U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

Data Acquisition & Processing Report

Type of Survey Navigable Area

Project Number S-E937-NRT5-12

Time Frame December

LOCALITY

State: Maryland

General Locality Potomac River

2012

CHIEF OF PARTY

LTJG Daniel D. Smith, NOAA

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DATE

19 MARCH 2013

NOAA FORM 77-28 U.S. DEPARTMENT OF COMMERCE (11-72) NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION **HYDROGRAPHIC TITLE SHEET**	PROJECT NUMBER: **S-E937-NRT5-12**
INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.	

State: **Maryland**

General Locality: **Potomac River**

Sub-Locality: **Key Bridge to the Woodrow Wilson Bridge**

Scale: **1:10,000**

Date of Survey: **12/7/2012 – 12/17/2012**
Instructions Dated: **12/4/2012**

Project Number: **S-E937-NRT5-12**

Vessel: **NOAA NRT5, S3002**

Chief of Party : **LTJG Daniel D. Smith, NOAA**

Surveyed by: **NOAA R/V BHII Personnel and LTJG Steven Loy**

Soundings by: **Kongsberg Simrad EM 3002 Multibeam Echosounder**

Imagery by: **Edgetech 4125-P Side Scan Sonar**

Verification by: **Pacific Hydrographic Branch Personnel**

Soundings in: **Meters at MLLW**

Remarks:
1) All Times are UTC.
2) Projection is UTM Zone 18N.

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APPENDICES

DATA ACQUISITION & PROCESSING REPORT

S-E937-NRT5-12
NOAA Navigation Response Team 5
LTJG Steven Loy, Team Lead
LTJG Daniel Smith, Lead Processing and Submittal

A. EQUIPMENT

A.1. Vessels

A.1.1. <u>S3002</u>
NRT5 operated a single vessel, S3002 (see Fig. 1), a 30-foot (overall), gray, aluminum-hull SeaArk Commander. NOAA Survey Vessel S3002 is powered by dual 200-horse power Honda outboards. A Kohler 7.5e generator supplied AC power. A rack-mount APC Smart-UPS (uninterruptable power supply) provided battery backup for the survey-system electronics.

Figure 1: NOAA S3002 (NRT5)

A.1.1.1. Calibration & Configuration
See section C.1.1 for a description of the full vessel survey.

A.2. Depth Measurement Equipment

A.2.1. <u>Kongsberg Simrad EM3002 Multibeam Echosounder</u>
S3002 is equipped with a hull-mounted Kongsberg EM3002 multibeam, which is located directly beneath the IMU. The EM3002 is a 300 kHz (nominal) system with a characteristic operating depth range of 1 to 150 meters water depth. Under ideal, cold water conditions, the range may extend to 200 meters. The swath width is 130°, and the nadir beam is 1.5° x 1.5°. The system has a maximum ping rate of 40 Hz. The processing unit (PU) performs beam forming and bottom detection and automatically controls transmit power, gain, and ping rate. The sonar processor incorporates real time surface sound speed measurements for initial beam forming and steering. SVP correction is also performed in real time. The Seafloor Information System (SIS) application, designed to run under Microsoft Windows, provides control and monitoring of the EM3002.

A.2.1.1. Calibration & Configuration

The installation and runtime parameter configuration files are included in Appendix IV (Electronic Appendix). See section C.1.3 for a description of the calibration patch test.

A.3. Vessel Position and Orientation Equipment

A.3.1. <u>POS/MV Position & Orientation Sensor</u>

S3002 is equipped with an Applanix POS/MV 320 version 4. The POS/MV serial# 3793 consists of dual Trimble BD960 GPS receivers (with corresponding Zephyr antennas), an inertial motion unit (IMU), and a POS computer system (PCS). This POS/MV was used for Day Numbers 342, 343, 344, and 345. The POS/MV serial# 3793 was replaced with POS/MV serial# 2034 due to a malfunctioning primary GPS receiver. The POS/MV serial# 2034 consists of dual BD950 GPS receivers (with corresponding Zephyr antennas), an inertial motion unit (IMU), and a POS computer system (PCS) and was used for Day Numbers 347, 349, 350, 351, and 352. The same Zephyr antennas and IMU were used for both POS computer systems. The two antennas are mounted approximately 1.5 meters apart atop the launch cabin (see Fig. 2). The primary receiver (on the port side) is used for position and velocity, and the secondary receiver is used to provide heading information as part of the GPS azimuthal measurement sub-system (GAMS).

Figure 2: POS/MV Antenna Installation

The IMU contains three solid-state linear accelerometers and three solid state gyros, which together provide a full position and orientation solution. The IMU is mounted on the top of the sonar housing, beneath a removable deck plate (see Fig. 3).

Figure 3: IMU Installation

A.3.1.1. Calibration & Configuration

A GAMS calibration was performed on 6/19/2012, prior to data acquisition. The GAMS calibration report is included in Appendix II.

The POS/MV is configured, operated, and monitored via the POS/MV controller software, which is installed on the S3002 acquisition computer. The primary GPS-to-reference point lever arm was accounted for in the POS/MV controller. A POS/MV configuration file detailing lever arms, input/output settings, and operational settings is contained in Appendix IV (Electronic Appendix).

A.3.2. Trimble DSM212L DGPS Receiver

The POS/MV receives differential (RTCM) correctors from a Trimble DSM212L GPS receiver that includes a dual-channel low-noise MSK beacon receiver, capable of receiving U.S. Coast Guard (USCG) differential correctors. The DSM212L can also accept RTCM messages from an external source such as a user-established DGPS reference station, however, no such stations were established for S-E937-NRT5-12.

A.3.2.1. Calibration & Configuration

Trimble's TSIP Talker was used to configure the DSM212L. The DGPS receiver was set to receive corrections from Hagerstown, MD (307 kHz). The DSM212L is configured to go off-line if the age of DGPS correctors exceeds 20 seconds, and to exclude satellites with an altitude below eight degrees.

A.4. Side Scanning Imagery Sonar

A.4.1. Edgetech 4125

Edgetech's 4125 Shallow Water Side Scan Sonar System features an AC/DC TPU loaded with Windows XP and a lightweight stainless steel towfish. There are two available options on the Edgetech 4125 towfish, the first operates with dual frequencies of 400/900 kHz, while the second option operates with dual frequencies of 600/1600 kHz. The towfish we operated utilizes the 400/900 kHz frequencies, however, due to crosstalk with the EM3002 on the 900 kHz frequencies, we only used the 400kHz frequency for this project. The towfish was operated from a pole mount on the starboard side of the vessel. A safety pin on the pole will break and allow the towfish to automatically return to a horizontal position. This will prevent further damage to the towfish if it comes in contact with anything while deployed. Specifications for each frequency are shown in the Table 1.

Table 1: Edgetech 4125 Specifications

	400 kHz	**900 kHz**	**600 kHz**	**1600 kHz**
Range	**150m**	**75m**	**120m**	**35m**
Horizontal Beam Width	**0.46°**	**0.28°**	**0.33°**	**0.20°**
Vertical Beam Width	**50°**	**50°**	**50°**	**50°**
Resolution (across track)	**2.3cm**	**1.5cm**	**1.5cm**	**0.6cm**

A.5. Sound Speed Equipment

S3002 is equipped with an Odom Digibar Pro surface sound speed sensor to measure surface sound speed, which is used in beam forming computations by the Kongsberg flat-face multibeam transducer head. For water column sound speed profiles NRT5 used an Odom Digibar Pro sound speed sensor and a Seabird SBE19+ CTD profiler. Speed of sound through water is determined by a minimum of one cast every four hours, in accordance with the NOS Specifications and Deliverables for Hydrographic Surveys. Daily Quality Assurance tests (DQA) between the surface and profile sound speed probes were performed using Velocipy.

A.5.1. Odom Digibar Pro – Surface Sound Speed

Odom Digibar Pro serial# 98214 provided surface sound speed data to the flat-face EM3002 for beam steering and beam forming. The unit is mounted in a removable pole that is inserted into a bracket mounted on the transom between the two motors (see Fig. 5). The unit is configured to output an AML datagram to SIS, which is installed on the acquisition computer (see wiring diagram in Appendix II).

Figure 4: Surface Sound Speed Digibar Installation

A.5.2. Seabird SBE19+ CTD Profiler

Seabird SBE19+ serial #4835 is used to obtain sound speed profiles. The raw profile data file is uploaded and processed with the acquisition computer using the NOAA Velocipy software. Velocipy generates an *.asvp file, which is loaded into SIS for real-time ray tracing, and an *.svp file which is used for post processing in Caris.

A.5.3. Calibration & Configuration

Calibration reports for both sound speed sensors are included in Appendix III.

A.6. Data Acquisition Software

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

A.6.1. Hypack Hysweep

Hypack Hysweep was used for real-time data display and navigation.

A.6.2. Applanix PosView

The Applanix POSView software was used to configure and monitor the Applanix PosMV, and to log PosPac files. The PosMV configuration file, which is created using POSView, is located in Appendix IV (Electronic Appendix).

A.6.3. Kongsberg SIS-Seafloor Information System

SIS was used to control the EM3002 MBES and for acquisition of .all files.

A.6.4. Discover II

Discover II was used to for the acquisition of all Edgetech 4125 SSS data and also logged towfish position and altitude.

A.7. Data Processing Software

A.7.1. Caris HIPS
Caris HIPS was used to process all MBES data including tide correction, SVP correction, merging with navigation data, TPU calculation, data cleaning, and CUBE BASE surface creation. The Caris HVF file, which contains offsets and correctors applied in Caris, is located in Appendix IV (Electronic Appendix).

A.7.2. Caris SIPS
Caris SIPS was used to process all SSS data, including towfish height, slant range correction, recomputing towfish navigation, and selecting contacts. The Caris HVF file, which contains offsets and correctors applied in Caris, is located in Appendix IV (Electronic Appendix).

A.7.3. Caris Bathy DataBASE
Caris Bathy Data BASE was used for feature management and quality assurance.

A.7.4. Velocipy
Velocipy was used to process SVP casts and for DQA tests. The .asvp files created by Velocipy were applied to the MBES data in real-time using SIS software.

A.7.5. Pydro
Pydro was used for feature management, DTON report generation, and tides requests.

B. QUALITY CONTROL

B.1. Multibeam Echosounder Data

B.1.1. Acquisition Operations
Mainscheme multibeam data were acquired concurrently with SSS data using planned lines at a spacing determined to achieve 100% SSS. When gaps in coverage were found, holiday line plans were created using Mapinfo and exported as Hypack line files. Sound speed casts were acquired as per HSSD section 5.2.3.3.

B.1.2. MBES Processing Workflow
Multibeam processing for S-E937-NRT5-12 was based on the BASE surface/directed-editing paradigm described in FPM section 5.2, Bathymetry Processing. The multibeam processing workflow had four main components: conversion, preliminary processing, surface generation, and surface review/data cleaning (see Fig. 6). Note that the surface generation and surface review/data cleaning steps are iterative.

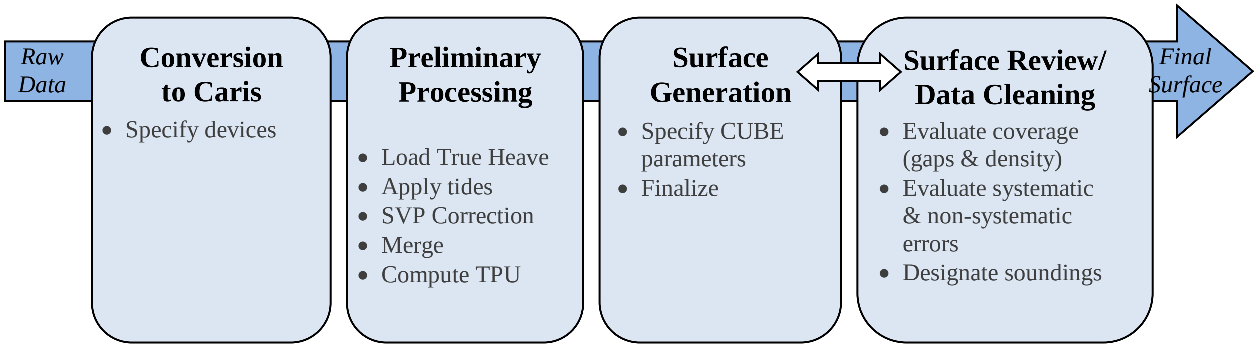


Figure 5: Multibeam Processing Workflow

B.1.2.1. Conversion

Raw multibeam .ALL data were converted to HDCS format in Caris HIPS. Device conversion parameters are shown in Figure 7.

