Jr. NOAA/NOS/NGS/Field Operations Branch 757-441-6595

# NOAA VESSEL BAY HYDRO II S5401

**Station Coordinates**

| NAME | EASTING | NORTHING | UP | |
|---|---|---|---|---|
| BOW BENCHMARK | -0.600 | 8.629 | 0.538 | |
| STARBOARD SIDE GPS (NOT CORRECTED to phase center) | 1.296 | 5.432 | 3.009 | -0.014 |
| STARBOARD SIDE GPS (corrected to phase center) | 1.296 | 5.432 | 2.995 | |
| PORT SIDE GPS (NOT CORRECTED to phase center) | -1.963 | 5.208 | 3.041 | -0.015 |
| PORT SIDE GPS (corrected to phase center) | -1.963 | 5.208 | 3.026 | |
| CL GPS | -0.351 | 5.277 | 2.942 | |
| MULTIBEAM (NOT CORRECTED to phase center) | 0.008 | -0.758 - 0.459 | -2.401 | +0.059 |
| MULTIBEAM (corrected to phase center of projector) | 0.008 | -1.217 | -2.342 | |
| STARBOARD BENCHMARK | 2.914 | -1.166 | 0.567 | |
| STERN BENCHMARK | 0.422 | -6.518 | -0.074 | |
| PORT BENCHMARK | -2.747 | -1.553 | 0.639 | |
| TOP OF MULTIBEAM STRUT | 0.044 | -0.829 | 0.335 | |
| MULTIBEAM MOUNTING PLATE | 0.046 | -1.451 | -1.942 | |
| IMU | -0.143 | -0.161 | 0.165 | |
| CL IMU PLATE (Reference Point) | 0.000 | 0.000 | 0.000 | |

Note: Units are meters.

Note: The EASTING runs perpendicular to the centerline of the vessel and runs in a positive direction to the right of the CL IMU PLATE, when looking at the CL IMU PLATE from the back of the vessel.

Note: The NORTHING runs along the centerline of the vessel in a positive direction from the CL IMU PLATE forward to the front of the vessel.

Note: The UP component is positive when above the level of the CL IMU PLATE.

Note: GPS antenna measurements were taken at the top center of each antenna and were not corrected to phase center initially. Corrections were measured using a steel metric ruler and additional entries were made depicting the corrected values.

Note: The multibeam measurement was taken in the center of the received transducer. The reference point for the Reson 7125 is 139mm aft of the prjector's forward edge and 26mm above the face of the projector. Corrections were measured using a steel metric ruler and a plumb bob. Additional entries were made depicting the corrected values.

Surveyed by:
NOAA/NOS/National Geodetic Survey/Observation and Analysis Division/Field Operations Branch
Norfolk, Virginia

Survey Date: March 23, 2009
Revised: June 18, 2009

NOTE: STATIONS NOT ROTATED TO ALIGN VESSEL CENTERLINE TO NORTHING AXIS. CORRECTED ON JULY 7, 2009.

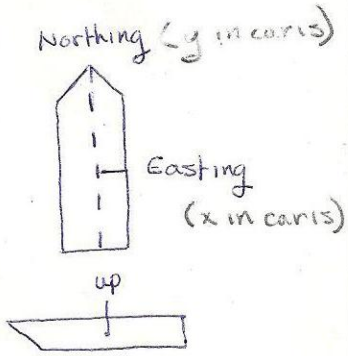
# NOAA VESSEL BAY HYDRO II S5401

**Station Coordinates**

| NAME | EASTING | NORTHING | UP |
|---|---|---|---|
| BOW BENCHMARK | -0.017 | 8.650 | 0.538 |
| STARBOARD SIDE GPS (not corrected to phase center) | 1.659 | 5.333 | 3.009 |
| STARBOARD SIDE GPS (corrected to phase center) | 1.659 | 5.333 | 2.995 |
| PORT SIDE GPS (not corrected to phase center) | -1.607 | 5.329 | 3.041 |
| PORT SIDE GPS (corrected to phase center) | -1.607 | 5.329 | 3.041 |
| CL GPS | 0.005 | 5.289 | 2.942 |
| Multibeam (not corrected to phase center) | -0.043 | -0.758 | -2.401 |
| MULTIBEAM (corrected to phase center of projector) | -0.043 | -1.217 | -2.342 |
| STARBOARD BENCHMARK | 2.829 | -1.359 | 0.567 |
| STERN BENCHMARK | -0.017 | -6.531 | -0.074 |
| PORT BENCHMARK | -2.844 | -1.365 | 0.639 |
| TOP OF MB STRUT | -0.011 | -0.829 | 0.335 |
| MB MOUNTING PLATE | -0.051 | -1.451 | -1.942 |
| IMU | -0.153 | -0.151 | 0.165 |
| CL IMU PLATE (RP) | 0.000 | 0.000 | 0.000 |

used in HVF

Note: Units are meters.




Note: The EASTING runs perpendicular to the centerline of the vessel and runs in a positive direction to the right of the CL IMU PLATE, when looking at the CL IMU PLATE from the back of the vessel.

Note: The NORTHING runs along the centerline of the vessel in a positive direction from the CL IMU PLATE forward to the front of the vessel.

Note: The UP component is positive when above the level of the CL IMU PLATE.

Note: GPS antenna measurements weretaken at the top center of each antenna and were not corrected to phase center initially. Corrections were measured using a steel metric ruler and additional entries were made depicting the corrected values.

Note: The multibeam measurement was taken in the center of the received transducer. The reference point for the Reson 7125 is 139mm aft of the projector's forward edge and 26mm above the face of the projector. Corrections were measured using a steel metric ruler and a plumb bob. Additional entries were made depicting the corrected values.

Surveyed by:
NOAA/NOS/National Geodetic Survey/Observation and Analysis Division/Field Operations Branch
Norfolk, Virginia

Revised: July 7, 2009

NOTE: STATION'S COORDINATES ROTATED TO ALIGN NORTHING AXIS TO VESSEL CENTERLINE.

# NOAA VESSEL BAY HYDRO II S5401

**Station Coordinates**

| NAME | EASTING | NORTHING | UP |
|---|---|---|---|
| BOW BENCHMARK | -0.017 | 8.650 | 0.538 |
| STARBOARD SIDE GPS (not corrected to phase center) | 1.659 | 5.333 | 3.009 |
| STARBOARD SIDE GPS (corrected to phase center) | 1.659 | 5.333 | 2.995 |
| PORT SIDE GPS (not corrected to phase center) | -1.607 | 5.329 | 3.041 |
| PORT SIDE GPS (corrected to phase center) | -1.607 | 5.329 | 3.041 |
| CL GPS | 0.005 | 5.289 | 2.942 |
| Multibeam (not corrected to phase center) | -0.043 | -0.758 | -2.401 |
| MULTIBEAM (corrected to phase center of projector) | -0.043 | -1.217 | -2.342 |
| STARBOARD BENCHMARK | 2.829 | -1.359 | 0.567 |
| STERN BENCHMARK | -0.017 | -6.531 | -0.074 |
| PORT BENCHMARK | -2.844 | -1.365 | 0.639 |
| TOP OF MB STRUT | -0.011 | -0.829 | 0.335 |
| MB MOUNTING PLATE | -0.051 | -1.451 | -1.942 |
| IMU | -0.153 | -0.151 | 0.165 |
| CL IMU PLATE | 0.000 | 0.000 | 0.000 |

Note: Units are meters.

Note: The EASTING runs perpendicular to the centerline of the vessel and runs in a positive direction to the right of the CL IMU PLATE, when looking at the CL IMU PLATE from the back of the vessel.

Note: The NORTHING runs along the centerline of the vessel in a positive direction from the CL IMU PLATE forward to the front of the vessel.

Note: The UP component is positive when above the level of the CL IMU PLATE.

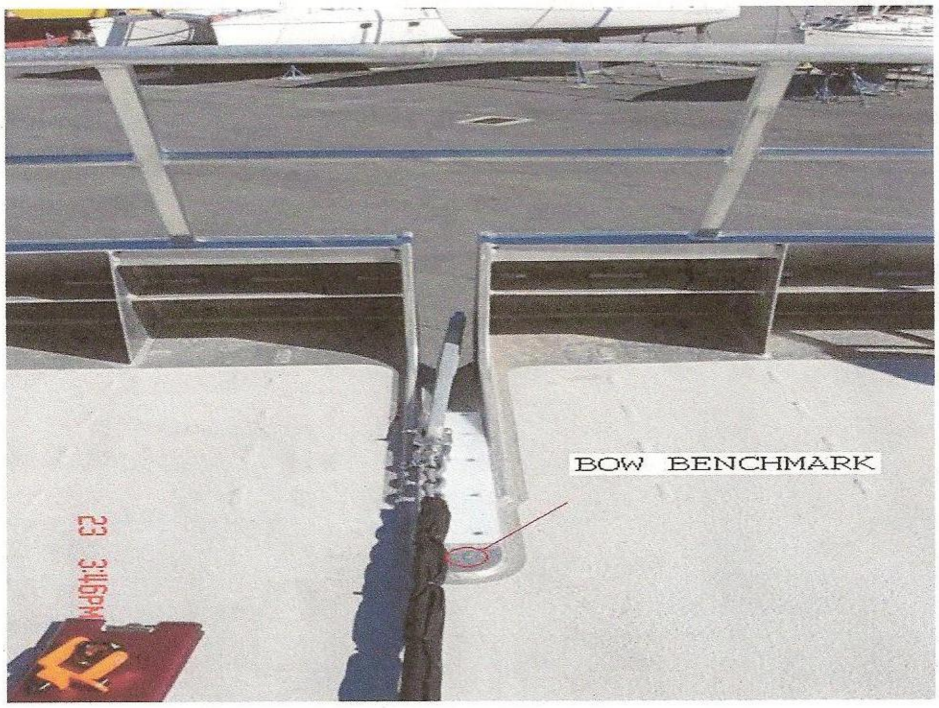
Note: GPS antenna measurements weretaken at the top center of each antenna and were not corrected to phase center initially. Corrections were measured using a steel metric ruler and additional entries were made depicting the corrected values.

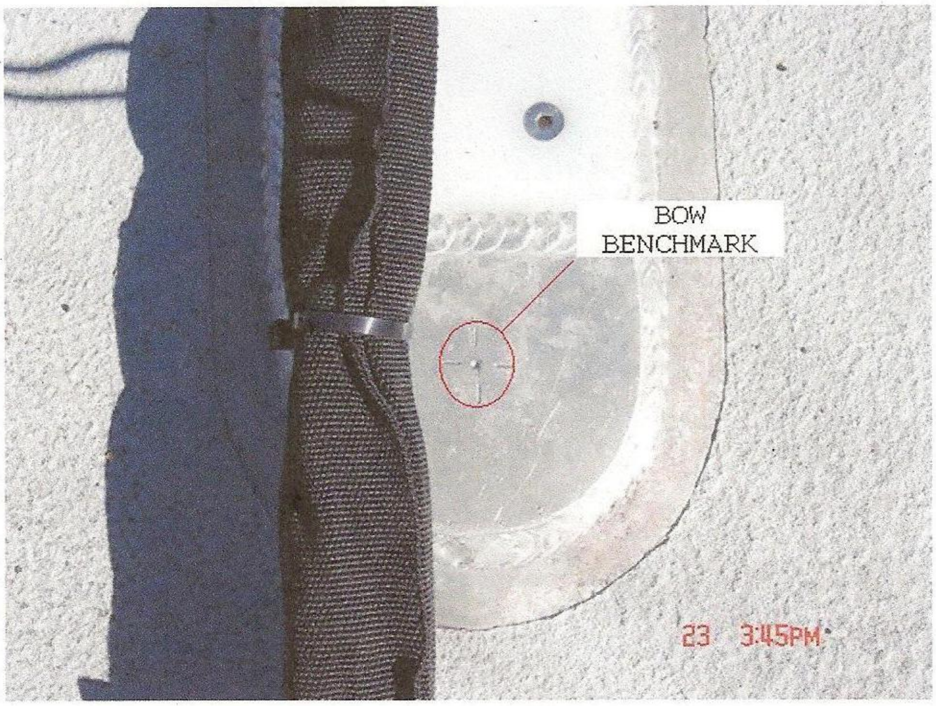
Note: The multibeam measurement was taken in the center of the received transducer. The reference point for the Reson 7125 is 139mm aft of the projector's forward edge and 26mm above the face of the projector. Corrections were measured using a steel metric ruler and a plumb bob. Additional entries were made depicting the corrected values.