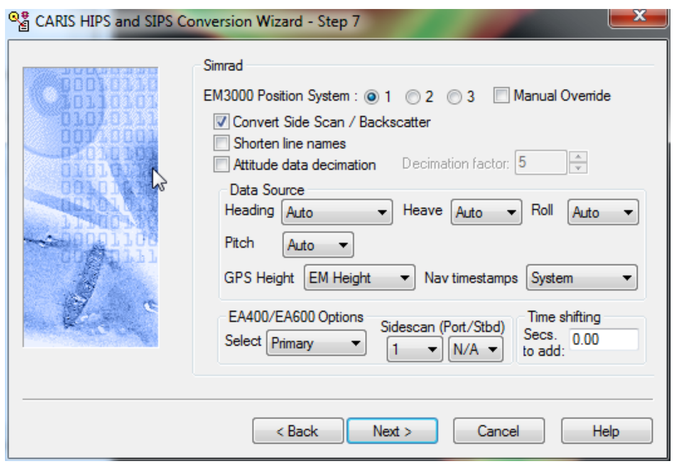


Figure 6: Device Conversion Parameters

B.1.2.2. Preliminary Processing

After conversion, preliminary processing consisted of applying True Heave, tide, SVP Correction, merging, and computing total propagated uncertainty (TPU).

Loading True Heave

True Heave was loaded for each day of data.

Applying Tides

Tide correction was performed using discrete tidal zoning. The tidal zones are defined in E937NRT52013CORP.zdf. See section C.3 for a detailed description of the tide correctors for S-E937-NRT5-12.

SVP Correction
SVP post processing was performed in Caris using the Simrad "intersection of cones" algorithm. Typically, the "Nearest in distance within time" option was used, with a time limit of 4 hours, unless a different method was warranted. True Heave was applied during this correction.

Merging
The merge process in Caris combines the observed depths (created during conversion) with the loaded tide file, the navigation data, the HVF draft sensor (containing dynamic draft values), and the HVF swath1 sensor (containing patch test biases) to compute the final processed depths. No smoothed sensors were applied during the merge process.

Computing TPU
The TPU computation process assigns each sounding a horizontal and vertical uncertainty, or estimate of error, based on the uncertainties of the various data components, such as position, sound speed, and loading conditions. Table 1 lists the HVF TPU values used for S-E937-NRT5-12.

Table 2: TPU Values

Data Component	*TPU Value*	*Data Component*	*TPU Values*
Motion Gyro	0.02°	X, Y, & Z Offsets	0.01 m
Heave % Amplitude	5%	Vessel Speed	0.03 m/s
Heave	0.05 m	Loading	0.01 m
Roll	0.02°	Draft	0.03 m
Pitch	0.02°	Delta Draft	0.03 m
Position Nav	1 m	MRU Align StdDev gryo	0.2°
Timing Transducer	0.01 s	MRU Align StdDev Roll/Pitch	0.2°
Nav Timing	0.01 s	Sound Speed Surface	0.5 m/s
Gyro Timing	0.01 s	Sound Speed Profile	4.0 m/s
Heave Timing	0.01 s	Tide measured	0.01
Pitch Timing	0.01 s	Tide zoning	.045*
Roll Timing	0.01 s		

*Note: The tide zoning uncertainty includes the estimated gauge measurement uncertainty.

B.1.2.3. Surface Generation
The multibeam sounding data were modeled using the CUBE BASE surface algorithm implemented in Caris HIPS. CUBE BASE surfaces were generated using the parameters outlined in Hydrographic Surveys Technical Directive 2009-02 (CUBE Parameters). Due to the shallow depth of water and high density of MBES data, the only finalized surface was at the 0.5m resolution.

B.1.2.4. Surface Review/Data Cleaning
Rather than a traditional line-by-line review and a full subset-cleaning, the data cleaning/quality review process for S-E937-NRT5-12 consisted of a combination of the directed-editing approach described in FPM section 4.2.4.3, and a full subset-review (not full subset-cleaning). All the sounding data were viewed in subset, but unlike in the traditional workflow, where every sounding deemed to be "noise" is rejected, only the soundings that negatively impacted the

CUBE surface were rejected. Surface review also consisted of evaluating achieved coverage and sounding density, checking for systematic errors, and designating soundings. Sounding designation was in accordance with Specs and Deliverable section 5.2.1.2.

B.2. Sidescan Sonar Data

B.2.1. SSS Processing Workflow

SSS processing for S-E937-NRT5-12 was performed using Caris SIPS.

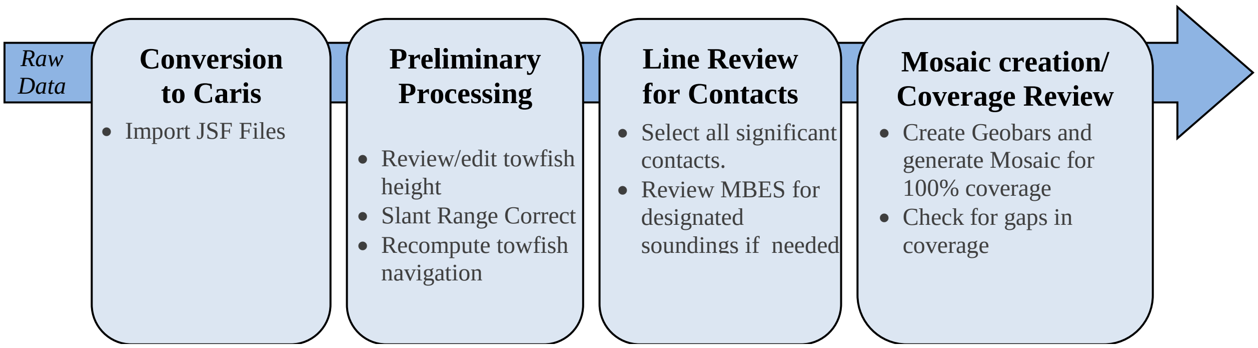


Figure 7: SSS Processing Workflow

B.2.1.1. Data Conversion

The JSF lines logged by Discover II were brought into Caris SIPs using the Conversion wizard. Parameters selected are shown in the figure below.

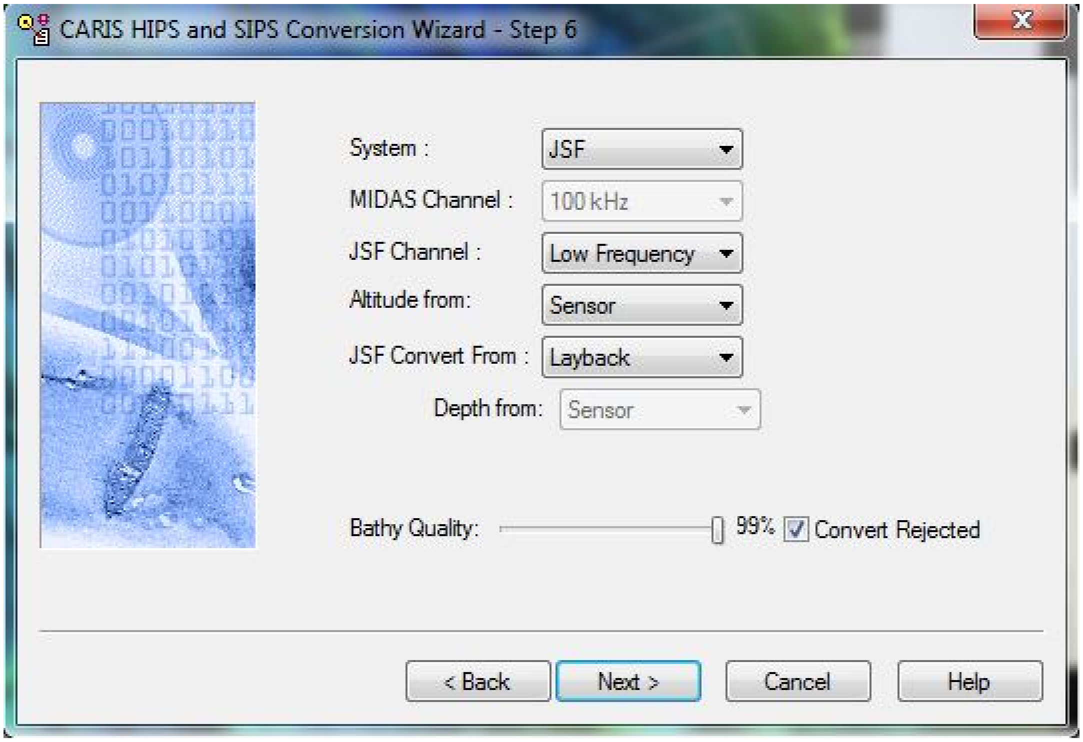


Figure 8: Caris Conversion Wizard

B.2.1.2. Towfish height Digitization

The towfish bottom tracking was reviewed for each line, and redigitized where needed.

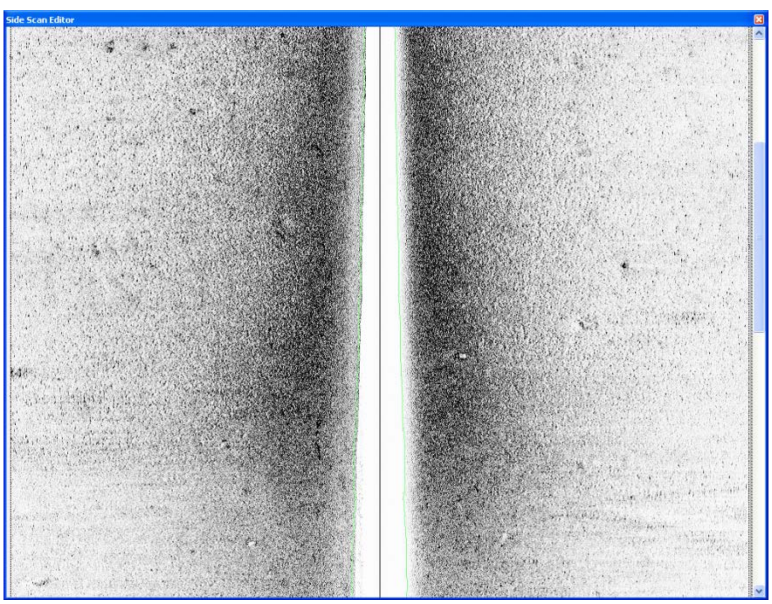


Figure 9: Digitizing Towfish Height

B.2.1.3. Recompute Towfish Navigation

Along with the sidescan imagery, Discover II logs towfish navigation and altitude. Recompute towfish navigation combines these sensors to compute the position of the towfish in relation to the vessel. The process is needed for accurate positioning of contacts and georeferencing of mosaics.

B.2.1.4. Slant Range Correct and Geobar Creation

All SSS lines were slant range corrected and then geobars were created. Once slant range corrected, the geographical position of contacts can be determined in Sidescan Editor.

B.2.1.5. Line Review and Contact Selection

Each line of SSS data was reviewed for possible contacts by a primary reviewer and they re-reviewed by a secondary reviewer. Significant contacts were selected for investigation and line plans were made for multibeam developments.

B.2.1.6. Creation of Mosaics

Mosaics were generated from the geobars and were reviewed to determine areas that required additional coverage.

B.3. Feature Data

Feature management consisted of one main workflow depicted in Figure 11. All assigned and new features were populated in Caris Bathy DataBASE with all mandatory S-57 attributes. All new features were digitized in Caris Bathy DataBASE. Caris HIPS was used for determining position and least depth for new bathy features.

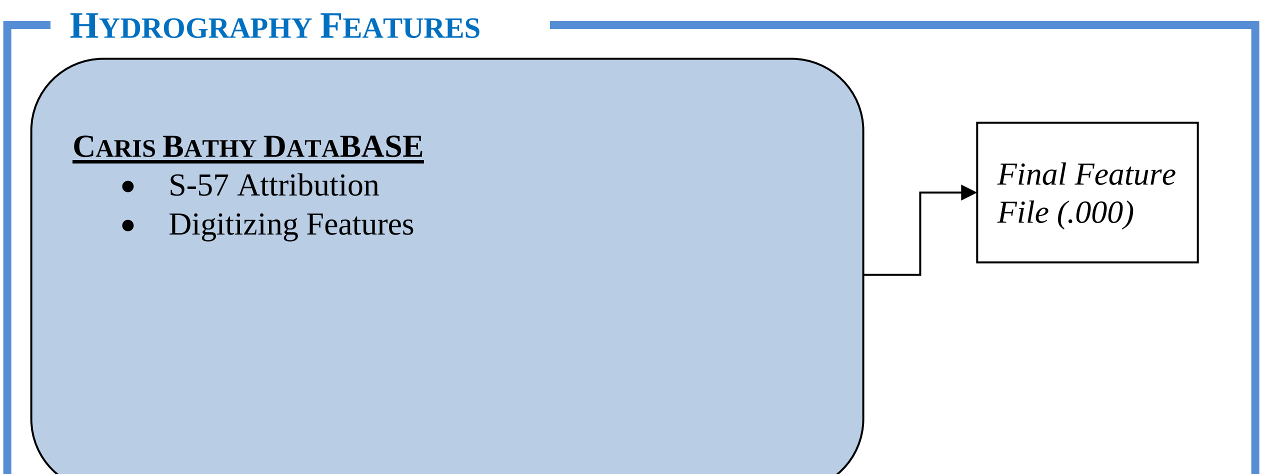


Figure 11: Feature Management Workflow

C. CORRECTIONS TO ECHO SOUNDINGS

The following section describes the determination and evaluation of the three main categories of corrections to echosoundings: vessel, sound speed, and water level correctors.