Surveyed by:
NOAA/NOS/National Geodetic Survey/Observation and Analysis Division/Field Operations Branch
Norfolk, Virginia

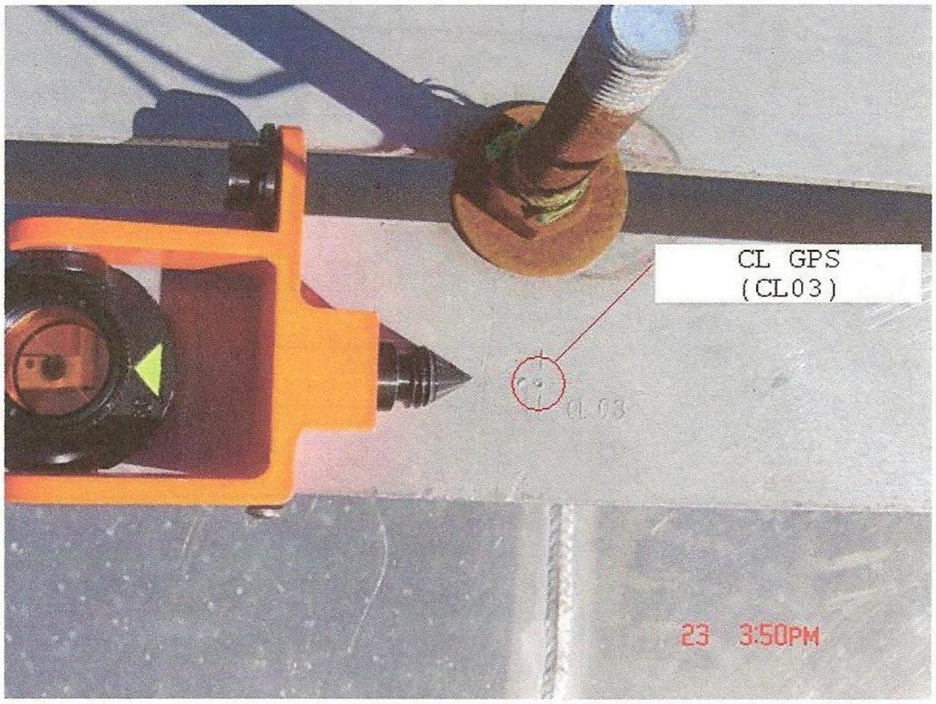
Revised: July 7, 2009

PHOTOGRAPHS

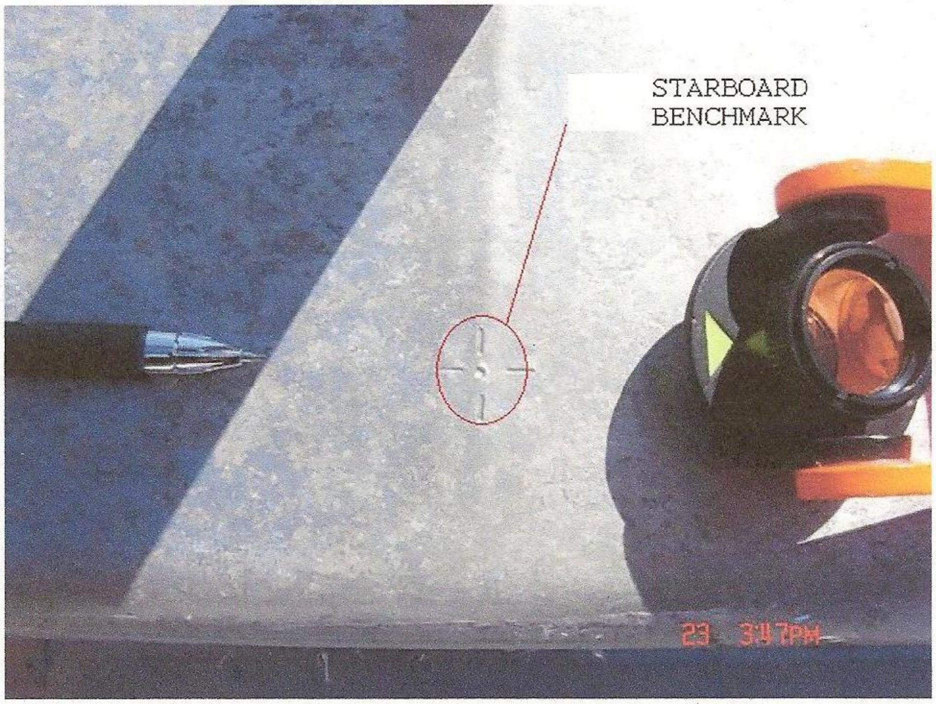



NOAA Bay Hydro II Sensor Survey


NOAA Bay Hydro II Sensor Survey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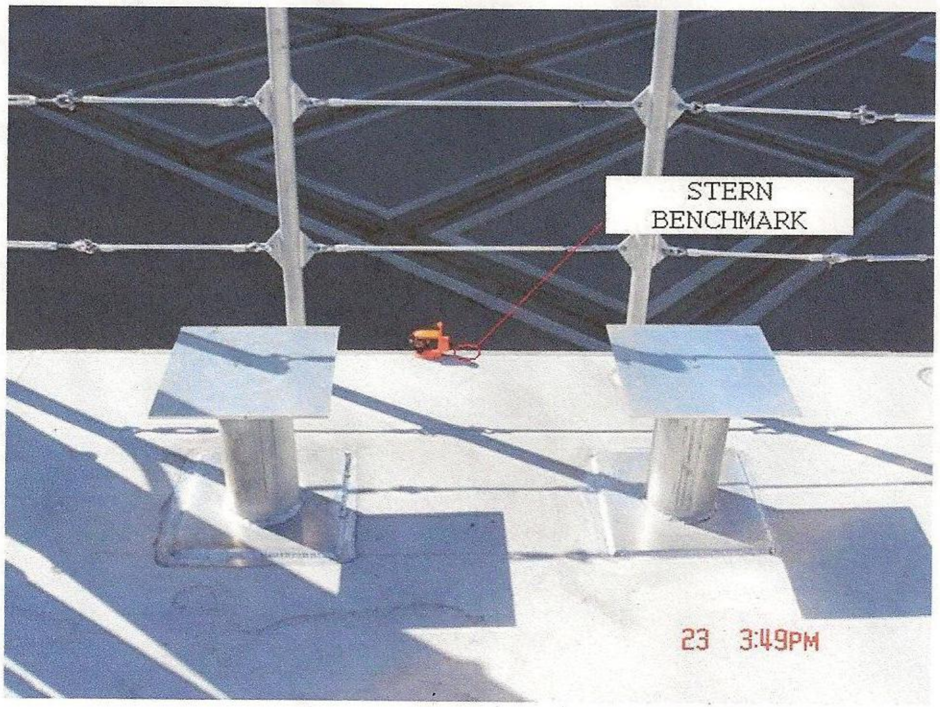
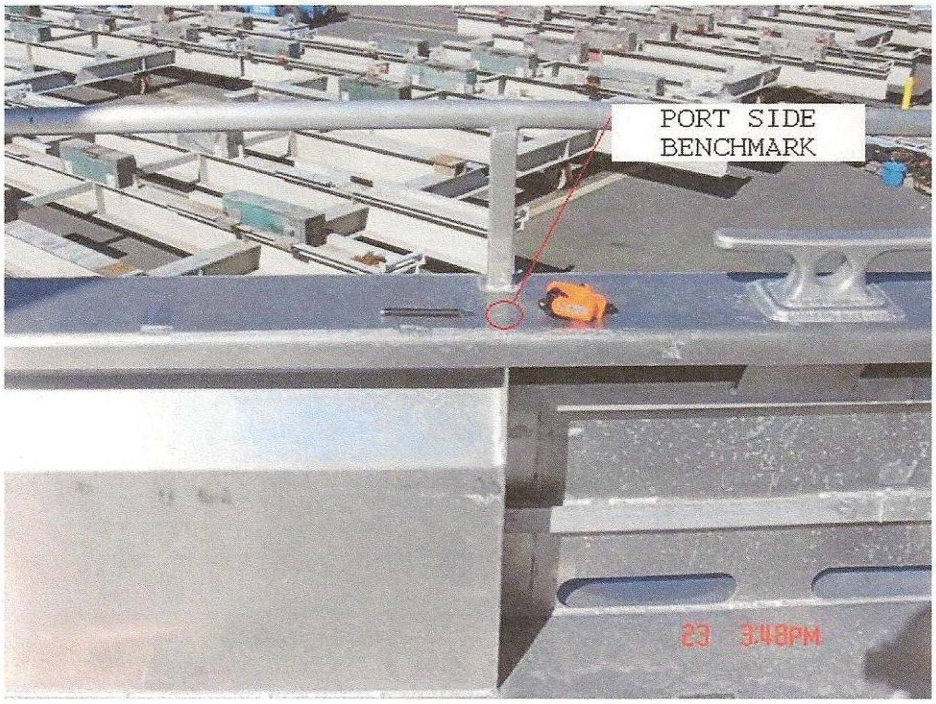
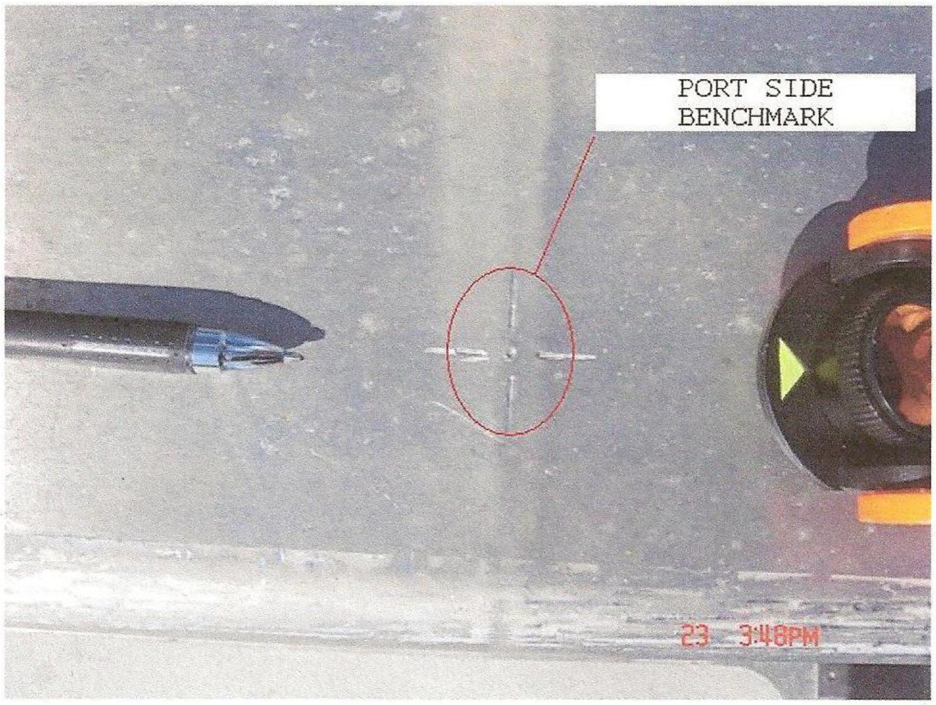


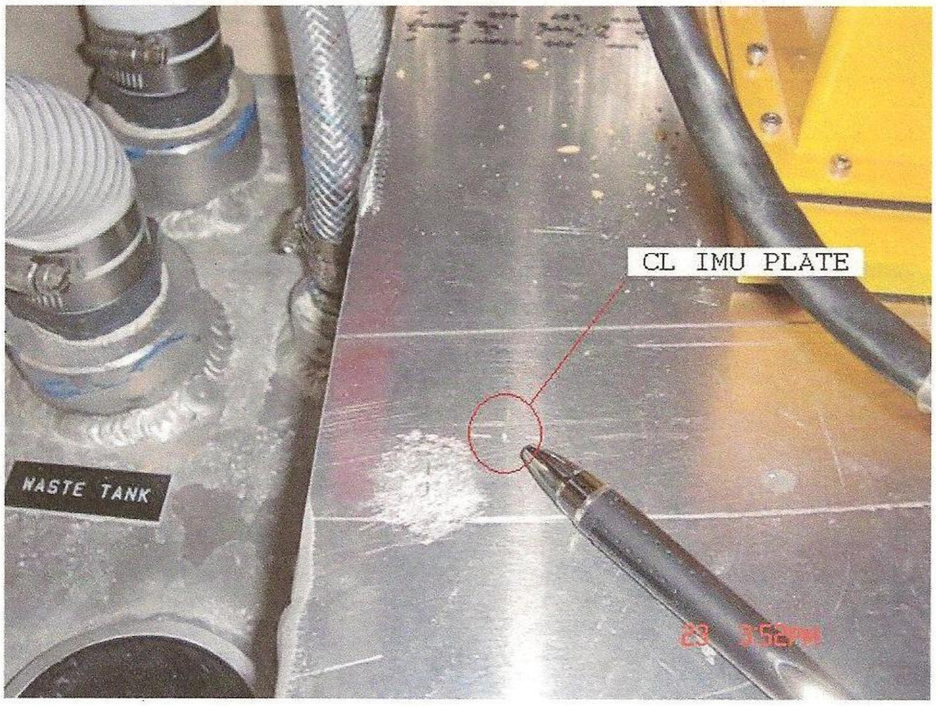


NOAA Bay Hydro II Sensor Survey

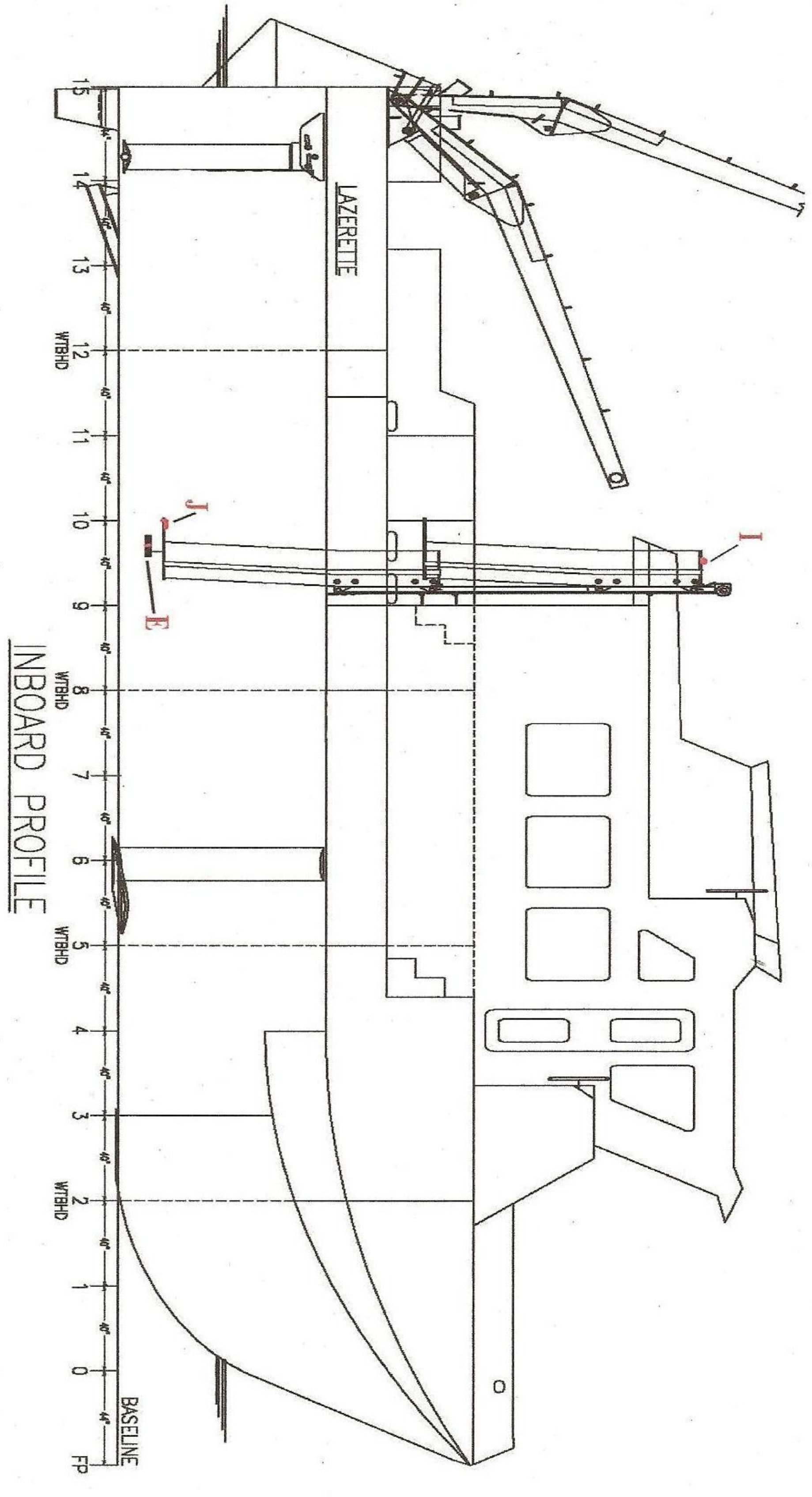



NOAA Bay Hydro II Sensor Survey


NOAA Bay Hydro II Sensor Survey


INBOARD PROFILE
LAZERETTE
WTBHD
BASELINE
FP
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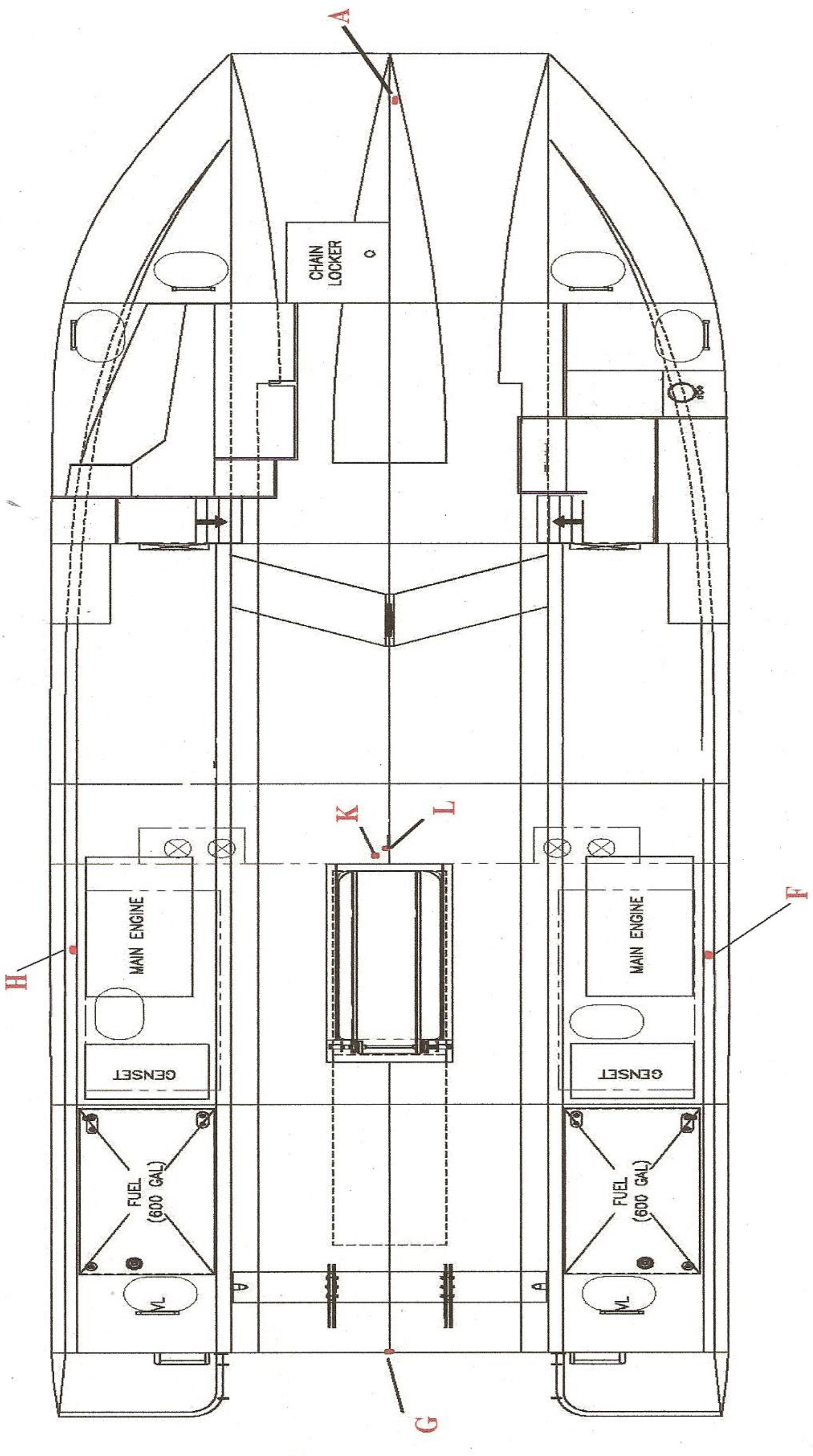
A
CHAIN LOCKER
K
L
F
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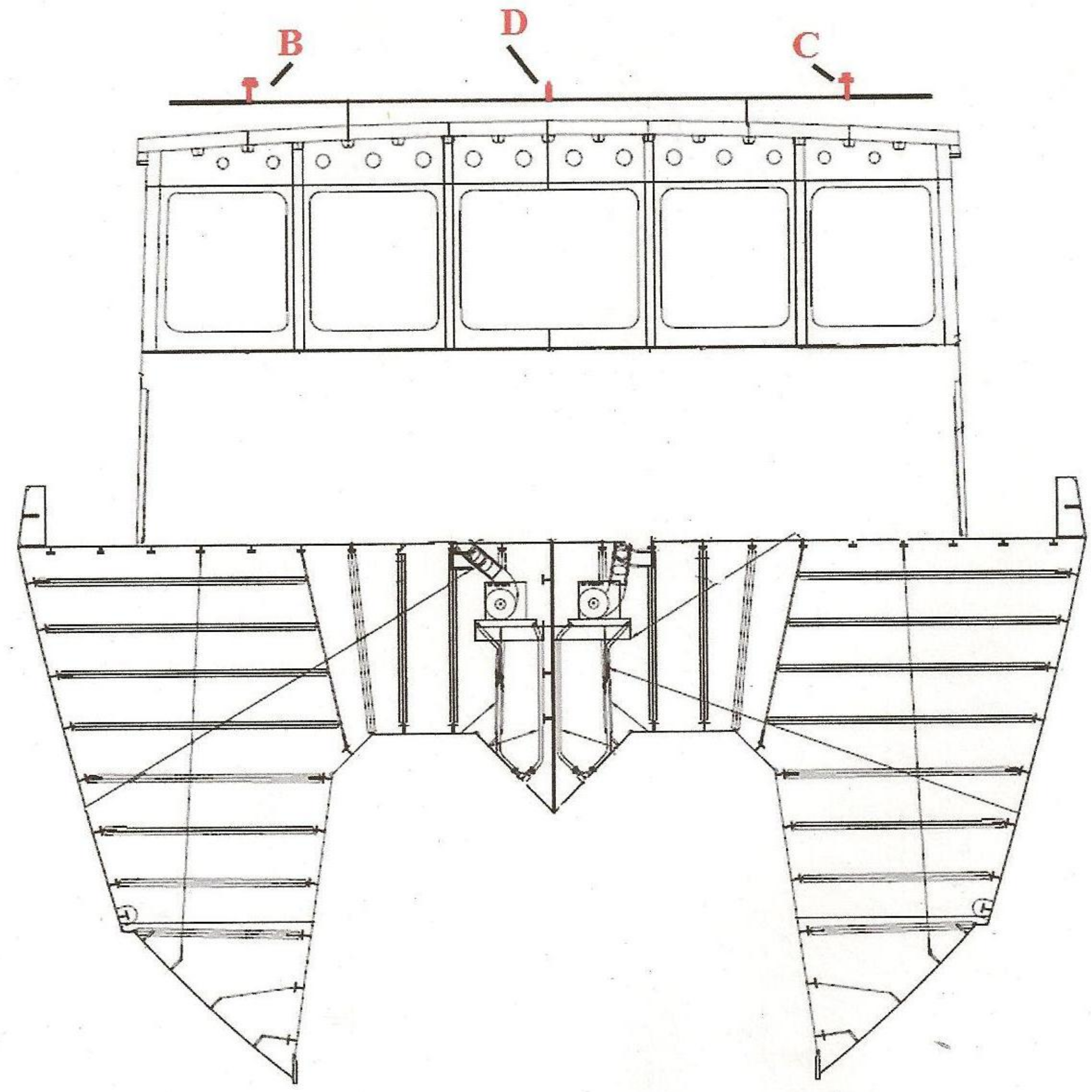
MAIN ENGINE
MAIN ENGINE
GENSET
GENSET
FUEL (600 GAL)
FUEL (600 GAL)
G


B
D
C

# ! ǈǈŜyŘƛȅ н
# Echosounder Reports

***R/V Bay Hydro II (S5401)***
**Lead-Line Calibration 2012**
LT Megan R. Guberski, Robert Mowery, Nicole Trenholm
Performed: 26 Jan 2012 (Julian Day 026)

## INTRODUCTION

In lieu of a traditional lead-line or a sounding pole, the R/V BAY HYDRO II is equipped with a non-traditional lead-line fabricated from Amsteel® brand line. This line is attached to a 7 inch tall mushroom anchor via a thimble and shackle. The Amsteel is marked in one meter graduations, with measurements beginning at the bottom of the anchor.