C.1. Vessel Correctors

Vessel correctors include static offsets, dynamic offsets, and patch test biases. The various correctors are applied to echo soundings at different points throughout the data pipeline, which is detailed in the sections below.

C.1.1. Static Offsets

C.1.1.1. Vessel Lever-Arms

The National Geodetic Survey conducted a full vessel survey on 8/4-8/5/09 in Middletown, RI (see Appendix II for the NGS report). The primary-GPS-to-Reference-Point lever arm is accounted for in the POS/MV controller. The Reference-Point-to-Multibeam-Transducer lever arm is accounted for in the Caris HVF.

C.1.1.2. Static Draft

A static draft measurement was performed in June 2012 in New York Harbor, NY. To determine the static draft (i.e., the height of the waterline above/below the reference point), a straight rod long enough to overhang the boat on each side was laid across the gunwales directly above the IMU. Measurements were taken with a tape measure from the rod to the water line on each side of the boat, and from the rod to the top of the IMU (RP). The port and starboard water line measurements were averaged, and then subtracted from the rod-to-IMU measurement to determine the separation between the reference point and water line.

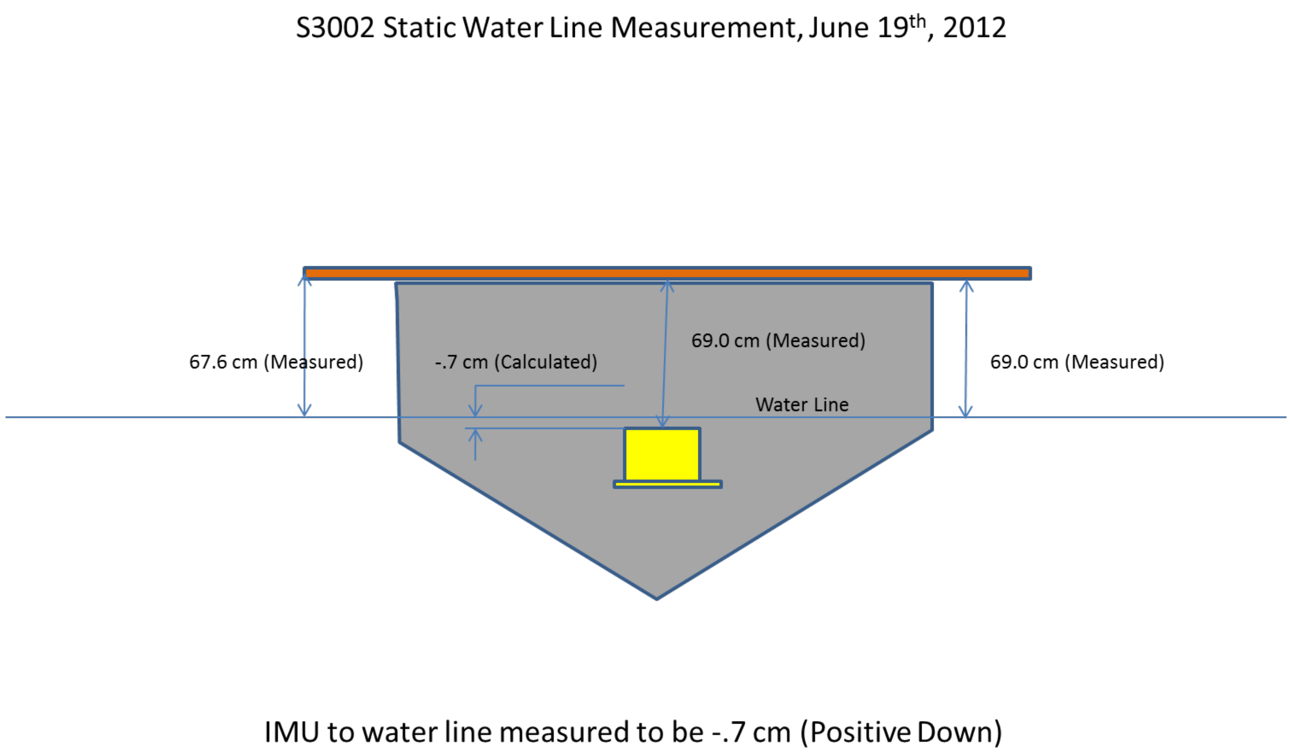


Figure 10: Static Draft Measurement

C.1.2. Dynamic Offsets

The dynamic draft values were obtained on 6/19/2012 prior to data acquisition. The dynamic draft measurements were obtained with an optical level positioned on shore using the methods described in section 1.4.2.1.2.1 of the NOAA Field Procedures Manual. Two independent tests conducted with different observers. The two tests showed excellent correlation, and the average of the two tests were taken as the final values. The dynamic correctors are summarized in Table 2. A positive draft corrector implies that the boat moved down.

Figure 11: Dynamic Draft Optical Level Setup

Table 3: 2012 Dynamic Draft Values

Speed (m/s)	Draft Correction (m)
1.132	0.000
1.582	0.012
2.829	0.021
3.614	0.042
4.257	0.069
5.556	0.014

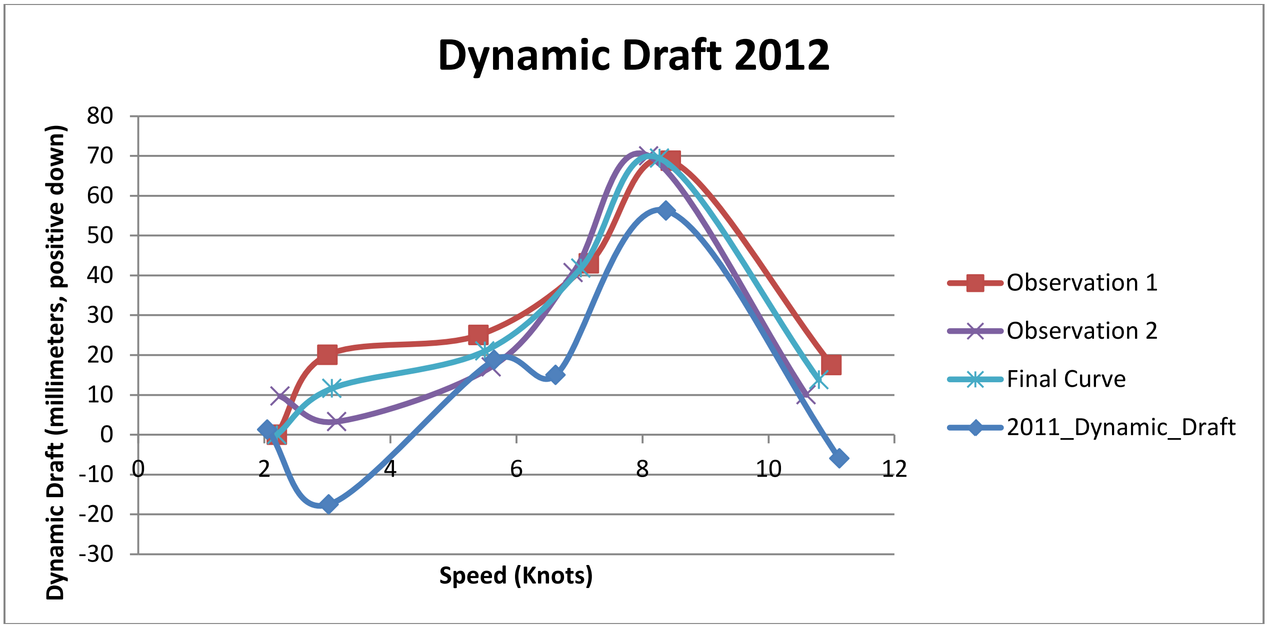


Figure 12: Dynamic Draft Plot

C.1.3. Patch Test Biases

A patch test was performed on 6/20/12 (DN 172), in New York Harbor, 1.4 nm north of the Verrazano-Narrows Bridge (see Fig. 16). A charted obstruction in 50 ft of water was located and used as the calibration target. A pair of roll bias lines was collected in a flat area 350 meters to the southwest. The timing offset was determined using the conventional method, rather than the "precise timing" method. The derived biases (summarized in Table 3), were entered into the Swath1 sensor of the Caris HVF and therefore were applied to the data during the merge step of post-processing.

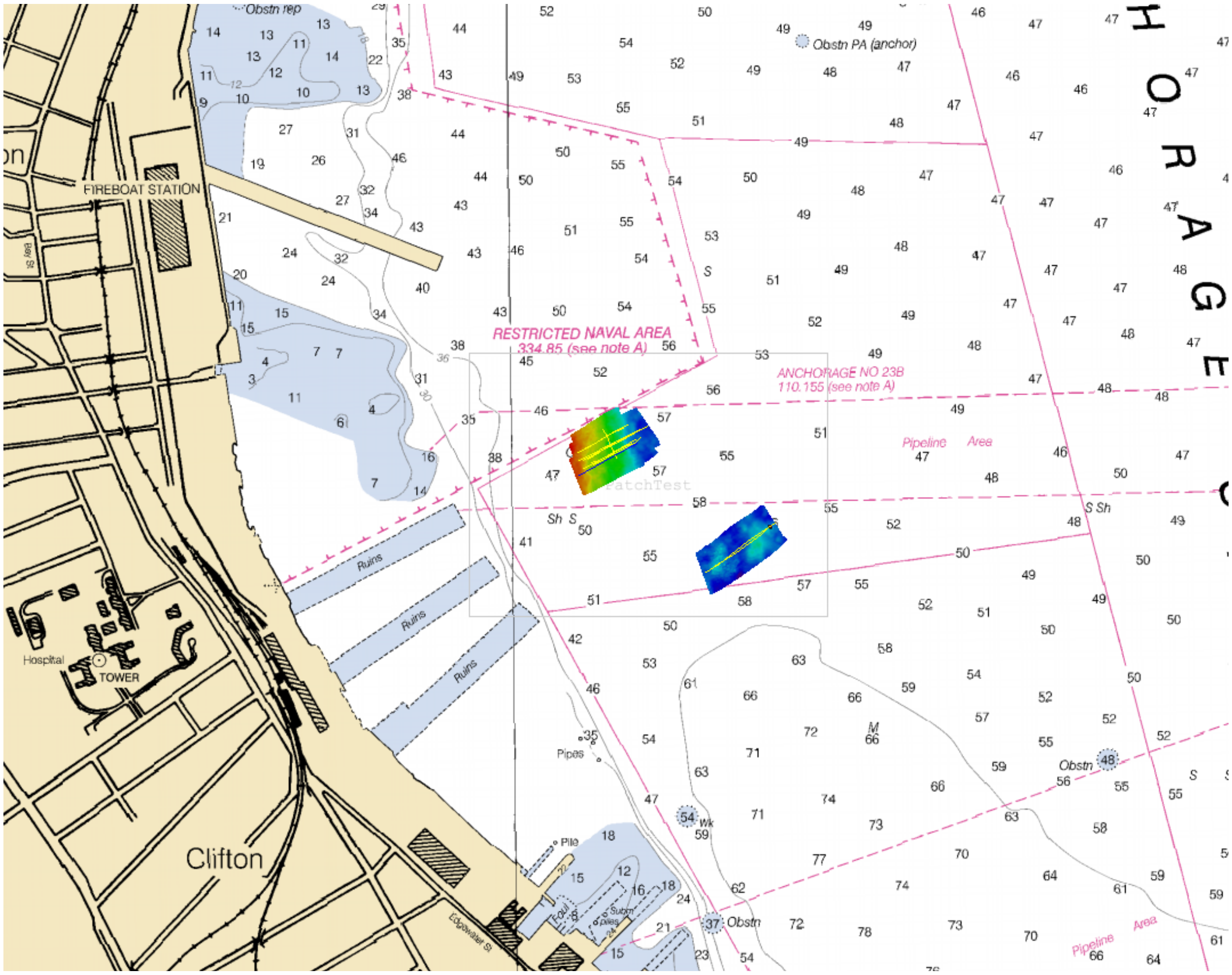


Figure 13: Patch Test Location (Charted depths are in feet)

Table 4: Patch Test Values

Bias	Estimate
Navigation Timing	0.000
Pitch	-0.148
Roll	-0.059
Heading (Yaw)	-0.687

C.2. Sound Speed

Sound speed corrections were performed in real-time by the EM3002 controller software, SIS. Casts were taken, at a minimum, every four hours as per NOS Specifications and Deliverables for Hydrographic Surveys. Sound velocity corrections were then post processed in Caris HIPS.

C.3. Water Level Corrections

Tide corrections for S-E937-NRT5-12 were applied using the discrete tidal zone file E937NRT52013CORP.zdf in Caris.

Tide data were downloaded automatically from the Center for Operational Oceanographic Products and Services (CO-OPS) using the Fetch Tides utility, and applied to the Caris Hips PVDL lines.

APPROVAL SHEET

Data Acquisition & Processing Report
Navigation Response Team 5

As Chief of Party, I have ensured that surveying and processing procedures were conducted in accordance with the Field Procedures Manual and that the submitted data meet the standards contained in the 2012 Hydrographic Surveys Specifications and Deliverables.

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

Respectfully,

SMITH.DANIEL.DUNNINGTON.1392691517
2013.03.18 13:01:21 -04'00'

LTJG Daniel D. Smith
Officer-in-Charge, NOAA R/V Bay Hydro II

Appendices

Appendix I – System Tracking

A	B
Hydrographic Vessel Inventory	
Field Unit: NRT5	
Effective Date: 15-April-2009	
Updated Through: 1-June-2012	
SURVEY VESSEL	
Vessel Name	NOAA NRT5
Hull Number	S3002
Call Letters	
Manufacturer	SeaArk Marine Inc., Portobello AK
Year of Construction	2003
Type of Construction	Welded Aluminum
Length Overall	9.65 m (31'8")
Beam	2.58 m (8'6")
Draft	
Date of Effective Full Vessel Static Offset Survey	1-Jan-09
Organization which Conducted the Effective Full Offset Survey	NGS
Date of Last Partial Survey or Offset Verification & Methods Used	
Date of Last Static Draft Determination & Method Used	June-2012Tape Measure
Date of Last Settlement and Squat Measurements & Method Used	19-June-2012 Optical Method
Additional Information	

Hydrographic Hardware Inventory

Field Unit:	NRT5
Effective Date:	15-Apr-09
Updated Through:	1-Jan-13

Equipment Type	Manufacturer	Model	Serial Number	Firmware and/or Software Version	Additional Information
Sonar & Sounding Equipment					
Multibeam Echosounder	Kongsberg Simrad	EM3002	563	SIS	256 Beams 1.5° X 1.5° Resolution
Side Scan Sonar	Edgetech	4125	TPU: 40412, Towfish: 40386	Discover II - 2012	
Vertical Beam Echosounder	Odom	Echotrac CV-200	23034	Odom Controller	
Positioning & Attitude Equipment					
GPS Aided Inertial Navigation	Applanix	POS/MV 320 V4	3793	5.03	
DGPS Reciever	Trimble	DSM212L	O220309909		
Sound Speed Measurement Equipment					
Sound Speed Profiler	Odom	Digibar Pro	98212		
Surface Sound Velocimeter	Odom	Digibar Pro	98214		

Hydrographic Software Inventory

Field Unit:	NRT5
Effective Date:	15-Apr-09
Updated Through:	1-Jan-13

Computers - Machine Name	CD0004099481	OCS-W-001670290	CD0001281236 Mist I - Alpha	CD0001281237 Mist I - Bravo
Location	Laptop - NRT5	S3002	Mist I	Mist I
Make/Model	Dell Latitude E6530	Dell Precision T3500	Dell Latitude E6420XFR	Dell Latitude E6420XFR
Date Purchased	2012	2012		
Processor, Speed	Intel®Core™i5-3360M CPU, 2.8GHz	Intel Xeon W3550, 3.07GHz	Intel®Core™i7-2640M CPU, 2.8GHz	Intel®Core™i7-2640M CPU, 2.8GHz
RAM	8.00 GB	6.00 GB	4.00 GB	4.00 GB
Video Card	NVIDIA NVS 5200M	NVIDIA Quadro NVS 420	Intel®	Intel®
Video RAM	1 GB	512 MB		
Service Tag #	6QY8VVV1	3T7SYQ1	D8PCSS1	B8PCSS1
Operating System:				
Windows 7	Win 7 Pro, 64 bit, SP1	Win 7 Enterprise, SP1	Win 7 Pro, 64 bit, SP1	Win 7 Pro, 64 bit, SP1
Acquisition Software:				
Hypack	Hypack 2012	Hypack 2012	Hypack 2012	Hypack 2012
Kongsberg SIS	3.8.3	3.8.3	Not Installed	Not Installed
Discover II	2012			
Velocipy	Pydro 12.9	Pydro 12.9	Pydro 12.9 (r4042)	Pydro 12.9 (r4030)
Processing Software				
CARIS HIPS and SIPS			v 7.1, SP2, HF5	v 7.1, SP2, HF5
Pydro			12.9 (r4042)	12.9 (r4030)
Applanix POSPac MMS			not installed	not installed
Support Software				
Office Suite	Office Suite 2007	Office Suite 2007	not installed	not installed
Adobe Acrobat	not installed	not installed	not installed	not installed
Software Licenses				
Caris	ey Serial Numbers: CW3604114, CW3604216, CW9605753 (HQ's ke		CK9606720 (BHII's key), CK9607068 (BHII's key)	
Pydro	not installed		d6e0c11de129c6997f	d6e0c11de4622a2cfe
GPS Pathfinder Office	Installation code: 001615-00300-10258-E73100AD		not installed	
MapInfo	Serial Number: MINWEU0900013988		not installed	
Applanix POSPac MMS	Key Serial Numbers: 2797 and 7959		not installed	

Processing

Hydrographic Personnel Roster			
Field Unit:	NRT-5		
Effective Date:	December 5, 2012		
Updated Through:	December 18, 2012		
Team Members			
Name & Grade	**Current Position**	**Years of hydro Experience**	**Notes**
Michael Davidson, LT	Chief NRB	7.0	
Steven Loy, LTjg	Team Lead	3.5	
Daniel Smith, LTjg	Team Lead	3.0	
Robert Mowery, NOAA	PST	5.5	
Nicole Trenholm	Contractor	3.0	

Appendix II - Vessel Reports, Offsets, and Diagrams

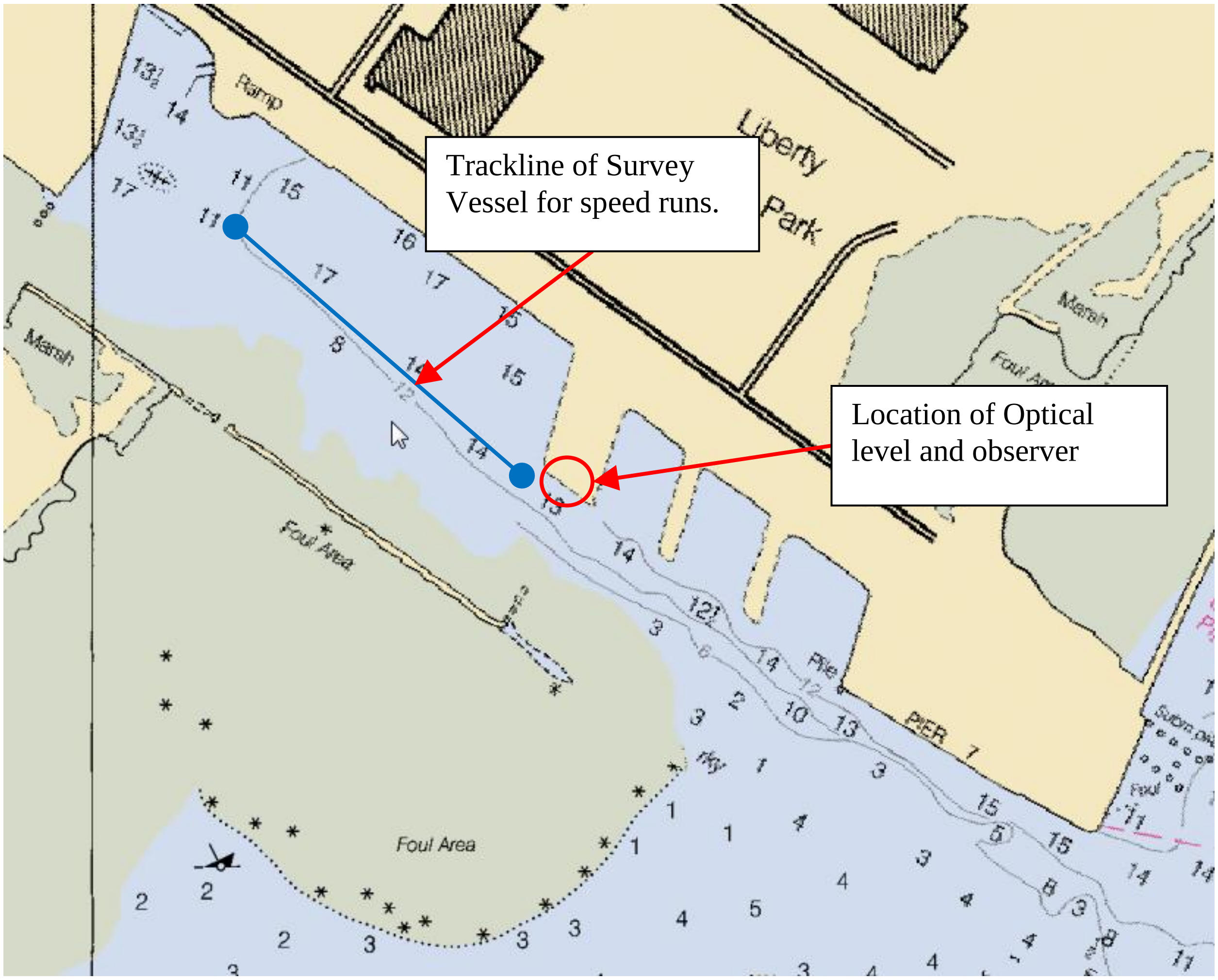
S3002 Dynamic Draft Test
19 June 2012
LT(jg) Steve Loy

Background:
NRT-5 is capable of acquiring both bathymetry data and side scan sonar imagery. Accuracy in data processing is in part dependent on the determination of the change in vessel draft in relation to vessel speed through the water. This test empirically determines the dynamic draft of S3002 using an optical level.

Location, Date, and Personnel:
The Dynamic Draft values were obtained using the optical method as described in the NOAA Field Proceedures Manual, section 1.4.2.1.2.1.

Figure 1: Setup Site

Figure 2: Overview of work site



Equipment:

Applanix POS/MV version 4
DSM 212L DGPS receiver
Optical Level

Procedure:

<u>Data Acquisition:</u>

The optical level was setup on stone rip rap at the end of an earthen wharf extending approximately 130 meters from shore. This site was chosen because the rip rap was low to the water, stable, and in a protected canal with adequate. A leveling rod was positioned aboard the vessel near the known center of rotation so that the vertical displacement would only be affected by settlement and not squat (The terms settlement and squat are used as they are defined in the NOAA Field Procedures Manual). Measurements on the rod were taken with the vessel at rest, and at six speeds, ranging from approximately 2 knots to 10.5 knots with the vessel moving directly away from the reader. Each reading was taken at the same range to minimize collimation error; this was accomplished by notifying the reader via hand held VHF when the vessel reached a predetermined target position in Hypack. Readings were also taken with the vessel at rest between each speed run to compensate for any tidal variation over the course of the test. The vessel speed was read from the PosMV viewer on each run. The vessel speed on the reciprocal course was also recorded to account for any current. The test was then repeated with a different observer.

<u>Data Processing:</u>

To determine the dynamic draft (vertical displacement) values the at-rest reading before and after each speed run were interpolated to the time of the measurement, and subtracted from the reading at speed. The speed value associated with each dynamic draft value was determined by averaging the speed on reciprocal courses for each run. The final set of values was obtained by averaging the results from the two trials. The values are tabulated below:

Table 1

Test 1					
Measured Values			Calculated Values		
speed knts			speed(average)		
away	towards	Staff Reading	knts	m/s	delta z
0	0	1.645			
2.2	2.2	1.665	2.200	1.132	0.000
0	0	1.685			
3.0	3.0	1.725	3.000	1.543	0.020
0	0	1.725			
5.4	5.4	1.785	5.400	2.778	0.025
0	0	1.775			
7.1	7.2	1.830	7.150	3.678	0.043
0	0	1.795			
8.4	8.5	1.875	8.450	4.347	0.069
0	0	1.810			
11.0	11.0	1.845	11.000	5.659	0.018
0	0	1.845			

Test 2					
Measured Values			Calculated Values		
speed knts			speed(average)		
away	towards	Staff Reading	knts	m/s	delta z
*	*	*	*	*	*
0	0	1.503			
3.2	3.1	1.532	3.150	1.620	0.003
0	0	1.548			
5.7	5.5	1.590	5.600	2.881	0.017
0	0	1.583			
7.0	6.8	1.645	6.900	3.550	0.041
0	0	1.615			
8.0	8.2	1.695	8.100	4.167	0.070
0	0	1.635			
11.0	10.2	1.655	10.600	5.453	0.010
0	0	1.660			