This lead line was fabricated on 16 June 2009. Amsteel line was chosen for its resistance to stretching under force (rated at ten percent at ten thousand pounds of applied force).

## PROCEDURE

The anchor was secured tight against a pile, and tag end of the lead line was secured to an inline scale, and pulled until 8lbs of pressure was observed. The scale was then tied off to another pile, and the graduations were measured using a steel measuring tape with millimeter gradations. All measurements began at the bottom of the anchor.

| Graduated Markings in Meters (A) | True measure (cm) | True measurement (M) (B) | Lead Line Corrector (C=B-A) |
|---|---|---|---|
| 1.0 | 97.7 | 0.977 | -0.023 |
| 2.0 | 202.5 | 2.025 | 0.025 |
| 3.0 | 301.5 | 3.015 | 0.015 |
| 4.0 | 400.3 | 4.003 | 0.003 |
| 5.0 | 499.3 | 4.993 | -0.007 |
| 6.0 | 603.7 | 6.037 | 0.037 |
| 7.0 | 703.7 | 7.037 | 0.037 |
| 8.0 | 804.2 | 8.042 | 0.042 |
| 9.0 | 904.5 | 9.045 | 0.045 |
| 10.0 | 1004.5 | 10.045 | 0.045 |
| 11.0 | 1104.5 | 11.045 | 0.045 |
| 12.0 | 1204.8 | 12.048 | 0.048 |

**Table I: True measurements compared to marked graduations of the non-traditional lead line.**

## RESULTS

The largest discrepancy was found to be 4.8cm (0.048M), with the average discrepancy being 3.325cm (0.03325M). This discrepancy is likely due to the fact that the initial measuring instrument that was used during lead line creation was a steel measuring tape in standard graduations and this calibration was conducted using a PVC measuring tape in metric graduations. The use of the metric measuring tape proved to be more accurate considering that there are more graduated markings provided than on a standard measuring tape. One other possible source of error is in the design of the lead line. The lead line's graduations are brightly colored PVC marking tape that are woven into the Amstel® line itself, at one meter increments. This woven PVC marker can, over time, slide on the line, changing its position.

The lead-line's individual and cumulative error remains below the accepted 10cm error budget stated in the Field Procedures Manual, section 1.5.3.1.1 (2011 ed).

**_R/V Bay Hydro II_ (S5401)**
**Lead Line to Vertical Beam Echo Sounder**
**Comparison 2012**

Robert Mowery, Nicole Trenholm

Performed: 26 January 2012 (Julian Day 026)

**Background:**

The R/V Bay Hydro II is equipped with an ODOM Echotrack CV vertical beam echosounder (VBES). On 26 January comparisons were made between depths found by the ODOM, and a leadline. The leadline had been calibrated previous to the VBES comparison.

**Method:**

The test was conducted while the vessel was tied portside to a floating pier. A calibrated lead line was deployed over the starboard side, as close to the VBES transducer as possible.* A total of three leadline measurements were recorded to the edge of the deck, with the weight being resettled between each reading (column A). The leadline readings were then corrected back to the draft of the sonar using the known distance between the deck edge, and the transducer face (columns B & C).

Simultaneous to the leadline measurements, three VBES readings were recorded, using the Hi Frequency channel (column D). High frequency was chosen to ensure the sonar was reading the true bottom, instead of a sub-bottom return. The VBES depths were then corrected for sound velocity. The difference between the corrected leadline soundings, and the VBES was then calculated and recorded.

*Due to the placement of the VBES, the leadline was deployed in the same transverse frame as the sonar, but 0.8m further outboard.

| Trial Number | Lead-Line Raw Depth (Meters) (A) | Deck Edge to Sonar (Meters) (B) | Corrected Lead-Line Depth (Meters) (A-B) = (C) | VEBS Raw Depth (Meters) (D) | Velocity Corrected Depth VBES (Raw Depth / 1446/1500) (E) | VBES Instrument Error (A-E) |
|---|---|---|---|---|---|---|
| 1 | 5.71 | 1.97 | 3.75 | 2.94 | 3.05 | -0.04 |
| 2 | 5.71 | 1.97 | 3.75 | 2.94 | 3.05 | -0.04 |
| 3 | 5.70 | 1.97 | 3.74 | 2.96 | 3.07 | -0.07 |

**Table I: Physical and digital measurements from single beam echosounder calibration with all correctors accounted for.**

**RESULTS**

The measured differences between the VBES and lead line ranged from -0.04 to -0.07 meters. While the difference is labeled VBES Instrument Error, it is difficult to determine whether this difference is solely due to the VBES, or also stems from inaccuracies in the leadline measurement or the errors in the measured offset between the deck edge and the VBES transducer.

**_R/V Bay Hydro II_ (S5401)**
**Vertical Beam Echosounder to Multibeam Echosounder Comparison 2012**
LTjg Megan Guberski, Robert Mowery, Nicole Trenholm
Performed: 4 January 2012 (Julian Day 004)

## Background

This comparison was performed in order to determine the difference between the *R/V Bay Hydro II's* Odom Echotrak CV200 Vertical Beam Echosounder (VBES), and the RESON SeaBat 7125 Multibeam Echosounder (MBES). The test was conducted while the vessel was tied to a floating pier.

## Procedure

Both the VBES and the MBES were energized, and 3 lines of data were recorded per sonar, using HYPACK Hysweep. All 6 lines were then converted using CARIS HIPS & SIPS 7.1, where tide and SVP correctors were applied.

After correctors were applied, the sounding data was imputed into excel for analysis. The VBES data was sorted by line, and the average depth found for each line. The MBES data was parsed to find the nadir beam of each ping (beam #128), and the average nadir depth of each line was calculated. The difference between VBES average depth and MBES average nadir depth was then found for each line

| Line Number | MBES average nadir depth (m) | VBES average depth (m) | Difference (m) |
|---|---|---|---|
| 000_1600 | 3.601 | 3.688 | 0.067 |
| 000_1601 | 3.602 | 3.638 | 0.036 |
| 000_1602 | 3.586 | 3.649 | 0.063 |

**Table 1: VBES and MBES Difference**

## Results

It was found that the VBES returned depths generally greater than the MBES. However the difference between MBES and VBES depths remains well below the 10cm error budget.

**_R/V Bay Hydro II_ (S5401)**
**Dynamic Draft Determination 2011**
LTjg Megan R. Guberski, Robert Mowery, Nicole Trenholm
Performed: 6 October 2011 (Julian Day 279)

## Background:

The Echosounder method was used to determine the dynamic draft for the *R/V Bay Hydro II* for the 2012 field season. The Echosounder method is described in the FPM section 1.4.2.1.2.1 and is adapted from a traditional practice whereby successive lines were run over a flat bottom at different speeds and the change in measured depth is recorded.

## Method:

Data was acquired on 6 October 2011 (Julian Day 279) by Robert Mowery. The test was conducted off Solomon Island, in the Patuxent River.

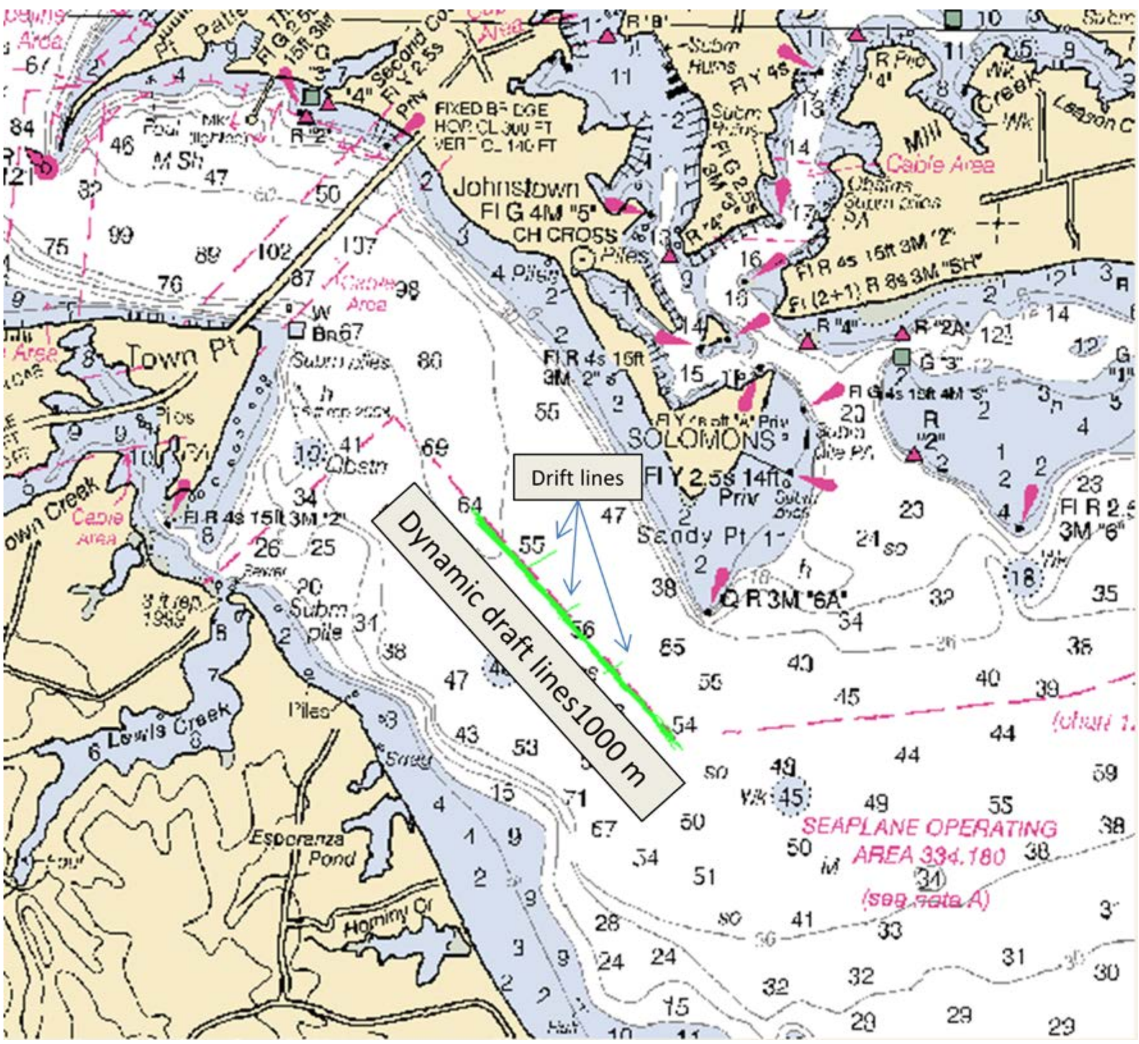



Figure 1: location of dynamic draft (chart 12264)

**Process:**

A total of sixteen,1000m long lines were run in opposite directions for each of 8 different RPM's on the vessel's main engines. The initial two lines were run using a single engine, in order to maintain the slowest speed possible. The remaining 14 lines were run using both engines. The evolution was completed by acquiring 3 drift lines, run orthogonal to the azimuth of the main lines. The relative engine RPMs, speed and directions are listed on table 1.