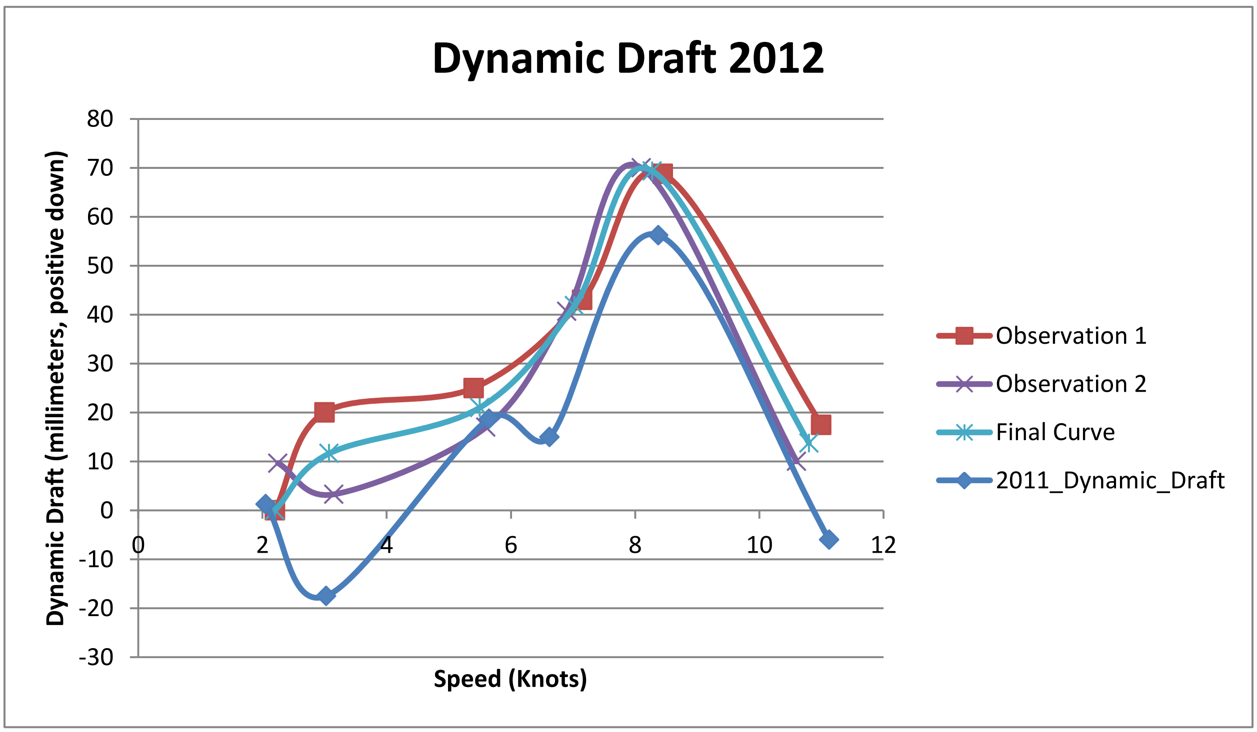
Note: * - Reading was ignored due because the setup was found to be disturbed.

Table 2

Test 1		Test 2		Average	
meters/sec	delta z	meters/sec	delta z	meters/sec	delta z
1.132	0.000	*	*	1.132	0.000
1.543	0.020	1.620	0.003	1.582	0.012
2.778	0.025	2.881	0.017	2.829	0.021
3.678	0.043	3.550	0.041	3.614	0.042
4.347	0.069	4.167	0.070	4.257	0.069
5.659	0.018	5.453	0.010	5.556	0.014

Note: * - Reading was ignored due because the setup was found to be disturbed.

Figure 3: Plot of Dynamic Draft Curve



Conclusions:

The excellent correlation between the two trials gives a high level of confidence in the testing methods employed.   It is our conclusion that the dynamic draft values obtained from this test are accurate, and suitable for use through the 2012 field season, assuming no major modifications are made to the survey vessel.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Ocean Service
National Geodetic Survey
Field Operations Branch

NOAA Boat – S 3002
IMU and MULTI-BEAM Component Spatial Relationship Survey
Field Report

Kevin Jordan
August, 2009

NOAA Boat – S 3002
IMU and MULTI-BEAM Survey

PURPOSE

The intention of this survey was to accurately position the Inertial Measuring Unit (IMU) and MULTI-BEAM (MBES) components that have been installed onboard the NOAA Boat S 3002.

PROJECT DETAILS

This survey was conducted on August 4 & 5, 2009 near the Naval Education and Training Center in Middletown, RI. The Boat was on a trailer and attached to a towing vehicle. The weather was clear and sunny on the day of the survey. Reconnaissance was conducted, and control marks CL 1, BM 1, BM 2, and BM 3 were found as described. CL 2 and BM 4 were searched for, but were not recovered.

INSTRUMENTATION

The TOPCON GPT 3000 Series Total Station was used to make all measurements.

A SECO 25 mm Mini Prism System configured to have a zero mm offset was used as target sighting and distance measurements.

SOFTWARE AND DATA COLLECTION

ADL Ver. 2.0.11 was used for data collection

ForeSight DXM Ver. 3.2.2 was used for post processing.

PERSONNEL

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

NOAA Boat – S 3002
IMU and MULTI-BEAM Survey

SURVEY PROCEDURES

Establishing the Centerline

To conduct this survey a local coordinate reference frame was established, where the X axis runs along the centerline of the boat and is positive from the primary reference point towards the bow of the boat. The Y axis is perpendicular to the centerline of the boat (X axis), and is positive from the primary reference point towards the right, when looking at the boat from the stern. The Z axis is positive in an upward direction from the primary reference point.

A temporary centerline mark (TCL) was established to align horizontally with CL 1. This was performed by measuring between the two benchmarks at the stern (BM 2 and BM 3) and placing a single punch mark on the deck halfway between them. An assumed distance of 3 meters was entered into NGS Program FORWARD.exe to produce a coordinate along the X axis to enter into the data collector to start the survey (initial azimuth). The instrument was setup on TCL and an assumed elevation of 100 ft was entered into the data collector. A prism was set above CL 1 and an azimuth of 0° 00’ 00” was entered into the data collector while aimed at CL 1. From this station, temporary control points (TP 1 and TP 2) were set off the boat on steady ground.

Setup 1
TP 1 – While occupying TP 1 the instrument was set to initialize on TCL. After initialization was conducted, angular and distance measurements were taken to collect the following points: VBES (SINGLE-BEAM center point), GPS STAR (Starboard GPS Receiver), GPS PORT (Port GPS Receiver), DGPS (Differential GPS Receiver), BM 1, IMU, and BM 3.

Setup 2
TP 2 – Occupying TP 2 the instrument was set to initialize on TCL. After initialization was conducted, angular and distance measurements were taken to collect the following points: MBES (MULTI-BEAM center point), BM 2, and SSS TP (SIDE SCAN SONAR TOW POINT), and CL 1 OBS*. Coordinate checks were made to the following previously established points:

BM 3
X, Y = 0.008(m)
Z = 0.005(m)

IMU
X, Y = 0.020(m)
Z = 0.005(m)

DGPS
X, Y = 0.005(m)
Z = 0.005(m)

GPS PORT
X, Y = 0.010(m)
Z = 0.002(m)

GPS STAR
X, Y = 0.000(m)
Z = 0.002(m)

BM 1
X, Y = 0.027(m)
Z = 0.009(m)

* CL 1 OBS was positioned, but was determined later to have a bad elevation after review of field work later that day. Survey operations were conducted on the following day to correct this bad elevation.

Setup 3
Occupying TP 1 the instrument was set to initialize on TCL. After initialization was conducted, angular and distance measurements were taken to collect the following point: TP 4

During this observation, a coordinate check was made to:
BM 2
X, Y = 0.002(m)
Z = 0.002(m)

Setup 4
TP 4 – Occupying TP 1 the instrument was set to initialize on TCL. After initialization was conducted, angular and distance measurements were taken to collect the following point: CL 1 OBS

During this observation, a coordinate check was made to:
TP 1
X, Y = 0.001(m)
Z = 0.009(m)

POST PROCESSING

Since the project was initialized using assumed positions and elevations, the collected points needed to be translated to a referenced coordinate system. Using ForeSight DXM, our observed CL 1 OBS was translated N 0.000(m), E 0.000(m), and Elev 0.000(m). See table 1

The same adjustment was made for the IMU as the reference point of N 0.000(m), E 0.000(m), and Elev 0.000(m). See table 1

DISCUSSION

All sensor/benchmark coordinates are contained in spreadsheet "S3002 2009.xls."

The positions given for all GPS antenna are to the top center of the antenna. As stated from the previous 2005 survey by Kendall L. Fancher:

> "To correct the Z value contained in the spreadsheet for each antenna to the electronic phase center, I recommend the following steps be taken;
>
> 1) Measure the total height of each antenna type. This information is probably located on the antenna or with equipment documentation.
> 2) Investigate to find the electronic phase center offset of the antenna. This information is probably located on the antenna or with equipment documentation. This value may also be available at the NGS website for antenna modeling.

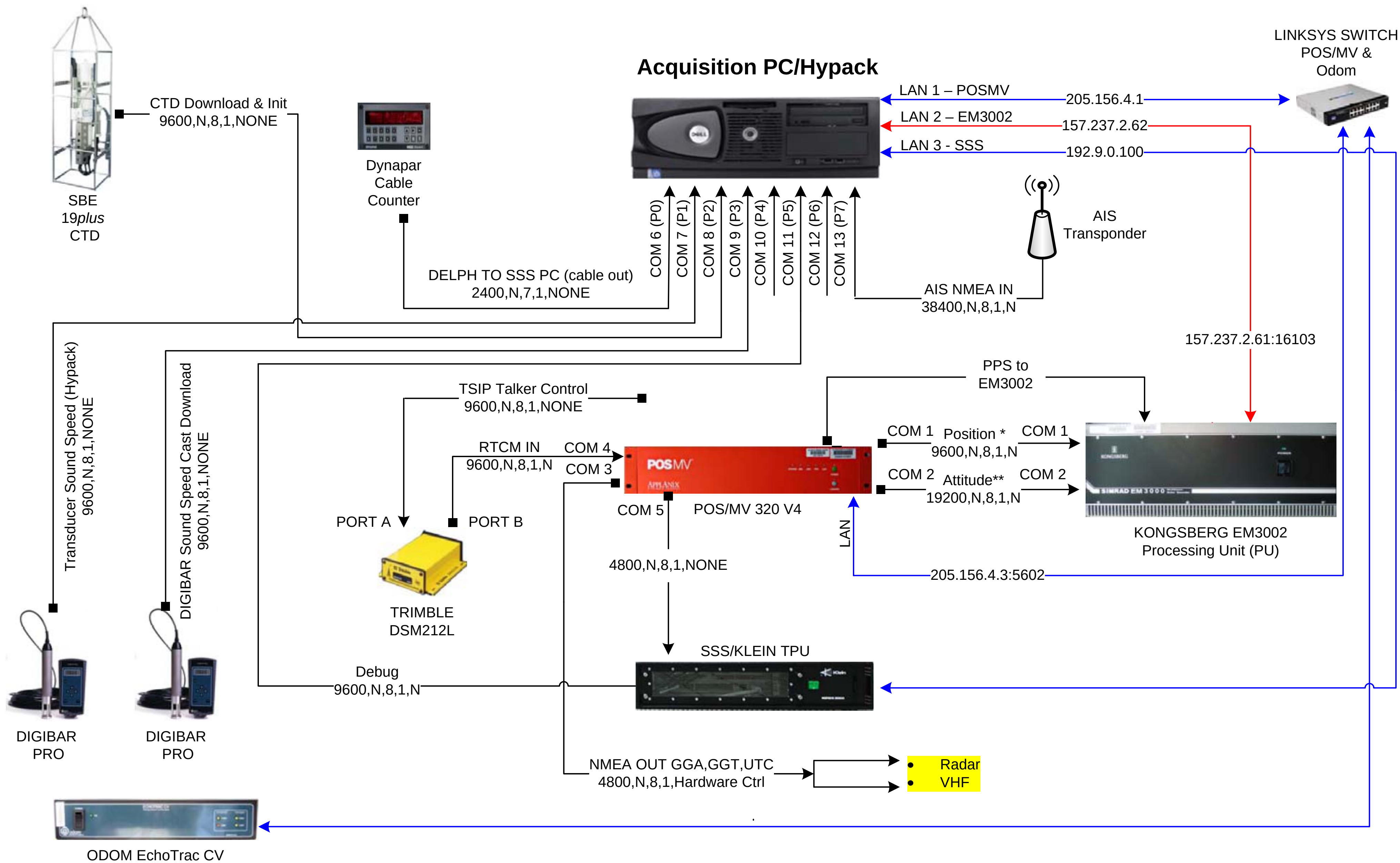
3) Subtract the total height of the antenna from the spreadsheet Z value for each antenna. This will give you a Z value for the ARP (antenna reference point)
4) Then add to this value the electronic phase center offset value."