| Line | RPM | Speed (m/s) | Heading |
|---|---|---|---|
| 017_1251 | 550 (one engine) | 2.1 | 319 |
| 017_1306 | 550 (one engine) | 1.7 | 138 |
| 017_1322 | 550 | 2.8 | 319 |
| 017_1333 | 550 | 2.3 | 138 |
| 017_1345 | 650 | 3.2 | 319 |
| 017_1357 | 650 | 2.8 | 138 |
| 017_1408 | 750 | 3.7 | 319 |
| 017_1416 | 750 | 3.3 | 138 |
| 017_1425 | 850 | 4.0 | 319 |
| 017_1433 | 850 | 3.6 | 138 |
| 017_1441 | 950 | 4.2 | 319 |
| 017_1449 | 950 | 3.8 | 138 |
| 017_1457 | 1050 | 4.5 | 319 |
| 017_1504 | 1050 | 4.2 | 138 |
| 006_1527 | 1150 | 4.9 | 319 |
| 006_1534 | 1150 | 5.1 | 138 |
| 006_1545 | Drift Line | | |
| 006_1553 | Drift Line | | |
| 006_1549 | Drift Line | | |

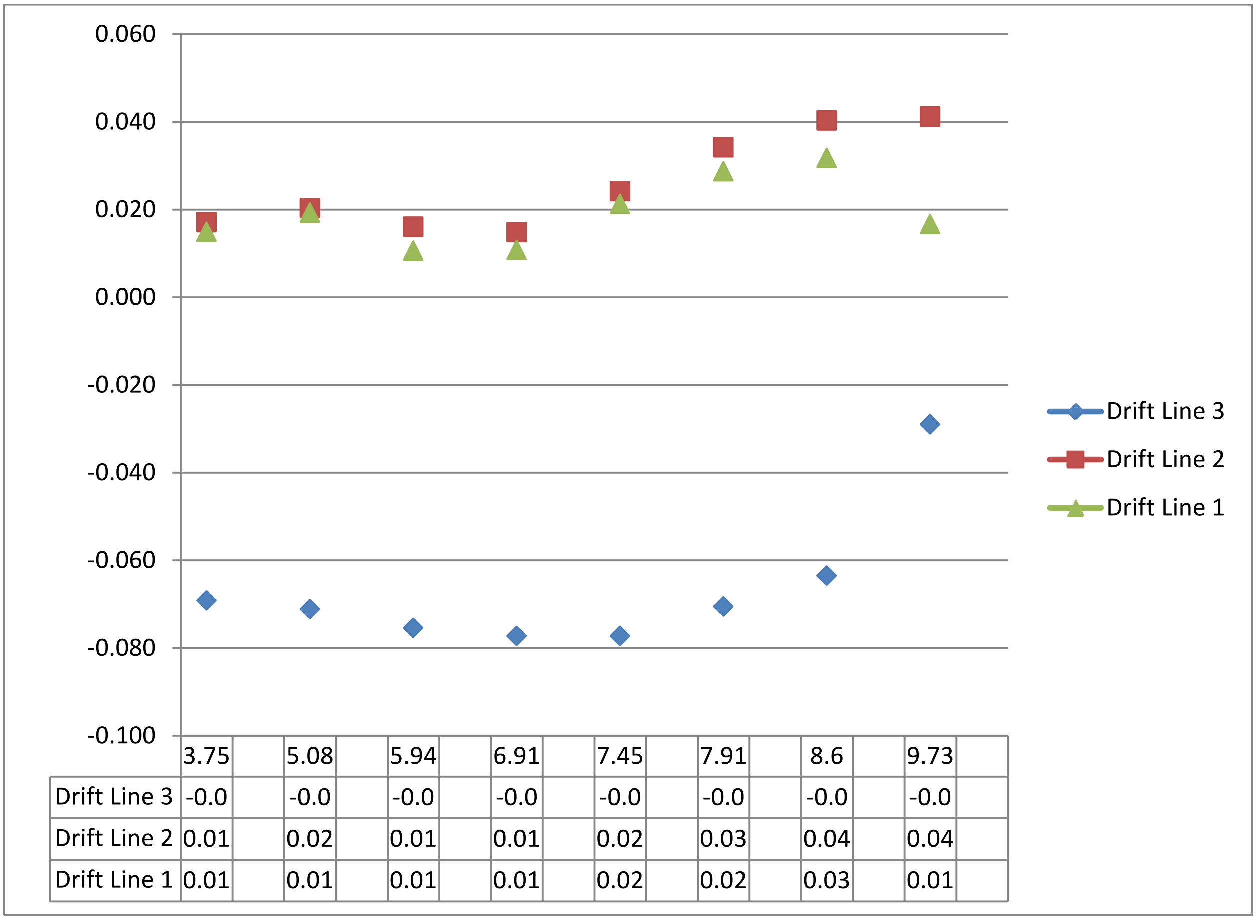
Table 1. characteristics of each line run

All Multibeam data was processed using CARIS HIPS and SIPS 7.0. The data was then analyzed using the following method

- At each intersection between drift line and main line a 20m x 20m subset was defined
- All the soundings inside the subset were queried for depth
- he average depth was calculated for each set lines run at the same RPMs lines run at the same RPM were calculated at each of the 3 drift line reference areas.
- The median depth of each drift line was calculated

- The Δdraft at for each line couplet, at each reference region, was calculated by subtracting the lines median depth from the median drift depth.

Chart 1 shows the resulting changes in draft at each of the reference regions.




| | 3.75 | 5.08 | 5.94 | 6.91 | 7.45 | 7.91 | 8.6 | 9.73 |
|---|---|---|---|---|---|---|---|---|
| Drift Line 3 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 |
| Drift Line 2 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.03 | 0.04 | 0.04 |
| Drift Line 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.01 |

Chart 1. Draft relative to vessel speed at 3 reference areas

**Results:**

The change in draft at each of the reference areas generally follow the same curve, with variation around 10 knots. Drift Line 3 has been disregarded as an outlier. The vessel's HFV was updated using values from Drift Line 2.

***R/V Bay Hydro II* (S5401)**
**HSRR Patch Test 2012**
LTjg Megan Guberski, ERT Nicole Trenholm, SS Douglas Wood
Performed: 6 October 2011 (DN 279)

**Background:**

This test was conducted to resolve the residual biases between the RESON 7125 receiver unit, and the Applanix POS M/V reference frame. The test was performed in the Patuxent River, south of Solomon Island, using an charted wreck. The bow of the wreck is conspicuous in MBES data, and was used as the patch point

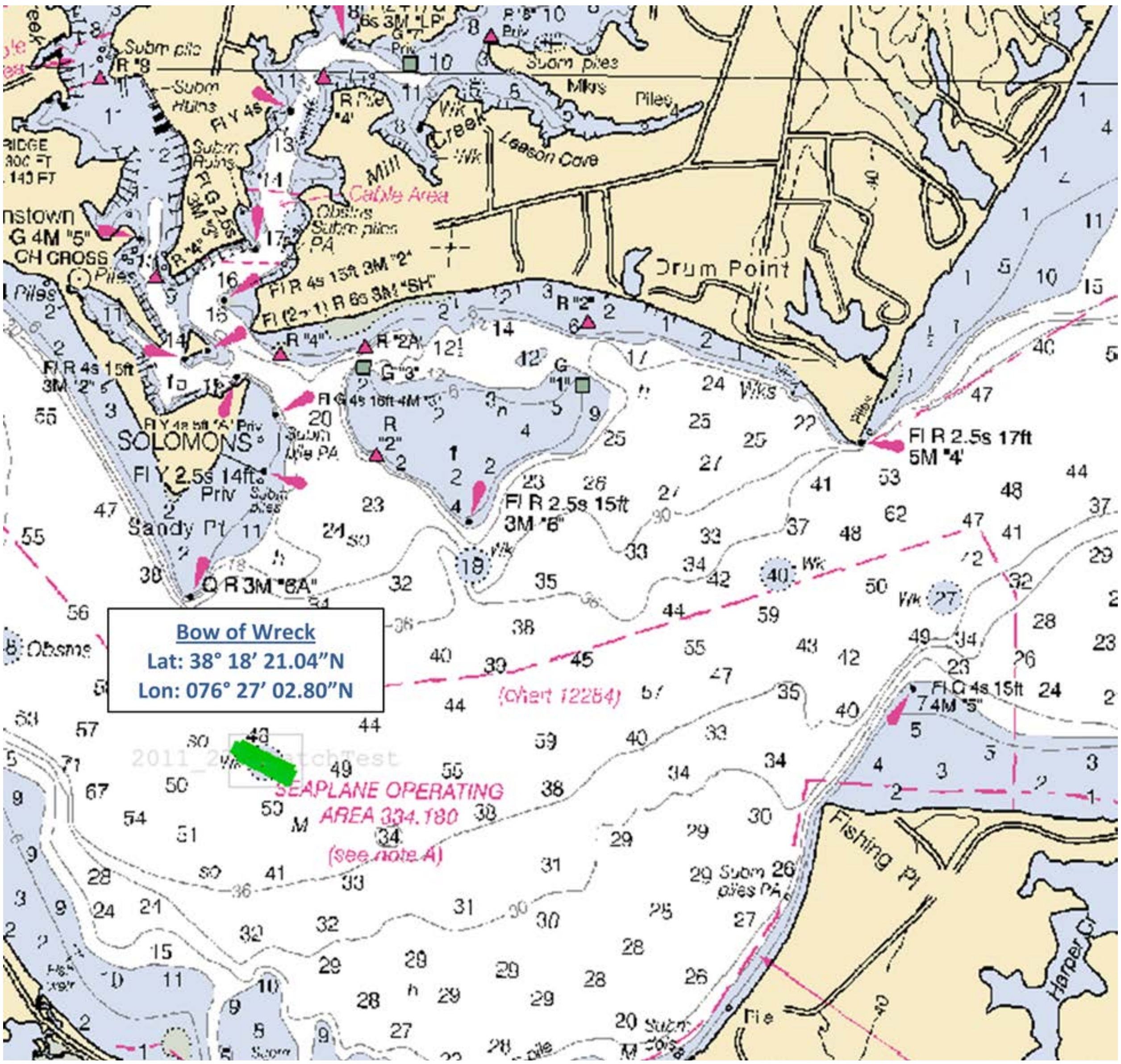


**Figure 1: Patch Test Area, and Fieldsheet**

**PROCEDURE**
The patch test was conducted using a series of six lines: two for Navigation timing, two to resolve Pitch and Roll, and two for Yaw.

The navigation lines were run directly over the object. Heading remained constant, while speed was varied. The Pitch and Roll lines were also run directly over the object. Heading between lines was reciprocal, while the speed was held constant. The Yaw lines had constant heading and speed, but were offset in order to place the object in the outer beams. Refer to Table 1 and Figure 2.

| Line Number | Azimuth | Speed | Purpose |
|---|---|---|---|
| 010_1622 | SE | 3.5 k | Navigation Timing |
| 010_1627 | NW | 8.2 k | Pitch, Roll |
| 010_1630 | SE | 7.9 k | Navigation Timing, Pitch, Roll |
| 011_1634 | NW | 7.4 | Yaw |
| 012_1642 | NW | 7.0 | Yaw |

**Table 1: Patch Test Lines**

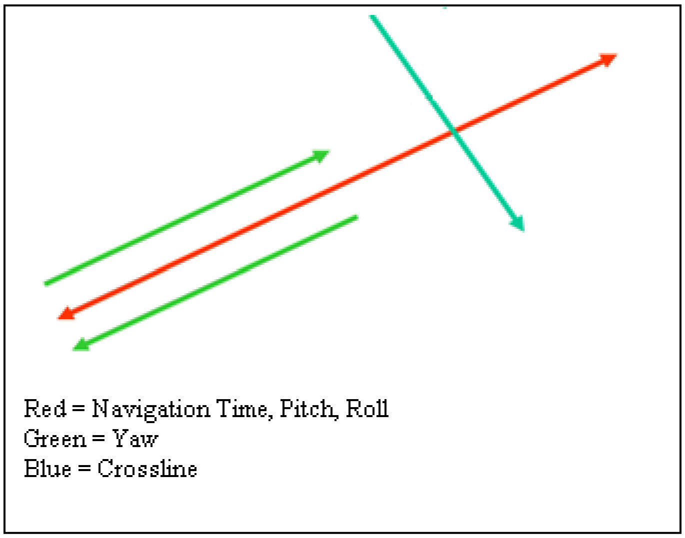



**Figure 2: Patch Test Line Plan**

After acquisition, the data was processed using CARIS HIPS & SIPS. Position was resolved using PosPAC. Biases were then resolved by two evaluators. Table 2 shows the individual bias resolutions.

| 2011-279 | | Nav Time | Pitch | Roll | Yaw |
|---|---|---|---|---|---|
| NMT | BHII_S5401_RESON7125_2011_PatchTest_DN279_NMT | 0.00 | -1.00 | 0.19 | 1.80 |
| RWM | BHII_S5401_RESON7125_2011_PatchTest_DN279_RWM | 0.00 | -1.20 | 0.21 | 1.75 |
| MRG | BHII_S5401_RESON7125_2011_PatchTest_DN279_MRG | 0.00 | -1.50 | 0.15 | 1.50 |
| Average | | 0.00 | -1.23 | 0.18 | 1.68 |
| STDDEV | | 0.00 | 0.25 | 0.03 | 0.16 |

# ! ǇǇŜyŘƋȅ п
# Sound Speed Sensor Report

Extract POS COnfig Version 1.0


April 11 2012 02:15 pm

Message 21 - GAMS Installation Parameters

Two Antenna Separation 3.263
Baseline Vector -0.005 3.263 0.006
Heading Calibration Threshold 0.500
Heading Correction 0.000

**SEA-BIRD ELECTRONICS, INC.**
**13431 NE 20th St. Bellevue, Washington 98005 USA**
**Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com**

# Pressure Test Certificate

| | |
|---|---|
| Customer | NOAA - NRT-1 |
| Job Number | 67482 |
| Date | 1/9/2012 |
| Technician | JK |
| Serial Number | 19P37217-4677 |

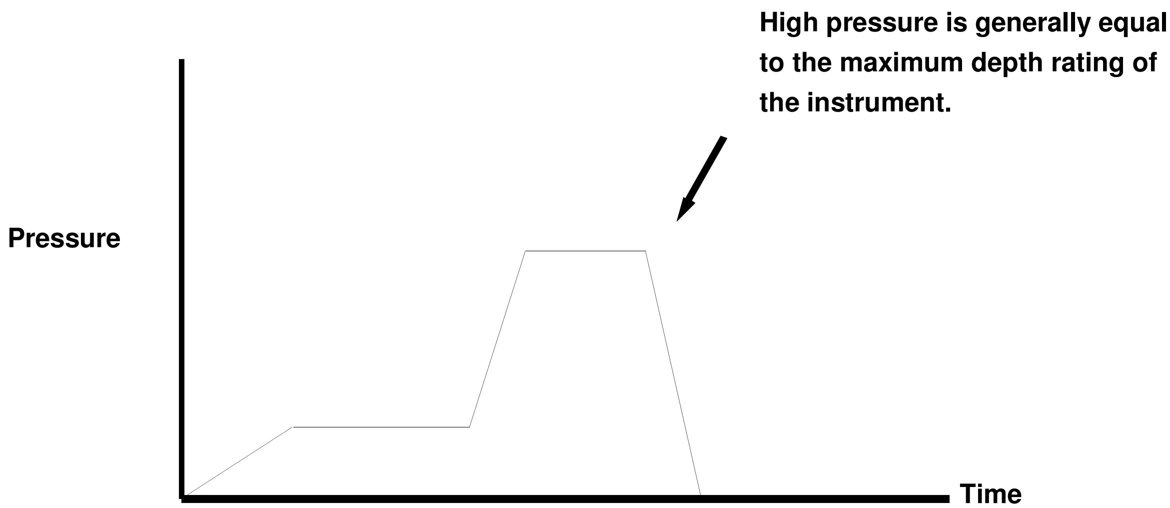
| | | |
|---|---|---|
| Low Pressure (PSI) | 50 | PSI |
| Time (Minutes) | 15 | Minutes |
| High Pressure (PSI) | 500 | PSI |
| Time (Minutes) | 30 | Minutes |

Pass ☑

Fail ☐

Comments

Replaced the main piston "O"-Rings.




Typical Test Profile

**Date:**
Jan 27, 2012

**Serial #:**
98445-012712

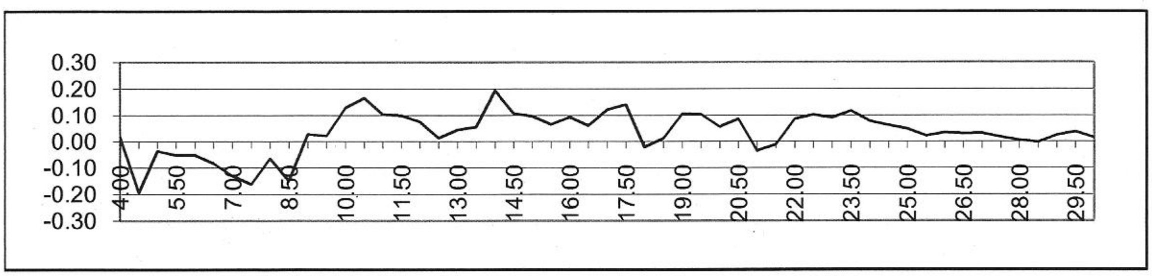
# DIGIBAR CALIBRATION REPORT

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 | 5557.00 | 1421.64 | 0.02 |
| 4.50 | 1423.90 | 5564.85 | 1423.71 | -0.19 |
| 5.00 | 1426.15 | 5574.00 | 1426.12 | -0.04 |
| 5.50 | 1428.38 | 5582.39 | 1428.33 | -0.05 |
| 6.00 | 1430.58 | 5590.74 | 1430.53 | -0.05 |
| 6.50 | 1432.75 | 5598.87 | 1432.67 | -0.08 |
| 7.00 | 1434.90 | 5606.84 | 1434.77 | -0.13 |
| 7.50 | 1437.02 | 5614.77 | 1436.86 | -0.16 |
| 8.00 | 1439.12 | 5623.10 | 1439.05 | -0.06 |
| 8.50 | 1441.19 | 5630.64 | 1441.04 | -0.15 |
| 9.00 | 1443.23 | 5639.08 | 1443.26 | 0.03 |
| 9.50 | 1445.25 | 5646.73 | 1445.28 | 0.02 |
| 10.00 | 1447.25 | 5654.71 | 1447.38 | 0.13 |
| 10.50 | 1449.22 | 5662.34 | 1449.39 | 0.17 |
| 11.00 | 1451.17 | 5669.49 | 1451.27 | 0.10 |
| 11.50 | 1453.09 | 5676.78 | 1453.19 | 0.10 |
| 12.00 | 1454.99 | 5683.90 | 1455.07 | 0.08 |
| 12.50 | 1456.87 | 5690.79 | 1456.89 | 0.01 |
| 13.00 | 1458.72 | 5697.94 | 1458.77 | 0.05 |
| 13.50 | 1460.55 | 5704.93 | 1460.61 | 0.06 |
| 14.00 | 1462.36 | 5712.31 | 1462.56 | 0.19 |
| 14.50 | 1464.14 | 5718.75 | 1464.25 | 0.11 |
| 15.00 | 1465.91 | 5725.40 | 1466.00 | 0.10 |
| 15.50 | 1467.65 | 5731.88 | 1467.71 | 0.07 |
| 16.00 | 1469.36 | 5738.50 | 1469.46 | 0.09 |
| 16.50 | 1471.06 | 5744.81 | 1471.12 | 0.06 |
| 17.00 | 1472.73 | 5751.39 | 1472.85 | 0.12 |
| 17.50 | 1474.38 | 5757.73 | 1474.52 | 0.14 |
| 18.00 | 1476.01 | 5763.30 | 1475.99 | -0.02 |
| 18.50 | 1477.62 | 5769.53 | 1477.63 | 0.01 |
| 19.00 | 1479.21 | 5775.91 | 1479.31 | 0.11 |
| 19.50 | 1480.77 | 5781.85 | 1480.88 | 0.11 |
| 20.00 | 1482.32 | 5787.53 | 1482.37 | 0.06 |
| 20.50 | 1483.84 | 5793.43 | 1483.93 | 0.09 |
| 21.00 | 1485.35 | 5798.68 | 1485.31 | -0.03 |
| 21.50 | 1486.83 | 5804.40 | 1486.82 | -0.01 |
| 22.00 | 1488.29 | 5810.33 | 1488.38 | 0.09 |
| 22.50 | 1489.74 | 5815.87 | 1489.84 | 0.10 |
| 23.00 | 1491.16 | 5821.23 | 1491.25 | 0.09 |
| 23.50 | 1492.56 | 5826.66 | 1492.68 | 0.12 |
| 24.00 | 1493.95 | 5831.77 | 1494.03 | 0.08 |
| 24.50 | 1495.32 | 5836.89 | 1495.38 | 0.06 |
| 25.00 | 1496.66 | 5841.95 | 1496.71 | 0.05 |
| 25.50 | 1497.99 | 5846.89 | 1498.01 | 0.02 |
| 26.00 | 1499.30 | 5851.90 | 1499.33 | 0.03 |
| 26.50 | 1500.59 | 5856.78 | 1500.62 | 0.03 |
| 27.00 | 1501.86 | 5861.61 | 1501.89 | 0.03 |
| 27.50 | 1503.11 | 5866.31 | 1503.13 | 0.02 |
| 28.00 | 1504.35 | 5870.95 | 1504.35 | 0.01 |
| 28.50 | 1505.56 | 5875.54 | 1505.56 | 0.00 |
| 29.00 | 1506.76 | 5880.19 | 1506.78 | 0.02 |
| 29.50 | 1507.94 | 5884.72 | 1507.98 | 0.04 |
| 30.00 | 1509.10 | 5889.05 | 1509.12 | 0.02 |




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

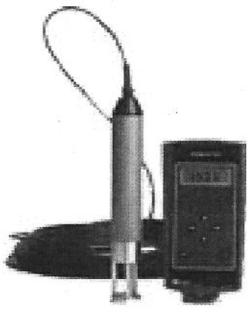
**Date:**
Jan 27, 2012

**Serial #:**
98445-012712

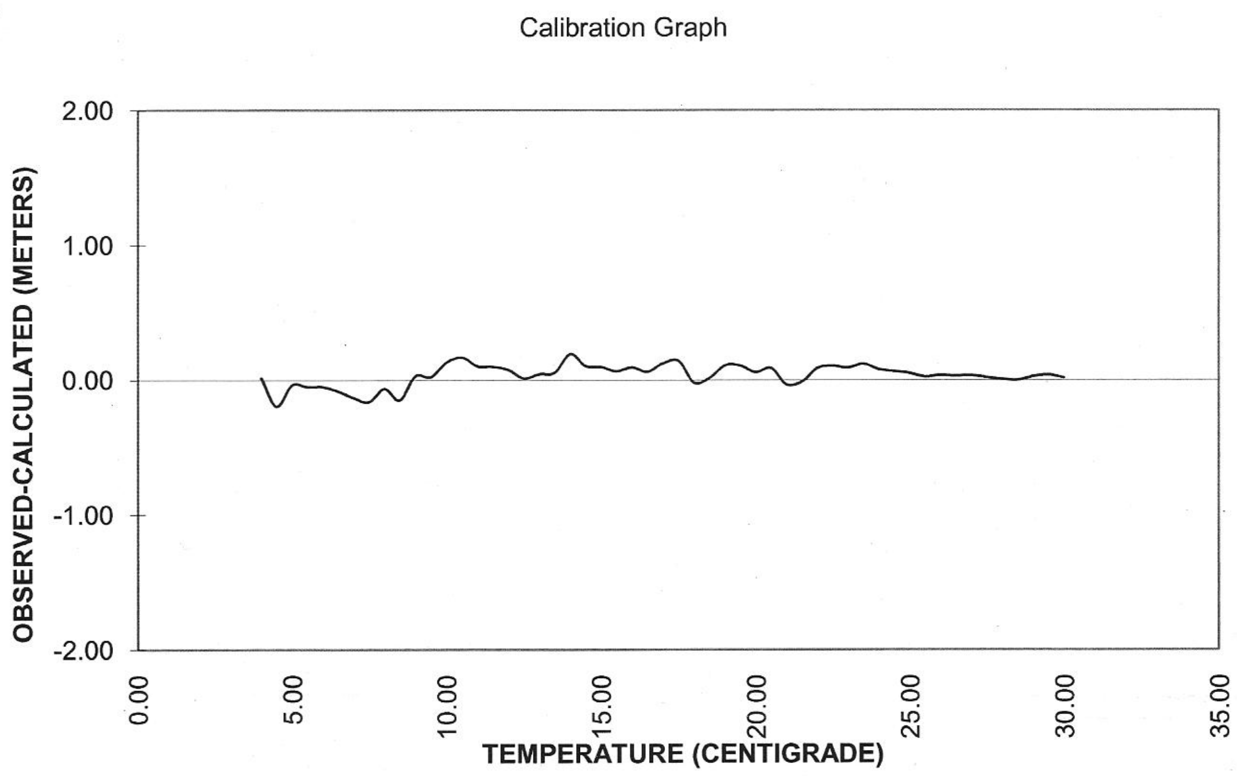
# DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



| Burn these numbers to EPROM: | | |
|---|---|---|
| | Gradient | **3373** |
| | Intercept | **425** |