NOAA BOAT S 3002							
		∆ Reference Point CL1			∆ Reference Point IMU		
POINT	Name	∆x (m)	∆y (m)	∆z (m)	∆x (m)	∆y (m)	∆z (m)
CL1 OBS	CENTERLINE POINT 1	0.000	0.000	0.000	2.070	0.001	-0.427
TCL	TEMPORARY CENTERLINE	-3.159	0.004	1.128	-1.089	0.004	0.701
BM1	BENCH MARK 1	4.477	0.022	1.497	6.547	0.022	1.070
BM2	BENCH MARK 2	-3.143	-1.129	1.256	-1.073	-1.128	0.829
BM3	BENCH MARK 3	-3.157	1.140	1.233	-1.087	1.141	0.806
IMU	IMU	-2.070	-0.001	0.427	0.000	0.000	0.000
DGPS	GPS NAVIGATION ANTENNA	-0.608	0.013	3.607	1.462	0.014	3.180
GPS PORT	IMU GPS PORT SIDE	1.125	-0.756	2.827	3.195	-0.755	2.400
GPS STAR	IMU GPS STARBOARD SIDE	1.137	0.782	2.825	3.207	0.783	2.398
MBES	MULTIBEAM REFERENCE POINT	-1.913	0.057	-0.112	0.158	0.058	-0.539
VBES	SINGLE BEAM REFERENCE POINT	0.179	-0.163	-0.026	2.249	-0.162	-0.453
SSS TP	SIDE SCAN SONAR TOW POINT	-2.826	1.646	2.915	-0.756	1.647	2.488

Table 1. - NRT S 3002 survey August 2009

CONTROL INVERSE COMPARISON (HORIZONTAL ONLY)			
	2005 SURVEY IN METERS	2009 SURVEY IN METERS	DIFFERENCE IN METERS
CL1 TO BM1	4.433	4.477	-0.044
CL1 TO BM2	3.371	3.399	-0.028
CL1 TO BM3	3.378	3.357	0.021
BM1 TO BM2	7.693	7.706	-0.013
BM1 TO BM3	7.699	7.719	-0.020
BM2 TO BM3	2.265	2.269	-0.004

Table 2. – NRT S 3002 Control network inverse comparison.



Key
- Serial
- Crossover
- Patch

* POS/MV COM 1 Position Data: 9600,N,8,1,NONE; GGA, HDT, ZDA, VTG; 1Hz
** POS/MV COM 2 Attitude Data: SIMRAD 1000 Tate-Bryant, 25Hz

Launch S3002 Wire Diagram

Rev 1.0	5/5/2011	Philip Sparr

Appendix III – Calibration

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

Conductivity Calibration Report

Customer:	NOAA-NAVIGATION RESPONSE BRANCH		
Job Number:	67534	**Date of Report:**	1/30/2012
Model Number	SBE 19Plus	**Serial Number:**	19P39974-4835

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: 1/28/2012 Drift since last cal: -0.00030 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.

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: 4835
CALIBRATION DATE: 28-Jan-12

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.267279e-003
a1 = 2.593243e-004
a2 = 5.041887e-007
a3 = 1.341580e-007

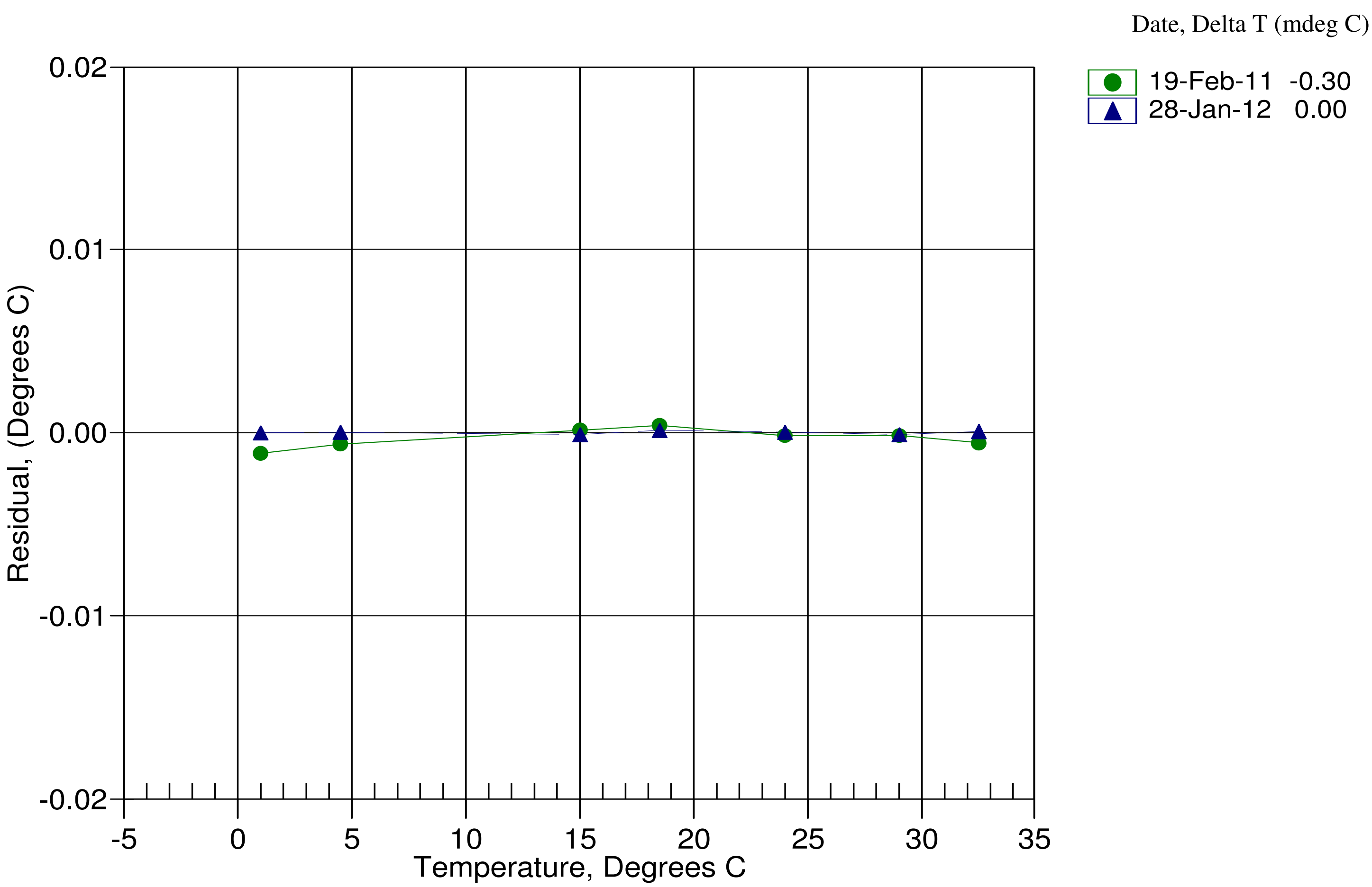
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	600974.254	0.9999	-0.0000
4.5000	533092.610	4.5000	0.0000
15.0000	365259.746	14.9999	-0.0001
18.5000	320328.508	18.5001	0.0001
24.0000	259412.424	24.0000	0.0000
29.0000	213095.051	28.9999	-0.0001
32.5000	185134.542	32.5001	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



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: 4835
CALIBRATION DATE: 26-Jan-12

SBE19plus PRESSURE CALIBRATION DATA
160 psia S/N 7813

COEFFICIENTS:

```
PA0 =   -3.956919e-003
PA1 =    4.871780e-004
PA2 =   -3.560781e-012
PTEMPA0 = -6.075336e+001
PTEMPA1 =  5.327189e+001
PTEMPA2 =  3.924029e-003
PTCA0 =   5.240192e+005
PTCA1 =   1.090882e+000
PTCA2 =  -8.473146e-002
PTCB0 =   2.512200e+001
PTCB1 =  -2.000000e-003
PTCB2 =   0.000000e+000
```

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.77	554243.0	1.6	14.75	-0.01
30.01	585545.0	1.6	30.02	0.01
60.03	647111.0	1.6	60.03	-0.00
95.03	718964.0	1.6	95.01	-0.01
125.02	780674.0	1.6	125.03	0.00
160.04	852730.0	1.6	160.05	0.00
125.05	780712.0	1.6	125.05	0.00
95.05	719044.0	1.6	95.05	-0.00
60.06	647175.0	1.6	60.06	-0.00
30.07	585695.0	1.6	30.09	0.01
14.77	554273.0	1.6	14.77	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.75	555177.34
29.00	1.69	555194.76
24.00	1.59	555213.03
18.50	1.49	555225.29
15.00	1.42	555226.36
4.50	1.23	555238.11
1.00	1.16	555233.68

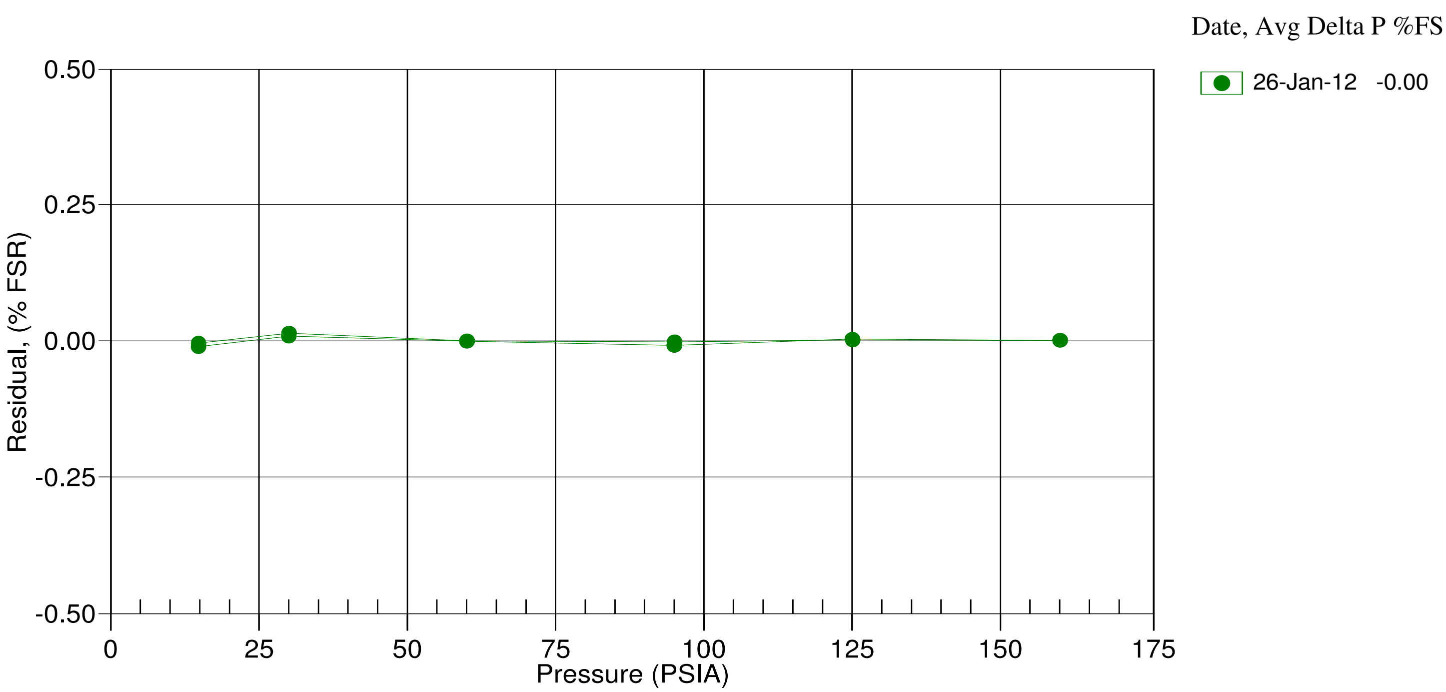
TEMP(ITS90)	SPAN(mV)
-5.00	25.13
35.00	25.05

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



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: 4835
CALIBRATION DATE: 28-Jan-12

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

COEFFICIENTS:

```
g = -1.018832e+000
h =  1.322201e-001
i = -2.587017e-004
j =  3.613662e-005

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

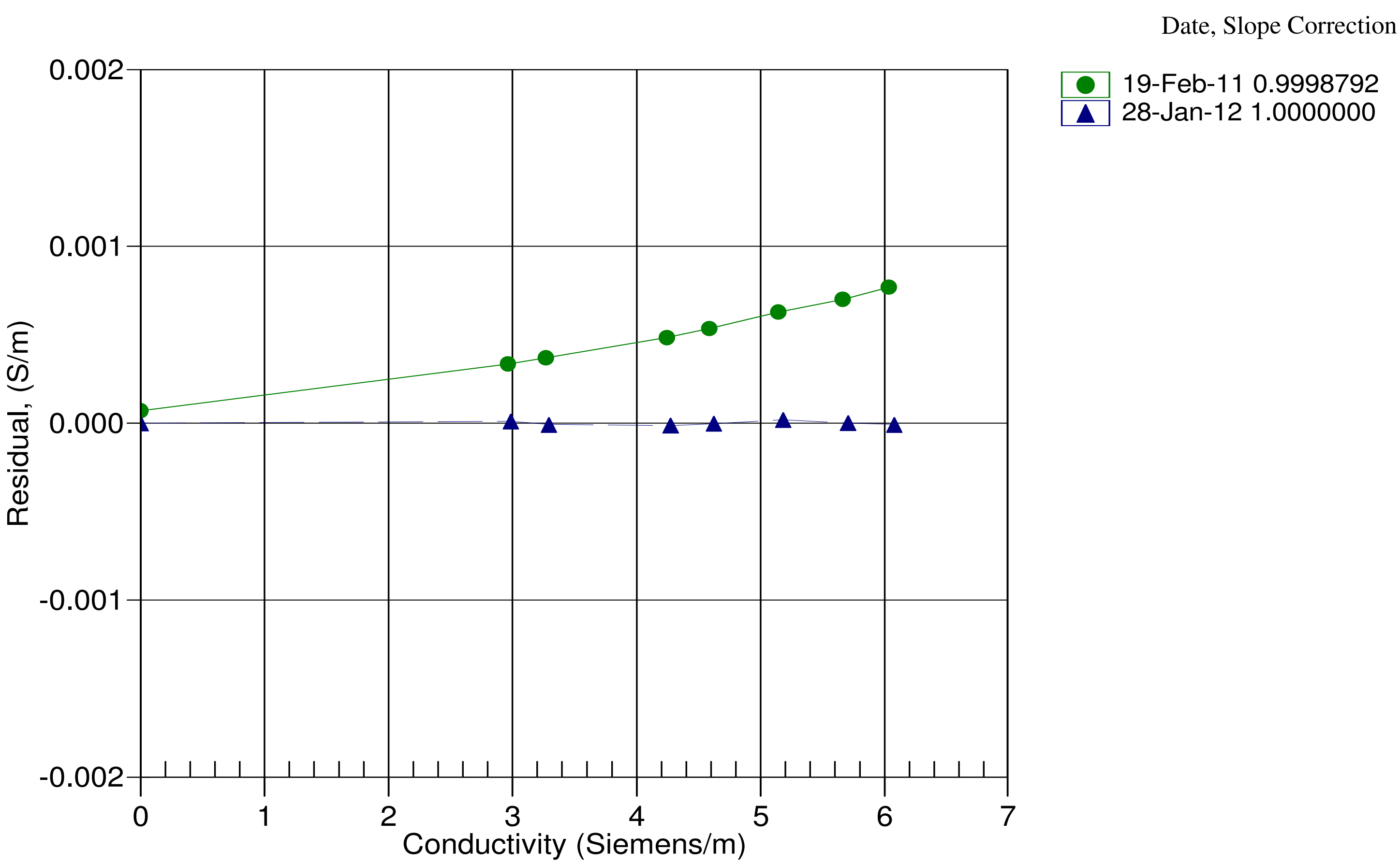
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2780.52	0.0000	0.00000
0.9999	34.9075	2.98301	5508.36	2.9830	0.00001
4.5000	34.8868	3.29072	5715.57	3.2907	-0.00001
15.0000	34.8424	4.27448	6331.90	4.2745	-0.00001
18.5000	34.8327	4.62031	6534.48	4.6203	-0.00000
24.0000	34.8217	5.17934	6848.95	5.1794	0.00002
29.0000	34.8151	5.70214	7130.12	5.7021	0.00000
32.5000	34.8095	6.07494	7323.82	6.0749	-0.00001

f = INST FREQ / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



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

Temperature Calibration Report

Customer:	NOAA-NAVIGATION RESPONSE BRANCH		
Job Number:	67534	**Date of Report:**	1/30/2012
Model Number	SBE 19Plus	**Serial Number:**	19P39974-4835

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: 1/28/2012 Drift since last cal: +0.00032 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

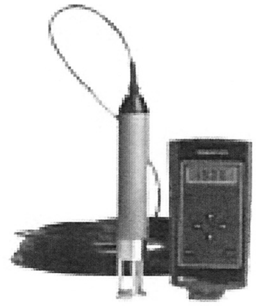
Date:
Oct 17, 2011

Serial #:
98214-101711

DIGIBAR CALIBRATION REPORT

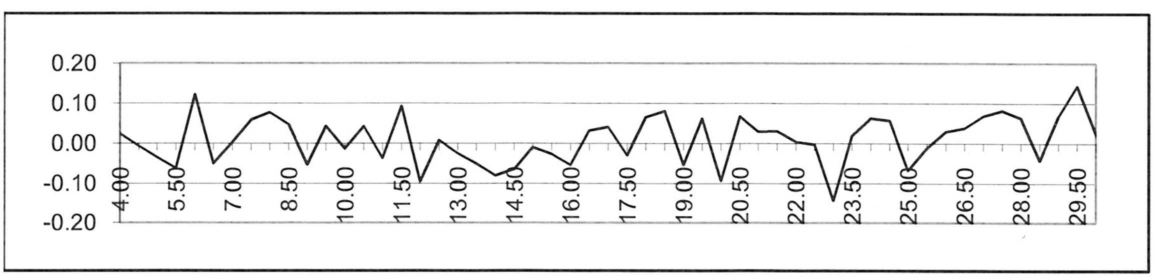
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL	TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5556.16	1421.65	0.02	17.50	1474.38	5754.23	1474.35	-0.03
4.50	1423.90	5564.61	1423.89	-0.01	18.00	1476.01	5760.71	1476.08	0.07
5.00	1426.15	5572.97	1426.12	-0.03	18.50	1477.62	5766.81	1477.70	0.08
5.50	1428.38	5581.23	1428.32	-0.06	19.00	1479.21	5772.27	1479.15	-0.05
6.00	1430.58	5590.19	1430.70	0.12	19.50	1480.77	5778.59	1480.83	0.06
6.50	1432.75	5597.71	1432.70	-0.05	20.00	1482.32	5783.81	1482.22	-0.09
7.00	1434.90	5605.98	1434.90	0.00	20.50	1483.84	5790.15	1483.91	0.07
7.50	1437.02	5614.16	1437.08	0.06	21.00	1485.35	5795.66	1485.38	0.03
8.00	1439.12	5622.11	1439.19	0.08	21.50	1486.83	5801.24	1486.86	0.03
8.50	1441.19	5629.78	1441.24	0.05	22.00	1488.29	5806.64	1488.30	0.00
9.00	1443.23	5637.09	1443.18	-0.05	22.50	1489.74	5812.04	1489.73	0.00
9.50	1445.25	5645.05	1445.30	0.04	23.00	1491.16	5816.86	1491.02	-0.14
10.00	1447.25	5652.34	1447.24	-0.01	23.50	1492.56	5822.75	1492.58	0.02
10.50	1449.22	5659.96	1449.27	0.04	24.00	1493.95	5828.12	1494.01	0.06
11.00	1451.17	5666.98	1451.13	-0.04	24.50	1495.32	5833.23	1495.37	0.06
11.50	1453.09	5674.70	1453.19	0.09	25.00	1496.66	5837.82	1496.59	-0.07
12.00	1454.99	5681.13	1454.90	-0.10	25.50	1497.99	5843.02	1497.98	-0.01
12.50	1456.87	5688.57	1456.88	0.01	26.00	1499.30	5848.09	1499.33	0.03
13.00	1458.72	5695.41	1458.70	-0.02	26.50	1500.59	5852.97	1500.63	0.04
13.50	1460.55	5702.19	1460.50	-0.05	27.00	1501.86	5857.86	1501.93	0.07
14.00	1462.36	5708.87	1462.28	-0.08	27.50	1503.11	5862.62	1503.19	0.08
14.50	1464.14	5715.63	1464.08	-0.06	28.00	1504.35	5867.19	1504.41	0.06
15.00	1465.91	5722.46	1465.90	-0.01	28.50	1505.56	5871.36	1505.52	-0.04
15.50	1467.65	5728.93	1467.62	-0.03	29.00	1506.76	5876.28	1506.83	0.07
16.00	1469.36	5735.28	1469.31	-0.05	29.50	1507.94	5881.00	1508.08	0.14
16.50	1471.06	5741.97	1471.09	0.03	30.00	1509.10	5884.92	1509.13	0.02
17.00	1472.73	5748.29	1472.77	0.04					



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

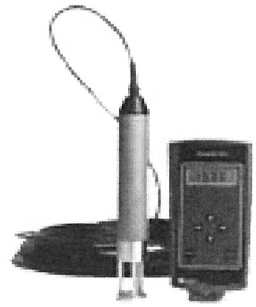
Date:
Oct 17, 2011

Serial #:
98214-101711

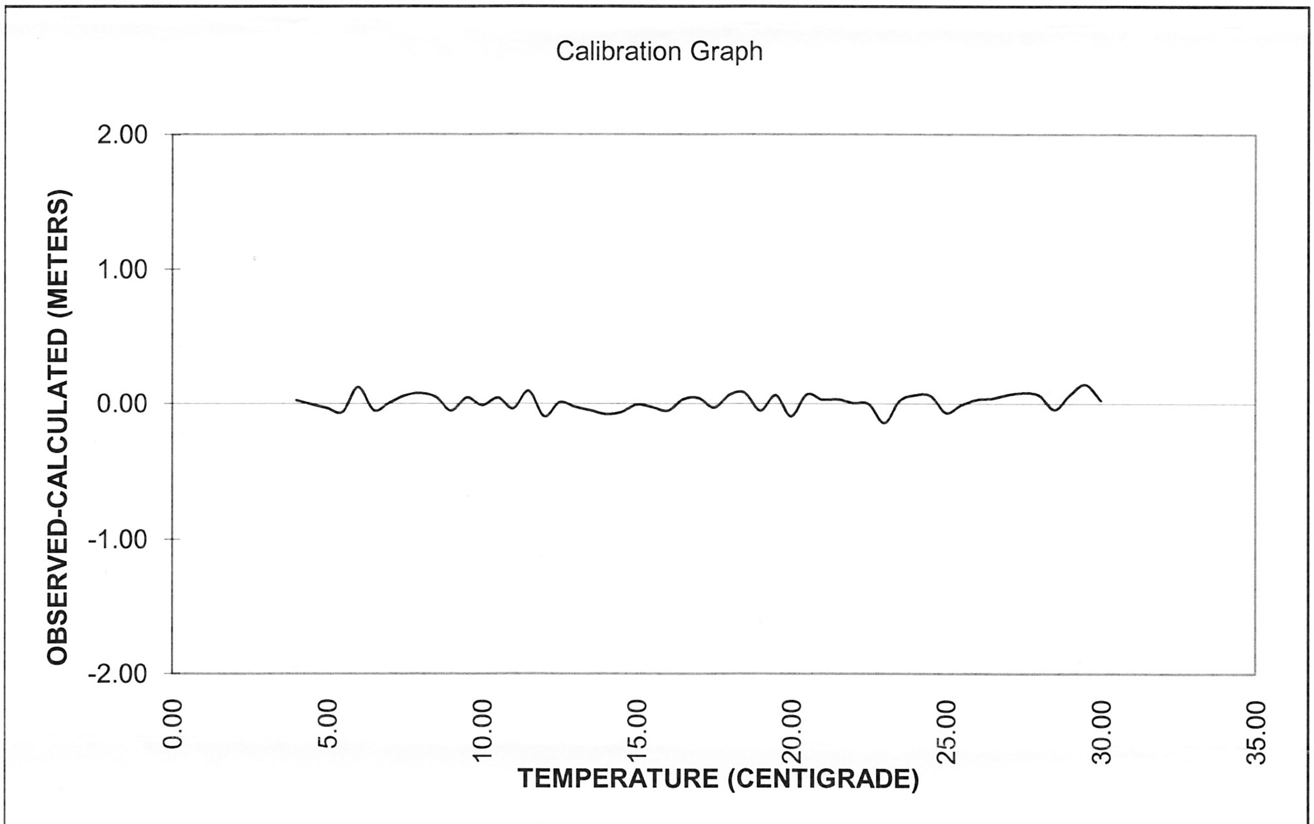
DIGIBAR CALIBRATION REPORT

version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



Burn these numbers to EPROM:	Gradient	**3407**
	Intercept	**569**



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

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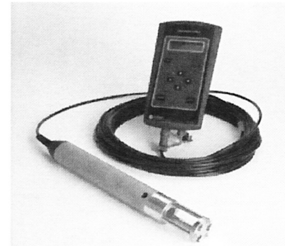
A Teledyne Technologies Company

Digibar