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

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

**TELEDYNE**
**ODOM HYDROGRAPHIC**
A Teledyne Technologies Company

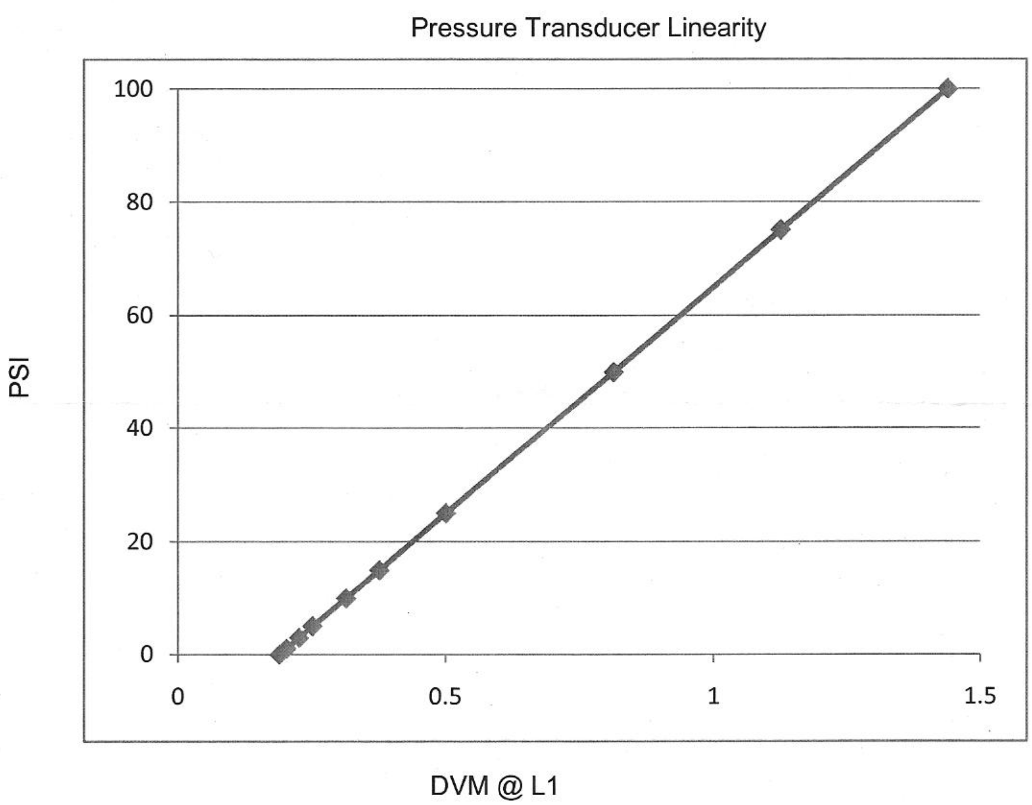
# Digibar

| | |
|---|---|
| Date | 1/31/2012 |
| Serial # | 98445 |
| SW Version | 1.13 |
| Cable Length | 30m |

| Board Identification | Serial # |
|---|---|
| Power Supply | |
| Control PCB | |
| LCD | |
| Probe Sensor | |
| Probe Controller | |
| Airmar Transducer | 853902 |

| | |
|---|---|
| Press Transducer | 82962 |
| Zero Voltage | .19 |
| Span Volage | 2.69 |
| Mid-Scale Voltage | 1.44 |
| R5 | 3.9K |
| R9 | 10K |
| Gradient | 3373 |
| Intercept | 425 |

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




| Transducer Linearity | |
|---|---|
| PSI | DVM@L1 |
| 0 | 0.19 |
| 1 | 0.203 |
| 3 | 0.227 |
| 5 | 0.252 |
| 10 | 0.315 |
| 15 | 0.377 |
| 25 | 0.501 |
| 50 | 0.814 |
| 75 | 1.127 |
| 100 | 1.44 |

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
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# Conductivity Calibration Report

| | | | |
|---|---|---|---|
| **Customer:** | NOAA - NRT-1 | | |
| **Job Number:** | 67482 | **Date of Report:** | 1/12/2012 |
| **Model Number:** | SBE 19Plus | **Serial Number:** | 19P37217-4677 |

*Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.*

*An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.*

**'AS RECEIVED CALIBRATION'** ☑ Performed ☐ Not Performed

Date: 1/12/2012 Drift since last cal: -0.00160 PSU/month*

Comments:

**'CALIBRATION AFTER CLEANING & REPLATINIZING'** ☐ Performed ☑ Not Performed

Date: Drift since Last cal: PSU/month*

Comments:

**Measured at 3.0 S/m*

***Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.***

| Depth | CTD | DigiBar | Difference |
|---|---|---|---|
| 0.75 | 141.98 | N/A | N/A |
| 1 | 1441.87 | 1441.53 | 0.34 |
| 1.5 | N/A | 1440.6 | N/A |
| 2 | N/A | 1440.7 | N/A |
| 2.5 | N/A | 1440.7 | N/A |
| 3 | 1441.59 | 1441.3 | 0.29 |
| 3.5 | N/A | 1441 | N/A |
| 4 | N/A | 1440.8 | N/A |
| 4.5 | N/A | 1441.1 | N/A |
| 5 | N/A | 1441.6 | N/A |

CDT-Digibar Pro Comparison
BAY HYDRO II
Date: 16 February 2012
TIME: 1130hours
LOCATION: Floating pier, Calvert Marina, Solomons, MD
CONDITIONS: Partly Cloudy skies, ~45$^{o}$F, winds 0-5 Knots
Chief of Party: LT Megan Guberski
Recorder: Robert Mowery

**PROCEEDURE**

The S/V BAY HYDRO II is equipped with two sound speed devices; a Seabird 19plus CTD (conductivity, temperature, and density) for collection of sound speed profiles throughout the water column and a Digibar Pro, which is used as a surface velocimeter for multibeam echosounder data collection. Both instruments are calibrated and repaired (if needed) by the manufacturer annually. The BHII conducts a comparison between the two instruments to insure they meet NOAA standards set forth by the Field Procedures Manual 1.5.2.2.2.

The Digibar Pro wet end unit was attached to the Seabird 19plus CDT, in such a manner that the sensors from both units were equal to each other in a horizontal plane. The Seabird 19plus was allowed to run its standard start up procedures on the deck of the BHII, and they both instruments were lowered into the water and held at the surface for two minutes (standard CTD procedure). The Digibar was set to acquire data, and both units were lowered to the sea floor at a rate of approximately 0.5 meters per second and brought to the surface at the same rate.

Seabird 19plus CTD data was downloaded and processed using NOAA's Velocipy software, and compared to the data stored on the Digibar Pro (See Table I: Sound speed device comparison).

| Depth | CTD | DigiBar | Difference |
|---|---|---|---|
| 0.75 | 141.98 | N/A | N/A |
| 1 | 1441.87 | 1441.53 | 0.34 |
| 1.5 | N/A | 1440.6 | N/A |
| 2 | N/A | 1440.7 | N/A |
| 2.5 | N/A | 1440.7 | N/A |
| 3 | 1441.59 | 1441.3 | 0.29 |
| 3.5 | N/A | 1441 | N/A |
| 4 | N/A | 1440.8 | N/A |
| 4.5 | N/A | 1441.1 | N/A |
| 5 | N/A | 1441.6 | N/A |

Table I: Sound Speed device comparison.

**Results**

At only two depths during the cast did both devices take a sound speed velocity reading; one meter and three meters.  At both depths, the readings from both instruments were within one half meter of each other.  Both instruments meet the one meter standard set forth by the Field Procedures Manual in section 1.5.2.2.1.