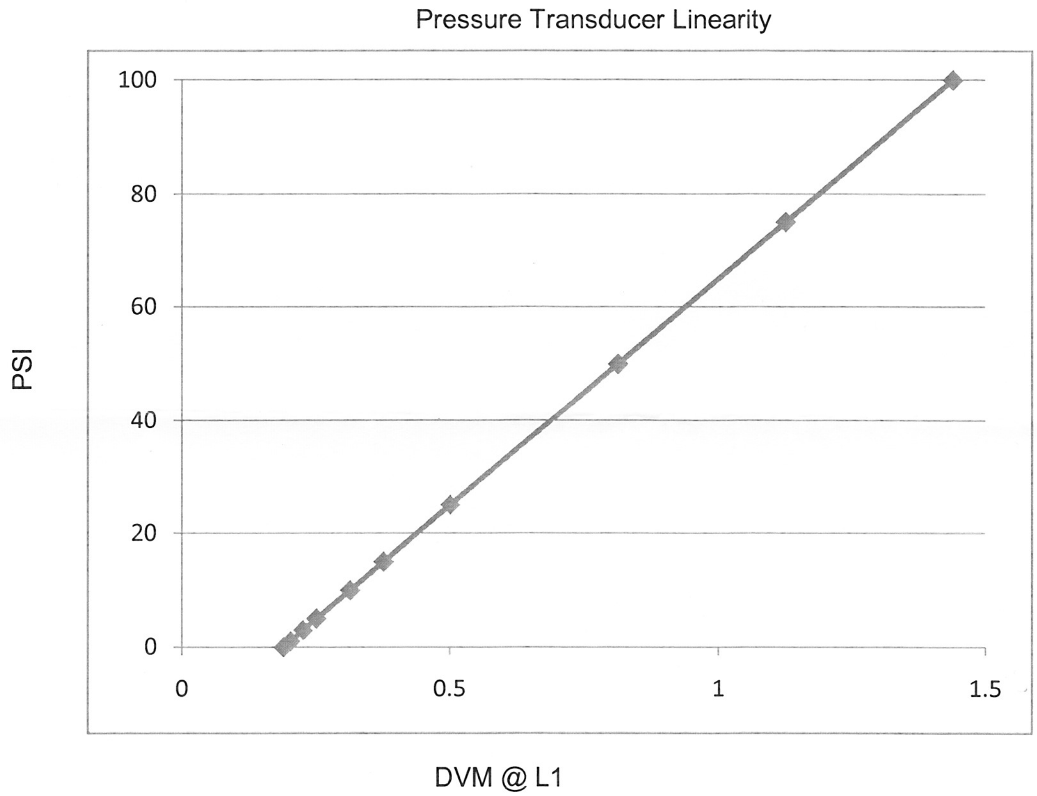


Date	10/19/2011
Serial #	98214
SW Version	1.11
Cable Length	100m

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	1811914

Press Transducer	57287
Zero Voltage	.19
Span Volage	2.69
Mid-Scale Voltage	1.44
R5	3.9K
R9	10K
Gradient	3407
Intercept	569

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

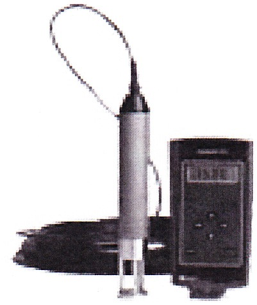
Date:
Jan 16, 2012

Serial #:
98212-011612

DIGIBAR CALIBRATION REPORT

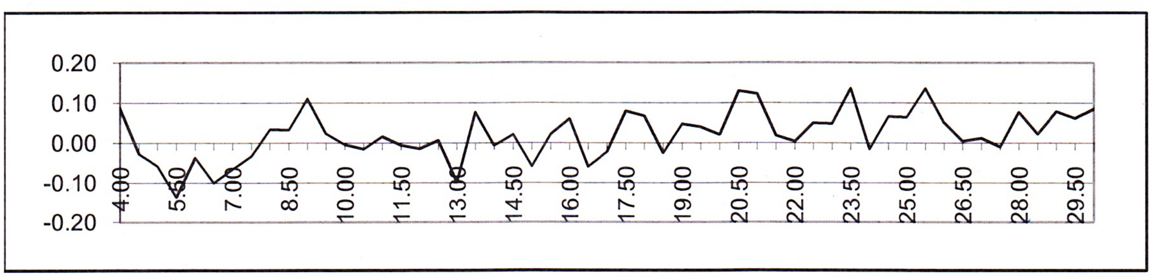
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



STANDARD DEL GROSSO H^2O

TEMP	VELOCITY	MEASURED FREQUENCY	RES_VEL	OBS-CAL
4.00	1421.62	5549.11	1421.71	0.09
4.50	1423.90	5557.24	1423.87	-0.03
5.00	1426.15	5565.58	1426.09	-0.06
5.50	1428.38	5573.64	1428.24	-0.14
6.00	1430.58	5582.27	1430.54	-0.04
6.50	1432.75	5590.19	1432.65	-0.10
7.00	1434.90	5598.38	1434.83	-0.07
7.50	1437.02	5606.47	1436.99	-0.03
8.00	1439.12	5614.59	1439.15	0.03
8.50	1441.19	5622.36	1441.22	0.03
9.00	1443.23	5630.33	1443.34	0.11
9.50	1445.25	5637.59	1445.28	0.02
10.00	1447.25	5644.98	1447.25	0.00
10.50	1449.22	5652.34	1449.21	-0.02
11.00	1451.17	5659.77	1451.19	0.02
11.50	1453.09	5666.91	1453.09	-0.01
12.00	1454.99	5674.01	1454.98	-0.01
12.50	1456.87	5681.13	1456.88	0.01
13.00	1458.72	5687.69	1458.63	-0.10
13.50	1460.55	5695.22	1460.63	0.08
14.00	1462.36	5701.69	1462.35	-0.01
14.50	1464.14	5708.49	1464.17	0.02
15.00	1465.91	5714.80	1465.85	-0.06
15.50	1467.65	5721.63	1467.67	0.02
16.00	1469.36	5728.22	1469.42	0.06
16.50	1471.06	5734.13	1471.00	-0.06
17.00	1472.73	5740.55	1472.71	-0.02
17.50	1474.38	5747.13	1474.46	0.08
18.00	1476.01	5753.20	1476.08	0.07
18.50	1477.62	5758.89	1477.59	-0.02
19.00	1479.21	5765.12	1479.25	0.05
19.50	1480.77	5770.97	1480.81	0.04
20.00	1482.32	5776.70	1482.34	0.02
20.50	1483.84	5782.83	1483.97	0.13
21.00	1485.35	5788.45	1485.47	0.12
21.50	1486.83	5793.63	1486.85	0.02
22.00	1488.29	5799.07	1488.30	0.00
22.50	1489.74	5804.66	1489.79	0.05
23.00	1491.16	5810.00	1491.21	0.05
23.50	1492.56	5815.60	1492.70	0.14
24.00	1493.95	5820.23	1493.93	-0.02
24.50	1495.32	5825.66	1495.38	0.07
25.00	1496.66	5830.71	1496.73	0.07
25.50	1497.99	5835.96	1498.13	0.14
26.00	1499.30	5840.55	1499.35	0.05
26.50	1500.59	5845.22	1500.59	0.01
27.00	1501.86	5850.02	1501.87	0.01
27.50	1503.11	5854.64	1503.10	-0.01
28.00	1504.35	5859.60	1504.42	0.08
28.50	1505.56	5863.96	1505.58	0.02
29.00	1506.76	5868.67	1506.84	0.08
29.50	1507.94	5873.04	1508.00	0.06
30.00	1509.10	5877.49	1509.19	0.09



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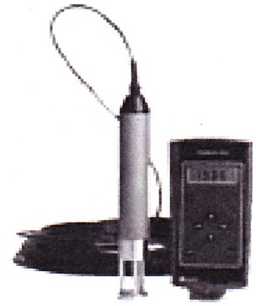
Date:	Jan 16, 2012
Serial #:	98212-011612

DIGIBAR CALIBRATION REPORT

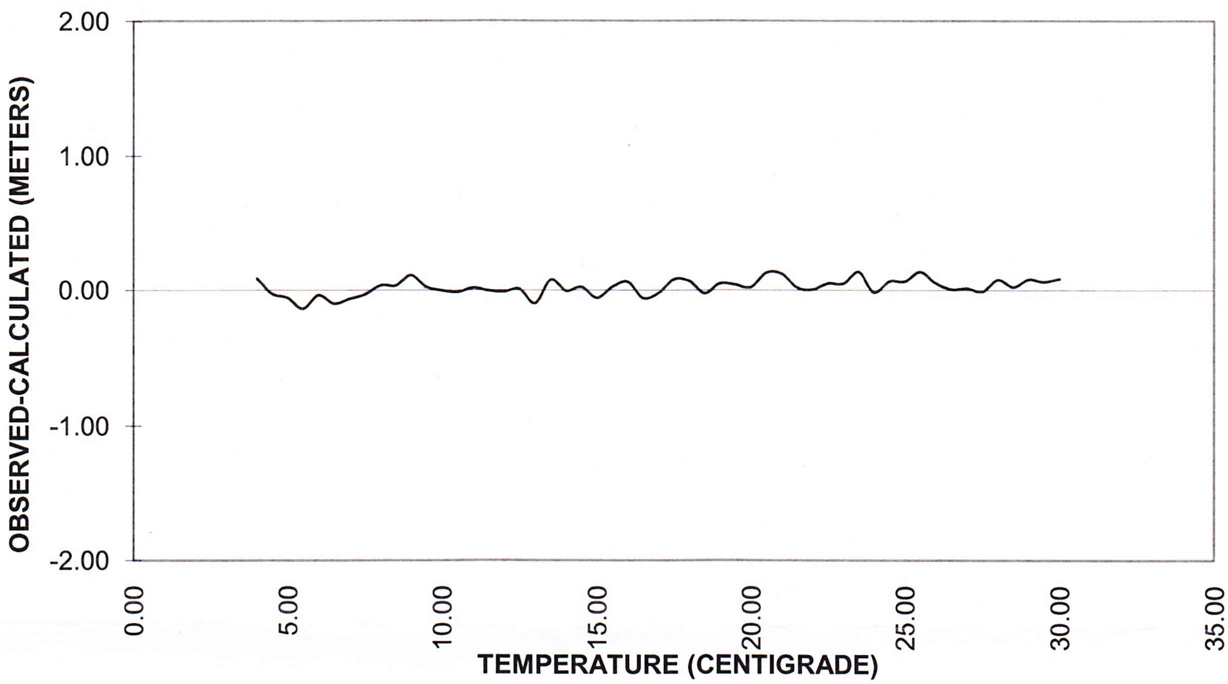
version 1.0 (c) 2004

ODOM HYDROGRAPHIC SYSTEMS, Inc.



Burn these numbers to EPROM:	Gradient	**3410**
	Intercept	**566**

Calibration Graph



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ODOM HYDROGRAPHIC
A Teledyne Technologies Company

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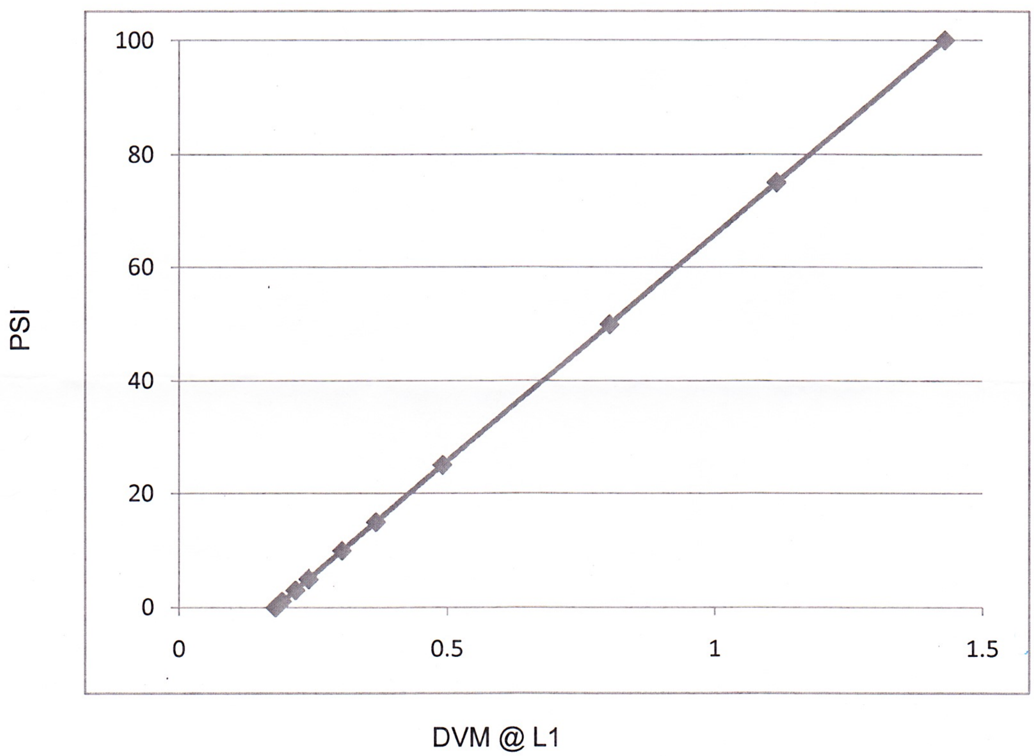
Date	1/17/2012
Serial #	98212
SW Version	1.12
Cable Length	20m

Board Identification	Serial #
Power Supply	
Control PCB	
LCD	
Probe Sensor	
Probe Controller	
Airmar Transducer	1753326

Press Transducer	58649
Zero Voltage	.18
Span Volage	2.68
Mid-Scale Voltage	1.43
R5	3.9K
R9	10K
Gradient	3410
Intercept	566

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

Pressure Transducer Linearity



Transducer Linearity	
PSI	DVM@L1
0	0.18
1	0.192
3	0.217
5	0.242
10	0.304
15	0.367
25	0.491
50	0.804
75	1.116
100	1.43

Appendix IV – Electronic Appendix

The Electronic Appendix contains digital files meant to accompany the report body. It is submitted as a .zip file located in the *Appendix4-ElectronicAppendix* folder.