**Sea-Bird Electronics, Inc.**
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4677
CALIBRATION DATE: 12-Jan-12

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

COEFFICIENTS:

```
g =  -1.054952e+000
h =   1.388022e-001
i =  -7.119394e-005
j =   1.733638e-005

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

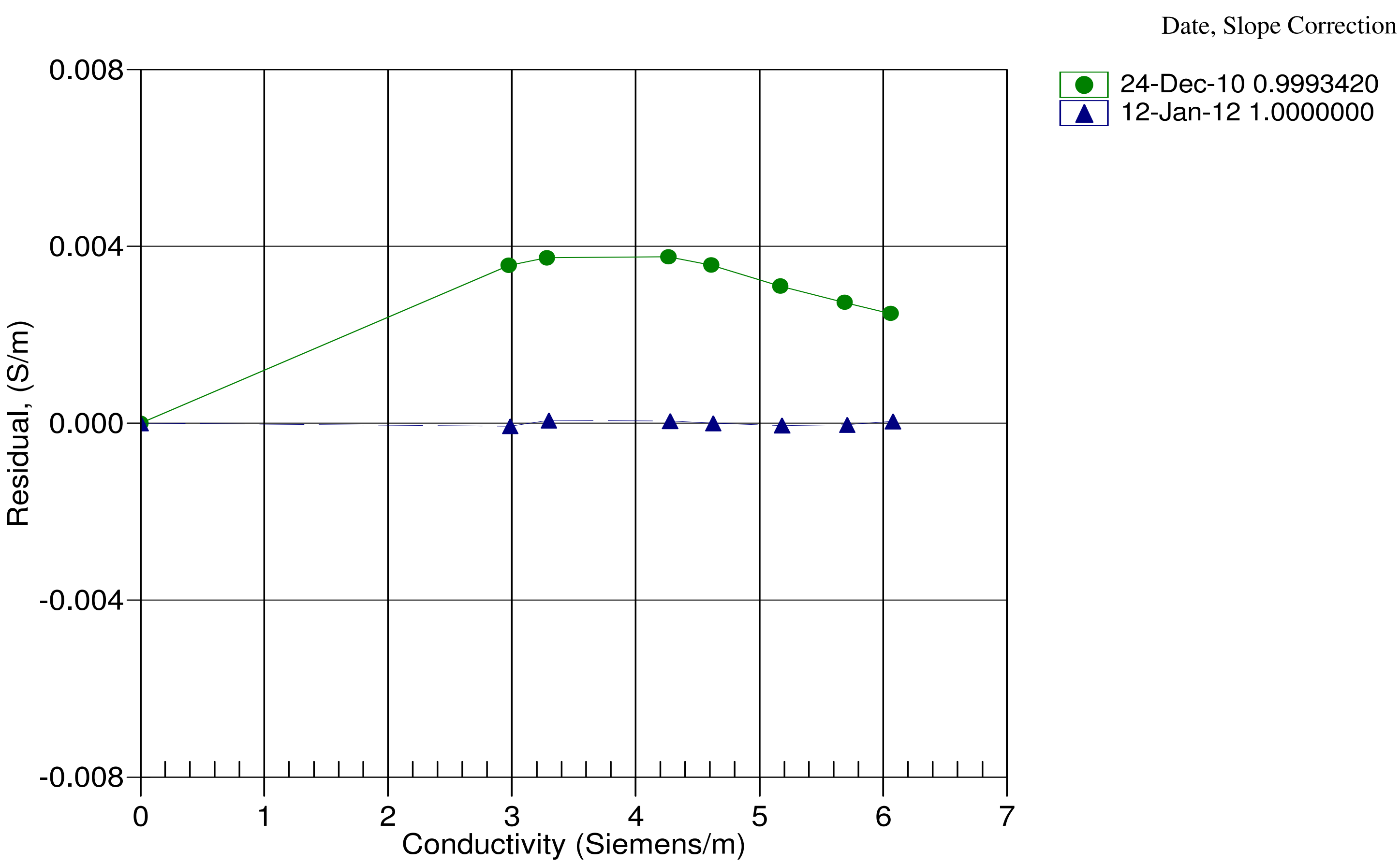
| BATH TEMP (ITS-90) | BATH SAL (PSU) | BATH COND (Siemens/m) | INST FREQ (Hz) | INST COND (Siemens/m) | RESIDUAL (Siemens/m) |
|---|---|---|---|---|---|
| 22.0000 | 0.0000 | 0.00000 | 2757.52 | 0.0000 | 0.00000 |
| 0.9999 | 34.9415 | 2.98564 | 5393.03 | 2.9856 | -0.00007 |
| 4.5365 | 34.9209 | 3.29690 | 5596.52 | 3.2970 | 0.00006 |
| 15.0000 | 34.8768 | 4.27825 | 6193.78 | 4.2783 | 0.00005 |
| 18.5000 | 34.8667 | 4.62433 | 6390.92 | 4.6243 | -0.00000 |
| 24.0000 | 34.8543 | 5.18365 | 6697.11 | 5.1836 | -0.00005 |
| 29.0000 | 34.8447 | 5.70645 | 6971.00 | 5.7064 | -0.00003 |
| 32.5000 | 34.8355 | 6.07896 | 7159.69 | 6.0790 | 0.00004 |

f = INST FREQ / 1000.0

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

t = temperature[°C)]; p = pressure[decibars]; $\delta$ = CTcor; $\epsilon$ = CPcor;

Residual = instrument conductivity - bath conductivity



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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4677
CALIBRATION DATE: 11-Jan-12

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 6135

COEFFICIENTS:

| | | | |
|---|---|---|---|
| PA0 = | 6.899297e-002 | PTCA0 = | 5.150636e+005 |
| PA1 = | 1.551715e-003 | PTCA1 = | 4.955795e+000 |
| PA2 = | 7.443829e-012 | PTCA2 = | -1.386019e-001 |
| PTEMPA0 = | -7.818595e+001 | PTCB0 = | 2.429287e+001 |
| PTEMPA1 = | 4.700444e+001 | PTCB1 = | -6.250000e-004 |
| PTEMPA2 = | -4.263564e-002 | PTCB2 = | 0.000000e+000 |

PRESSURE SPAN CALIBRATION

| PRESSURE PSIA | INST OUTPUT | THERMISTOR OUTPUT | COMPUTED PRESSURE | ERROR %FSR |
|---|---|---|---|---|
| 14.82 | 524605.0 | 2.1 | 14.82 | 0.00 |
| 105.09 | 582728.0 | 2.1 | 105.09 | -0.00 |
| 205.09 | 647051.0 | 2.1 | 205.05 | -0.01 |
| 305.07 | 711350.0 | 2.1 | 305.04 | -0.01 |
| 405.07 | 775618.0 | 2.1 | 405.04 | -0.01 |
| 505.08 | 839871.0 | 2.1 | 505.08 | -0.00 |
| 405.09 | 775670.0 | 2.1 | 405.12 | 0.01 |
| 305.09 | 711413.0 | 2.1 | 305.14 | 0.01 |
| 205.11 | 647108.0 | 2.1 | 205.14 | 0.01 |
| 105.14 | 582753.0 | 2.1 | 105.13 | -0.00 |
| 14.81 | 524607.0 | 2.1 | 14.82 | 0.00 |

THERMAL CORRECTION

| TEMP ITS90 | THERMISTOR OUTPUT | INST OUTPUT |
|---|---|---|
| 32.50 | 2.36 | 524814.15 |
| 29.00 | 2.29 | 524827.61 |
| 24.00 | 2.18 | 524838.94 |
| 18.50 | 2.06 | 524844.80 |
| 15.00 | 1.99 | 524842.13 |
| 4.54 | 1.76 | 524819.81 |
| 1.00 | 1.69 | 524804.66 |

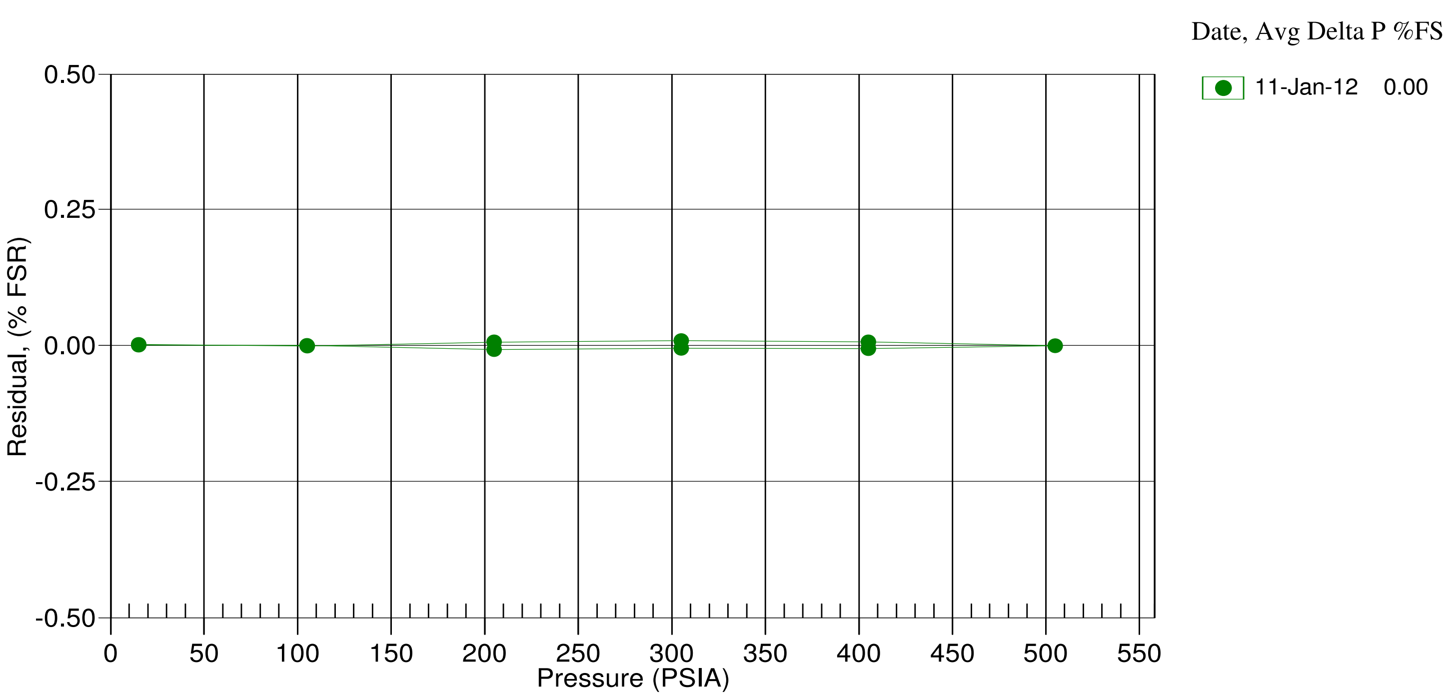
| TEMP(ITS90) | SPAN(mV) |
|---|---|
| -5.00 | 24.30 |
| 35.00 | 24.27 |

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

x = pressure output - PTCA0 - PTCA1 * t - PTCA2 * $t^2$

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

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



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Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4677
CALIBRATION DATE: 12-Jan-12

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = 1.166265e-003
a1 = 2.722563e-004
a2 = -7.413910e-007
a3 = 1.708075e-007

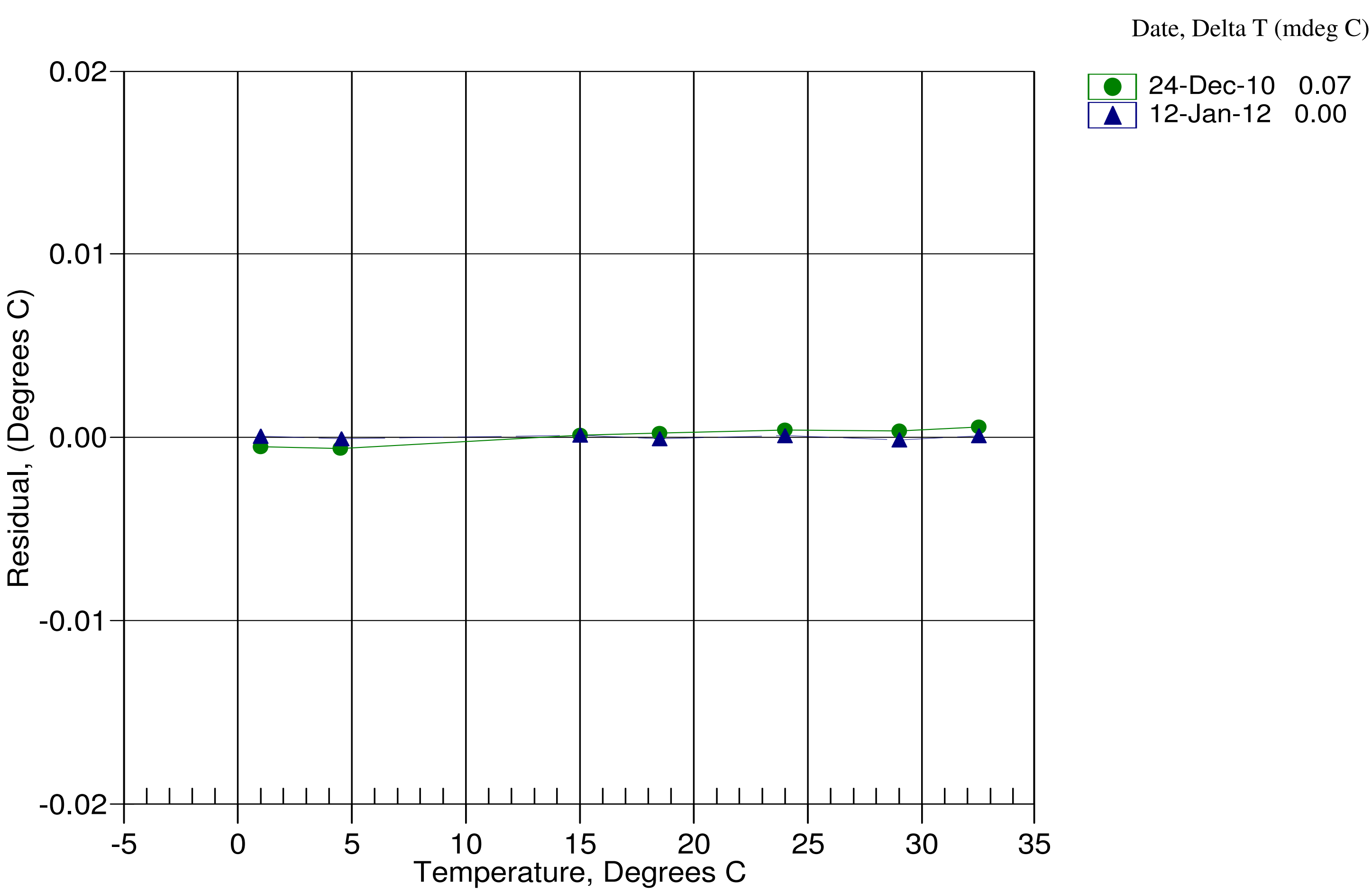
| BATH TEMP (ITS-90) | INSTRUMENT OUTPUT(n) | INST TEMP (ITS-90) | RESIDUAL (ITS-90) |
|---|---|---|---|
| 0.9999 | 693734.051 | 0.9999 | 0.0000 |
| 4.5365 | 619722.475 | 4.5364 | -0.0001 |
| 15.0000 | 435203.763 | 15.0001 | 0.0001 |
| 18.5000 | 384596.186 | 18.4999 | -0.0001 |
| 24.0000 | 315254.305 | 24.0001 | 0.0001 |
| 29.0000 | 261964.881 | 28.9998 | -0.0002 |
| 32.5000 | 229548.559 | 32.5001 | 0.0001 |

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

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

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

Residual = instrument temperature - bath temperature



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# Temperature Calibration Report

| | | | |
|---|---|---|---|
| **Customer:** | NOAA - NRT-1 | | |
| **Job Number:** | 67482 | **Date of Report:** | 1/12/2012 |
| **Model Number:** | SBE 19Plus | **Serial Number:** | 19P37217-4677 |

***Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.***

***An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.***

**'AS RECEIVED CALIBRATION'** ☑ Performed ☐ Not Performed

Date: 1/12/2012 Drift since last cal: -0.00007 **Degrees Celsius/year**

Comments:

**'CALIBRATION AFTER REPAIR'** ☐ Performed ☑ Not Performed

Date: Drift since Last cal: **Degrees Celsius/year**

Comments: