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

Data Acquisition & Processing Report

Type of Survey	**Navigable Area**
Project No.	**OPR-B310-FH-13**
Registry No.	**H12627, H12628, H12629**
Time Frame	**10 October 2013 - 22 November 2013**

LOCALITY

State	**New York**
General Locality	**Approaches to New York**

2013

CHIEF OF PARTY

LCDR Marc S. Moser, NOAA

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Data Acquisition and Processing Report

NOAA Ship *Ferdinand R. Hassler*
Chief of Party: LCDR Marc S. Moser, NOAA
Year: 2013
Version: 1
Publish Date: 2014-01-31

A Equipment

A.1 Survey Vessels

A.1.1 NOAA Ship FERDINAND R. HASSLER

Name	NOAA Ship FERDINAND R. HASSLER	
Hull Number	S250	
Description	FERDINAND R. HASSLER is a Small Waterplane Area, Twin-Hull (SWATH) coastal mapping vessel.	
Utilization	Survey	
Dimensions	*LOA*	37.7 meters
	Beam	18.5 meters
	Max Draft	3.85 meters
Most Recent Full Static Survey	*Date*	2009-11-04
	Performed By	Raymond C. Impastato, Professional Land Surveyor
	Discussion	This survey was provided by the shipbuilder, V.T. Halter Marine, and performed in the shipyard prior to delivery.
Most Recent Partial Static Survey	*Date*	2012-06-12
	Performed By	Kevin Jordan, NGS
	Discussion	This survey was performed after the POS/MV antenna mounts were reconfigured to newly fabricated mounts and ties the POS antennae into benchmarks on the 03 deck.

Most Recent Full Offset Verification	Full offset verification was not performed.	
Most Recent Partial Offset Verification	*Date*	2013-04-07
	Method Used	Optical level run while ship was out of the water in drydock
	Discussion	A level loop was run from the POS antenna's to each sensor mounted on the ship hull. In addition, measurements were made to both IMU base plates through the 7125 cable passage. The resulting offsets from this survey were used to verify and update Z offsets between all sensors.
Most Recent Static Draft Determination	*Date*	2011-07-12
	Method Used	Calculation from design waterline and measured offsets
	Discussion	Assumed design waterline of 3.80 meters and measured offsets to IMU were used to determine static draft of the reference point. The ship's draft is operationally managed with daily ballast to achieve the true design waterline of 3.80 meters. Draft uncertainty is estimated at 0.05 meters. See Section C.2.1.1 for additional discussion.
Most Recent Dynamic Draft Determination	*Date*	2013-06-26
	Method Used	Ellipsoid referenced dynamic draft measurement (ERDDM)
	Discussion	Data were acquired with canards at zero trim angle. During all survey operations, the canards are set to zero trim angle.

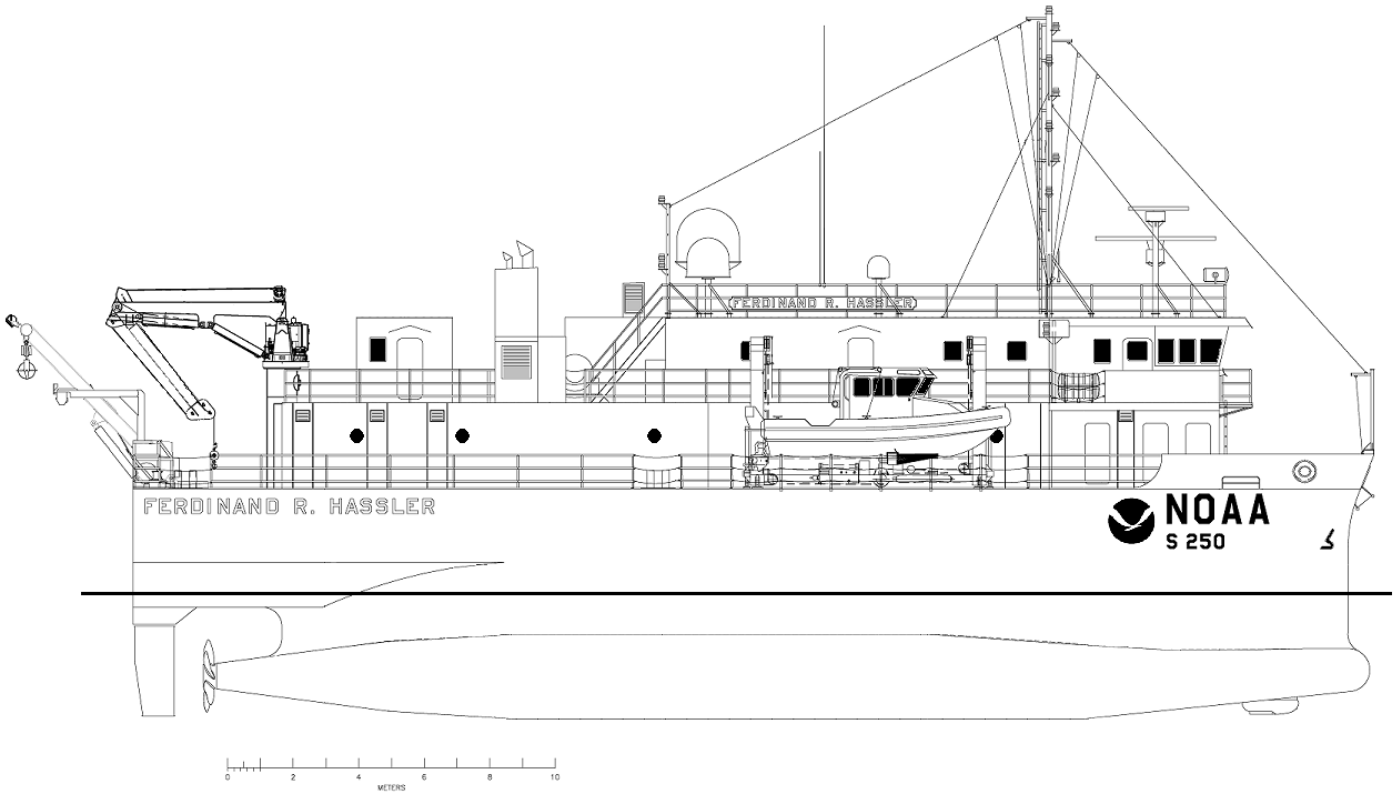


Figure 1: NOAA Ship FERDINAND R. HASSLER, Starboard View

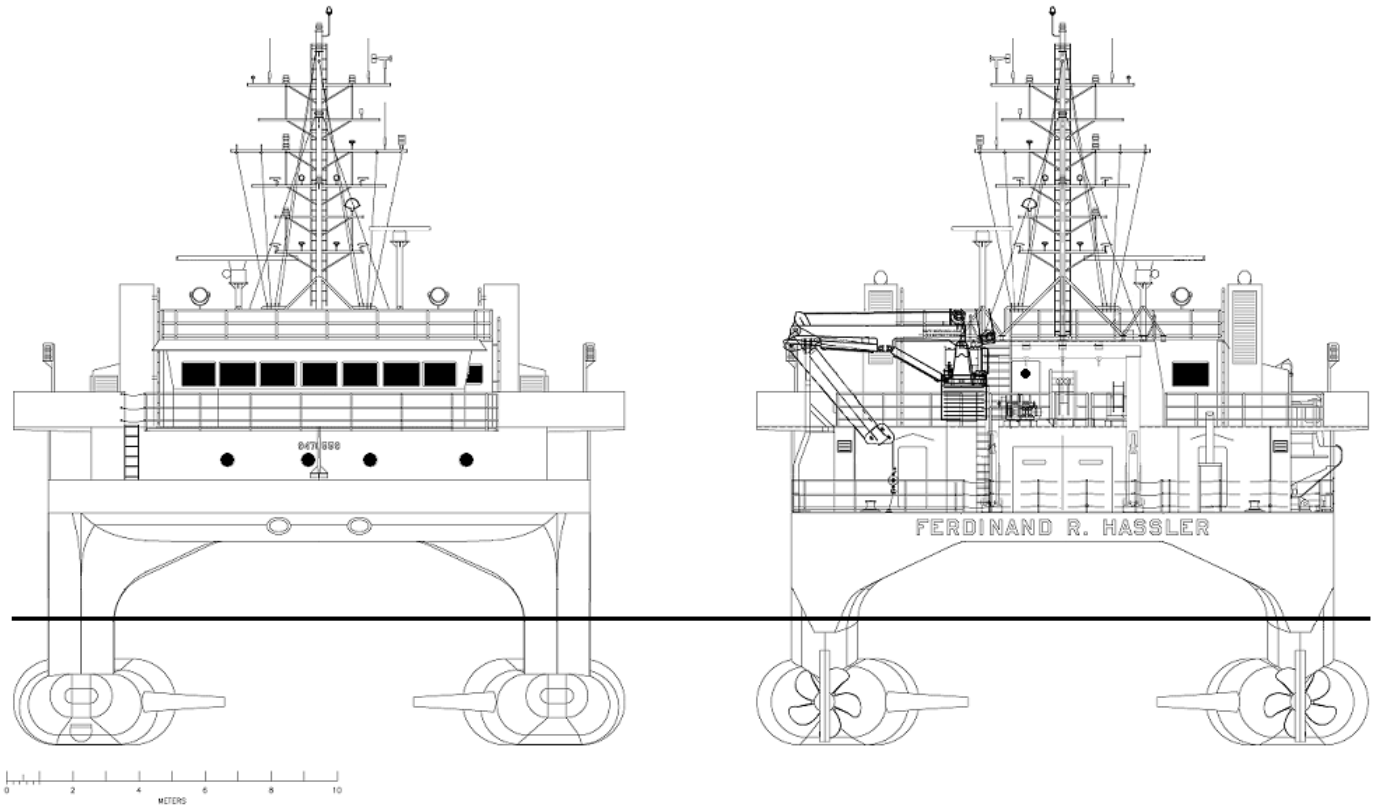


Figure 2: NOAA Ship FERDINAND R. HASSLER, Bow and Stern View

A.2 Echo Sounding Equipment

A.2.1 Side Scan Sonars

A.2.1.1 Klein 5000 V2 Bathymetry

Manufacturer	Klein
Model	5000 V2 Bathymetry
Description	High-speed high-resolution towed side-scan sonar (SSS) system. This system is a beam-forming acoustic imagery device with an operating frequency of 455 kHz and vertical beam width of 40°. The Klein 5000 V2 system consists of a 5250 V2 towfish and a 5105 V2 Transceiver Processing Unit (TPU). The towfish is towed via 3/8" armored coaxial cable connected to a DT marine electro-hydraulic winch (s/n 1271 302 OEHLW3R) equipped

with a Klein slip ring model: (14103033, s/n 1802003). The towfish is fitted with a Klein K-wing depressor wing. The winch is controllable from the sonar operator's station. Cable out is measured with a 3PS cable counter integrated with a General Oceanics model 4042 sheave. The sheave is mounted on the A-frame and is the tow point for offsets measurements. Cable counter accuracy was verified on August 3, 2012 using a known length of line.

The SSS cable was re-terminated on July 27, 2012 and a new 12 meter cable mark for the docked and zero measurement was marked and verified on July 27, 2013.

A side scan calibration was conducted on July 17, 2013 (Dn198) in the vicinity of Cape Charles City with towfish SN: 386.

In this test a number of lines were run adjacent to a buoy block. The side scan positions are compared with the multibeam positions in the attached report. The 95% confidence interval of the positioning error is 7.2 meters.

In all cases during survey operation, an area well in excess of 20 meters to each side of a side scan contact is investigated with multibeam, therefore the positioning errors, if caused by current or vessel maneuvers, would not cause a feature to be improperly investigated. No features are recommended for charting at SSS derived positions.

Serial Numbers

Vessel Installed On	S250
TPU s/n	777
Towfish s/n	386

Specifications

Frequency	455 kilohertz				
Along Track Resolution	*Resolution*	10 centimeters	20 centimeters	36 centimeters	61 centimeters
	Min Range	38 meters	75 meters	150 meters	250 meters
	Max Range				
Across Track Resolution	3.75 centimeters				
Max Range Scale	250 meters				

Manufacturer Calibrations

Vessel Installed On	S250
Calibration Date	2013-07-17

Figure 3: Klien 5000 V2 configured for towing

A.2.2 Multibeam Echosounders

A.2.2.1 Reson 7125

Manufacturer	Reson
Model	7125
Description	The Reson 7125 is a dual head, dual multibeam system configured to work as a unit. While the particulars of the port system are specified in this section and the starboard head in the following section, this description and following quality control address the two heads as an integrated system.

The port and starboard sonars are mounted in their respective hulls with a 4.5 degree outboard tilt. The sonars can be operated independently, but are typically operated together as a dual-head system using frequency modulated (FM) pulses combined with center frequency separation to enable simultaneous pinging between the heads. When operated as a dual head system, the starboard system acts as the master and the port system the slave. The range scale, ping rate, surface sound speed, and time varied gain (TVG) parameters are controlled by the master.

The 7125 receivers and projectors on both hulls were removed during the drydock period and reinstalled.

400 kHz -

A patch test for the 400kHz mode was conducted on July 30, 2013 (Dn211) to account for newly installed POS-MV V5 inertial measurement and positioning devices. The values from this test were used on all data collected post July 25, 2013 (Dn206).

200 kHz -

A patch test for the 200kHz mode was conducted on July 31, 2013 (Dn212) in the vicinity of Hudson Canyon, NY.

Serial Numbers

Vessel Installed On	S250	same
Processor s/n	18210412051	same
Transceiver s/n	212036	same
Transducer s/n	n/a	n/a
Receiver s/n	2411045	same
Projector 1 s/n	2611093	same
Projector 2 s/n	n/a	n/a

Specifications	*Frequency*	400 kilohertz		200 kilohertz	
	Beamwidth	*Along Track*	1.0 degrees	*Along Track*	2 degrees
		Across Track	0.5 degrees	*Across Track*	1 degrees
	Max Ping Rate	50 hertz		50 hertz	
	Beam Spacing	*Beam Spacing Mode*	Equidistant	*Beam Spacing Mode*	Equidistant
		Number of Beams	512	*Number of Beams*	320
	Max Swath Width	140 degrees		140 degrees	
	Depth Resolution	6 millimeters		6 millimeters	
	Depth Rating	*Manufacturer Specified*	150 meters	*Manufacturer Specified*	400 meters
		Ship Usage	100 meters	*Ship Usage*	250 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.				

System Accuracy Tests	*Vessel Installed On*	S250	S250
	Methods	Reference surface comparison	Ellipsoidal Referenced Lead Line and Water Line
	Results	Shallow water (15 meters) reference surfaces were performed in the vicinity of Cape Charles City, VA on July 18, 2013 (Dn199). The location of the reference surfaces are shown in Figure 5. The 7125 400kHz sonars were operated in dual head FM, and single head CW. These surfaces were run with roll compensation turned on and their respective HVF's have been edited to remove the roll sensor as specified in CARIS Helpdesk ticket #01302295. For the 400kHz systems, the starboard head was on average 0.03 meters deeper with a standard deviation of 0.07. Differences between the FM and CW modes were within 0.02 meters for both heads, showing good agreement between the different methods. The results of this test are shown in Figures 6 through 8. Deeper water (80 meters) reference surfaces were performed for the 200kHz in the vicinity of Hudson Canyon, NY on July 31, 2013 (Dn212) using data obtained during the patch test. The location of the reference surfaces are shown in Figure 9. For the 200kHz systems, the starboard head was on average 0.02 shallower with a standard deviation of 0.27. While this standard deviation is large, 95% of all nodes are within +/- 0.50 in an area with depths in excess of 1.0 meters total allowable vertical uncertainty. The results of this test are shown in Figures 10.	On June 14, 2013 a static lead line comparison was performed relative to the ellipsoid for the port 7125 system. Ellipsoid height was obtained on a fixed mark ashore using static GPS observations. While the ship was pierside at MOC-A, a lead-line was lowered to the sea floor in the port 7125 field of view while logging sounding data. Observed ellipsoid height was transferred to the suspended lead-line using differential leveling, and the distance from the lead to the mark measured with a steel survey tape. Logged sonar data was processed through CARIS using standard ERS methods to yield an ellipsoid referenced measurement. Results of this test show the sonar measured depth to be 0.04 meters shallower than the lead-line derived depths with a propagated uncertainty of 0.03 meters. In addition to the ellipsoid measurement, the lead-line was marked at the waterline and the distance from the lead to the mark measured with a steel survey tape. Logged sonar data was processed through Caris using a zero-tide file to yield a waterline referenced measurement. Sonar depths were an average of 0.10 meters shallower than lead-line derived depths with a propagated error of 0.06 meters. This result suggests there may be a small error in the waterline offset values, but is not conclusive. The uncertainty of the measurement is dominated by the uncertainty in reading ship draft marks. This test was repeated on July 16, 2013 for the starboard 7125 system. Results show the sonar depth 0.06 meters shallower than the lead-line derived depths with a propagated uncertainty of 0.03 meters. For the waterline; sonar measured depths were an average of 0.01 meters shallower than the lead-line derived depths with a propagated error of 0.06 meters. There is still uncertainty of the measurement, mainly dominated by the uncertainty in reading ship draft marks.

Snippets	Sonar has snippets logging capability.

Figure 4: 7125 Housing flush mounted on hull

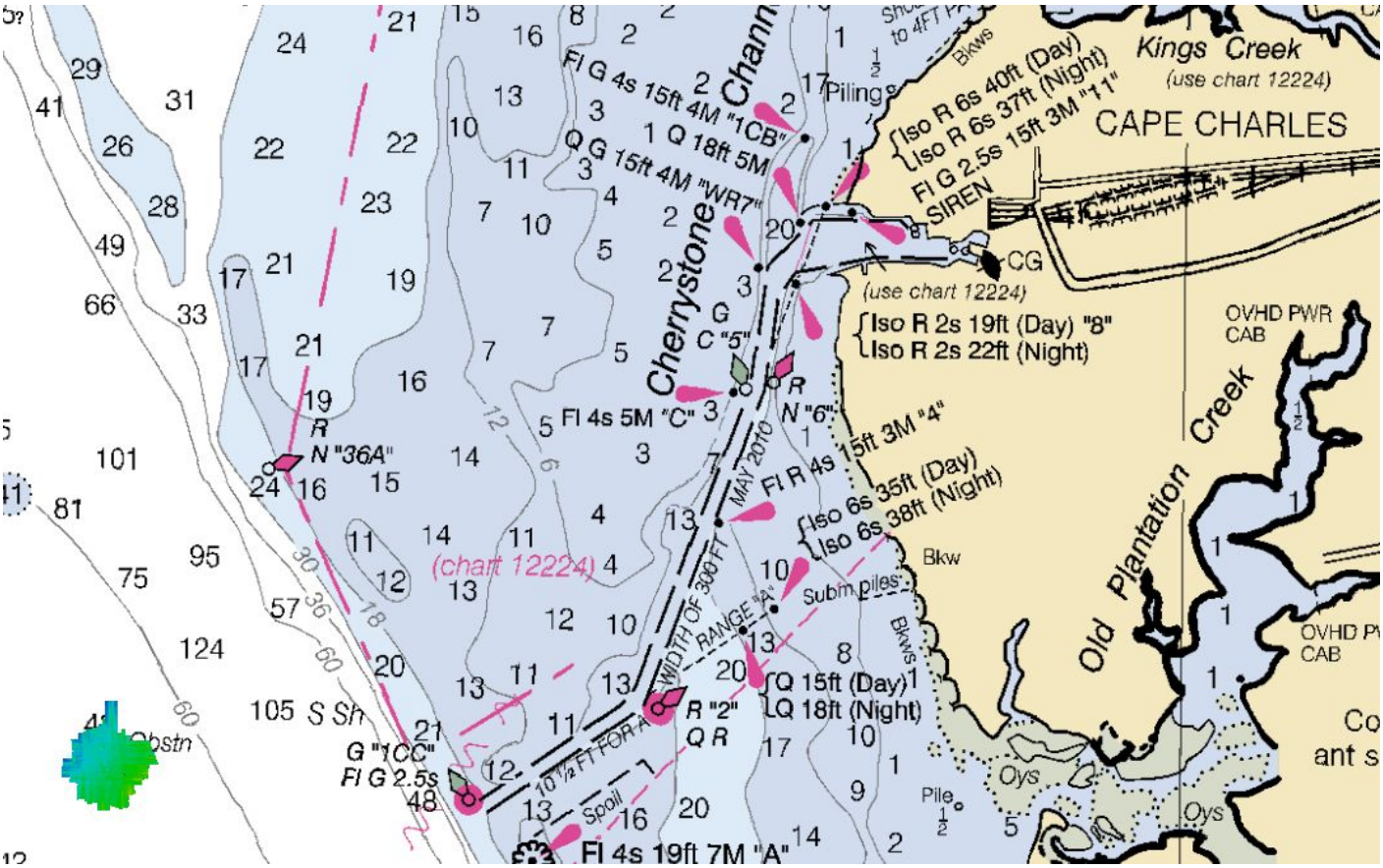
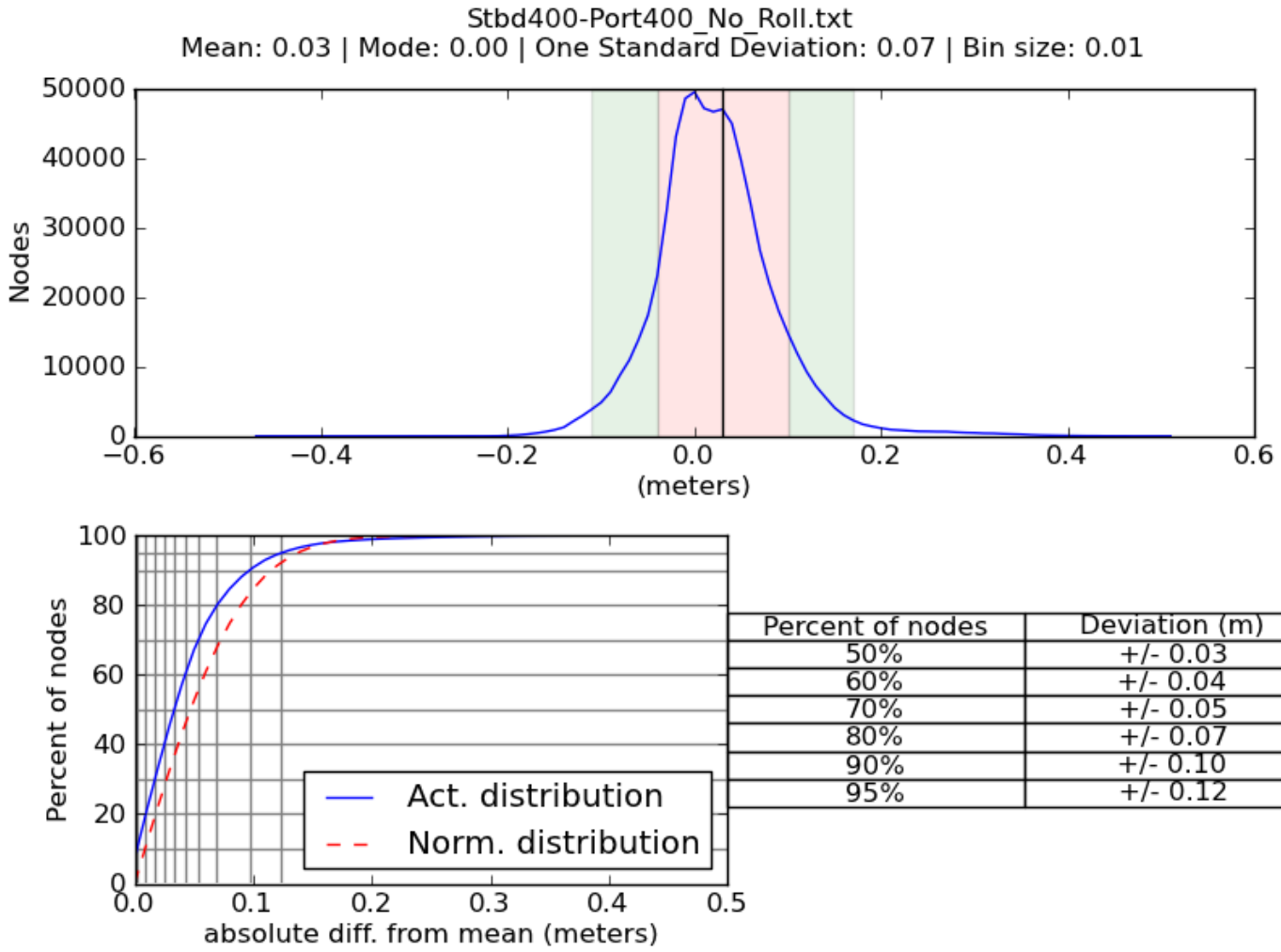
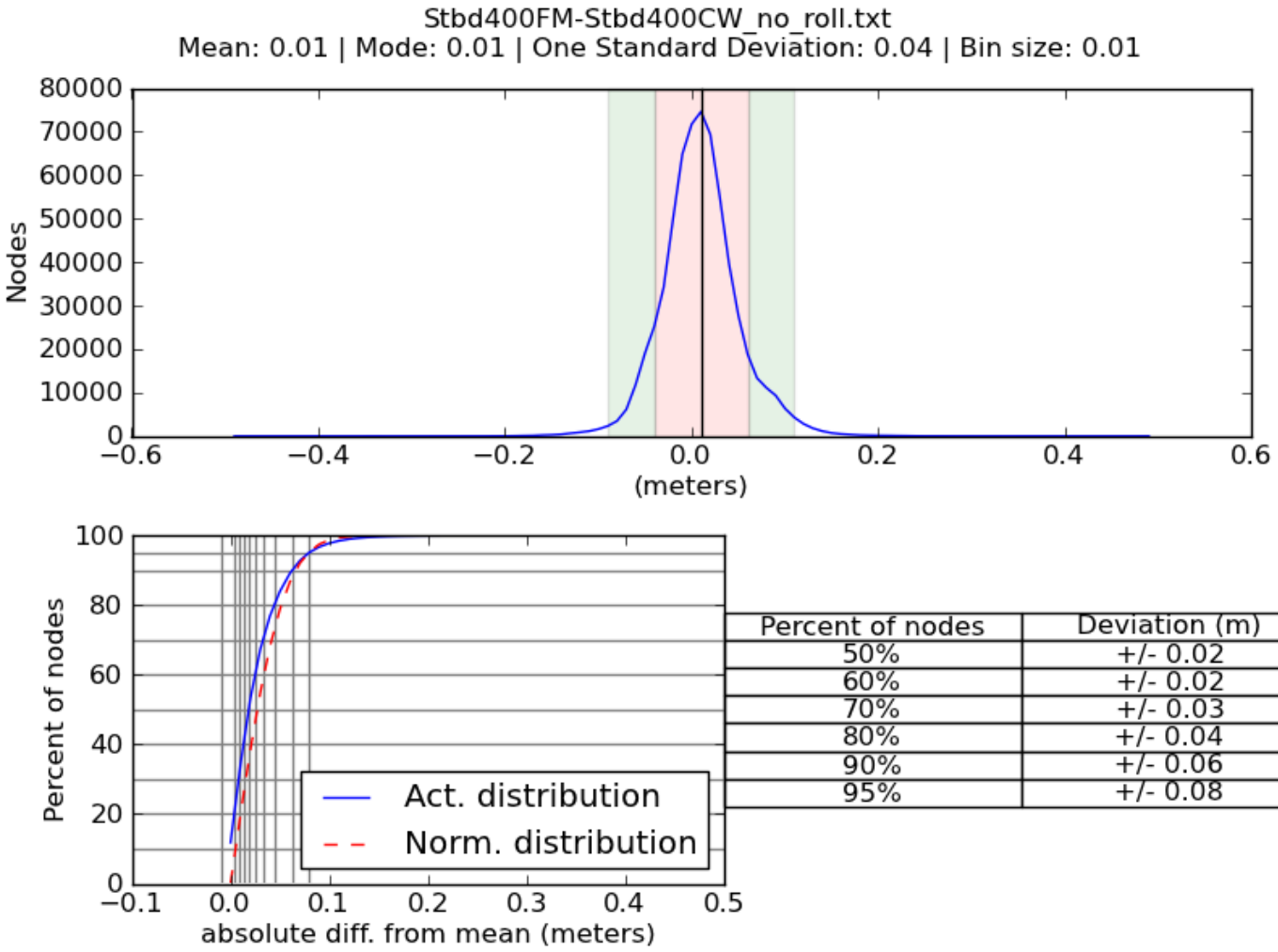


Figure 5: General location of Dn178 patch test and Dn199 shallow water reference surface in vicinity of Cape Charles, VA. Charted depths are in feet.



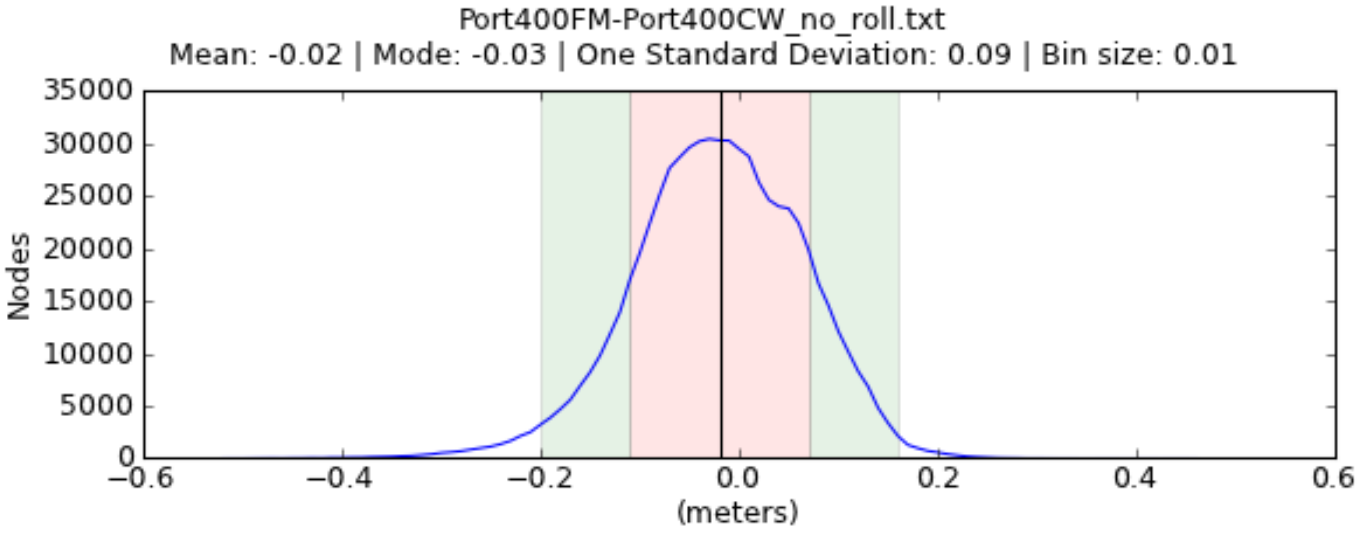
Percent of nodes	Deviation (m)
50%	+/- 0.03
60%	+/- 0.04
70%	+/- 0.05
80%	+/- 0.07
90%	+/- 0.10
95%	+/- 0.12

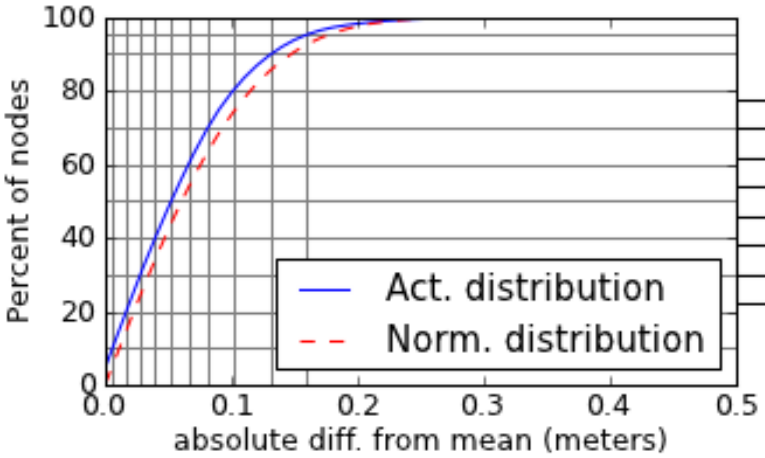
Figure 6: Distribution of depth differences, starboard minus port for Dn151 reference surface. Depths from starboard are on average 0.03 meters deeper than depths from port system with a standard deviation of 0.07 meters. Sonars configured in FM simultaneous pinging configuration.



Percent of nodes	Deviation (m)
50%	+/- 0.02
60%	+/- 0.02
70%	+/- 0.03
80%	+/- 0.04
90%	+/- 0.06
95%	+/- 0.08

Figure 7: Distribution of depth differences between the starboard FM minus CW for Dn151 reference surface.





Percent of nodes	Deviation (m)
50%	+/- 0.05
60%	+/- 0.07
70%	+/- 0.08
80%	+/- 0.10
90%	+/- 0.13
95%	+/- 0.16

Figure 8: Distribution of depth differences between the port FM minus CW for Dn151 reference surface.

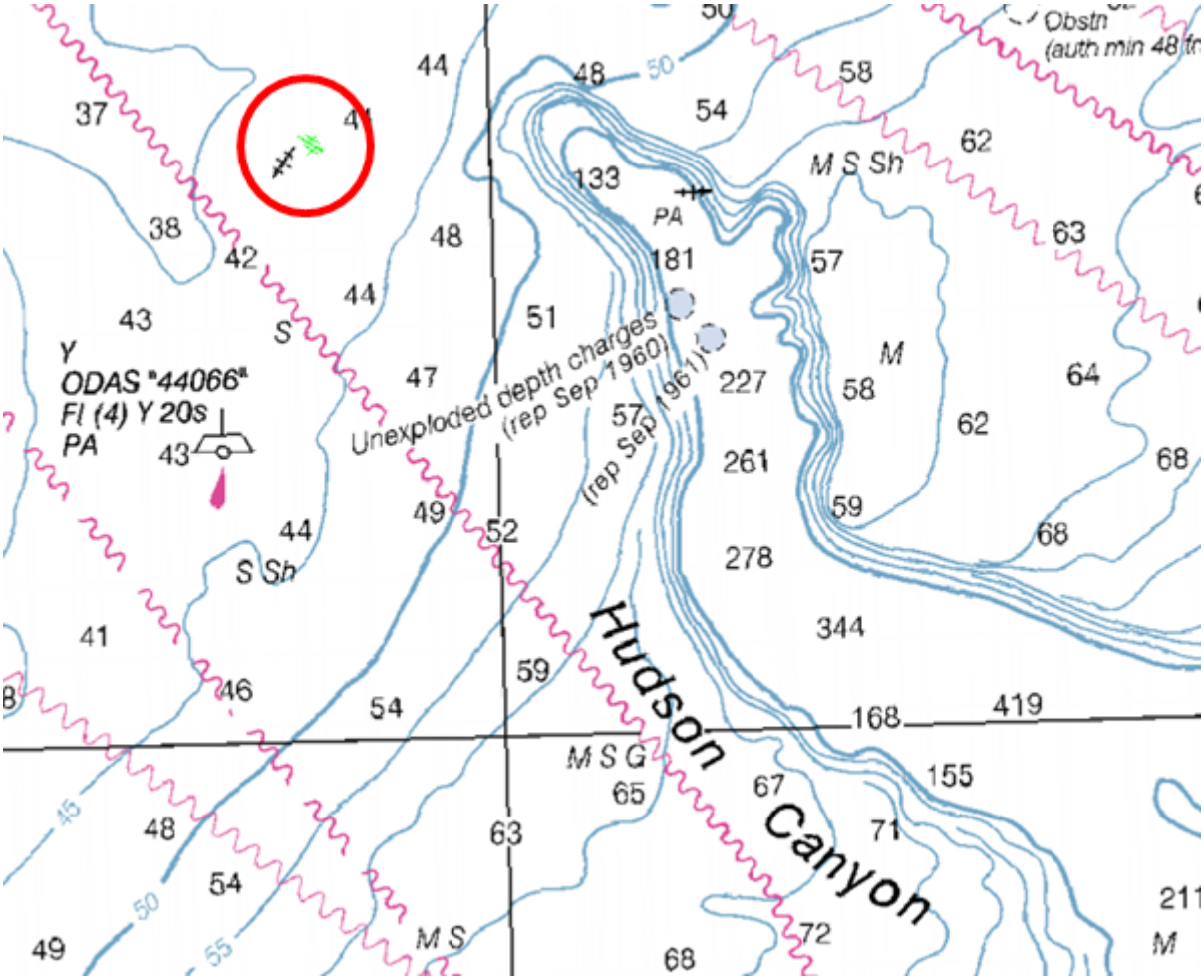
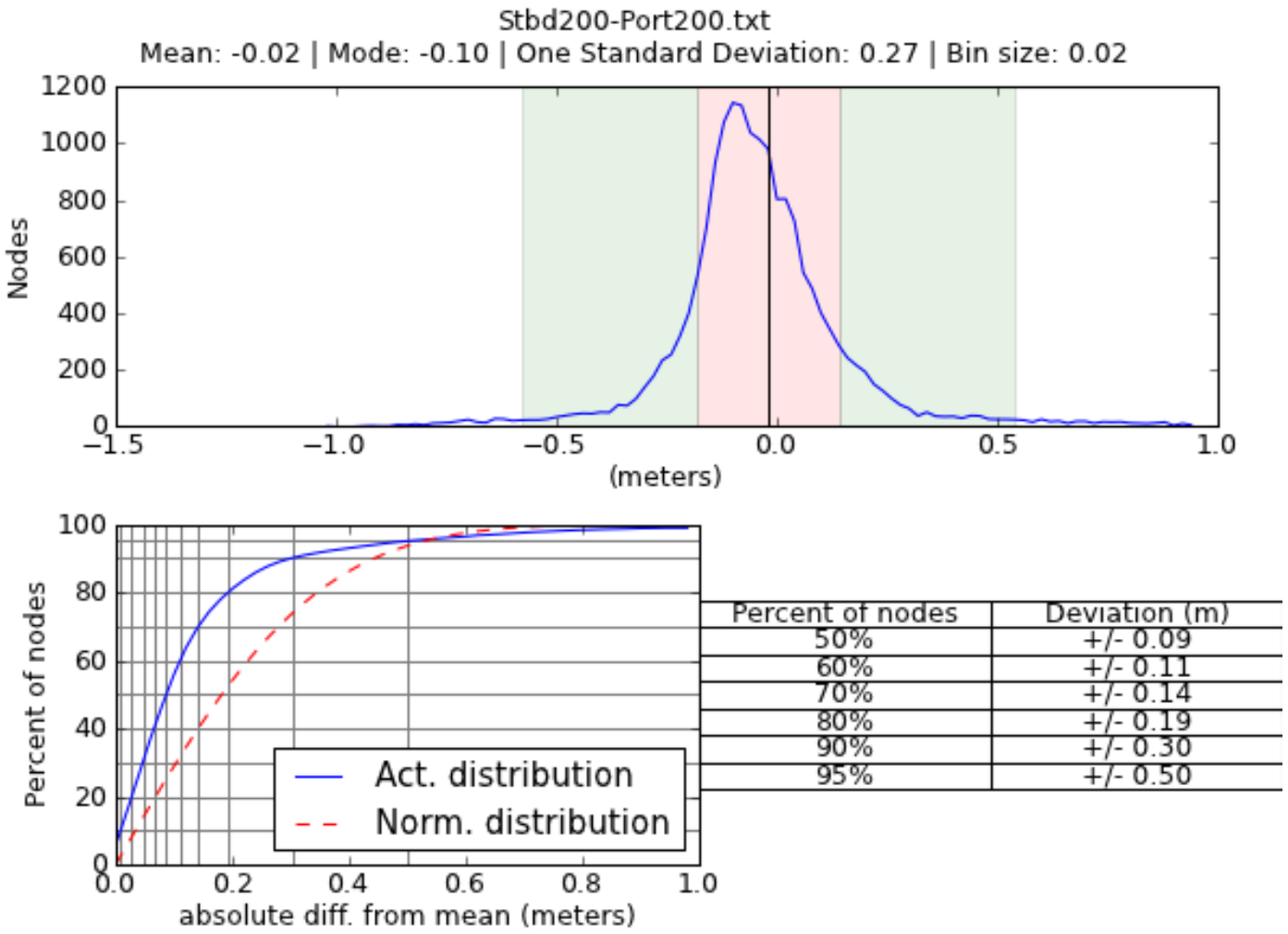


Figure 9: General location of Dn212 patch test and deeper water reference surface in the vicinity of Hudson Canyon, NY. Charted depths are in fathoms



Percent of nodes	Deviation (m)
50%	+/- 0.09
60%	+/- 0.11
70%	+/- 0.14
80%	+/- 0.19
90%	+/- 0.30
95%	+/- 0.50

Figure 10: Distribution of depth differences between the 200kHz; starboard minus port.

A.2.2.2 Reson 7125

Manufacturer	Reson
Model	7125
Description	Starboard system of a dual head configuration. For a description of this system and associated quality control tests, see entry for port 7125.

<table>
<tr><td>Serial Numbers</td><td>
<table>
<tr><td>Vessel Installed On</td><td colspan="2">S250</td><td>same</td></tr>
<tr><td>Processor s/n</td><td colspan="2">18215011048</td><td>same</td></tr>
<tr><td>Transceiver s/n</td><td colspan="2">212035</td><td>same</td></tr>
<tr><td>Transducer s/n</td><td colspan="2">n/a</td><td>n/a</td></tr>
<tr><td>Receiver s/n</td><td colspan="2">85002184</td><td>same</td></tr>
<tr><td>Projector 1 s/n</td><td colspan="2">1111236</td><td>same</td></tr>
<tr><td>Projector 2 s/n</td><td colspan="2">n/a</td><td>n/a</td></tr>
</table>
</td></tr>
<tr><td>Specifications</td><td>
<table>
<tr><td>Frequency</td><td colspan="2">400 kilohertz</td><td colspan="2">200 kilohertz</td></tr>
<tr><td rowspan="2">Beamwidth</td><td>Along Track</td><td>0.5 degrees</td><td>Along Track</td><td>2 degrees</td></tr>
<tr><td>Across Track</td><td>1 degrees</td><td>Across Track</td><td>1 degrees</td></tr>
<tr><td>Max Ping Rate</td><td colspan="2">50 hertz</td><td colspan="2">50 hertz</td></tr>
<tr><td rowspan="2">Beam Spacing</td><td>Beam Spacing Mode</td><td>Equidistant</td><td>Beam Spacing Mode</td><td>Equidistant</td></tr>
<tr><td>Number of Beams</td><td>512</td><td>Number of Beams</td><td>320</td></tr>
<tr><td>Max Swath Width</td><td colspan="2">140 degrees</td><td colspan="2">140 degrees</td></tr>
<tr><td>Depth Resolution</td><td colspan="2">6 millimeters</td><td colspan="2">6 millimeters</td></tr>
<tr><td rowspan="2">Depth Rating</td><td>Manufacturer Specified</td><td>150 meters</td><td>Manufacturer Specified</td><td>400 meters</td></tr>
<tr><td>Ship Usage</td><td>100 meters</td><td>Ship Usage</td><td>250 meters</td></tr>
</table>
</td></tr>
<tr><td>Manufacturer Calibrations</td><td>Manufacturer calibration was not performed.</td></tr>
<tr><td>System Accuracy Tests</td><td>System accuracy test was not performed.</td></tr>
<tr><td>Snippets</td><td>Sonar has snippets logging capability.</td></tr>
</table>

A.2.2.3 Reson 7111

Manufacturer	Reson
Model	7111
Description	The Reson 7111 is a mid-water 100kHz multibeam sonar system. The system is mounted in a blister fairing forward on the starboard hull. A patch test for the 7111 was conducted on July 31, 2013 (Dn212) in the vicinity of Hudson Canyon, NY.

<table>
<tr><td>Serial Numbers</td><td>
<table>
<tr><td>Vessel Installed On</td><td colspan="2">S250</td></tr>
<tr><td>Processor s/n</td><td colspan="2">1908005</td></tr>
<tr><td>Transceiver s/n</td><td colspan="2">4506285</td></tr>
<tr><td>Transducer s/n</td><td colspan="2">807208</td></tr>
<tr><td>Receiver s/n</td><td colspan="2">1409098</td></tr>
<tr><td>Projector 1 s/n</td><td colspan="2">Low</td></tr>
<tr><td>Projector 2 s/n</td><td colspan="2">None</td></tr>
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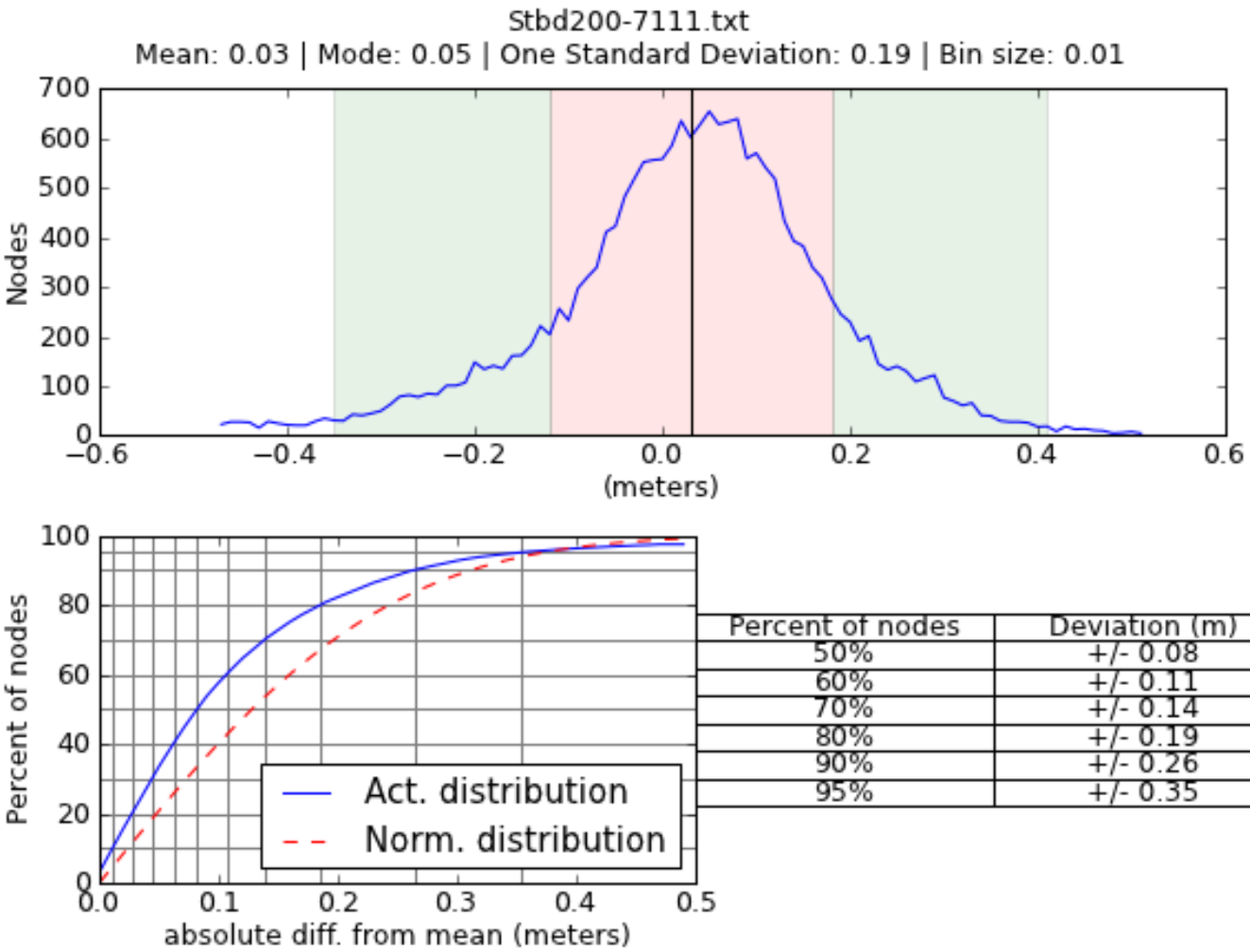
</td></tr>
<tr><td>Specifications</td><td>
<table>
<tr><td>Frequency</td><td colspan="2">100 kilohertz</td></tr>
<tr><td rowspan="2">Beamwidth</td><td>Along Track</td><td>1.9 degrees</td></tr>
<tr><td>Across Track</td><td>1.5 degrees</td></tr>
<tr><td>Max Ping Rate</td><td colspan="2">20 hertz</td></tr>
<tr><td rowspan="2">Beam Spacing</td><td>Beam Spacing Mode</td><td>Equidistant</td></tr>
<tr><td>Number of Beams</td><td>301</td></tr>
<tr><td>Max Swath Width</td><td colspan="2">150 degrees</td></tr>
<tr><td>Depth Resolution</td><td colspan="2">3 centimeters</td></tr>
<tr><td rowspan="2">Depth Rating</td><td>Manufacturer Specified</td><td>1000 meters</td></tr>
<tr><td>Ship Usage</td><td>500 meters</td></tr>
</table>
</td></tr>
<tr><td>Manufacturer Calibrations</td><td>Manufacturer calibration was not performed.</td></tr>
<tr><td>System Accuracy Tests</td><td>
<table>
<tr><td>Vessel Installed On</td><td>S250</td></tr>
<tr><td>Methods</td><td>Reference surface comparison</td></tr>
<tr><td>Results</td><td>Deeper water (80 meters) reference surfaces were performed for the 100kHz in the vicinity of Hudson Canyon, NY on July 31, 2013 (Dn212) using data obtained during the patch test. The location of the reference surfaces are shown in Figure 9. For the 100kHz systems, the 7111 was on average 0.03 shallower than the starboard 200kHz system with a standard deviation of 0.19. 95% of all nodes are within +/- 0.35 in an area with depths in excess of 1.0 meters total allowable vertical uncertainty. The results of this test are shown in Figures 11.</td></tr>
</table>
</td></tr>
<tr><td>Snippets</td><td>Sonar has snippets logging capability.</td></tr>
</table>

Figure 11: 7111 mount and fairing. Sonar is located forward on the starboard hull.



Percent of nodes	Deviation (m)
50%	+/- 0.08
60%	+/- 0.11
70%	+/- 0.14
80%	+/- 0.19
90%	+/- 0.26
95%	+/- 0.35

Figure 12: Distribution of depth differences, starboard 200kHz 7125 less 7111 for Dn212 deep water (80 meter) reference surface. Depths from 7111 are on average 0.03 meters deeper than depths from the 7125 with a standard deviation of 0.19 meters.

A.2.3 Single Beam Echosounders

A.2.3.1 Odom CV-200

Manufacturer	Odom
Model	CV-200
Description	Dual-frequency digital recording echosounder system with a transducer in each hull. The high frequency band is tunable from 100kHz to 1 MHz. The low band is tunable

<table>
<tr><td></td><td>from 10-50 kHz. The installed Airmar M42 transducers are not broadband and the sonar is tuned to the operating frequency of the dual-frequency transducers installed. Each transducer is most efficient at 24 or 200kHz. The system is configured with the low frequency signal to the port transducer and the high frequency signal to the starboard system to permit simultaneous, dual frequency acquisition. The starboard POS system is used for positioning of the singlebeam and the starboard POS serves as the reference point for both transducers.</td></tr>
<tr><td>Serial Numbers</td><td>
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<tr><td>Vessel</td><td>S250</td></tr>
<tr><td>Processor s/n</td><td>3038</td></tr>
<tr><td>Transducer s/n</td><td>unknown</td></tr>
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<tr><td>Specifications</td><td>
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<tr><td>Frequency</td><td colspan="2">200 kilohertz</td><td colspan="2">24 kilohertz</td></tr>
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<tr><td>Across Track</td><td>4 degrees</td><td>Across Track</td><td>20 degrees</td></tr>
<tr><td>Max Ping Rate</td><td colspan="2">100 hertz</td><td colspan="2">100 kilohertz</td></tr>
<tr><td>Depth Resolution</td><td colspan="2">0.01 meters</td><td colspan="2">0.01 meters</td></tr>
<tr><td rowspan="2">Depth Rating</td><td>Manufacturer Specified</td><td>200 meters</td><td>Manufacturer Specified</td><td>6000 meters</td></tr>
<tr><td>Ship Usage</td><td>50 meters</td><td>Ship Usage</td><td>700 meters</td></tr>
</table>
</td></tr>
<tr><td>Manufacturer Calibrations</td><td>Manufacturer calibration was not performed.</td></tr>
</table>

System Accuracy Tests	*Vessel Installed On*	S250	S250
	Methods	Sounding systems comparison	Reference surface comparison
	Results	Sounding comparisons were made while at anchor using the dual-frequency vertical beam echosounder, both port and starboard 7125 systems and lead line on June 26, 2013. Sea state was calm with an estimated 1 foot chop. This chop may have affected the lead line measurement to report a deeper than actual measurement. The data from each VBES head was averaged and compared to the averaged data from the 7125 sonar head on the corresponding hull. The VBES was 0.13 meters shallower than the lead line measurement, 0.28 meters deeper than the Starboard 7125 measurements, and 0.46 meters deeper than the Port 7125 measurements. This may be the result of acoustic penetration into a soft sediment bottom in the test area, which could explain why progressively lower frequencies produced deeper depth measurements. Although no sediment sample was taken in the area, charted bottom type is sand.	Reference surfaces were performed in the vicinity of Cape Charles City, VA on July 18, 2013 (Dn199). The location of the patch test is shown in Figure 5. Results of this comparison are inconclusive and suggest that additional investigation into transducer offsets and HVF values are warranted. Currently VBES are not planned on being utilized for the 2013 field season.

Figure 16: Hull mounted Odom Vertical Beam Echosounder

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

Manufacturer	Unknown		
Model	Traditional		
Description	FERDINAND R. HASSLER is equipped with two lead lines. Lead lines are used for measurements near shore over submerged shoals and for echosounder depth comparisons.		
Serial Numbers	RA6S		
	7		
Calibrations	No calibrations were performed.		
Accuracy Checks	*Serial Number*	RA6S	7
	Date	2013-06-12	2013-06-12
	Procedures	The wet lead line was stretched with an amount of force equal to the weight, on relatively flat ground and compared with a steel survey tape. Values were recorded of true measurements at lead line markings.	The wet lead line was stretched with an amount of force equal to the weight, on relatively flat ground and compared with a steel survey tape. Values were recorded of true measurements at lead line markings.
Correctors	From the table of values obtained during the accuracy checks a table of correctors was calculated for both lead lines. This table is stored locally aboard the FERDINAND R. HASSLER and referenced when appropriate.		
Non-Standard Procedures	Non-standard procedures were not utilized.		

Figure 17: Leadline fitted with custom mud-shoe to limit penetration of soft bottoms.

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
Model	POS/MV 320 V5
Description	Tightly coupled GPS and inertial positioning and attitude sensing system for port hull. Inertial motion unit (IMU) is located below water line close to the port side 7125 wet end. GPS antennae are located on flying bridge of S250. The V5 system was installed on July 29, 2013.
PCS	*Manufacturer*: Applanix *Model*: POS/MV 320 V5 *Description*: Rack mounted POS control system located in charting lab. *Firmware Version*: 7.61 *Software Version*: 7.60 *Serial Numbers*: *Vessel Installed On*: S250 Port; *PCS s/n*: 5806
IMU	*Manufacturer*: Applanix *Model*: Type 36 *Description*: Inertial measurement system consisting of three orthogonal accelerometers and three orthogonal fiber-optic gyroscopes. Located in port hull near 7125 wet end. *Serial Numbers*: *Vessel Installed On*: S250 Port hull; *IMU s/n*: 2423 *Certification*: *IMU s/n*: 2423; *Certification Date*: 2013-06-26

Antennas	*Manufacturer*	Trimble		
	Model	382AP GNSS		
	Description	GNSS antennae are used for position input as well as aiding the heading solution. The antennae pair for the port system is the forward and aft pair on the port side. The separation distance between the antennae is approximately 2 meters.		
	Serial Numbers	*Vessel Installed On*	S250 Port (forward)	S250 Port (aft)
		Antenna s/n	8848	8839
		Port or Starboard	Port	Port
		Primary or Secondary	Primary	Secondary
GAMS Calibration	*Vessel*	S250		
	Calibration Date	2013-07-30		
Configuration Reports	POS/MV configuration reports were not produced.			

Manufacturer	Applanix		
Model	POS/MV 320 V5		
Description	Tightly coupled GPS and inertial positioning and attitude sensing system for port hull. Inertial motion unit (IMU) is located below water line close to the port side 7125 wet end. GPS antennae are located on flying bridge of S250. The V5 system was installed on July 29, 2013.		
PCS	*Manufacturer*	Applanix	
	Model	POS/MV 320 V5	
	Description	Rack mounted POS control system located in charting lab.	
	Firmware Version	7.61	
	Software Version	7.60	
	Serial Numbers	*Vessel Installed On*	S250 Starboard
		PCS s/n	5807

IMU	*Manufacturer*	Applanix		
	Model	Type 36		
	Description	Inertial measurement system consisting of three orthogonal accelerometers and three orthogonal fiber-optic gyroscopes. Located in starboard hull near 7125 wet end.		
	Serial Numbers	*Vessel Installed On*	S250 Starboard hull	
		IMU s/n	2424	
	Certification	*IMU s/n*	2424	
		Certification Date	2013-06-26	
Antennas	*Manufacturer*	Trimble		
	Model	382AP GNSS		
	Description	GNSS antennae are used for position input as well as aiding the heading solution. The antennae pair for the starboard system is the forward and aft pair on the starboard side. The separation distance between the antennae is approximately 2 meters.		
	Serial Numbers	*Vessel Installed On*	S250 Starboard (forward)	S250 Starboard (aft)
		Antenna s/n	8840	8838
		Port or Starboard	Starboard	Starboard
		Primary or Secondary	Primary	Secondary
GAMS Calibration	*Vessel*	S250		
	Calibration Date	2013-07-26		
Configuration Reports	POS/MV configuration reports were not produced.			

A.4.2 DGPS

Description	Hemisphere PGS MBX Kit		
Antennas	*Manufacturer*	Hemisphere	
	Model	MBX-4	
	Description		
	Serial Numbers	*Vessel Installed On*	S250
		Antenna s/n	1113139440044
Receivers	*Manufacturer*	Hemisphere	
	Model	MBX-4	
	Description		
	Firmware Version	1.0	
	Serial Numbers	*Vessel Installed On*	S250
		Antenna s/n	1118144550001

A.4.3 Trimble Backpacks

Trimble backpack equipment was not utilized for data acquisition.

A.4.4 Laser Rangefinders

No laser rangefinders were utilized for data acquisition.

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 SeaCat 19plus 350 meter and 3500 meter

Manufacturer	Sea-Bird			
Model	SeaCat 19plus 350 meter and 3500 meter			
Description	Internal logging conductivity, temperature, and depth measuring devices.			
Serial Numbers	*Vessel Installed On*	S250	S250	S250
	CTD s/n	19P65591-6918	19P32914-4480	19P36399-4642
Calibrations	*CTD s/n*	6918	4480	4642
	Date	2013-02-21	2013-02-21	2013-02-21
	Procedures	Routine calibration service	Routine calibration service	Routine calibration service

Figure 18: Ferdinand R. Hassler CTD inventory

A.5.1.2 Sound Speed Profilers

A.5.1.2.1 Brooke Ocean MVP-30

Manufacturer	Brooke Ocean		
Model	MVP-30		
Description	Moving vessel profiler equipped with an AML Micro-CTD in a single sensor free fall fish: The MVP cable was end-for-ended and re-terminated on September 3, 2013. A new towfish was equipped with an AML Micro-CTD on September 27th, 2013, and verified to be in working order by sound speed comparison cast.		
Serial Numbers	*Vessel Installed On*	S250	S250
	Sound Speed Profiler s/n	8609	8610
Calibrations	*Sound Speed Profiler s/n*	8609	8610
	Date	2013-05-09	2013-05-09
	Procedures	Initial calibration for new sensor	Initial calibration for new sensor

Figure 19: MVP control station & winch

Figure 20: MVP single sensor free fall fish.

A.5.2 Surface Sound Speed

A.5.2.1 Sea-Bird 45 MicroTSG

Manufacturer	Sea-Bird

Model	45 MicroTSG		
Description	Two SBE-45 thermosalinographs are installed to determine the sound velocity of the water at the sonar transducers. This data is used to aid beam steering of the multibeam 7111 sonar system. One is located in the starboard engine room, the other in the port. Both units draw sampling water from the main cooling water line of the respective main engine. The SBE-45s are configured to use their internal temperature sensors. Both units are insulated with foam to ensure accurate temperature readings. These devices calculate the sound speed from the measured salinity and temperature (using the Chen-Millero equation) of the sampled water. A serial broadcast device sends the sound speed message from the SBE-45 to the Reson 7111 and SCS acquisition server.		
Serial Numbers	*Vessel Installed On*	S250 Port	S250 Starboard
	Sound Speed Sensor s/n	4553332-0276	4553332-0277
Calibrations	*Sound Speed Sensor s/n*	4553332-0276	4553332-0277
	Date	2013-02-28	2013-02-28
	Procedures	Routine calibration service	Routine calibration service

A.5.2.2 Reson SVP-70

Manufacturer	Reson		
Model	SVP-70		
Description	Sound velocity probe developed for fixed-mount installation near Reson 7125 transducer heads which uses a direct path echosounding technique that instantly compensates for temperature and pressure with internal sensors, providing accurate surface sound velocity measurements for beam steering.		
Serial Numbers	*Vessel Installed On*	S250 Port hull	S250 Starboard hull
	Sound Speed Sensor s/n	2011278	2011276
Calibrations	*Sound Speed Sensor s/n*	2011278	2011276
	Date	2011-09-21	2011-09-21
	Procedures	Manufacturer performed temperature and pressure calibrations and validation prior to delivery. A Hart 1504 and thermistor was used for temperature and a custom-built tank was used for the pressure calibration.	Manufacturer performed temperature and pressure calibrations and validation prior to delivery. A Hart 1504 and thermistor was used for temperature and a custom-built tank was used for the pressure calibration.

Additional Discussion

When in the deployed and docked position, the MVP sensor is towed at approximately the same height as the surface sound speed sensor. As part of the system start up and watch turnover procedures as well as periodically through a survey watch, these values are verified to be in agreement. In addition, comparison casts between a SeaCat 19+ and the MVP are conducted once a leg or if any issues with the MVP sensor are suspected. The results of these tests are included in the Separates section of each survey.

A.6 Horizontal and Vertical Control Equipment

A.6.1 Horizontal Control Equipment

A.6.1.1 Base Station Equipment

Description	Trimble NetR5 receiver used for long-term GPS base observations and correctors.	
GPS Antennas	*Manufacturer*	Trimble
	Model	Zephyr Geodetic Model 2
	Description	The Zephyr Geodetic 2 is the antenna component for the NetR5 system which incorporates a large Trimble Stealth™ Ground Plane, which burns up multipath energy using technology similar to that used by Stealth aircraft to hide from radar. The antenna is made with weather-resistant materials and a low profile design, so the antenna can be used for many years of continuous operation on a permanent installation.
	Serial Numbers	1440921338
GPS Receivers	*Manufacturer*	Trimble
	Model	NetR5 GNSS
	Description	The Trimble NetR5 Reference Station is a multi-channel, multi-frequency GNSS receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution.
	Firmware Version	4.03
	Serial Numbers	4934K63376
UHF Antennas	No UHF antennas were installed.	
UHF Radios	No UHF antennas were installed.	
Solar Panels	No solar panels were installed.	

Solar Chargers	No solar chargers were installed.
DQA Tests	No DQA tests were performed.

A.6.1.2 Rover Equipment

No rover 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

Manufacturer	Dell				
Model	T5500				
Description	Processing Computers				
Serial Numbers	*Computer s/n*	FH-PROC1 Service Tag # GFTQ8V1	FH-PROC2 Service Tag # GFTR8V1	FH-PROC3 Service Tag # GFTN8V1	FH-PROC4 Service Tag # GFTM8V1
	Operating System	Windows 7	Windows 7	Windows 7	Windows 7
	Use	Processing	Processing	Processing	Processing

Manufacturer	Dell

Model	T3400
Description	Acquisition Computers
Serial Numbers	

Computer s/n	FH-ACQ1 Service Tag # 101WTK1	FH-ACQ2 Service Tag # 201WTK1	FH-ACQ3 Service Tag # 6P5VTK1
Operating System	Windows XP	Windows XP	Windows XP
Use	Acquisition	Acquisition	Acquisition

Manufacturer	Cybertron PC
Model	Generic
Description	Processing Computer
Serial Numbers	

Computer s/n	FH-PROC5 Service Tag # FQC-00765
Operating System	Windows 7
Use	Processing

A.7.2 Computer Software

Manufacturer	CARIS
Software Name	HIPS/SIPS
Version	7.1
Service Pack	2
Hotfix	5
Installation Date	2013-04-02
Use	Processing
Description	Data Processing

Manufacturer	CARIS
Software Name	Bathy DataBASE Editor
Version	4.0
Service Pack	0
Hotfix	0
Installation Date	2013-04-02
Use	Processing
Description	Data analysis and feature management

Manufacturer	CARIS

Software Name	Plot Composer
Version	5.2
Service Pack	
Hotfix	
Installation Date	2013-04-02
Use	Processing
Description	Mapping and plotting software

Manufacturer	Applanix
Software Name	POSPac
Version	6.1
Service Pack	
Hotfix	
Installation Date	2013-04-02
Use	Processing
Description	Position and Attitude processing software

Manufacturer	NOAA
Software Name	Pydro
Version	13.2
Service Pack	r4326
Hotfix	
Installation Date	2013-09-28
Use	Processing
Description	Feature management, correlation, and report generator

Manufacturer	NOAA
Software Name	Pydro
Version	13.8
Service Pack	r4429
Hotfix	
Installation Date	2014-01-06
Use	Acquisition
Description	Feature management, correlation, and report generator (further updated versions that occur during processing will be discussed in the descriptive report)

Manufacturer	NOAA
Software Name	Velocipy
Version	12.9
Service Pack	r3952
Hotfix	
Installation Date	2013-04-02
Use	Acquisition and Processing
Description	Sound velocity download and processing software

Manufacturer	NOAA
Software Name	Velocipy
Version	13.2
Service Pack	r4326
Hotfix	
Installation Date	2013-09-28
Use	Acquisition and Processing
Description	Sound velocity download and processing software

Manufacturer	NOAA
Software Name	Velocipy
Version	13.8
Service Pack	r4429
Hotfix	
Installation Date	2014-01-06
Use	Acquisition and Processing
Description	Sound velocity download and processing software (further updated versions that occur during processing will be discussed in the descriptive report)

Manufacturer	Pitney Bowes
Software Name	MapInfo
Version	11.5
Service Pack	
Hotfix	
Installation Date	2013-04-02
Use	Acquisition and Processing

Description	GIS software

Manufacturer	IVS 3D
Software Name	Fledermaus
Version	7
Service Pack	3
Hotfix	4
Installation Date	2013-07-02
Use	Processing
Description	Data modeling

Manufacturer	Hypack
Software Name	Hypack/Hysweep
Version	2013
Service Pack	
Hotfix	
Installation Date	2013-04-02
Use	Acquisition
Description	Data logging

Manufacturer	Klein
Software Name	SonarPro
Version	12.1
Service Pack	
Hotfix	
Installation Date	2012-05-11
Use	Acquisition
Description	Side Scan control

Manufacturer	Applanix
Software Name	POSView
Version	7.0
Service Pack	
Hotfix	
Installation Date	2013-07-26

Use	Acquisition
Description	Positioning

Manufacturer	Synergy
Software Name	Synergy
Version	1.3.6
Service Pack	
Hotfix	
Installation Date	2011-05-10
Use	Acquisition
Description	Shared mouse and keyboard between acquisition systems

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

A.8.1.1 Ponar Wildco 1728

Manufacturer	Ponar Wildco
Model	1728
Description	Grab sampler triggered by contact with sea floor.

Figure 21: Ponar Grab Sampler

B Quality Control

B.1 Data Acquisition

B.1.1 Bathymetry

B.1.1.1 Multibeam Echosounder

Multibeam data are logged locally on the Reson topside machines in s7k format. Multibeam data are also acquired through Hypack/Hyweep in HSX format for bathymetry, though these files are only used in the event of errors in the s7k file and are otherwise discarded. The HSX format includes sounding solutions, navigation and attitude data. Ship navigation and survey line monitoring are performed with Hypack/ Hysweep. The s7k format includes sounding solutions, navigation, attitude and backscatter snippet data. This record is configured to include the following Reson datagrams: 1003: Position; 1012: Roll, Pitch, Heave; 1013: Heading; 7000: 7k Sonar Settings; 7004: 7k Beam Geometry; 7006: 7k Bathymetric Data; 7008: 7k Generic Watercolumn Data (used for snippets backscatter) and 7503: Remote Control Sonar Settings.

All multibeam sonars are configured in equidistant ("Best Coverage" in newest Reson version) beam steering mode. The opening angle of the 7125 systems is configured based on analysis of coverage, speed, and expected sound speed refraction errors for each survey. This angle typically varies between 120 and 140 degrees. Power, gain, and TVG parameters are typically set for a particular project and not changed during acquisition.

The Reson units are interfaced with the acquisition machines through UDP LAN connections over a dedicated network switch (NetGear ProSafe Gigabit Switch). Position and attitude data is passed from the POS-MV to both the Reson machines and to the acquisition computers through dedicated network switches (NetGear ProSafe Gigabit Switch). There is a dedicated switch for the port and starboard POS systems. Time is passed from the POS to the Reson machines via a RS232 serial connection and a PPS pulse via a coaxial cable with BNC connectors. The starboard POS is interfaced with the starboard 7125 and the 7111, which is located in the starboard hull. The port POS is interfaced to the port 7125. A diagram of this configuration is included with the support files to this report and illustrated in Figure 22.

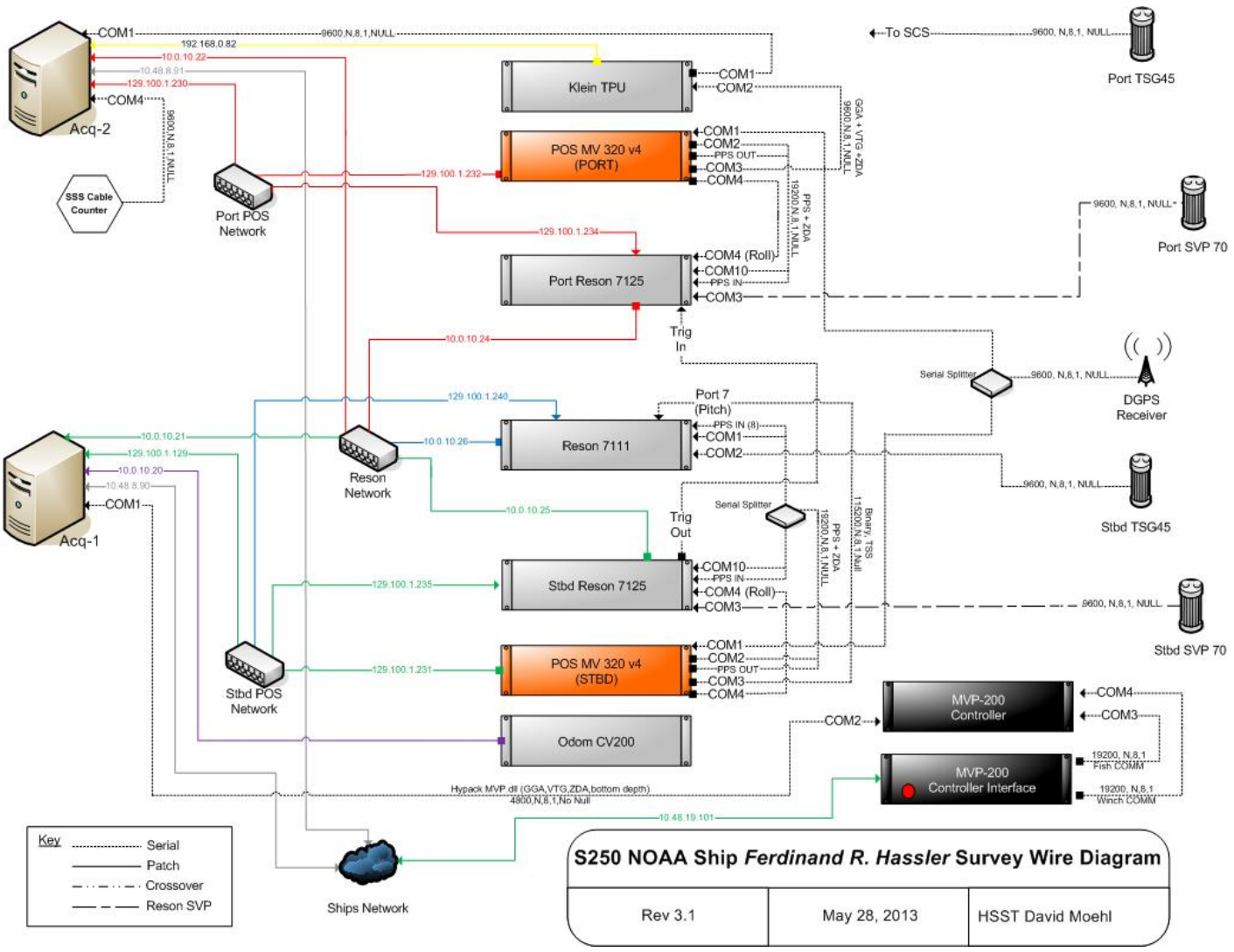


Figure 22: Ship survey systems wiring diagram

B.1.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not acquired.

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

The side scan fish is towed from a block suspended from the A-frame on the stern of the vessel. The height of the fish above the sea floor is actively managed through use of the remote winch control. Side scan

imagery is monitored and logged using SonarPro. Tow cable offset values are entered into SonarPro to account for cable out in the docked tow position. This position has 12 meters of cable between the tow point and the fish.

Survey lines are pre-planned to achieve coverage required by the project instructions. These lines are planned in MapInfo and exported to Hypack. Hypack is used for ship navigation and for survey line tracking.

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

Seabird SBE 19plus and MVP sound speed profilers are used regularly to collect sound speed data for ray tracing corrections for the multibeam sonar systems. In shallow water, the SBE 19plus is hand deployed from the stern. In deeper water the MVP winch is used. Data is retrieved from the Seabird CTDs with a serial connection to a processing computer. Data from both the Seabirds and MVP are processed through the NOAA in-house program Velocipy to give CARIS .svp formatted sound velocity profiles. All .svp profiles for a survey sheet are concatenated to one master file for a survey.

Casts are taken at least every four hours, but typically far more frequently. The interval between casts is typically between ten minutes and three hours based on the observed variability between casts and is discussed in the Descriptive Report of each survey.

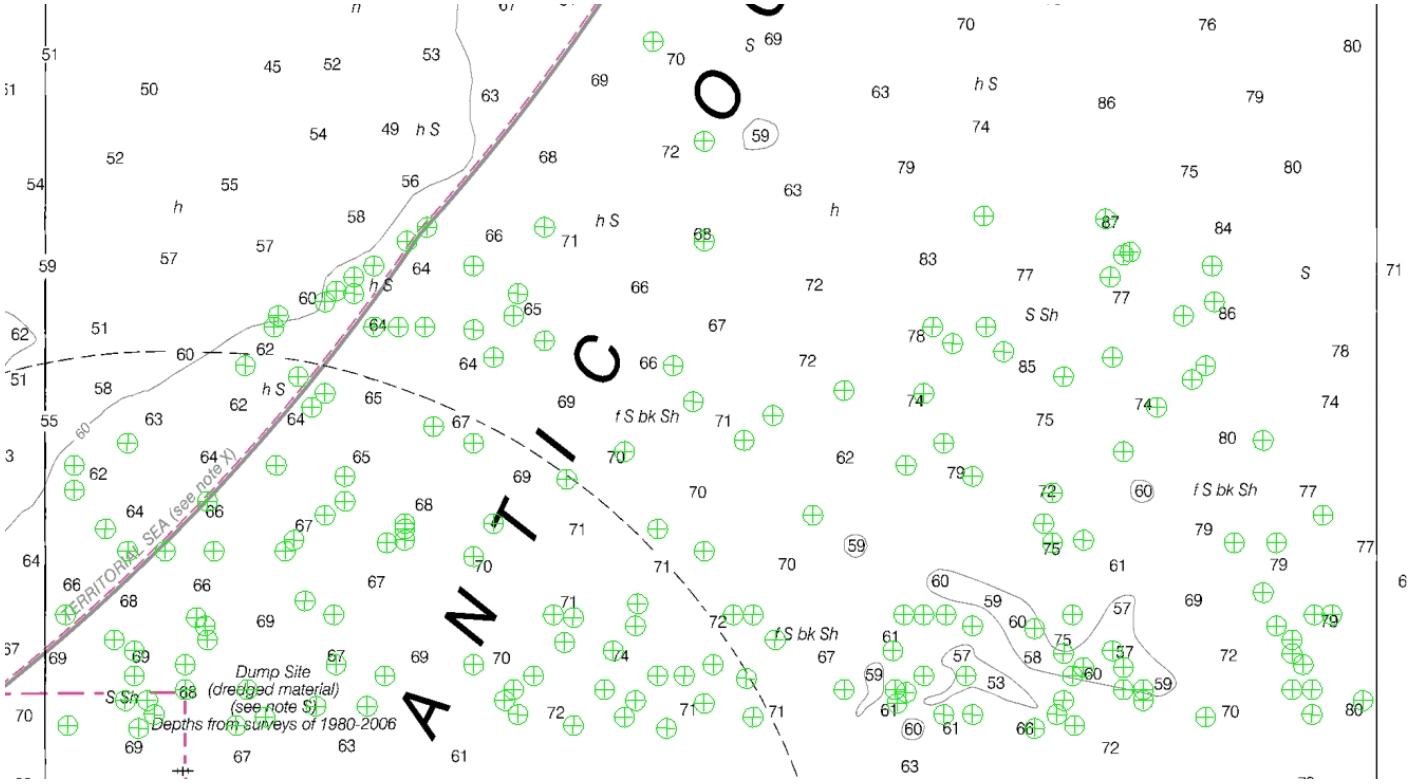


Figure 23: Example of sound speed samples taken in a survey area

B.1.3.2 Surface Sound Speed

Surface sound speed for both Reson 7125's is fed from individual SVP-70 sound velocity sensors mounted near each transducer. While operating in dual-head mode the starboard SVP-70 feeds both the master and slave. Seabird TSG 45 thermosalinograph is used for determination of sea surface conductivity and temperature and calculate surface sound speed for the Reson 7111.

During data acquisition, the port SVP-70 sensor began reporting sound speeds of 1350 m/s (the default value used by Reson). Additionally, the starboard SVP-70 was determined to be reporting incorrect sound speed values. A comparison was performed on Dn307 between the starboard SVP-70, TSG, MVP, and CTD sensors determined the magnitude of the error reported by the starboard SVP-70 to be 5 m/s from the estimated corrected value (Figure 24). The port TSG sensor was configured to be the source of surface sound speed data for both Reson 7125's on Dn319.

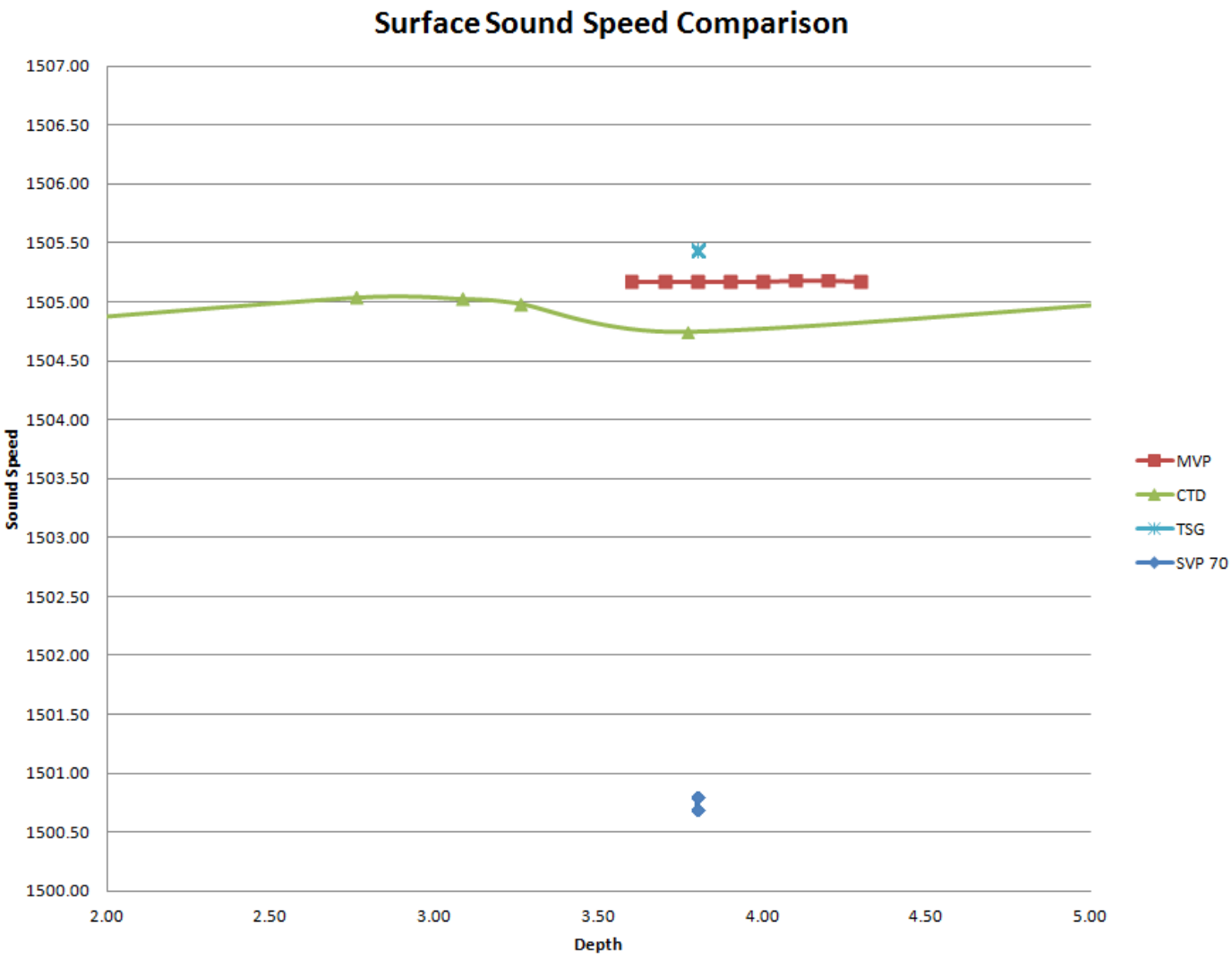


Figure 24: Results of Surface Sound Speed comparison to determine SVP-70 measurement error.

B.1.4 Horizontal and Vertical Control

B.1.4.1 Horizontal Control

Applanix POS/MV files are logged using both the internal (USB) logging function and using the external Ethernet logging function. Both files contain the same data records including attitude, heading, position and velocity data as stated in section 3.4.1 of the FPM. During acquisition, the navigation solution status is constantly monitored by the acquisition watch stander.

The internal (USB) logged files are size limited, therefore files submitted typically start with the .000 extension and increment upwards (e.g. .001, .002, .003, ...). There are approximately 240 files generated

during 24 hours of acquisition. The Ethernet logged files are typically broken at approximately UTC noon each day to yield two files per hull for a survey day.

Real-time USCG DGPS correctors are used for all acquisition. Specific DGPS stations are noted in the DR accompanying each survey.

B.1.4.2 Vertical Control

Preliminary, observed and verified water levels are downloaded using FetchTides and applied to the data using CARIS HIPS Load Tide function. For data submission, depth data are reduced to MLLW either through application of Verified Water levels and Verified Tidal Zoning or using GPS derived vertical positions and the VDatum model. Refer to individual sheet DRs for detailed methods and additional information.

B.1.5 Feature Verification

Feature verification followed guidelines set forth in section 3.5.5 of the FPM. Refer to individual sheet DRs for additional information.

B.1.6 Bottom Sampling

Bottom Sampling followed guidelines set forth in sections 7.1 of the HSSD and 2.5.4.2.1 of the FPM. Bottom sample locations are guided by analysis of the backscatter and bathymetry of the survey area Refer to individual sheet DRs for additional information.

B.1.7 Backscatter

Backscatter is acquired in the 7008 record logged in the .s7k files directly from the Reson 7125 processors. For the 7125 400kHz systems, snippet size is set to 25 samples in water depths less than 50 meters and to 50 samples in depth greater than 50 meters. The 7125 200kHz system has snippets size set to 100 in depths less than 100 meters and 200 in all depths greater than 100 meters. 7111 snippet size is set to 40 samples in depths less than 80 meters, 80 samples in depths between 150 and 300 meters, and 120 samples in deeper depths. All processing of backscatter is done using the FMGT module of the QPS Fledermaus package.

B.1.8 Other

No additional data were acquired.

Additional Discussion

FERDINAND R. HASSLER maintains a continuous manned survey watch during all survey acquisition. The watch stander is in constant communication with the bridge and monitors the performance of all systems. Thresholds set in Hypack/Hysweep, POSview, Reson and SonarPro alert the watch stander by displaying alarm messages when error thresholds or tolerances are exceeded. Alarm conditions that may compromise survey data quality are corrected and then noted in acquisition log. Warning messages such as the temporary loss of differential GPS, excessive cross track error, or vessel speed approaching the maximum allowable survey speed are addressed by the watch stander and corrected before further data acquisition occurs.

B.2 Data Processing

B.2.1 Bathymetry

B.2.1.1 Multibeam Echosounder

Bathymetry processing follows section 4.2 of the FPM unless otherwise noted.

Raw .s7k multibeam data are converted to CARIS HIPS HDCS format using established and internally documented settings. After TrueHeave, sound speed and water level correctors are applied to all lines, the lines are merged. Once lines are merged, Total Propagated Uncertainty (TPU) is computed using settings documented for each survey in the Descriptive Report. Default CARIS device models (C:\CARIS\HIPS \71\System\devicemodels.xml) are used during processing.

The general resolution, depth ranges, and Combined Uncertainty and Bathymetric Estimator (CUBE) parameter settings outlined in section 5.2.2.2 of the HSSD and section 4.2.1.1.1.1 of the FPM are used for surface creation and analysis. If these depth range values for specific resolutions require adjustment for analysis and submission of individual surveys then the required waiver from HSD Operations is requested. A detailed listing of the resolutions and the actual depth ranges used during the processing of each survey, along with the corresponding fieldsheet(s), is provided in the Descriptive Report of each survey.

BASE surfaces are created using the CUBE algorithm and parameters contained in the NOAA CUBEParams_NOAA.xml file as provided in Appendix 4 of the FPM. The CUBEParams_NOAA.xml file is included with the HIPS Vessel Files with the individual survey data. The NOAA parameter configurations for resolutions 0.5-16 meters are used.

Multibeam data are reviewed and edited in HIPS Subset Editor as necessary. The finalized BASE surfaces and CUBE hypotheses guide directed data editing at the appropriate depth range in subset editor. The surfaces and subset editor view are also used to demonstrate coverage and to check for errors due to tides, sound speed, attitude and timing.

Vessel heading, attitude, and navigation data are reviewed in HIPS navigation editor and attitude editor if deemed necessary upon review of surfaces. Where necessary, fliers or gaps in heading, attitude, or navigation data are manually rejected or interpolated for small periods of time. Any editing of this nature will be outlined in the Descriptive Report for the particular survey.

Either the Density or the Density & Locale method for hypothesis disambiguation is typically used. This follows section 4.2.1.1.1 of the FPM as available disambiguation methods. The disambiguation method can be seen in each individual layers properties and can be modified if desired.

The surface filtering function in CARIS HIPS is not utilized routinely. If utilized, the individual Descriptive Report lists the confidence level settings for standard deviation used and discuss the particular way the surface filter was applied.

Designated soundings are selected as outlined in section 5.2.1.2 of the HSSD.

IHO child layers are created using the following two formulas for IHO_1 and IHO_2, respectively; -Uncertainty/((0.5^2 +((Depth*0.013)^2))^0.5) and -Uncertainty/((1.0^2 +((Depth*0.023)^2))^0.5). IHO_1 is created for all soundings less than 100 meters while IHO_2 is for 100 meters and deeper. This layer is then exported and run through an application which computes statistics. The results are reported and analyzed in each sheets' individual DR, but the layers are not submitted with the survey.

Additionally, a combined surface is reviewed in 3-D mode using one of the following programs; CARIS HIPS, CARIS Base Editor or IVS Fledermaus, to ensure that the data are sufficiently free of artifacts and is a reasonable model of the sea floor.

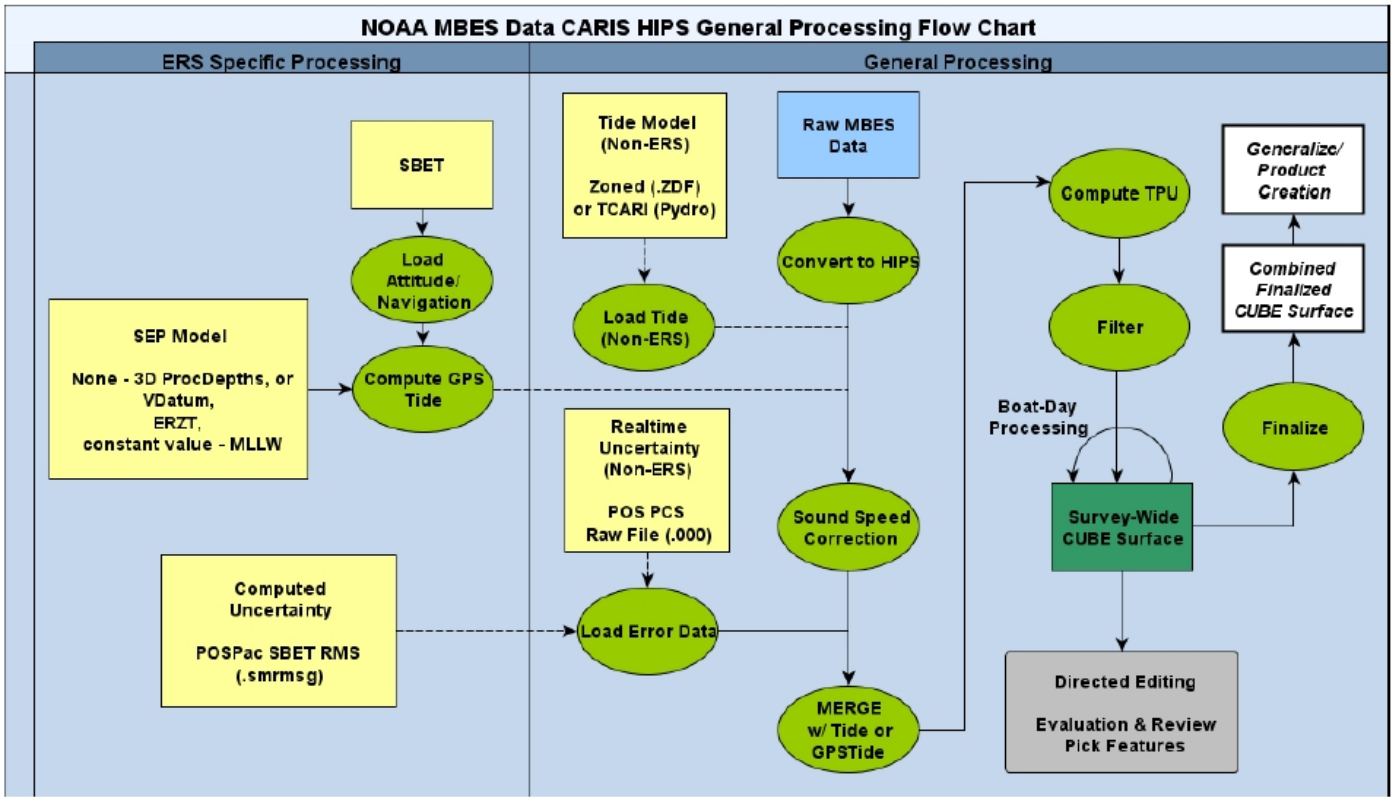


Figure 25: MBES flow diagram

B.2.1.2 Single Beam Echosounder

ODOM single beam data are converted to CARIS HIPS HDCS format using the Hypack .RAW file and internally documented settings. The .BIN file is copied along with the .RAW file to allow for the manual adjustment of fliers rather than rejecting completely.

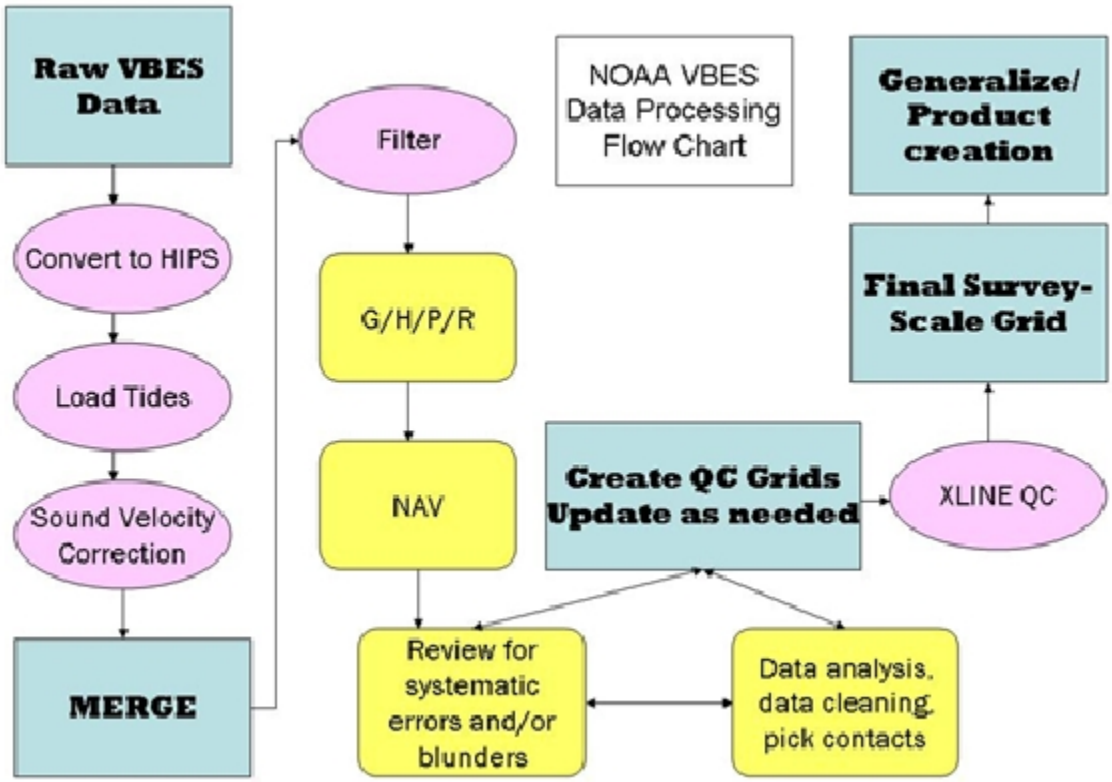


Figure 26: VBES flow diagram

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

Processing logs are used to record and communicate problems from acquisition to final processing.

B.2.1.4.2 Methods Used to Generate Bathymetric Grids

All methods used to generate final bathymetric grids are followed as put forth in section 4.2 and all relevant subsections of the FPM.

B.2.1.4.3 Methods Used to Derive Final Depths

Methods Used	Cleaning Filters
	Gridding Parameters
	Surface Computation Algorithms
Description	Filters are used on a case by case basis as determined by the hydrographer, refer to individual sheet DRs for more information.

B.2.2 Imagery

B.2.2.1 Side Scan Sonar

Side scan sonar data are converted from .sdf (SonarPro raw format) to CARIS HDCS lines. Fish height, vessel heading, and vessel navigation records are reviewed for each file and edited as necessary. Tow point offsets (A-Frame and cable out), fish depth, fish attitude, and water depth are used to calculate horizontal layback. Towfish navigation is recalculated using CARIS SIPS.

After towfish navigation is recalculated, side scan imagery data are slant-range corrected and examined for targets. Targets are selected and saved as contacts to a contact file for each line of SSS data. Contact selections includes measuring apparent height and width, selecting contact position, and creating a contact snapshot image. Targets are exported to CARIS BASE Editor for correlation and processing. Significant targets (as defined in Section 6.3.2 of the Specifications and Deliverables) are correlated with MBES to obtain least depths. All side scan lines are check-scanned by a qualified hydrographer, i.e. all SSS imagery is examined by at least two independent hydrographers.

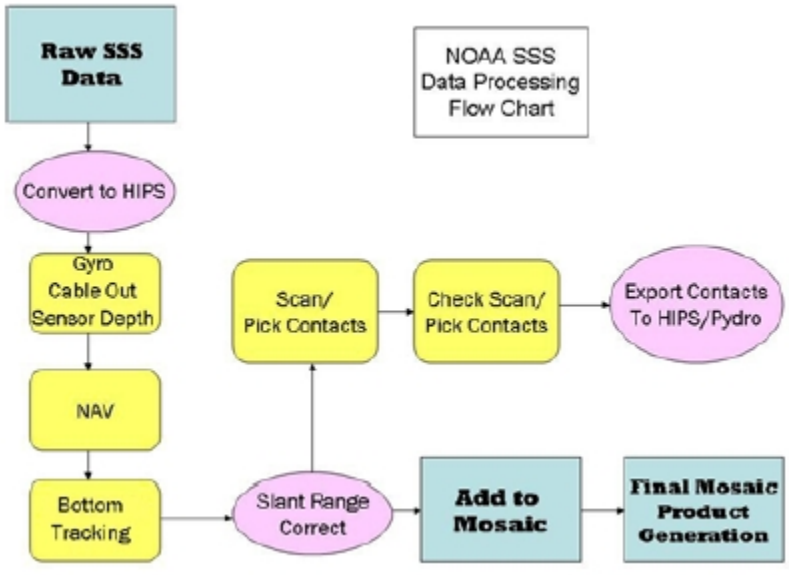


Figure 27: SSS flow diagram

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

Processing logs are used to record and communicate problems from acquisition to final processing.

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

Range of the SSS, XTE, speed of vessel collecting data and repetitious processing examinations are all used to ensure that object detection and accuracy requirements are met.

B.2.2.3.3 Methods Used to Verify Swath Coverage

Swath coverage is verified through construction of side scan mosaics. During acquisition, the outer portions of the swath are monitored for refraction artifacts. If an apparent refraction artifact impacts objects detection ability and cannot be eliminated through adjustment of fish height, the range scale is reduced.

B.2.2.3.4 Criteria Used for Contact Selection

In CARIS SIPS, if an apparent shadow measures greater than 1.0 meters a contact is chosen for development by MBES.

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

Daily sound speed profiles from the SBE and MVP profilers are processed with Velocipy after acquisition.

B.2.3.1.1 Specific Data Processing Methods

B.2.3.1.1.1 Caris SVP File Concatenation Methods

CTD profiles from the Seabird SBE 19-plus and AML Micro-CTD are processed using the NOAA developed program Velocipy. From each system, sound speed profiles are extracted and archived as both individual and concatenated CARIS SVP files.

Figure 99: no figure

B.2.3.2 Surface Sound Speed

The SBE-45s are configured to average four samples and report the result once a second. No additional filters are applied.

Figure 99: no figure

B.2.4 Horizontal and Vertical Control

B.2.4.1 Horizontal Control

Fixed USCG DGPS stations are used for all real time horizontal control. If post-processed GPS techniques are used to improve horizontal and vertical control, specific information is included in the Descriptive Report and/or the project's Horizontal and Vertical Control Report.

If USB logged TrueHeave files contain IMU data gaps or other errors apparent during post processing then Ethernet logged files may be examined and used if free from gaps. If this is the case both files will be submitted with the GNSS data.

Figure 99: no figure

B.2.4.2 Vertical Control

CO-OPS zoned water levels utilizing water level observations from fixed, continuously operating NOAA tide gages are used for reduction of data to MLLW. Predicted water levels are applied during preliminary processing. Before submission, verified water levels are applied to all tidally corrected data. If post processed GPS techniques are used to improve vertical control, specific information is included in the Descriptive Report and/or the project's Horizontal and Vertical Control Report.

Figure 99: no figure

B.2.5 Feature Verification

Features are processed using CARIS Bathy DataBase software and are included with submitted processed data in the survey's final feature file (FFF) in S-57 .000 format. The FFF includes all features; buoys, rocks, wrecks, bottom samples, etc., addressed within the limits of each individual sheet.

Figure 99: no figure

B.2.6 Backscatter

All backscatter was processed from acquired Reson .s7k or Hypack .HSX files. All backscatter processing is performed with QPS Fledermaus Geocoder Toolbox and a mosaic calculated with default processing parameters. Reson TVG plugins are used for all processing steps.

Figure 99: no figure

B.2.7 Other

No additional data were processed.

B.3 Quality Management

Standard operating procedures (SOPs) and checklists are followed by personnel throughout the survey to ensure consistent high quality data and products.

Data is reviewed for artifacts and errors during daily processing and is reviewed by the Operations Officer and/or Hydrographic Senior Survey Technician daily. Before any data is to be submitted it is reviewed independently by at least three experienced hydrographers who are signatories to the Descriptive Report.

B.4 Uncertainty and Error Management

TPU is processed using the following settings.

B.4.1 Total Propagated Uncertainty (TPU)

B.4.1.1 TPU Calculation Methods

TPU is calculated in CARIS HIPS using the Compute TPU tool. Project specific values for tide and sound speed are entered and used over the duration of each project.

B.4.1.2 Source of TPU Values

Error values for the multibeam and positioning systems were compiled from manufacturer specifications sheets for each sensor and from values set forth in section 4.2.3.8 of the 2013 FPM.

B.4.1.3 TPU Values

Vessel	S250 (Port)		
Echosounder	Reson 7125 200 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees

	Navigation Position	0.500 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*	0.050 meters
		y	0.050 meters
		z	0.050 meters
	MRU Alignment	*Gyro*	0.100 degrees
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Vessel	*Speed*	0.050 meters/second
		Loading	0.050 meters
		Draft	0.050 meters
		Delta Draft	0.050 meters
Vessel	S250 (Port)		
Echosounder	Reson 7125 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	0.500 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*	0.050 meters
		y	0.050 meters
		z	0.050 meters

	MRU Alignment	*Gyro*	0.060 degrees
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Vessel	*Speed*	0.050 meters/second
		Loading	0.050 meters
		Draft	0.050 meters
		Delta Draft	0.050 meters
Vessel	S250 (Starboard)		
Echosounder	Reson 7111 100 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 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*	0.100 meters
		y	0.100 meters
		z	0.100 meters
	MRU Alignment	*Gyro*	0.130 degrees
		Pitch	0.030 degrees
		Roll	0.030 degrees
	Vessel	*Speed*	0.030 meters/second
		Loading	0.040 meters
		Draft	0.050 meters
		Delta Draft	0.050 meters
Vessel	S250 (Starboard)		
Echosounder	Reson 7125 200 kilohertz		

TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 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*	0.050 meters
		y	0.050 meters
		z	0.050 meters
	MRU Alignment	*Gyro*	0.080 degrees
		Pitch	0.010 degrees
		Roll	0.010 degrees
	Vessel	*Speed*	0.050 meters/second
		Loading	0.050 meters
		Draft	0.050 meters
		Delta Draft	0.050 meters
Vessel	S250 (Starboard)		
Echosounder	Reson 7125 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 radians
	Navigation Position	1.000 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*	0.050 meters
	y	0.050 meters
	z	0.050 meters
MRU Alignment	*Gyro*	0.050 degrees
	Pitch	0.020 degrees
	Roll	0.020 degrees
Vessel	*Speed*	0.050 meters/second
	Loading	0.050 meters
	Draft	0.050 meters
	Delta Draft	0.050 meters

B.4.2 Deviations

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

Additional Discussion

During the 2012 field season, the method of calculating the MRU alignment uncertainty was revised. The previous method estimated the alignment uncertainty by taking the standard deviation of each evaluators' best estimate. This method was modified to have each evaluator make five measurements of each offset (e.g. roll). The average of all these values was taken as the patch test value, the standard deviation of the mean (standard deviation of all the independent measurements divided by the square root of the number of measurements) was used as at the MRU alignment error. This better models the expected error in the estimate of the true offset value rather than the uncertainty of any particular evaluator's estimate. This new method was utilized for calculating the MRU alignment uncertainty for the 2013 field season.

For the port 7125, the MRU gyro alignment uncertainty value is 0.06 degrees with the new method compared with 0.29 degrees with the previous method. The Roll/ Pitch MRU alignment uncertainty is 0.02 degrees with the new method compared to 0.13 degrees with the previous method.

For the starboard 7125, the MRU gyro alignment uncertainty value is 0.05 degrees with the new method compared with 0.22 degrees with the previous method. The Roll/ Pitch MRU alignment uncertainty is 0.02 degrees with the new method compared to 0.11 degrees with the previous method.

C Corrections To Echo Soundings

C.1 Vessel Offsets and Layback

C.1.1 Vessel Offsets

C.1.1.1 Description of Correctors

C.1.1.2 Methods and Procedures

Sensor offsets are measured with respect to the vessel's reference point. These offsets are derived from the full survey performed in the shipyard, a partial survey performed by NGS personnel and measurements/ verifications performed by FERDINAND R. HASSLER personnel. All offsets are tracked and updated as needed on a spreadsheet submitted with the appendices of this report.

The port IMU serves as the reference point for the port-only 7125 HSX configuration, the port 7125 s7k configuration and the side scan sonar. For all other vessel configurations the starboard IMU is the reference point.

POS GPS antennae pairs are mounted to a 2 meter length of channel extrusion in a fore and aft orientation.

C.1.1.3 Vessel Offset Correctors

Vessel	S250 Port		
Echosounder	Reson 7125 - After installation of POS-MV V5 (July 25, 2013) this is not a dual head system. 400 kilohertz		
Date	2013-07-01		
Offsets	*MRU to Transducer*	*x*	-1.244 meters
		y	0.362 meters
		z	1.381 meters
		x2	-1.244 meters
		y2	0.362 meters
		z2	1.349 meters

	Nav to Transducer	*x*	-2.246 meters
		y	-2.351 meters
		z	14.250 meters
		x2	-2.246 meters
		y2	-2.351 meters
		z2	14.269 meters
	Transducer Roll	*Roll*	4.500 degrees
		Roll2	4.500 degrees
Vessel	S250 Starboard		
Echosounder	Reson 7125 - After installation of POS-MV V5 (July 25, 2013) this is not a dual head system. 400 kilohertz		
Date	2013-07-01		
Offsets	*MRU to Transducer*	*x*	1.424 meters
		y	0.380 meters
		z	1.390 meters
		x2	1.424 meters
		y2	0.380 meters
		z2	1.358 meters
	Nav to Transducer	*x*	4.528 meters
		y	-2.320 meters
		z	14.259 meters
		x2	4.528 meters
		y2	-2.320 meters
		z2	14.278 meters
	Transducer Roll	*Roll*	-4.500 degrees
		Roll2	-4.500 degrees
Vessel	S250		
Echosounder	Reson 7111 100 kilohertz		
Date	2013-07-01		
Offsets	*MRU to Transducer*	*x*	1.203 meters
		y	11.608 meters
		z	0.977 meters
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	4.307 meters
		y	8.908 meters
		z	13.897 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	0.000 degrees
Vessel	S250		
Echosounder	Odom Echotrac CV200 - Transducer 1 = Starboard hull (200 kHz), Transducer 2 = Port hull (24 kHz) 24 kilohertz		
Date	2013-07-01		
Offsets	*MRU to Transducer*	*x*	-0.455 meters
		y	4.620 meters
		z	1.383 meters
		x2	-12.701 meters
		y2	4.620 meters
		z2	1.381 meters
	Nav to Transducer	*x*	2.649 meters
		y	1.920 meters
		z	14.303 meters
		x2	-9.597 meters
		y2	1.920 meters
		z2	14.301 meters
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	0.000 degrees

C.1.2 Layback

C.1.2.1 Description of Correctors

Layback is calculated in CARIS from the cable-out and fish depth. Cable-out is output from a cable counter and recorded in the .sdf file. The side scan cable is marked at 12 meters and is deployed to this position on launching. The cable counter is reset to zero at this position and the 12 meter offset applied in SonarPro. Thus, the cable out value in the .sdf file is the correct value for the cable between the tow point and the towfish.

C.1.2.2 Methods and Procedures

No layback correctors are applied in the HVF

C.1.2.3 Layback Correctors

Vessel	S250		
Echosounder	Klein 5250 455 kilohertz		
Date	2013-07-01		
Layback	*Towpoint*	*x*	7.161 meters
		y	-26.032 meters
		z	-9.347 meters
	Layback Error	0.00 meters	

Additional Discussion

C.2 Static and Dynamic Draft

C.2.1 Static Draft

C.2.1.1 Description of Correctors

Because of her SWATH design, FERDINAND R. HASSLER is particularly susceptible to loading and trim. While underway, the ballast is actively managed to maintain the draft at the design draft of 3.80 meters. During typical survey operations, HASSLER burns approximately 4,000 liters of diesel per day. At a density of 0.83 kilograms/ liter this is approximately 3.3 metric tons of fuel per day. At design draft of 3.80 meters, 1.3 metric tons is required to submerge an additional 0.01 meters of the hull in salt water. The daily fuel burn would thus account for 0.03 meters of variation in the draft. Ballast is adjusted daily to account for fuel burn and the levels in other tanks. As noted in Section A.1.1, design draft of 3.85 meters was mistakenly used to compute static draft of the reference point. The resulting bias is not considered significant for this survey. Uncertainty is estimated at 0.05 meters.

C.2.1.2 Methods and Procedures

The waterline to reference point is calculated from the vessel offset survey and the vessel draft marks.

C.2.2 Dynamic Draft

C.2.2.1 Description of Correctors

Dynamic draft is calculated as the dynamic height of the vessel reference point as a function of vessel speed compared to the height at rest. This correction is applied during CARIS processing.

C.2.2.2 Methods and Procedures

An ellipsoidally referenced dynamic draft measurement (ERDDM) was performed following guidelines in the 2013 FPM on June 26, 2013 (Dn177). An area was selected offshore of Cape Charles, VA where the slope of the geoid was minimal. Speeds from 6 to 13 knots were run in one direction. The ship was then turned to the reciprocal heading, brought to a complete stop, and then the speeds from 6 to 13 knots were run in the opposite direction.

The fourth order polynomial results for the dynamic draft curves from the port and starboard side were averaged. These results were significantly different from the 2011 and 2012 values, with a 0.15 meter difference at typical survey speeds from the prior year. This may be accounted for by the significant changes made to the hull during the off season drydock for added buoyancy. The 2013 results are included in the attached report and shown in Figure 26.

C.2.2.3 Dynamic Draft Correctors

Vessel	S250										
Date	2012-01-01										
Dynamic Draft Table	*Speed*	0.0 met second	1.0 met second	2.0 met second	3.0 met second	3.5 met second	4.0 met second	4.5 met second	5.0 met second	5.5 met second	6.0 met second	6.5 met second
	Draft	0.000 n	0.010 n	-0.110	-0.180	-0.170	-0.130	-0.070	0.010 n	0.090 n	0.160 n	0.180 f

Additional Discussion

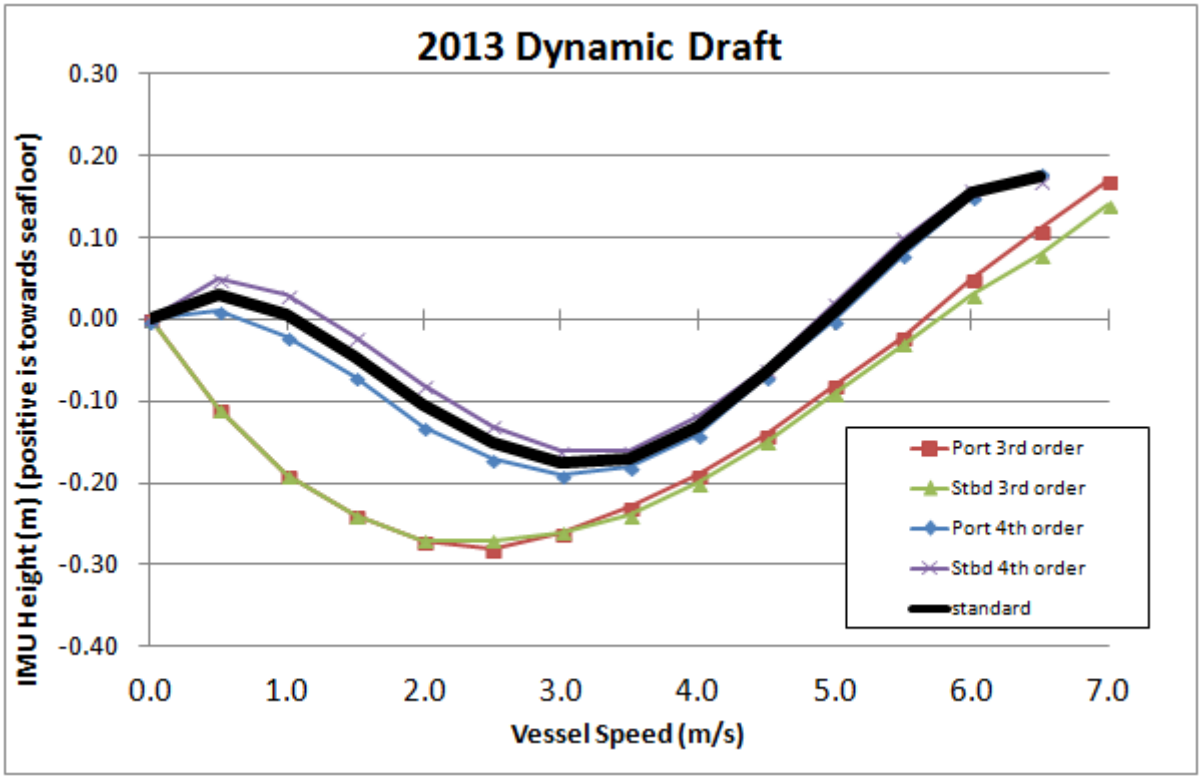


Figure 27: Dynamic draft derived from ERDDM methods. Positive values are displacements of the IMU towards the sea floor. Thin lines are results from port and starboard head for third and fourth order polynomial fits. Black bold line is dynamic draft value used for both hulls.

C.3 System Alignment

C.3.1 Description of Correctors

C.3.2 Methods and Procedures

Methods and Procedures used follow recommendations given in Section 1.5 of the 2013 FPM.

C.3.3 System Alignment Correctors

Vessel	S250
Echosounder	Reson 7125 Starboard 400 megahertz
Date	2013-10-20

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.190 degrees
	Roll	0.100 degrees
	Yaw	0.510 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7125 Starboard 400 kilohertz	
Date	2013-07-25	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.190 degrees
	Roll	0.010 degrees
	Yaw	0.510 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7125 Starboard 200 kilohertz	
Date	2013-07-31	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	0.050 degrees
	Roll	0.010 degrees
	Yaw	0.620 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7125 Port 400 kilohertz	
Date	2013-10-20	

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.390 degrees
	Roll	-0.080 degrees
	Yaw	0.090 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7125 Port 400 kilohertz	
Date	2013-07-25	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.390 degrees
	Roll	-0.020 degrees
	Yaw	0.090 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7125 Port 200 kilohertz	
Date	2013-07-31	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	0.160 degrees
	Roll	0.000 degrees
	Yaw	-0.07 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	S250	
Echosounder	Reson 7111 100 kilohertz	
Date	2013-07-31	

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.880 degrees
	Roll	-0.020 degrees
	Yaw	1.610 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.4 Positioning and Attitude

C.4.1 Description of Correctors

C.4.2 Methods and Procedures

Vessel navigation and attitude is measured by the POS/MV and recorded in the Hysweep .hsx file and the Reson .s7k file. Pitch is applied real-time to the Reson 7111. Navigation and attitude measurements not applied in real time are applied during post processing in CARIS HIPS using the attitude data recorded in the .hsx or .s7k file.

The POS/MV TrueHeave data is logged within the POS/MV .000 files and applied in CARIS HIPS during post processing using the "Apply TrueHeave" function. TrueHeave is a forward-backward filtered heave corrector as opposed to the real time heave corrector, and is fully described in section 6 of the POS/MV V4 User Guide 2009.

In most cases, PPK data in the form of SBET files are applied to soundings to increase the accuracy of the kinematic vessel corrections and to allow the ability to reference soundings to the ellipsoid. Standard daily data processing procedures include post processing of POS/MV kinematic .000 files using Applanix POSPac MMS and POSGNSS software using either IN-Fusion SmartBase, IN-Fusion SingleBase or Precise Point Positioning (PPP) processing modes. After processing and quality control analysis of the post-processed SBET files is complete, the SBET and SMRMSG files are applied to the HDCS data in CARIS HIPS using the "Load Attitude/Navigation Data" and "Load Error Data" processing tools, respectively.

The heave lever arms are configured to a point on the centerline of the vessel between the two POS IMU's. This was done to prevent long-term static roll angles from causing a steady state heave offset.

C.5 Tides and Water Levels

C.5.1 Description of Correctors

C.5.2 Methods and Procedures

Unless otherwise noted in the survey Descriptive Report (DR) and/or project Horizontal and Vertical Control Report (HVCR), the vertical datum for all soundings and heights is Mean Lower Low Water (MLLW). Predicted, preliminary, and/or verified water level correctors from the primary tide station(s) listed in the Project Instructions may be downloaded from the CO-OPS website and used for water level corrections during the course of the project. These tide station files are collated to include the appropriate days of acquisition and then converted to CARIS .tid file format using FetchTides.

Water level data in the .tid files are applied to HDCS data in CARIS HIPS using the zone definition file (.zdf) or a Tidal Constituent and Residual Interpolation (TCARI) model supplied by CO-OPS. Upon receiving final approved water level data, all data are reduced to MLLW using the final approved water levels as noted in the individual survey's DR.

A complete description of vertical control utilized for a given project can be found in the project specific HVCR, submitted for each project under separate cover when necessary as outlined in section 5.2.3.2.3 of the FPM.

Newer methods for handling vertical control are being developed and, if utilized, are explained in more detail in the project-wide HVCR or survey DR.

C.6 Sound Speed

C.6.1 Sound Speed Profiles

C.6.1.1 Description of Correctors

C.6.1.2 Methods and Procedures

Seabird .cnv and MVP .bot files are collected when necessary and converted to .svp files using NOAA's Pydro/Velocipy program. These .svp files are concatenated into one sheet specific master file per project which is then applied to HDCS data using a specified method. This method of applying sound speed to data is listed in the sheet's processing log included in the Separates submitted with the individual survey.

C.6.2 Surface Sound Speed

Surface sound speed correctors were not applied.

D. APPROVAL SHEET

This Data Acquisition and Processing Report for project OPR-B310-FH-13, Approaches to New York, is respectfully submitted.

As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to during these projects in accordance with the Hydrographic Surveys Specifications and Deliverables (4/2013); Hydrographic Survey Technical Directives 2010-2, 2011-3, 2012-1; and the Field Procedures Manual for Hydrographic Surveying (4/2013).

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

This DAPR applies to surveys H12627, H12628, and H12629 which were completed in 2013.

Approved and Forwarded:

Adam Reed
2014.02.14 19:51:02
Z

LT Adam Reed, NOAA
Field Operations Officer

Marc S. Moser

Digitally signed by Marc S. Moser
DN: cn=Marc S. Moser, o=NOAA, ou=Ferdinand R. Hassler, email=marc.s.moser@noaa.gov, c=US
Date: 2014.02.14 14:52:59 -05'00'

LCDR Marc S. Moser, NOAA
Chief of Party

Appendix I

Vessel Reports

Final report

SURVEY REPORT

SHIP: M286 SWATH
FERDINAND R. HASSLER

LOCATION: PASCAGOULA, MS

DATE: 7/18-7/26, 2009
And **11/4, 2009**

PURPOSE:
Determine the ship's centerline, roll, and pitch. Install benchmarks, install the master reference plane in the same planes as the measured roll, pitch, and azimuth of the ship. Assist the shipyard to install the IMUs parallel to the centerline, and in the same plane as the ship's roll and pitch. Assist the shipyard in installing the transducers in the same plane as roll, pitch and azimuth of the ship. Measure and spot the draft marks.

PERSONNEL:
Eric Kostelak
Brian Kloter
Raymond Impastado
John Miskimmin

EQUIPMENT LIST:
WILD T2 THEODOLITE SN: 169786 Calibration Expiration Date; 12/19/09

WILD T2 THEODOLITE SN: 155062 Calibration Expiration Date; 12/19/09

WYLER CLINO 2000 CLINOMETER SN: M4416 Calibration Expiration Date; 07/10/10

TOPCON GTS-301 One Second Electronic Total Station, Serial number GU1193 Calibration Expiration Date; 07/12/09

WILD NA1 AUTO LEVEL: SN 472810 Calibration Expiration Date; 07/12/09

Procedures:

1. Establish a baseline in relation to the centerline of both pontoons.
   A. Locate points on each of the pontoons to determine centerline
   B. Measure the elevation differences of the points. Take the average of these to determine the pitch and roll of each pontoon.

2. Take the average of the measurements of the two pontoons for roll, pitch, and centerline. The result can then be used as the Master reference.

3. Create a traverse, in a level plane, around the ship using the established baseline as a reference. Set various points that will be used to locate the master reference block, IMUs, bench marks, transducers, and antennas.

4. Locate, set and secure the master reference block to within 9 arc seconds of the calculated roll, pitch, and centerline values.

5. Once the MRB has set for a day, confirm the measurements relative to the results of step 2. If the measurements are within the two values used in Step 2, these values will become the Final Master Reference, which all further measurements will be referenced to.

6. Locate IMU foundations, adjust to be level with roll and pitch, and aligned with centerline.

7. Establish bench marks that are aligned to the centerline in any areas that require future measurements.

8. For transducers, on the bottom of the hull, establish punch marks aligned to the centerline that can be used to align the transducers to the centerline.

9. Run a closed level loop from the master reference block to all bench marks, Transducers, antennas, and sensors to determine their elevation values relative to the reference. (Z axis).

10. Using established elevation points within the traverse, determine the correct locations for all draft marks.

11. Work with the shipyard to determine the correct alignment of the transducers.

METHODS

All angles at intersections were turned 4 times, 2 in regular, and 2 in inverted position. All other angles were turned 2 times, once in regular, and once in inverted position.

Slope distances were measured with a zenith angle in the regular and inverted Position.

The Traverse was closed and computed for accuracy.

Results

MRB

After the MRB has set up for 24 hours, it was found the chock fast had caused an 18 second movement in roll. As this small value was well within the average of the two pontoons, the final reference was shifted to the MRB values.

IMU

During measurements of the IMUs, we discovered it was impossible to meet the specification to be level to the roll and pitch within 90 arc seconds using the existing mounts. The shipyard manufactured a double plate separated by three threaded rods, which allowed fine adjustment in two planes (roll and pitch). The IMUs were aligned to zero measurable azimuth error, and to within 5 arc seconds in roll and pitch relative to the MRB.

TRANSDUCERS

7125

During measurements it became apparent that it was impossible to meet the roll and pitch specification on the multibeam transducer mounts. There was no measurable azimuth error on either 7125 transducer mount, when the welding was finished. The shipyard came up with the roll and pitch solution of machining the surfaces in place once the mounting plates were completely welded out. We attended for the machine work on 8/19/09. A portable milling machine was put in place, leveled to within 5 arc seconds of the MRB plus 4.5 degrees of roll to Give the transducer mounting surfaces the specified 4.5 degree outward roll angle. See attached photo. It was agreed by all that if the milling machine was positioned correctly, the surfaces had to be correct, but as a check to confirm the process, we measured the machined surface on the port unit, and found the pitch error was zero, and the roll error was 15 seconds. This was well within the required 90 seconds.

Milling machine set up on 7125 transducer housing

7111

Like the 7125s, it was impossible to meet the roll and pitch specification on this transducer mounting plate. It too, was machined by the portable milling machine.
The machine was set up to be within 5 seconds of the MRB Pitch and Roll values.

XYZ COORDINATES TABLE

POINT	X-AXIS	Y-AXIS	Z-AXIS	DESCRIPTION
5	9.264	-7.555	7.169	POINT FP
6	9.409	6.256	7.168	POINT FS
7	3.491	-7.478	7.176	POINT MP
8	3.872	6.168	7.178	POINT MS
9	-4.035	-7.561	7.168	POINT AP
10	-4.022	6.258	7.169	POINT AS
15	9.326	-0.652	7.168	CENTERLINE
18	-4.017	-0.652	7.168	CENTERLINE
19	16.343	2.530	-5.065	STARBOARD BENCH MARK TOP WHEEL HOUSE
20	16.343	-0.653	-5.064	MID BENCH MARK TOP WHEEL HOUSE
21	16.343	-3.836	-5.066	PORT BENCH MARK TOP WHEEL HOUSE
25	-1.336	0.001	0.160	AFT BENCH MARK MASTER REFERENCE PLATE
26	0.000	0.000	0.000	MASTER REFERENCE PLATE
27	-0.353	0.000	0.161	FWD BENCH MARK MASTER REFERENCE PLATE
28	13.428	-8.960	-2.496	PORT BENCH MARK BRIDGE WING
29	13.428	-5.592	-2.476	STARBOARD BENCH MARK BRIDGE WING
30	7.115	5.836	7.154	FWD PUNCH MARK ADCP
31	5.765	5.835	7.145	AFT PUNCH MARK ADCP
33	7.841	6.846	7.167	FWD PUNCH MARK RESON 7125 STARBOARD PONTOON
34	5.025	6.847	7.168	AFT PUNCH MARK RESON 7125 STARBOARD PONTOON
36	5.022	-8.169	7.157	AFT PUNCH MARK RESON 7125 PORT PONTOON
37	7.792	-8.169	7.154	FWD PUNCH MARK RESON 7125 PORT PONTOON
39	15.307	6.610	6.843	AFT PUNCH MARK RESON 7111
40	16.098	6.611	6.771	FWD PUNCH MARK RESON 7111
41	10.822	5.864	7.169	FWD PUNCH MARK MDS* STARBOARD PONTOON
42	9.818	5.863	7.172	AFT PUNCH MARK MDS* STARBOARD PONTOON
43	10.608	-7.081	7.177	FWD PUNCH MARK MDS* PORT PONTOON
44	9.762	-7.080	7.175	AFT PUNCH MARK MDS* PORT PONTOON
45	-13.926	-0.615	0.105	AFT MID BENCH MARK BACK DECK
46	-9.031	-0.615	0.125	FWD BENCH MARK BACK DECK

POINT	X-AXIS	Y-AXIS	Z-AXIS	DESCRIPTION
47	-13.926	6.471	0.114	STARBOARD BENCH MARK BACK DECK
48	-13.926	-7.697	0.093	PORT BENCH MARK BACK DECK
51	5.891	-6.878	5.839	IMU PORT PONTOON (OLD LOCATION)
52	5.923	5.428	5.840	IMU STARBOARD PONTOON (OLD LOCATION)
53	17.655	6.584	6.890	RESON 7111 CENTER OF PLATE
54	6.265	6.774	7.095	PORT EDGE RESON 7125 STARBOARD PONTOON
55	6.265	6.805	7.093	RESON 7125 STARBOARD PONTOON
56	6.223	-8.078	7.087	STARBOARD EDGE RESON 7125 PORT PONTOON
57	6.223	-8.109	7.085	RESON 7125 PORT PONTOON
58	16.039	5.417	2.563	INBOARD DRAFT MARK FRAME 4 STARBOARD
59	16.025	-6.711	2.567	INBOARD DRAFT MARK FRAME 4 PORT
60	-11.204	5.626	2.588	INBOARD DRAFT MARK FRAME 46 STARBOARD
61	-11.208	-6.870	2.562	INBOARD DRAFT MARK FRAME 46 PORT
62	16.040	7.458	2.565	OUTBOARD DRAFT MARK FRAME 4 STARBOARD
63	-11.208	7.462	2.588	OUTBOARD DRAFT MARK FRAME 46 STARBOARD
64	16.025	-8.735	2.570	OUTBOARD DRAFT MARK FRAME 4 PORT
65	-11.205	-8.711	2.555	OUTBOARD DRAFT MARK FRAME 46 PORT
66	6.273	-9.907	5.789	PORT BENCH MARK IMU PORT PONTOON
67	6.273	-5.007	5.861	STARBOARD BENCH MARK IMU PORT PONTOON
68	6.624	3.666	5.862	PORT BENCH MARK IMU STARBOARD PONTOON
69	6.624	8.571	5.798	STARBOARD BENCH MARK IMU STARBOARD PONTOON
70	5.861	-6.865	5.767	IMU PORT PONTOON
71	5.885	5.381	5.768	IMU STARBOARD PONTOON
72	-20.247	-0.609	-4.327	BOTTOM OF CENTER BLOCK "A" FRAME
73	11.205	-1.904	-7.782	BOTTOM OF GPS ANTENNAE PORT LOWER
74	10.488	-1.896	-9.774	BOTTOM OF GPS ANTENNAE PORT UPPER
75	11.180	0.594	-7.776	BOTTOM OF GPS ANTENNAE STARBOARD LOWER
76	10.455	0.589	-9.776	BOTTOM OF GPS ANTENNAE STARBOARD UPPER

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER

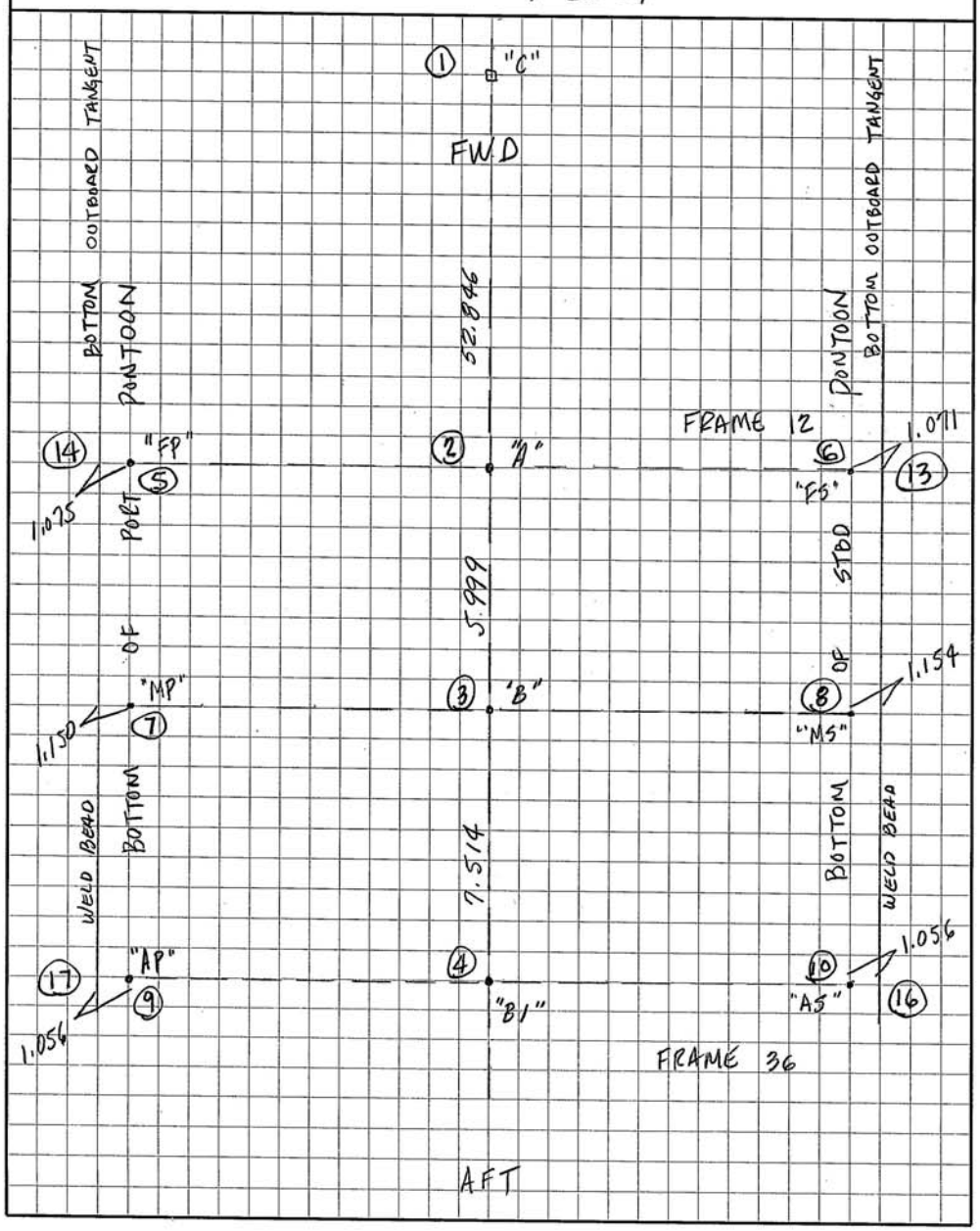
M286 SWATH

PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 1
7-26-09



RAYMOND C. IMPASTATO
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PHONE NO: (985) 774-1955

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JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J.M. & B.K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 SHEET NO.: 1A

INST. ON PT "A" - B.S. @ PT "C"

∠1	∠2	AVG.	Z∠1	Z∠2	AVG.	DIST.	PT.
89°20'25"	89°20'30"	89°20'28"	87°41'56"	272°17'59"	87°41'59"	6.779	"FS"
268°11'37"	268°11'42	268°11'40"	87°54'43"	272°05'12"	87°54'45"	7.044	"FP"
		INST. ON PT "B" - B.S. @ PT "C"					
85°25'42"	85°25'46"	85°25'44	88°45'06"	271°14'57"	88°45'05"	6.770	"MS"
270°02'26"	270°02'28"	270°02'27"	88°53'12"	271°07'02"	88°53'05"	6.895	"MP"
		INST. ON PT "B1" - B.S @ PT "C"					
88°39'43"	88°39'43"	88°39'43	87°52'44"	272°07'20"	87°52'42"	6.932	"AS"
269°56'40"	269°56'48"	269°56'44"	87°54'20"	272°05'48"	87°54'16"	6.897	"AP"

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JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 2

STA	BS	HI	FS	ELEV	DESCRIPTION
				0.000	(ASSUMED ELEVATION) PT. "B1" -8.526
	0.780	0.780			
			-0.564	1.344	"AP" -7.182
			-0.578	1.358	"AS" -7.168
			0.812	-0.032	PT "B" -8.558
	1.017	0.985			
			-0.363	1.348	"MP" -7.178
			-0.376	1.361	"MS" -7.165
			-0.379	1.364	"FP" -7.162
			-0.395	1.380	"FS" -7.146
	-0.416	0.964			
			-0.400	1.364	"FP" -7.162
			-0.385	1.349	"MP"
			-0.397	1.361	"MS"
			0.996	-0.032	"PT" "B"
	0.807	0.775			
			-0.583	1.358	"AS"
			-0.569	1.344	"AP"
			0.775	0.000	✓ PT "B1"

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JOB: FERDINAND R. HASSLER

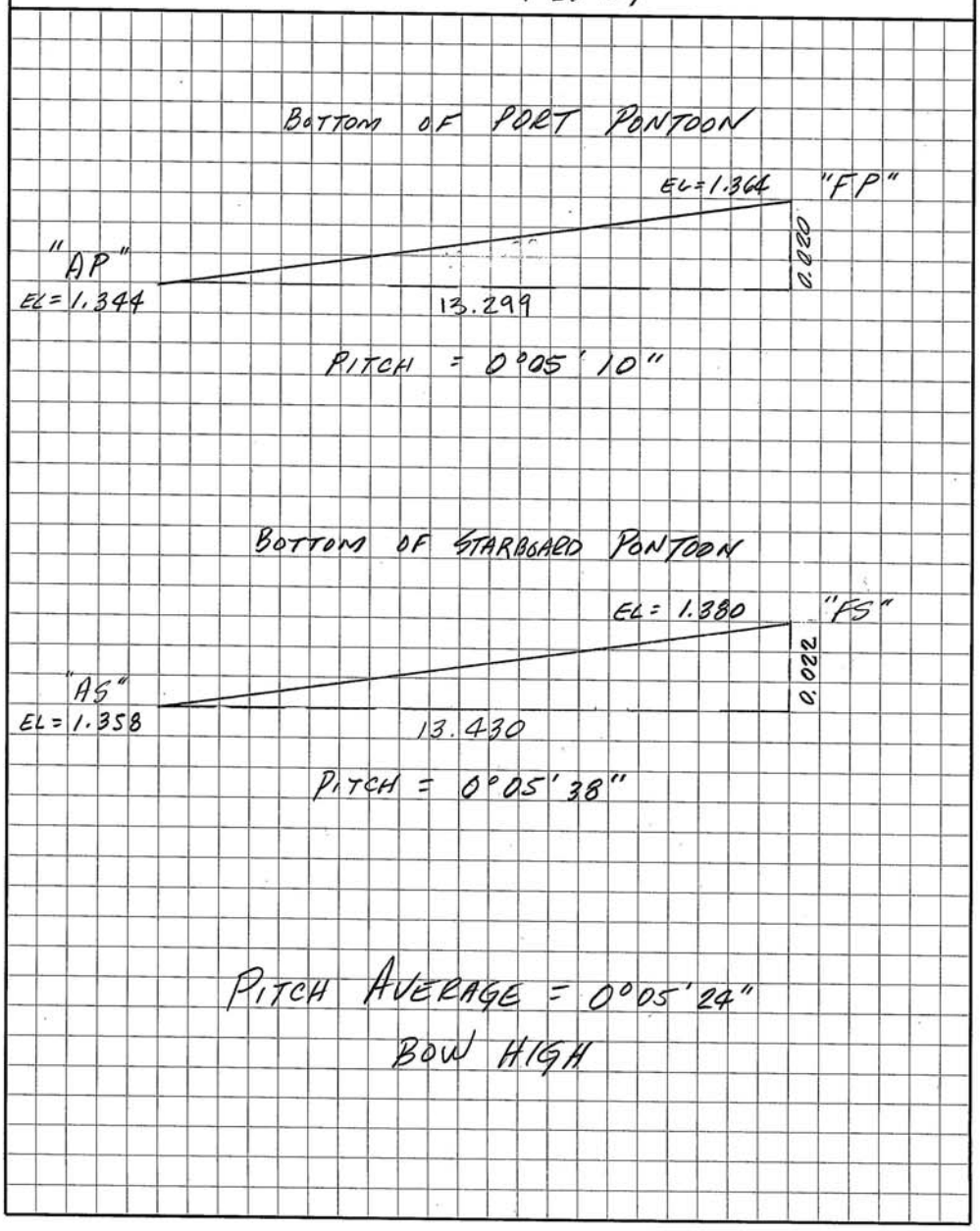
M286 SWATH

PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 3
7-26-09



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PHONE NO: (985) 774-1955

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M286 SWATH

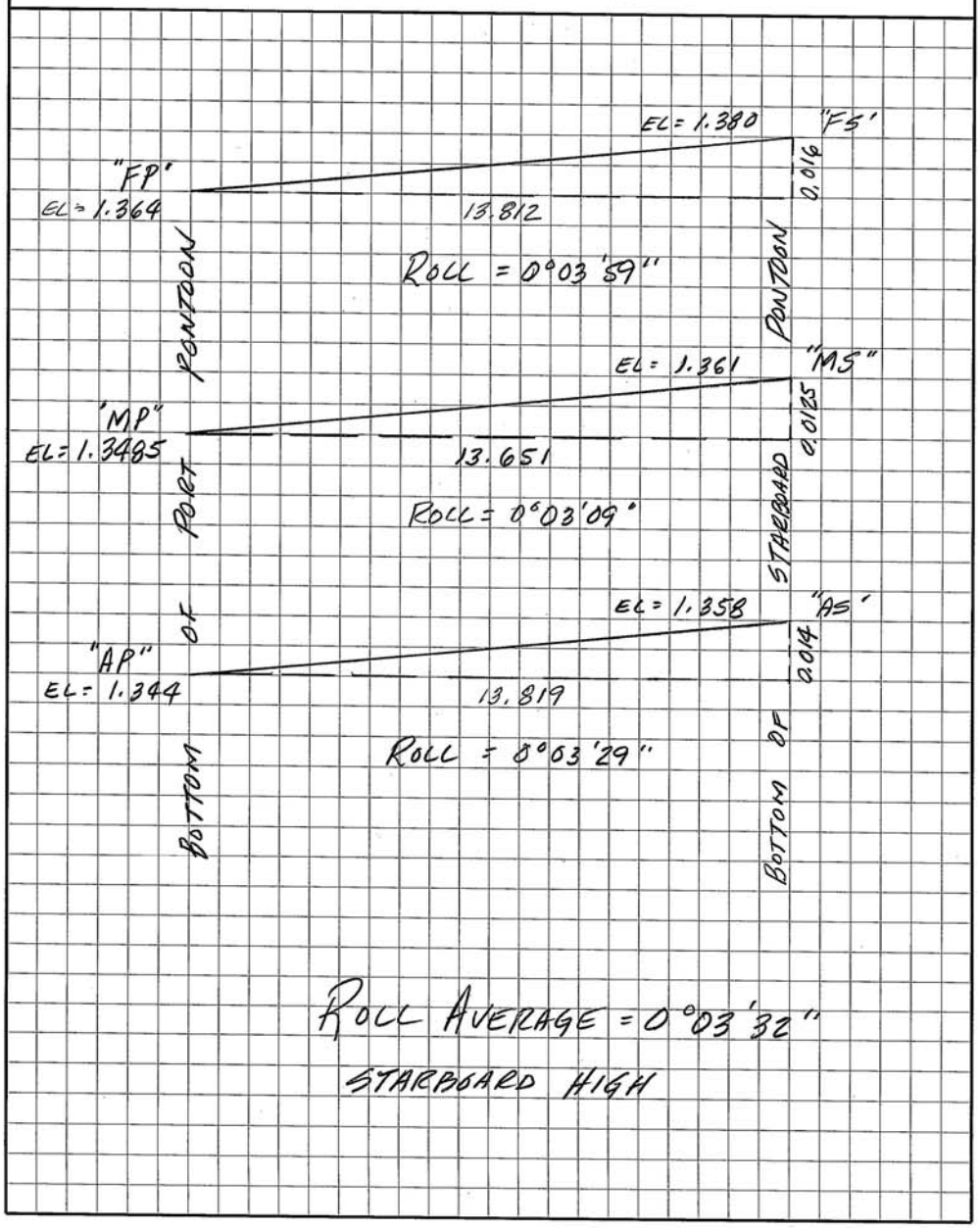
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 4



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PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER

M286 SWATH

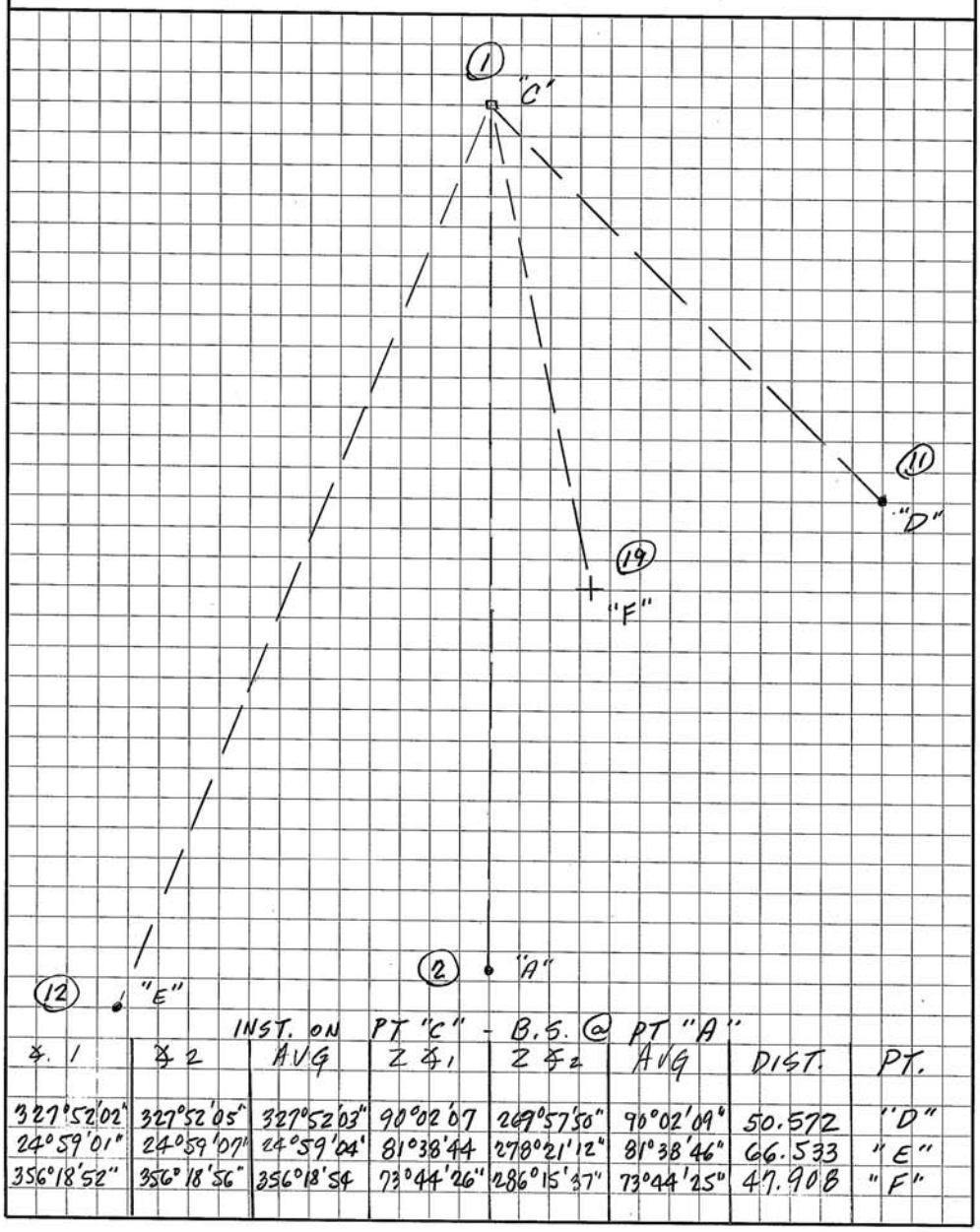
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 5



INST. ON PT "C" - B.S. @ PT "A"

∡ 1	∡ 2	AVG	Z ∡ 1	Z ∡ 2	AVG	DIST.	PT.
327°52'02"	327°52'05"	327°52'03"	90°02'07"	269°57'50"	90°02'09"	50.572	"D"
24°59'01"	24°59'07"	24°59'04"	81°38'44"	278°21'12"	81°38'46"	66.533	"E"
356°18'52"	356°18'56"	356°18'54"	73°44'26"	286°15'37"	73°44'25"	47.908	"F"

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SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER

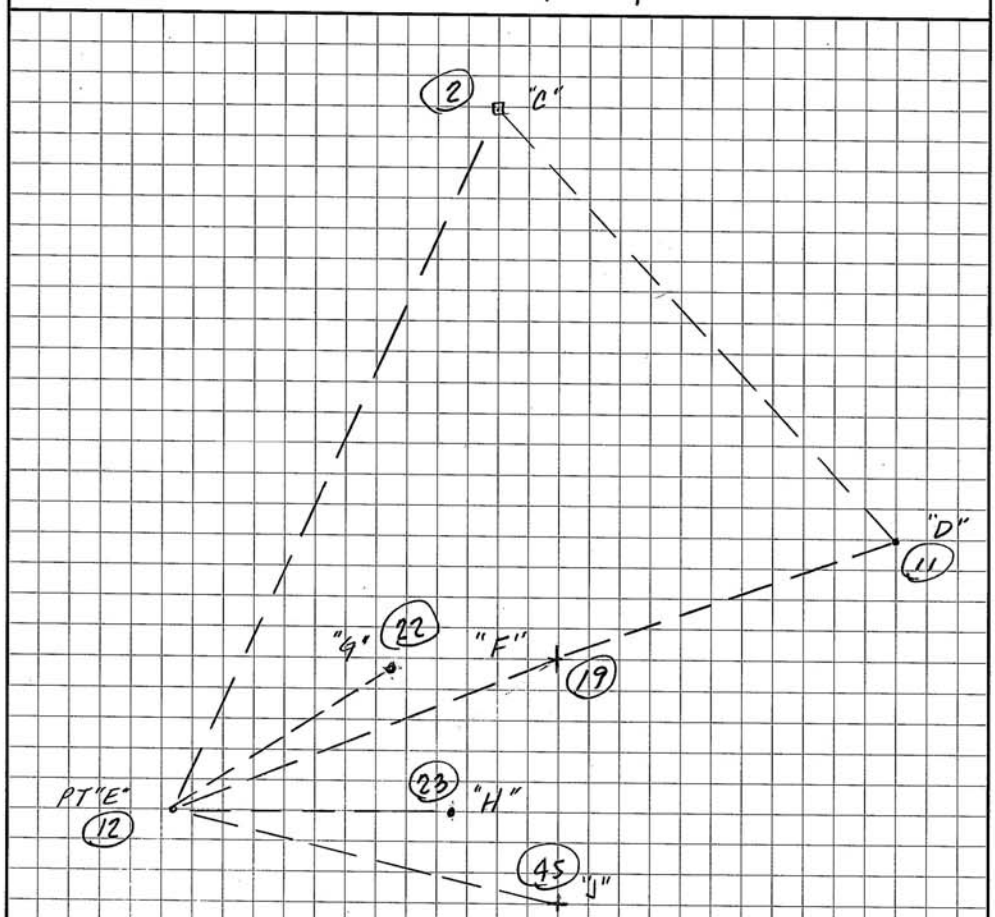
M286 SWATH

PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 6
7-26-09



INST. ON POINT "E" - B.S. @ PT "C"

∠1	∠2	AVG	Z∠1	Z∠2	AVG	DIST.	PT.
40°53'50"	40°53'44"	40°53'47"	83°41'57"	276°18'12"	83°41'53"	33.906	"F"
37°40'49"	37°40'52	37°40'51"	87°24'16"	272°35'54"	87°24'11"	23.410	"G"
59°49'14"	59°49'17"	59°49'16"	93°09'48"	266°50'20"	93°09'44"	23.114	"H"
95°35'50"	95°35'46"	95°35'48"	92°05'16"	267°54'37"	92°05'20"	32.496	"J"
INST ON PT "D" - B.S. @ PT "C"							
294°49'26"	294°49'27"	294°49'27"	61°04'08"	298°55'49"	61°04'10"	27.580	"F"

RAYMOND C. IMPASTATO
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139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J. M. & B. K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 SHEET NO.: 7
7-26-09

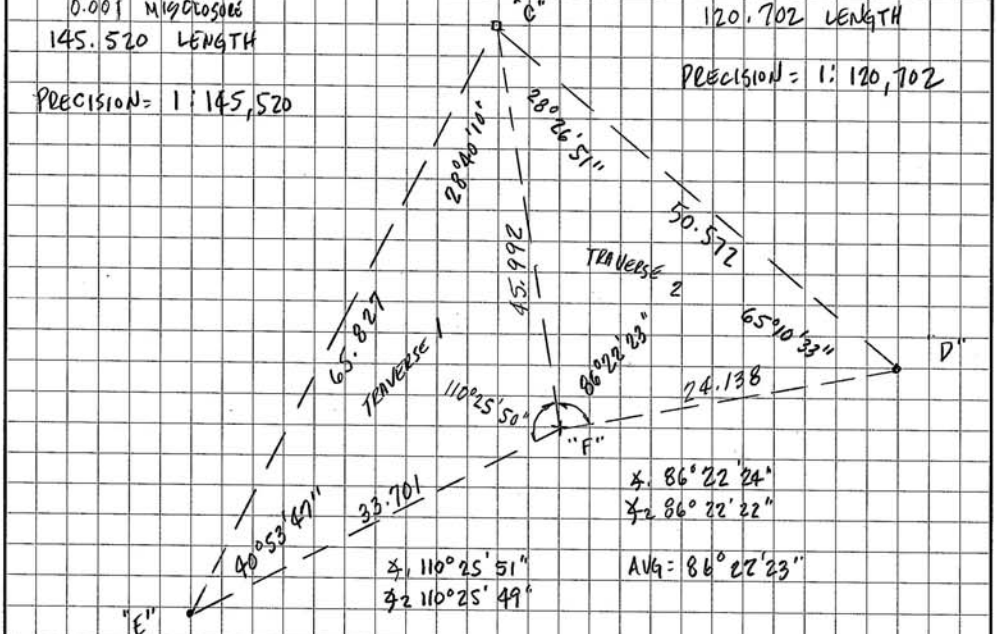
CLOSING ANGLES

TRAVERSE 1
0.001 MISCLOSURE
145.520 LENGTH

PRECISION = 1: 145,520

TRAVERSE 2
0.001 MISCLOSURE
120.702 LENGTH

PRECISION = 1: 120,702



∡1 86° 22' 24"
∡2 86° 22' 22"

AVG = 86° 22' 23"

∡1 110° 25' 51"
∡2 110° 25' 49"

AVG = 110° 25' 50"

	ADJUSTED ∡'S
40° 53' 47"	40° 53' 51"
28 40' 10"	28° 40' 14"
110 25' 50"	110° 25' 55"
179° 59' 47"	180° 00' 00"

13 SECOND MISCLOSURE

	ADJUSTED ∡'S
28° 26' 51"	28° 26' 55"
86° 22' 23	86° 22' 28"
65° 10 33'	65° 10' 37"
179° 59' 47	180° 00' 00"

13 SECOND MISCLOSURE

RAYMOND C. IMPASTATO
PROFESSIONAL
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139 RANCH ROAD
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PHONE NO: (985) 774-1955

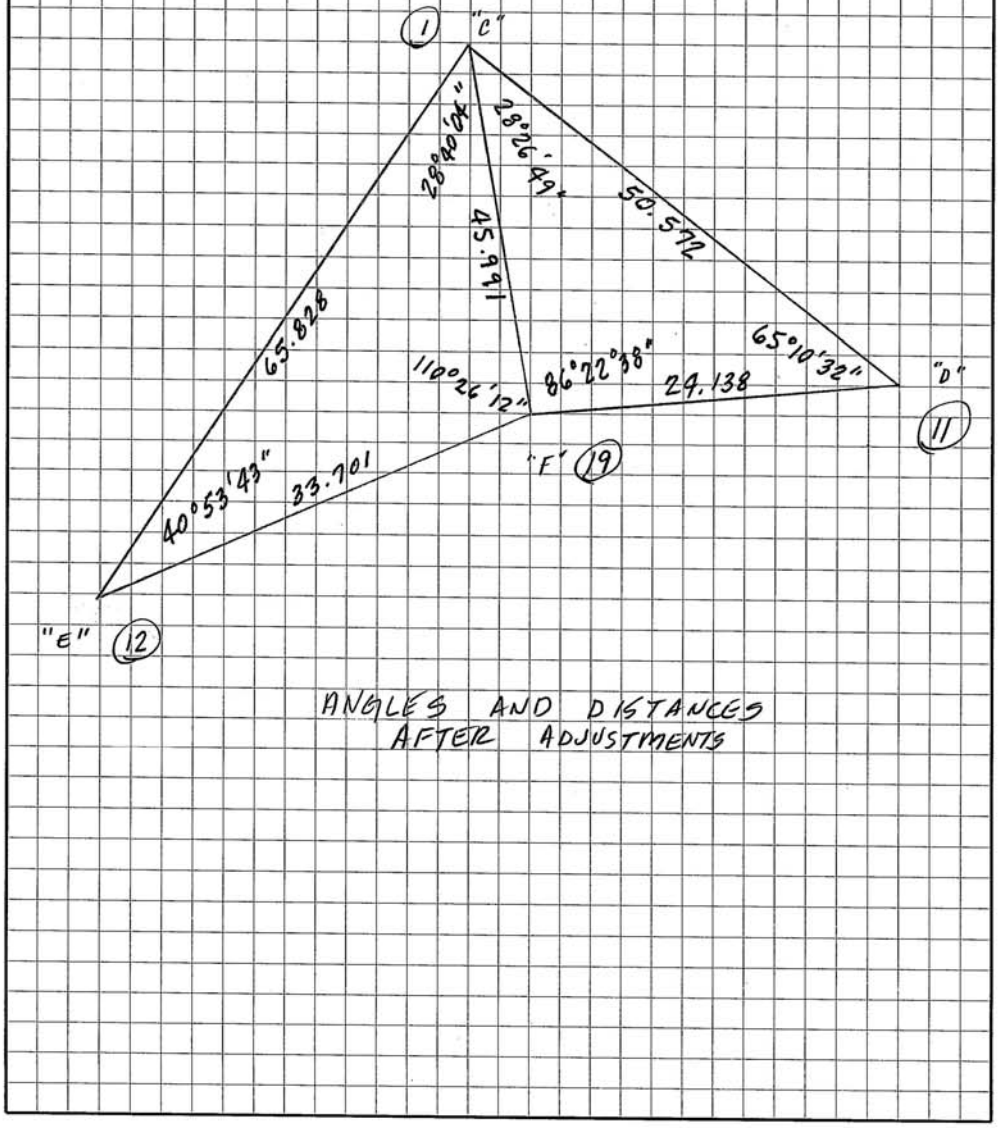
SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 8
7-26-09



ANGLES AND DISTANCES
AFTER ADJUSTMENTS

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

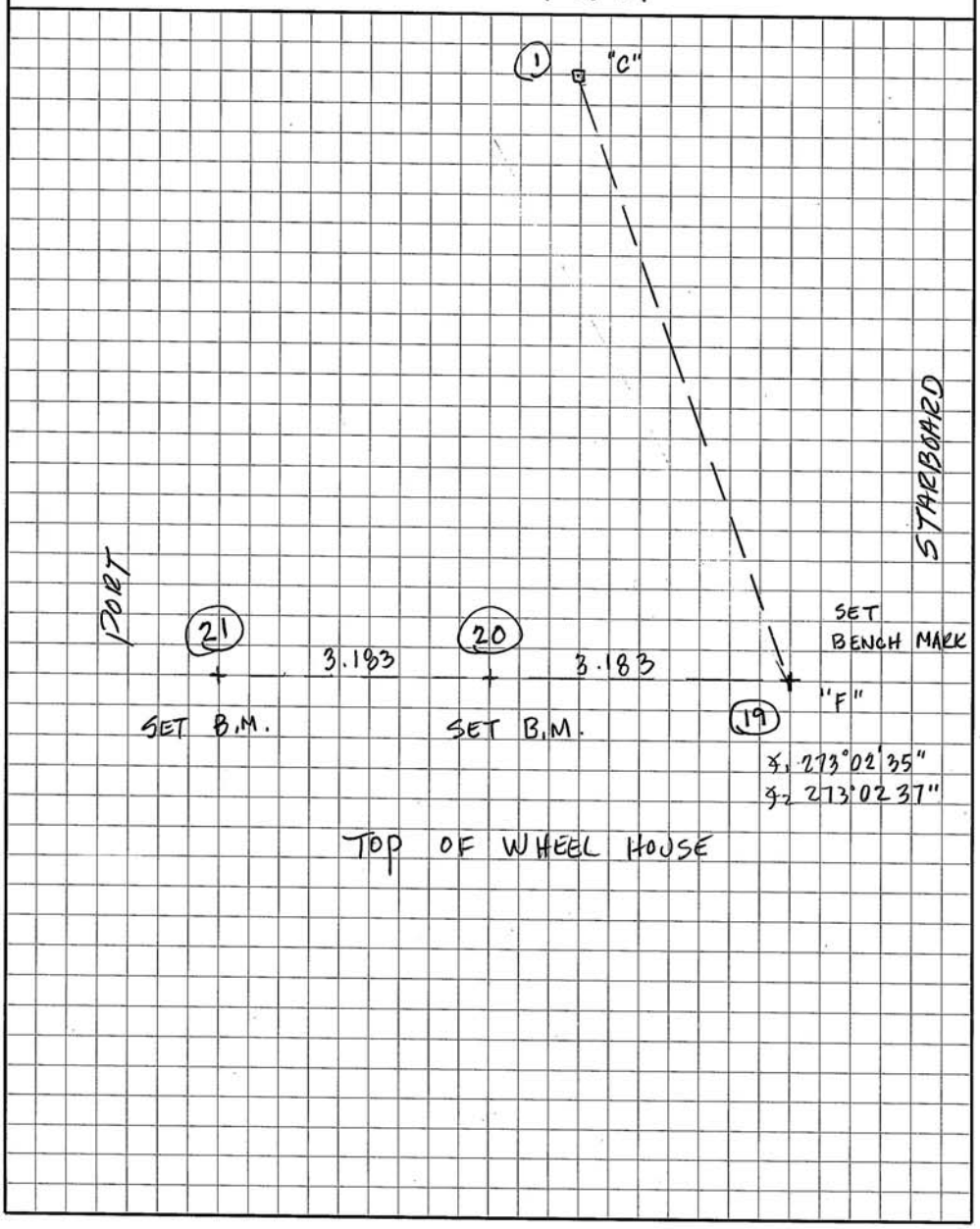
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 9



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

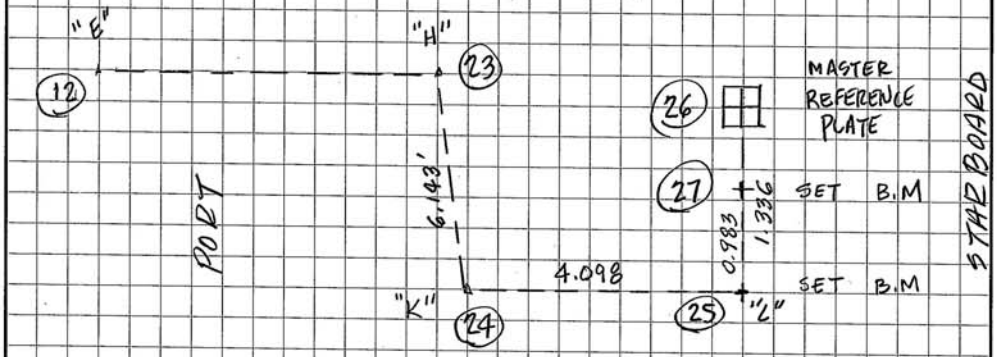
FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 10

MASTER REFERENCE PLATE ROOM



INST. ON PT. "H" - B.S @ PT. "E"

∠1	∠2	AVG.	Z∠1	Z∠2	AVG.	DIST.	POINT
262°24'48"	262°24'50	262°24'49"	92°09'18"	267°50'37"	92°09'21"	6.143	"K"

INST. ON PT "K" - B.S. @ PT "H"

103°10'42"	103°10'41"	103°10'42"	93°29'07"	266°30'33"	93°29'17"	4.098	"L" AFT B.M

INST. ON PT "L" - B.S @ PT "K"

88°52'34	88°52'30'	88°52'32"	—	—	—	0.983	FWD. B.M
88°54'52"	88°54'48	88°54'50'	-	-	-	1.336	MRP

RAYMOND C. IMPASTATO
PROFESSIONAL
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SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 11

STA	BS	HI	FS	ELEV	DESCRIPTION
				0.000	MASTER REFERENCE PLATE
	1.300	1.300			
			1.461	-0.161	FWD B.M -0.162
			1.461	-0.161	AFT B.M -0.162
			1.429	-0.129	PT "H" -0.130
			1.432	-0.132	T.P. 1
	1.467	1.335			
			0.440	0.895	T.P. 2
	0.414	1.309			
			0.392	0.917	T.P. 3 TOP OF RAIL
	-8.118	-7.201			
			1.357	-8.558	PT "B"
	1.352	-7.206			
			-8.122	0.916	T.P. 3
	0.365	1.281			
			0.387	0.894	T.P. 2
	0.429	1.323			
			1.456	-0.133	T.P. 1
	1.429	1.296			
			1.427	-0.131	PT "H"
			1.459	-0.163	AFT B.M.
			1.459	-0.163	FWD B.M.
			1.297	-0.001	M.R.P.

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JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 12

STA	BS	HI	FS	ELEV	DESCRIPTION
				0.917	T.P. 3 TOP OF RAIL
	0.427	1.344			
			-1.207	2.551	T.P. 4 EDGE OF DECK (BRIDGE WING)
	3.980	6.531			
			1.437	5.094	STBD B.M. TOP OF WHEEL HOUSE
			1.442	5.089	MID B.M. " " " "
			1.443	5.088	PORT B.M. " " " "
	1.387	6.475			
			1.386	5.089	MID B.M
			1.381	5.094	STBD. B.M
			3.923	2.552	T.P. 4
	-1.228	1.324			
			0.406	0.918	(0.001) T.P. 3

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

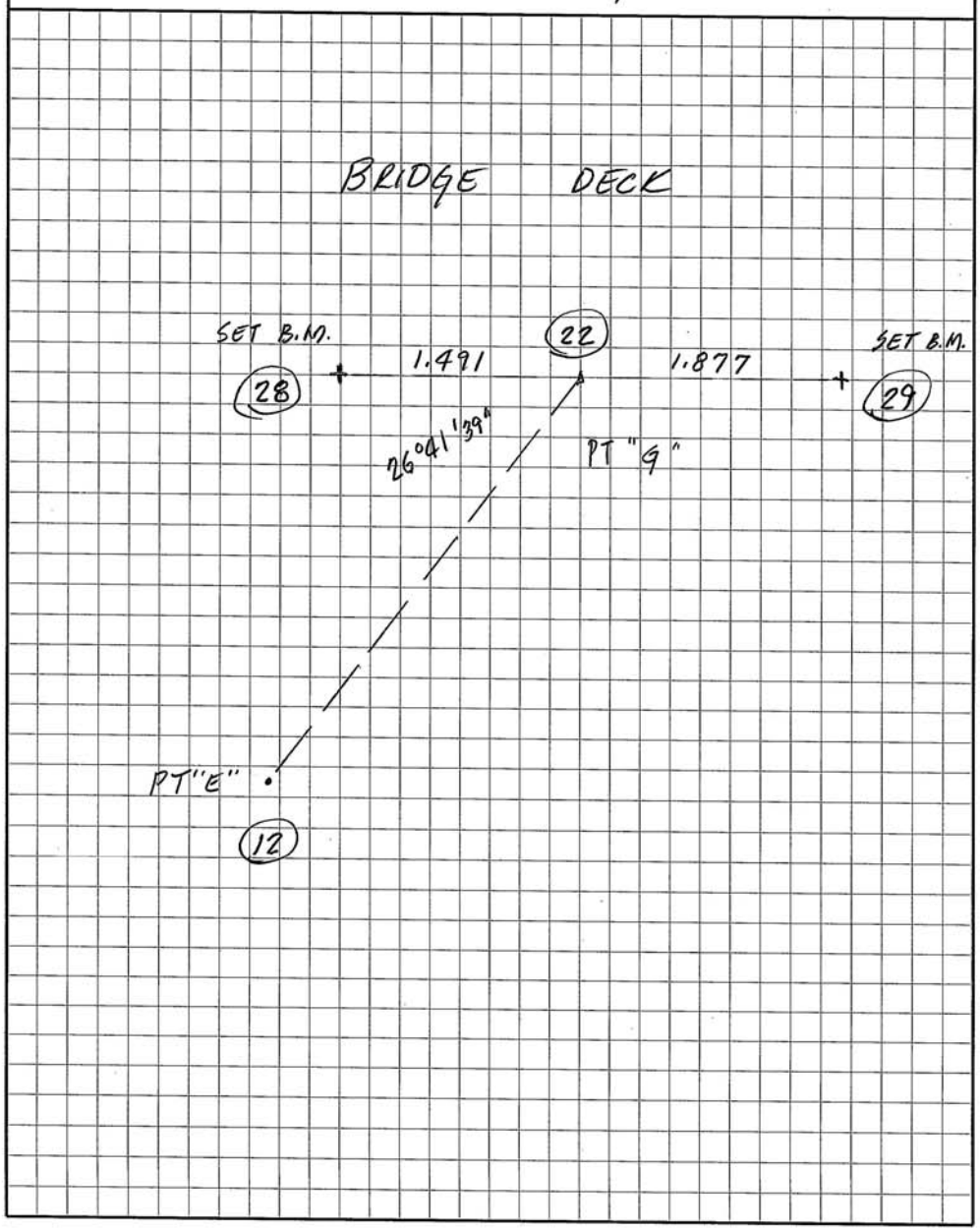
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 13



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

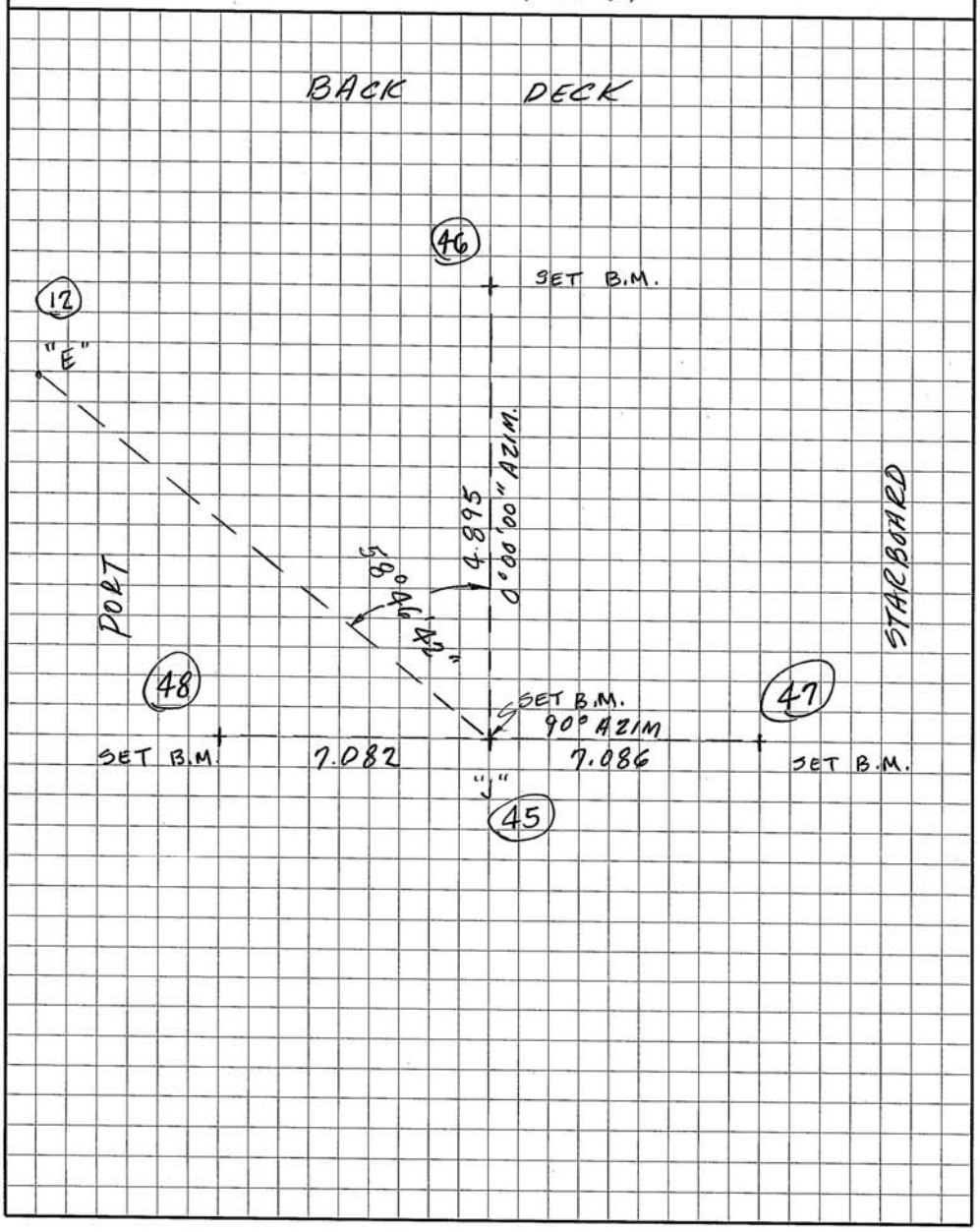
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 14



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 15
7-26-09

STA	BS	HI	FS	ELEV	DESCRIPTION
				2.551	T.P. 4 EDGE OF DECK (BRIDGE WING)
	1.385	3.936			
			1.445	2.491	STARBOARD B.M. BRIDGE WING (PORT SIDE)
			1.429	2.507	PORT B.M. (BRIDGE WING (PORT SIDE)
	1.411	3.918			
			1.427	2.491	STARBOARD B.M.
			1.367	2.551	T.P. 4
				0.000	MASTER REFERENCE PLATE
	1.344	1.344			
			1.375	-0.031	T.P. 5
	1.399	1.368			
			1.508	-0.140	FWD. B.M BACK DECK
			1.496	-0.128	AFT MID B.M. BACK DECK
			1.497	-0.129	STARBOARD B.M. BACK DECK
			1.492	-0.124	PORT B.M. BACK DECK
	1.466	1.342			
			1.471	-0.129	ST. B.M.
			1.470	-0.128	AFT MID B.M.
			1.482	-0.140	FWD. B.M.
			1.373	-0.031	T.P. 5
	1.383	1.352			
			1.352	0.000	MASTER REFERENCE PLATE

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

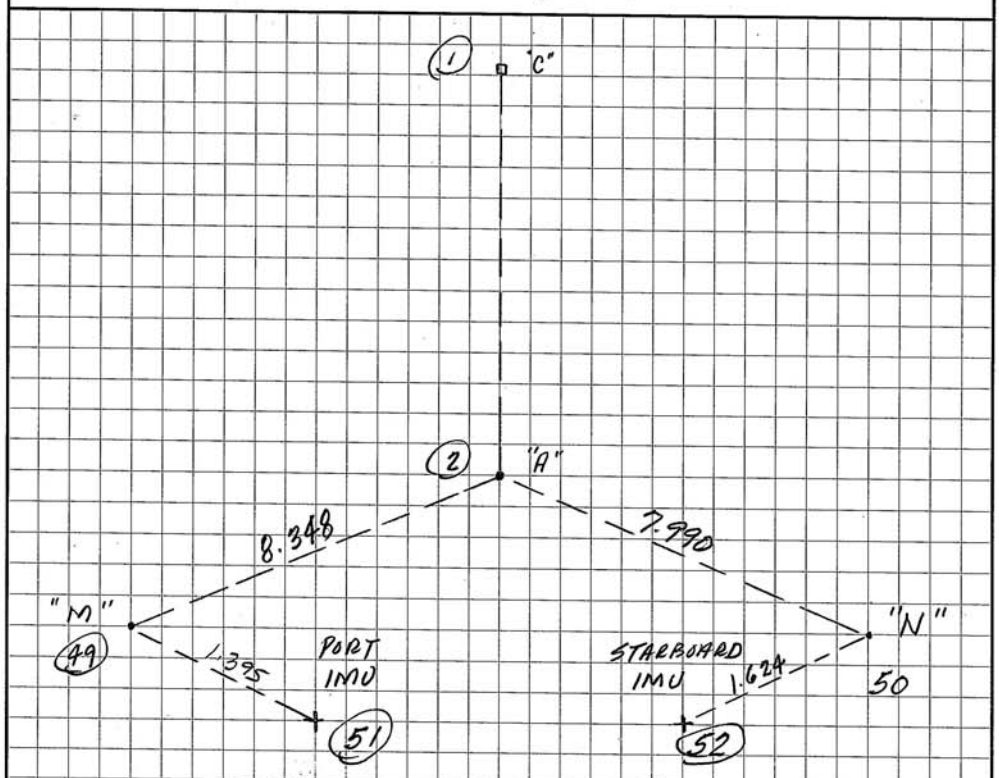
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 16



INST ON PT "A" - B.S. @ PT "C"

∡.1	∡2	AVG	Z∡1	Z∡2	AVG	DIST.	PT.
246°56'46"	246°56'42"	246°56'44"	91°15'05"	268°44'45"	91°15'10"	8.348	"M"
110°36'30"	110°36'38"	110°36'34"	90°16'21"	269°43'51"	90°16'15"	7.990'	"N"

INST. ON PT. "M" - B.S. @ PT "A"

36°21'23"	36°21'27"	36°21'25"	91°19'18"	268°40'45"	91°19'17"	1.395	IMU PORT

INST. ON PT "N" - B.S. @ PT "A"

317°19'00"	317°18'54"	317°18'57"	96°08'50"	263°50'58"	96°08'56"	1.624	IMU STARBOARD

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 17

STA	BS	HI	FS	ELEV	DESCRIPTION
				-8.558	PT "B"
	1.092	-7.466			
			-0.357	-7.109	T.P. 6 PORT SIDE
	-0.349	-7.458			
			1.100	-8.558	PT "B"
	1.100	-7.458			
			-0.361	-7.097	T. P. 7 STARBOARD SIDE
	-0.346	7.443			
			1.116	-8.559	(0.001) PT "B"
				-7.097	T.P.7
	1.377	-5.720			
			0.104	-5.824	IMU STARBOARD (OLD)
	0.103	-5.721			
			1.376	-7.097	T.P. 7
				-7.109	T.P. 6
	1.341	-5.768			
			0.070	-5.838	IMU PORT (OLD)
	0.087	-5.751			
			1.358	-7.109	T. P. 6

RAYMOND C. IMPASTATO
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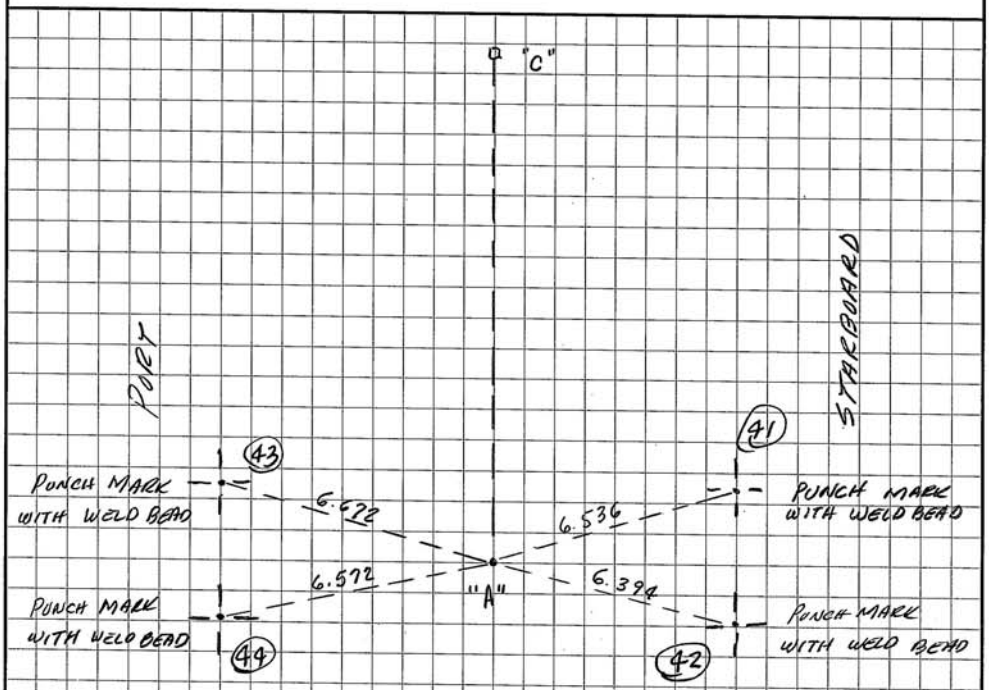
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J. M. & B. K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 / 7-26-09 SHEET NO.: 18



INSTRUMENT OF PT "A" - B.S. @ PT "C"

∠1	∠2	AVG.	Σ∠1	Σ∠2	AVG	DIST.	POINT
76°51'22"	76°51'28"	76°51'25"	89°41'15"	270°18'38"	89°41'19"	6.536	41
85°40'36"	85°40'32"	85°40'34"	89°44'20"	270°15'43"	89°44'16"	6.394	42
279°43'20"	279°43'21"	279°43'21"	89°58'54"	270°00'50"	89°59'02"	6.672	43
272°26'53"	272°27'01"	272°26'57"	90°00'48"	269°59'21"	90°00'43"	6.572	44

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

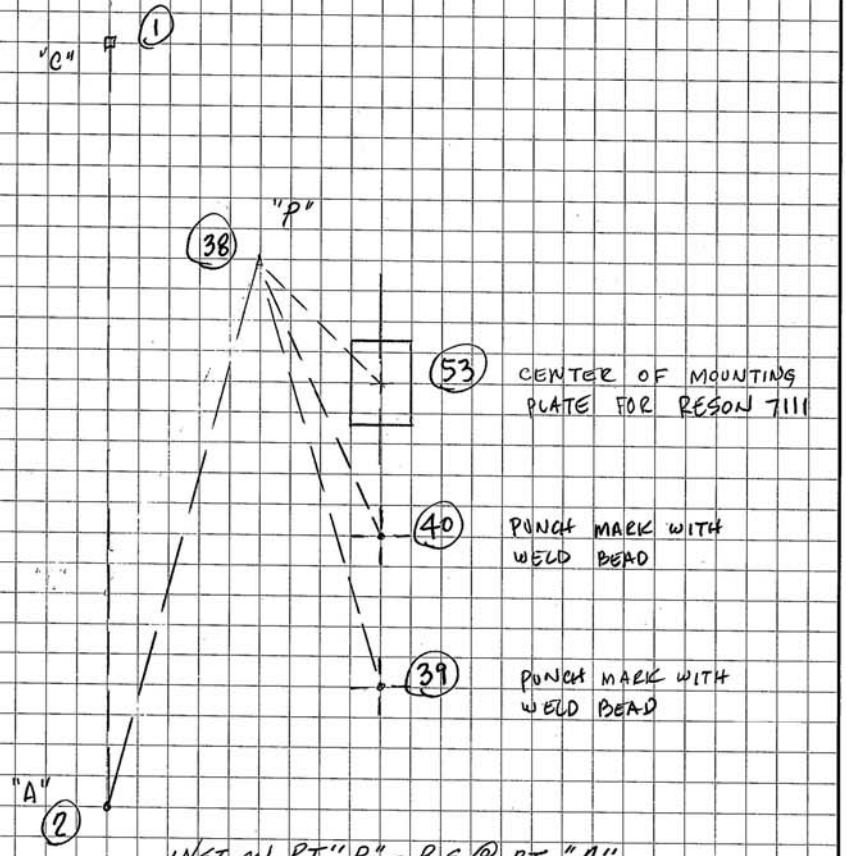
CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 19

INST ON PT "A" - B.S @ PT "C"

∡1	∡2	AVG	Σ∡1	Σ∡2	AVG	DIST.	POINT
19°03'19"	19°03'21"	19°03'20"	92°05'28"	267°54'30"	92°05'28"	10.455	"P"



INST ON PT "P" - B.S. @ PT. "A"

∡1	∡2	AVG	Σ∡1	Σ∡2	AVG.	DIST	POINT
274°14'00"	274°13'51"	274°13'56"	82°48'55"	277°11'02"	82°48'57"	3.947	RESON 7111
291°24'44"	291°24'49"	291°24'46"	83°00'01"	276°59'44"	83°00'09"	4.820	PUNCH MARK
297°48'51"	297°49'01"	297°48'56"	84°29'45"	275°30'01"	84°29'52"	5.363	PUNCH MARK

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

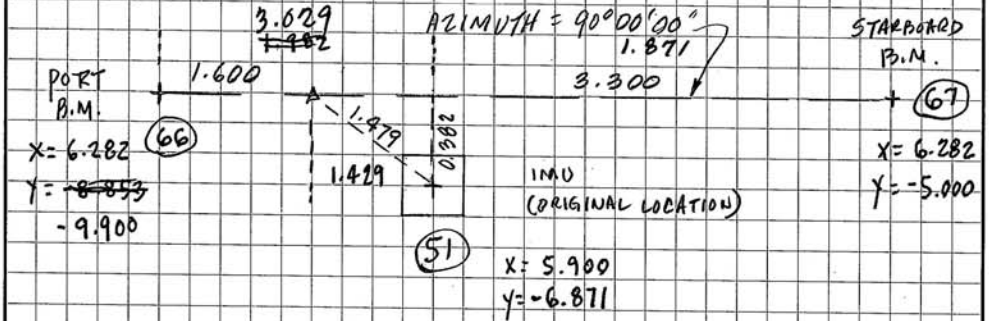
FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 20

BENCH MARKS IMU ROOM
PORT SIDE PONTOON



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

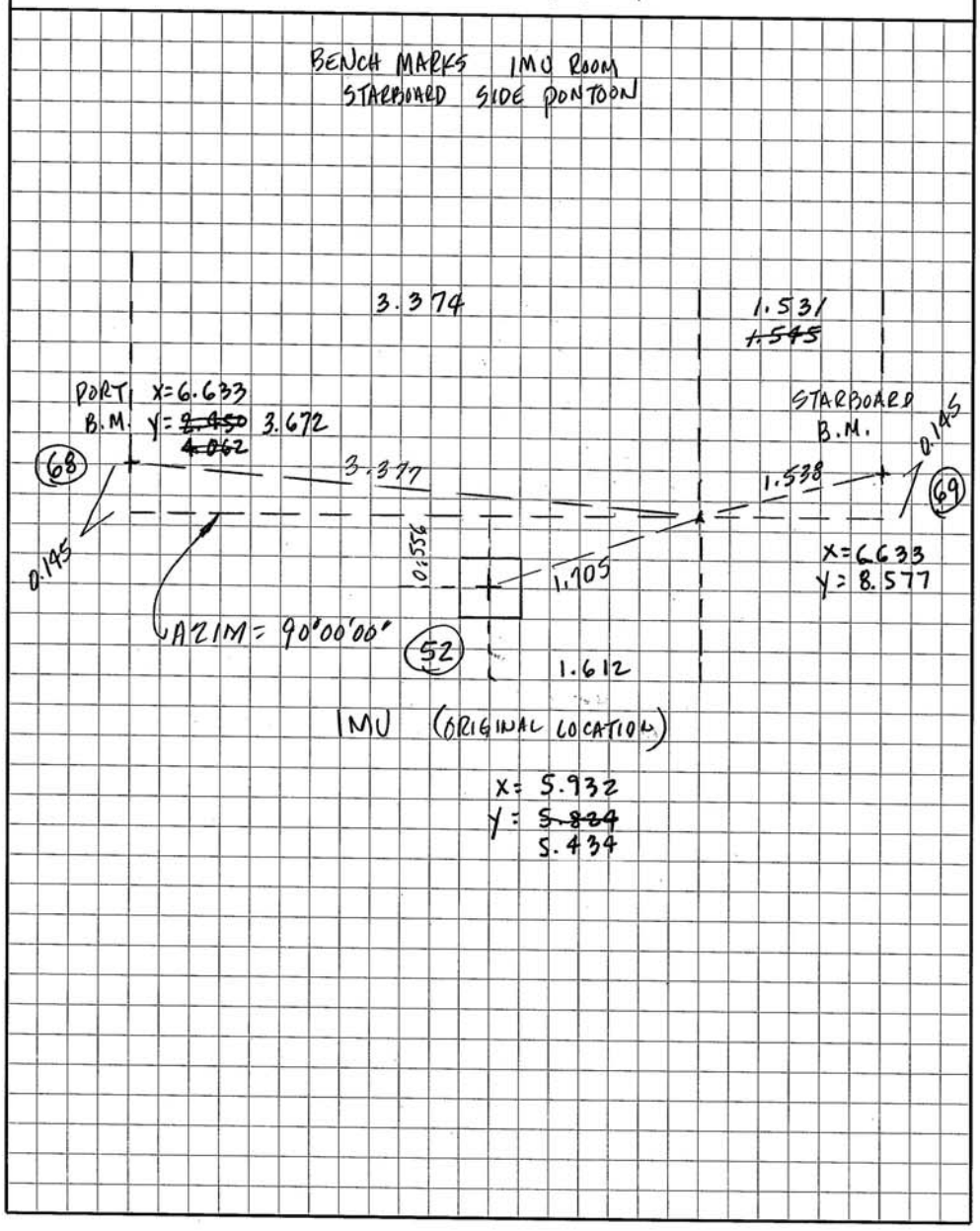
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 21



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 22
7-26-09

STA	BS	HI	FS	ELEV	DESCRIPTION
					(ORIGINAL LOCATION)
				-5.838	IMU PORT SIDE PONTOON
	0.268	-5.570			
			0.220	-5.790	PORT B.M.
			0.289	-5.859	STARBOARD B.M
	0.296	-5.560			
			0.227	-5.790	PORT B.M.
			0.275	-5.838	IMU
					(ORIGINAL LOCATION)
				-5.824	IMU STARBOARD SIDE B.M.
	0.227	-5.597			
			0.250	-5.847	PORT B.M
			0.200	-5.797	STARBOARD B.M.
	0.215	-5.582			
			0.266	-5.848	PORT B.M.
			0.242	-5.824	IMU

RAYMOND C. IMPASTATO
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139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

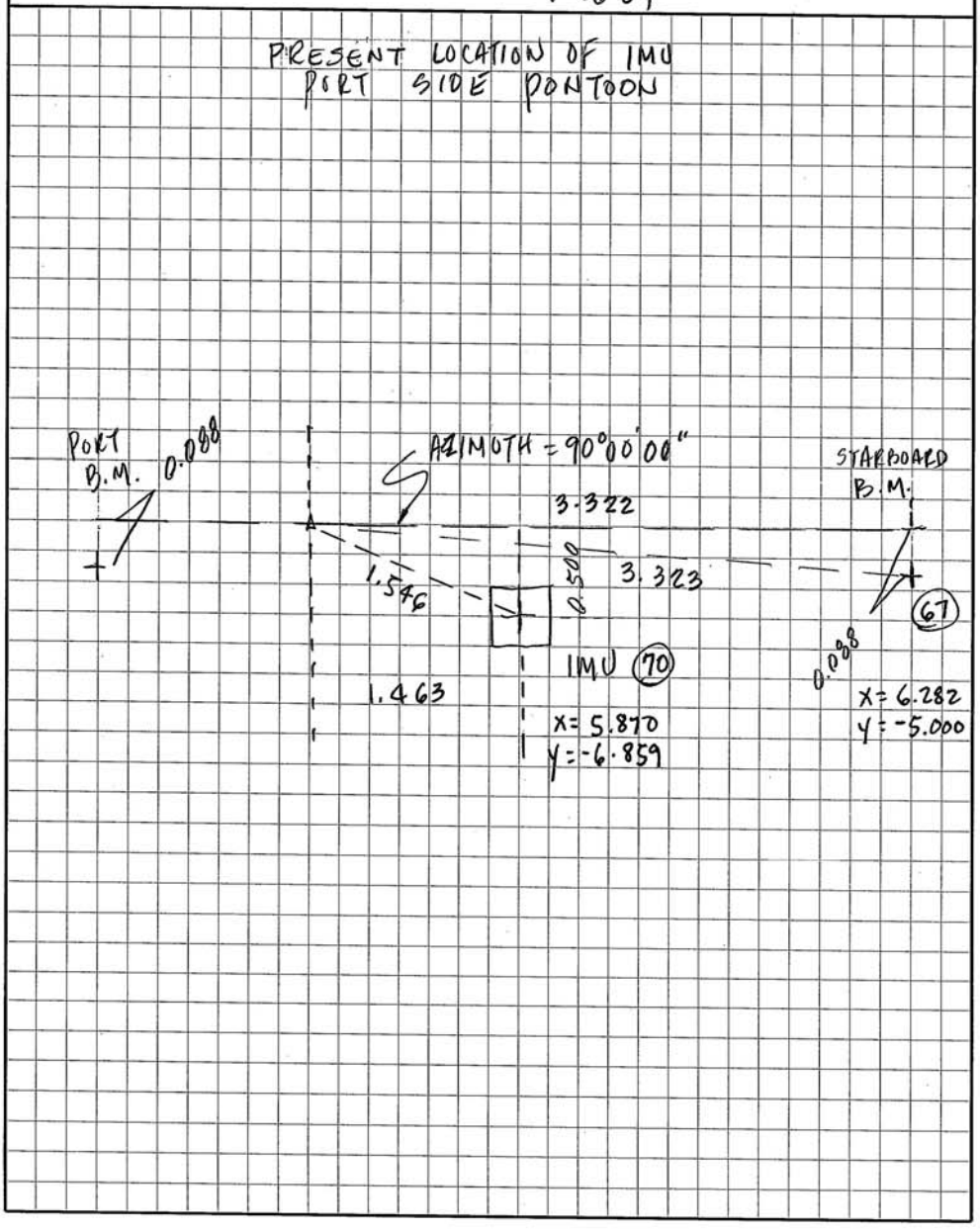
SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 23
7-26-09



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

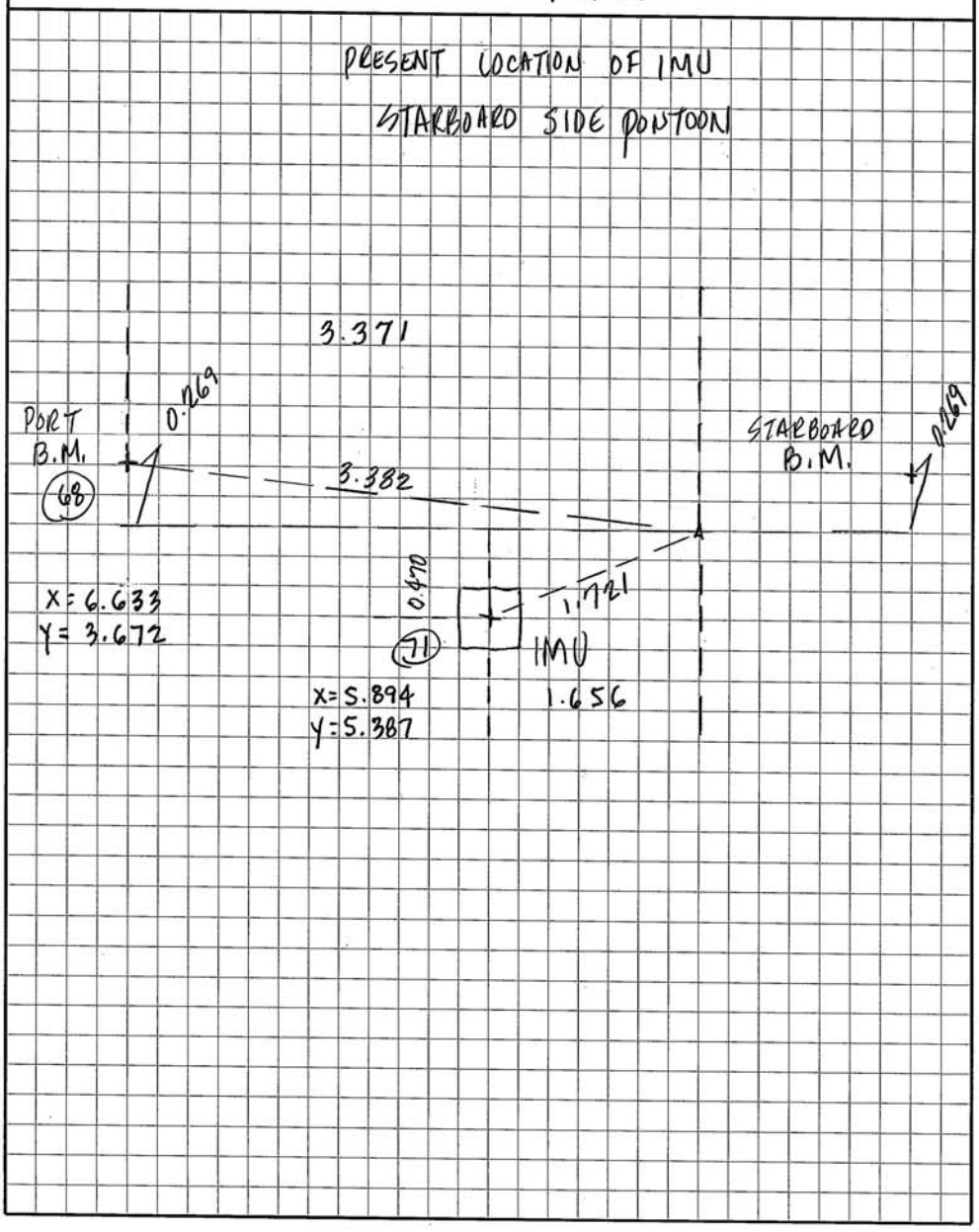
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 24



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 25

STA	BS	HI	FS	ELEV	DESCRIPTION
					PRESENT LOCATION PORT SIDE PONTOON IMU
				-5.859	STARBOARD B.M.
	0.184	-5.675			
			0.091	-5.766	IMU
	0.103	-5.663			
			0.196	-5.859	STARBOARD B.M
					PRESENT LOCATION STARBOARD SIDE PONTOON IMU
				-5.847	PORT B.M.
	0.236	-5.611			
			0.142	-5.753	IMU
	0.158	-5.595			
			0.252	-5.847	PORT B.M.

RAYMOND C. IMPASTATO
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LAND SURVEYOR

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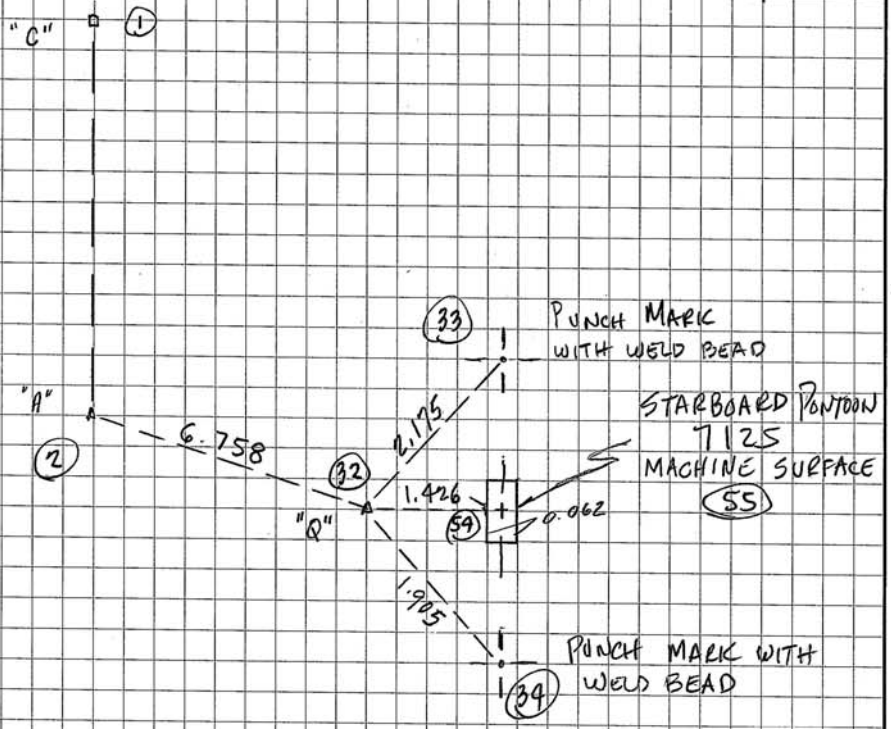
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J.M. & B.K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 / 7-26-09 SHEET NO.: 26

INST. ON PT. "A" - B.S. @ PT "C"

∠1	∠2	AVG	Z∠1	Z∠2	AVG.	DIST	POINT
117°20'06"	117°20'10"	117°20'08	90°54'43"	269°05'11"	90°54'46"	6.758	"Q"



INST. ON PT. "Q" - B.S. @ PT. "A"

∠1	∠2	AVG	Z∠1	Z∠2	AVG	DIST	POINT
150°50'00"	150°50'18"	150°50'09	68°11'10"	291°48'44"	68°11'13"	1.426	PORT SIDE OF 7125
103°03'47"	103°04'00"	103°03'54"	77°48'15"	282°11'54	77°48'11"	2.175	PUNCH MARK
192°58'26"	192°58'41"	192°58 34"	76°10'56"	283°49'00"	76°10'58	1.905	PUNCH MARK

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

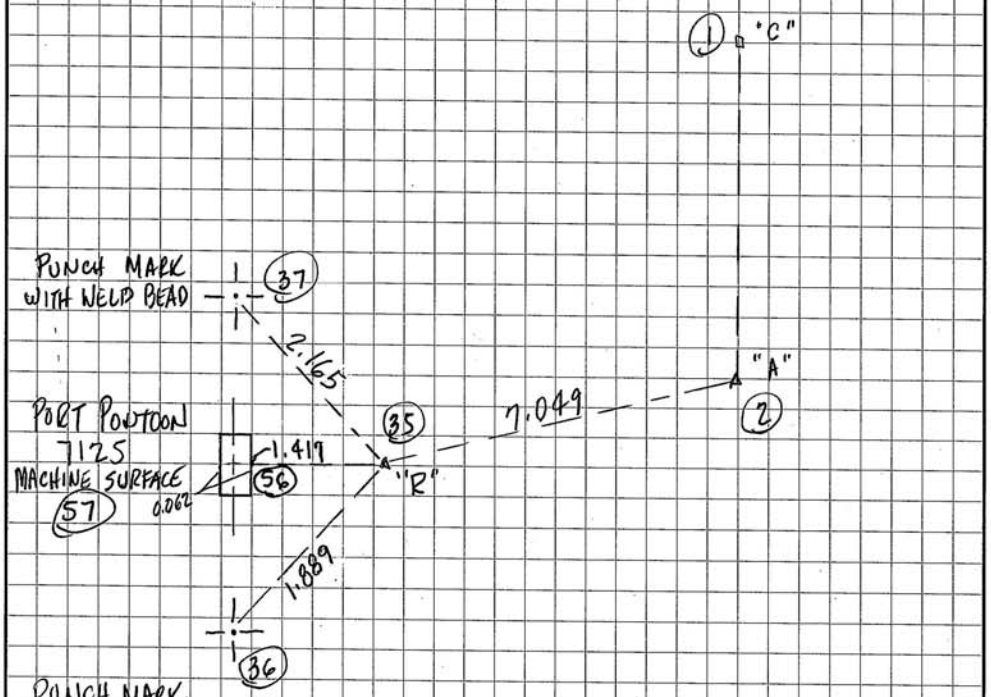
139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J.M. & B.K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 SHEET NO.: 27
7-26-09

INST. ON PT "A" - B.S. @ PT "C"

∡1	∡2	AVG	Z ∡1	Z ∡2	AVG	DIST	POINT
242°20'59"	242°20'59"	242°20'59"	91°17'11"	268°42'49"	91°17'11"	7.049	"R"



INST. ON PT "R" - B.S. @ PT "A"

∡1	∡2	AVG	Z ∡1	Z ∡2	AVG	DIST	POINT
207°41'09"	207°44'21"	207°44'15"	64°49'01"	295°10'23"	64°49'19"	1.417	STARB. SIDE 7125
256°06'39"	256°06'49"	256°06'44"	75°35'51"	284°23'58"	75°35'57"	2.165	PUNCH MARK
166°12'22"	166°12'21"	166°12'22"	73°41'25"	286°18'14"	73°41'36"	1.889	PUNCH MARK

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 28
7-26-09

STA	BS	HI	FS	ELEV	DESCRIPTION
				-8.558	PT "B"
	1.234	-7.324			
			-0.166	-7.158	AFT P.M. 7125 PORT PONTOON
			-0.239	-7.085	7125 PORT SIDE " "
			-0.242	-7.082	7125 STARB. SIDE " "
			-0.174	-7.150	FWD P.M. 7125 " "
			-0.158	-7.166	AFT P.M. (-7.167) " "
			-0.157	-7.167	FWD P.M (-7.168) " "
			-0.494	-6.830	RESON 7111 STARBOARD PONTOON
			-0.586	-6.738	FWD. P.M. 7111 " "
			-0.513	-6.811	AFT P.M. 7111 " "
			-0.179	-7.145	FWD P.M FB " "
			-0.175	-7.149	AFT P.M. FB " "
			-0.178	-7.146	FWD P.M. 7125 " "
			-0.247	-7.077	7125 PORT SIDE " "
			-0.251	-7.073	7125 STARB. SIDE " "
			-0.172	-7.152	AFT P.M. 7125 " "
	-0.186	-7.330			
			-0.265	-7.073	7125 STARB. SIDE " "
			-0.261	-7.077	7125 PORT SIDE " "
			-0.191	-7.147	FWD P.M 7125 " "
			-0.188	-7.150	AFT P.M. FB " "
			-0.192	-7.146	FWD P.M. FB " "
			-0.526	-6.812	AFT P.M. 7111 " "
			-0.600	-6.738	FWD P.M. 7111 " "
			-0.507	-6.831	RESON 7111 " "
			-0.169	-7.169	FWD P.M. FB PORT PONTOON
			-0.170	-7.168	AFT P.M. FB " "
			-0.187	-7.151	FWD P.M. 7125 " "
			-0.256	-7.082	7125 STARB. SIDE " "
			-0.252	-7.086	7125 PORT SIDE " "
			-0.179	-7.159	AFT P.M. 7125 " "
			1.220	-8.558	PT "B"

RAYMOND C. IMPASTATO
PROFESSIONAL
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139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

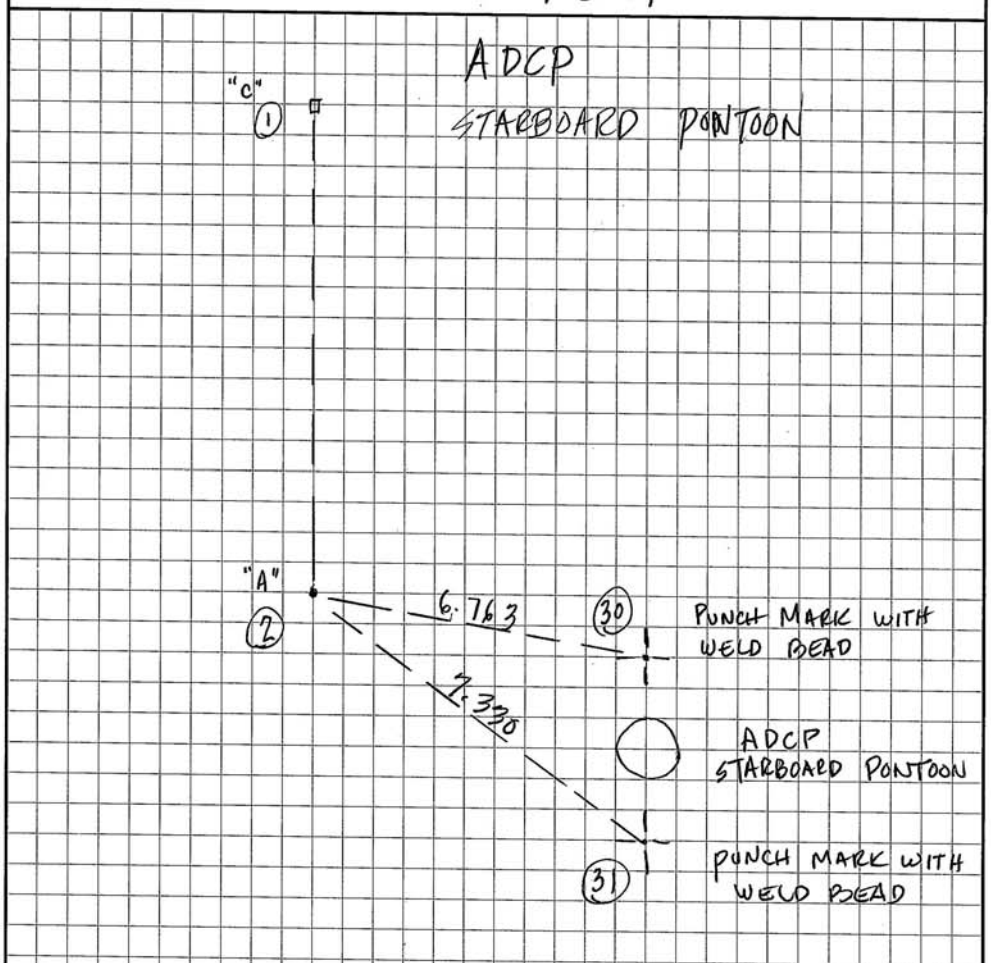
SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09 SHEET NO.: 29
7-26-09



∡1	∡2	AVG	Σ∡1	Σ∡2	AVG	DIST	POINT
109°11'49"	109°11'57"	109°11'53"	87°03'07"	272°56'52"	87°03'07"	6.763	FWD PUNCH MARK
119°11'11"	119°11'14"	119°11'13"	87°20'24"	272°39'40"	87°20'22"	7.336	AFT PUNCH MARK

RAYMOND C. IMPASTATO
PROFESSIONAL
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139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 38

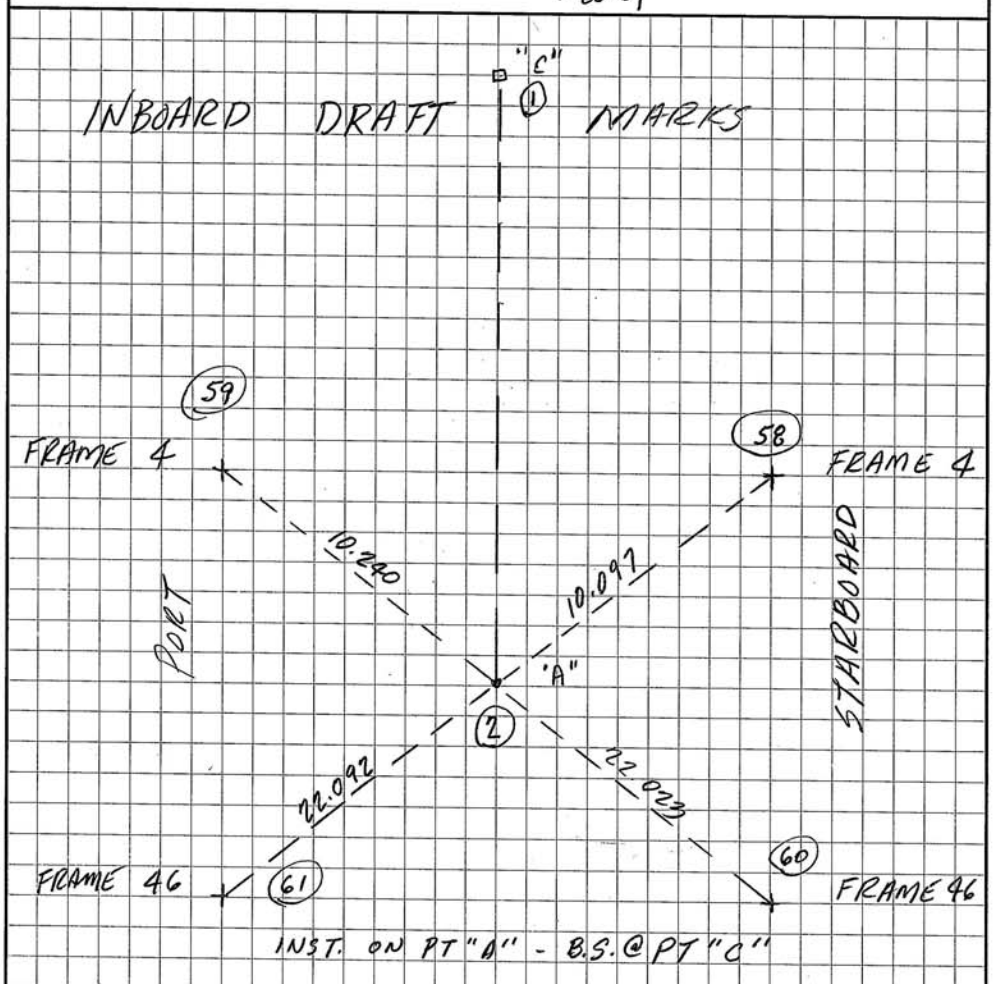
STA	BS	HI	FS	ELEV	DESCRIPTION
				-7.152	AFT P.M. 7125 STARBOARD PONTOON
	0.279	-6.873			
			0.256	-7.129	AFT PUNCH MARK ADCP
			0.263	-7.136	FWD PUNCH MARK ADCP
	0.297	-6.839			
			0.290	-7.129	AFT PUNCH MARK ADCP
			0.313	-7.152	AFT P.M. 7125 STARBOARD PONTOON

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J. M. & B. K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 SHEET NO.: 31
7-26-09



∡1	∡2	AVG	Z ∡1	Z ∡2	AVG	DIST	POINT
41°11'21"	41°11'05"	41°11'13"	61°42'40"	298°17'23"	61°42'31"	10.097	FRAME 4
316°12'03"	316°12'10"	316°12'07"	62°15'00	297°45'04	62°14'58	10.240	FRAME 4
162°46'43	162°46'44"	162°46'44"	77°38'18"	282°21'40"	77°38'19"	22.023	FRAME 46
196°29'33"	196°29'37"	196°29'30"	77°38'32"	282°21'26"	77°38'33"	22.092	FRAME 46

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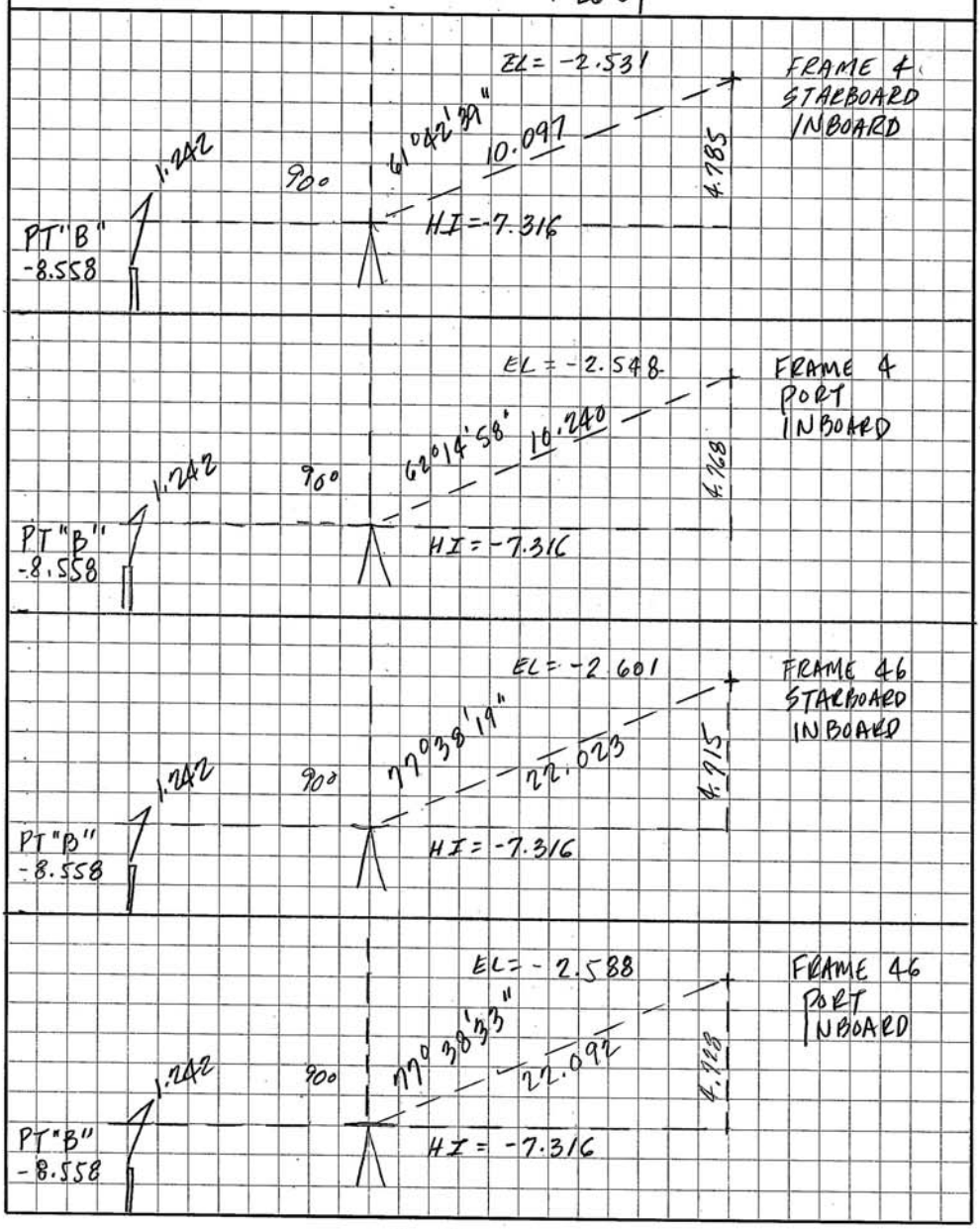
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J. M. & B. K.

CALCULATED BY: R. IMPASTATO

DATE: 1-18-09 SHEET NO.: 32
1-26-09



RAYMOND C. IMPASTATO
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LAND SURVEYOR

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PHONE NO: (985) 774-1955

SCALE: 1" = NONE

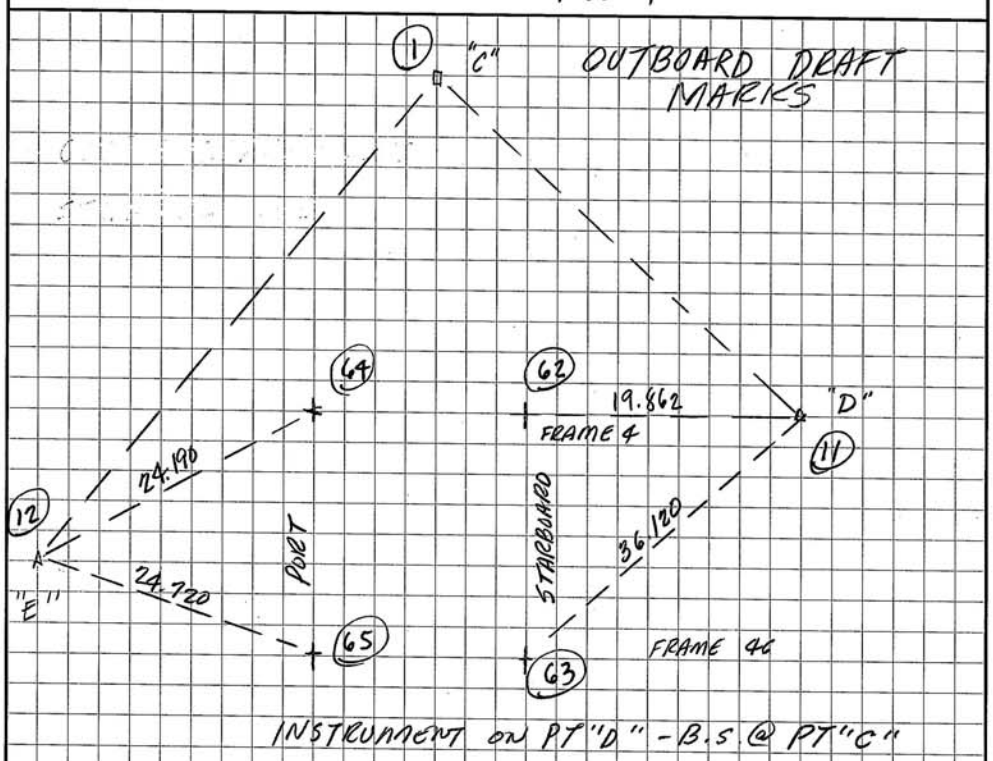
JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI

FIELD CREW: R.I., E.K., J.M. & B.K.

CALCULATED BY: R. IMPASTATO

DATE: 7-18-09
7-26-09

SHEET NO.: 33



∡1	∡2	AVG	Z ∡1	Z ∡2	AVG	DIST	POINT
292°15'44"	292°15'53"	292°15'49"	76°11'28"	283°48'34"	76°11'27"	19.862	FRAME 4 STARBOARD
243°35'26"	243°35'34"	243°35'30"	82°33'53"	277°26'07"	82°33'53"	36.120	FRAME 46 STARBOARD
		INST. @ PT "E" - B.S. @ PT "C"					
30°38'48"	30°38'49"	30°38'49"	101°49'55"	258°10'01"	101°49'57"	24.145	FRAME 4 PORT
100°00'48"	100°00'49"	100°00'49"	101°37'22"	258°22'42"	101°37'20"	24.720	FRAME 46 PORT

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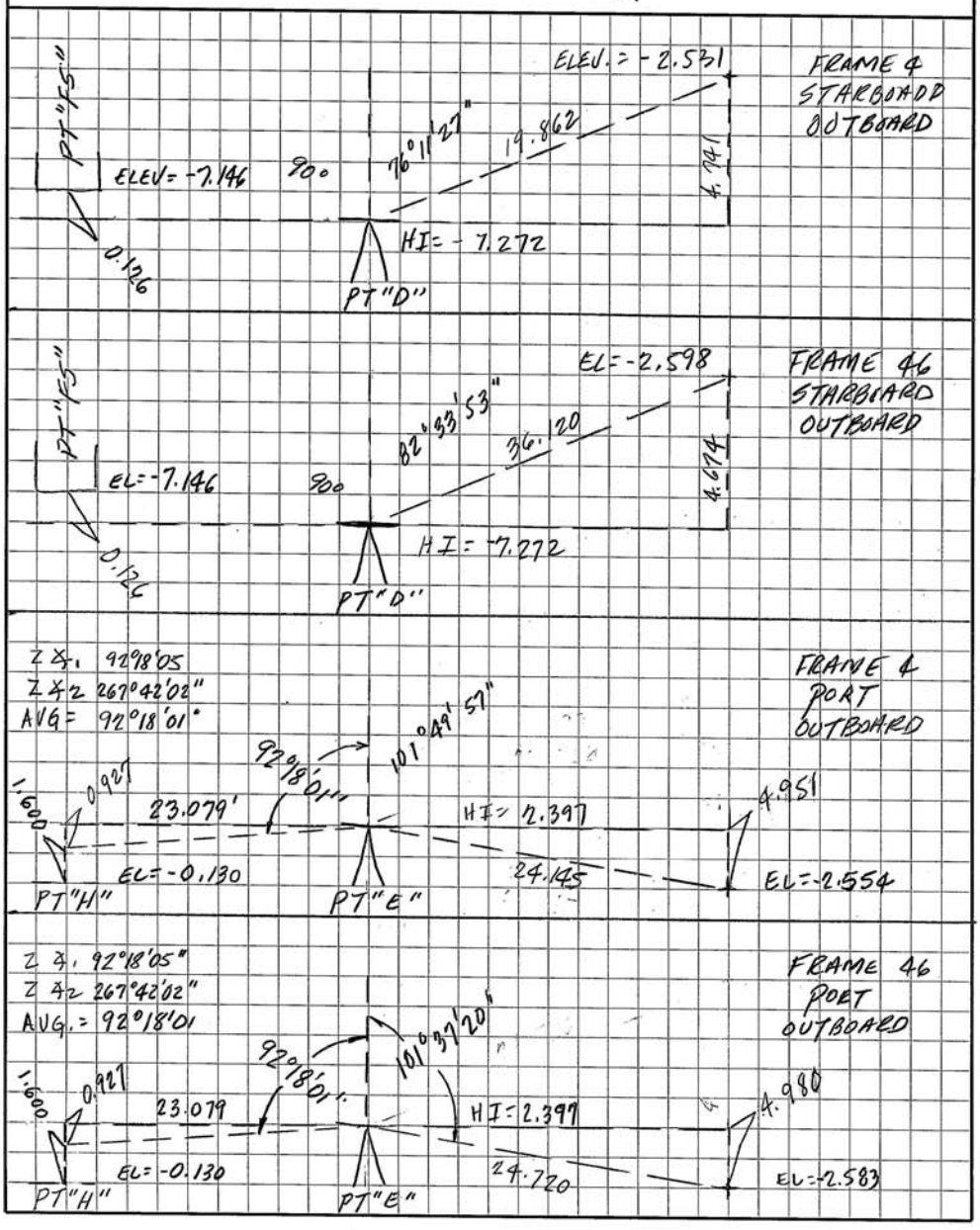
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I., E.K., J. M. & B. K.
CALCULATED BY: R. IMPASTATO
DATE: 7-18-09 / 7-26-09 SHEET NO.: 34



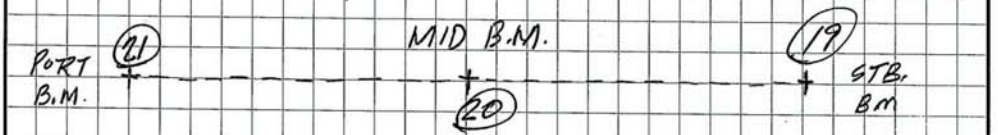
RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 1

TOP OF WHEEL HOUSE



INSTRUMENT ON STB. B.M. - B.S @ PORT B.M. ZA = 103°44'50"

	HOR. ∠	AZIMUTH
BOLT & LOWER GPS ANTENNAE	310° 52' 34"	
	310° 52' 42"	
AVG	310° 52' 38"	220° 52' 38
BOLT & UPPER GPS ANTENNAE	307° 14' 02"	
	307° 14 23	
AVG	307° 14' 13"	217° 14' 13"

INSTRUMENT ON MID B.M. - B.S @ PORT B.M. ZA = 115° 58' 30"

	HORIZ ∠	AZIMUTH	ZENITH ∠
BOLT & LOWER GPS ANTENNAE	283° 53' 39"		77° 53' 50"
	283° 53' 48"		282° 06' 40"
AVG	283° 53' 43	193° 53' 43"	77° 53' 35"
BOLT & UPPER GPS ANTENNAE	282° 18' 38"		62° 31' 34"
	282 18' 40"		297° 28' 25"
AVG	282° 18' 39	192° 18' 39"	62° 31' 35"

PORT GPS ANTENNAES

NOTE: 0.022" FROM BOTTOM OF BOLT TO BOTTOM OF ANTENNAE

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

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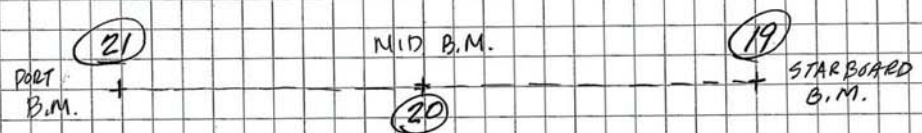
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 2

TOP OF WHEEL HOUSE



INSTRUMENT ON PORT B.M. - B.S. @ STARBOARD B.M.

	HORIZ ∠	AZIMUTH	
BOLT & LOWER GPS ANTENNAE	49°34'47"		
	49°34'43"		
AVG.	49°34'45"	139°34'45	
BOLT & UPPER GPS ANTENNAE	53°24'46"		
	53°24'50"		
AVG.	53°24'48"	143°24'48	

INSTRUMENT ON MID B.M. B.S @ PORT B.M. Z.A = 115°58'30"

	HORIZ. ∠	AZIMUTH	ZENITH ∠
BOLT & LOWER GPS ANTENNAE	256°41'23"		77°46'38"
	256°41'18"		282°14'00"
AVG	256°41'21"	166°41'21"	77°46'19"
	258°30'00"		62°24'45"
BOLT & UPPER GPS ANTENNAE	258°29'42"		297°35'00"
AVG.	258°29'51"	168°29'51"	62°24'53"

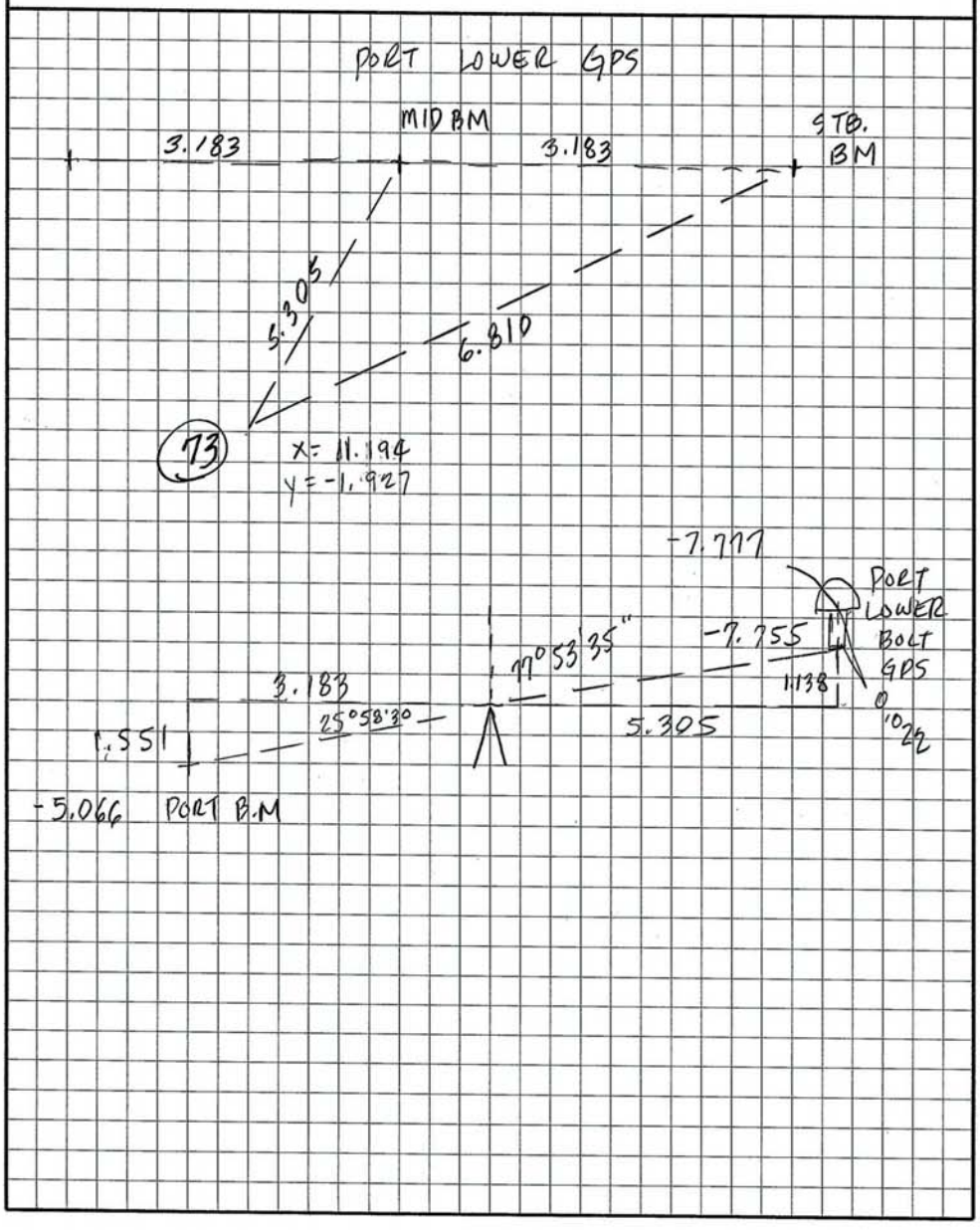
STARBOARD GPS
ANTENNAES

RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 3



RAYMOND C. IMPASTATO
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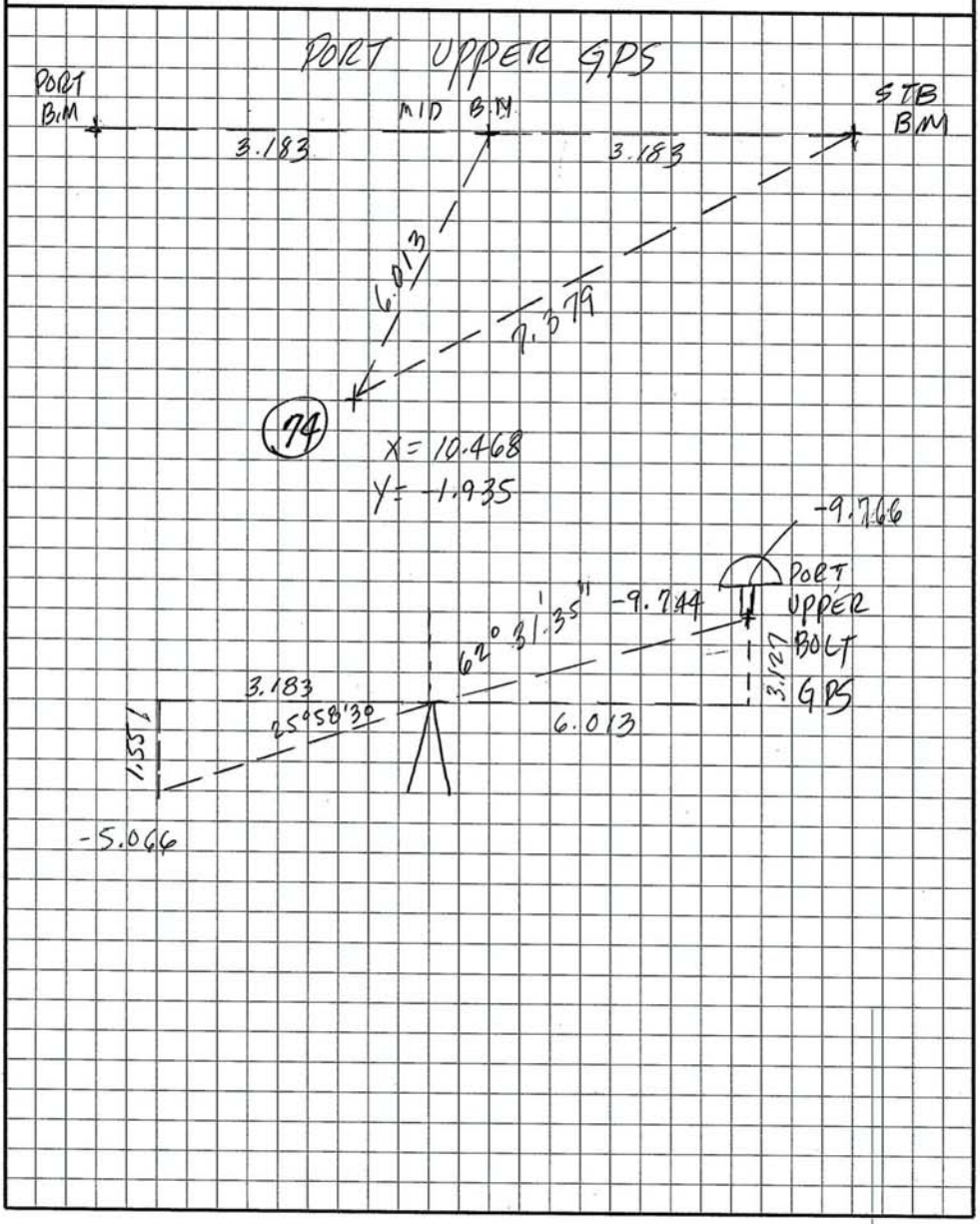
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 4



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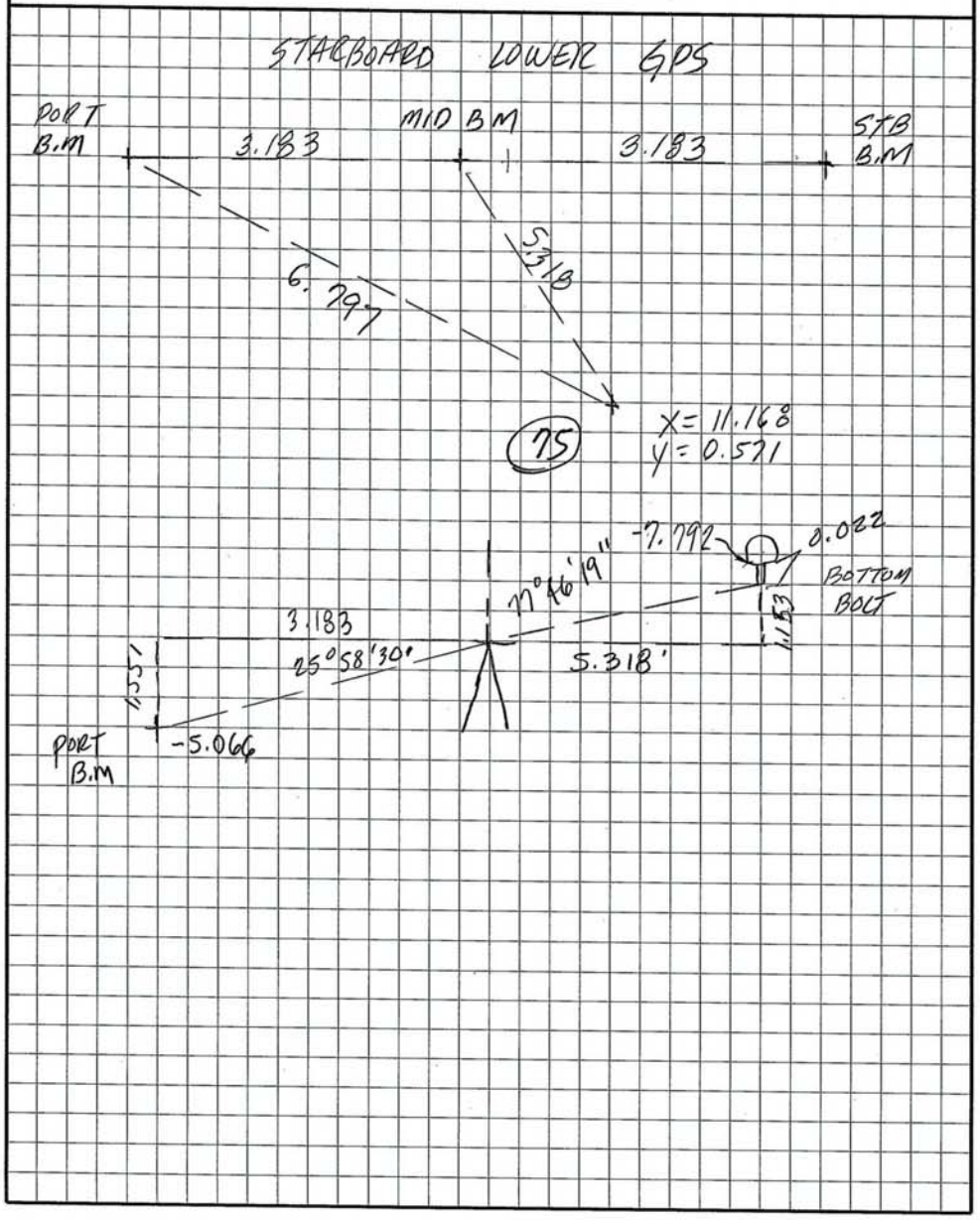
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 5



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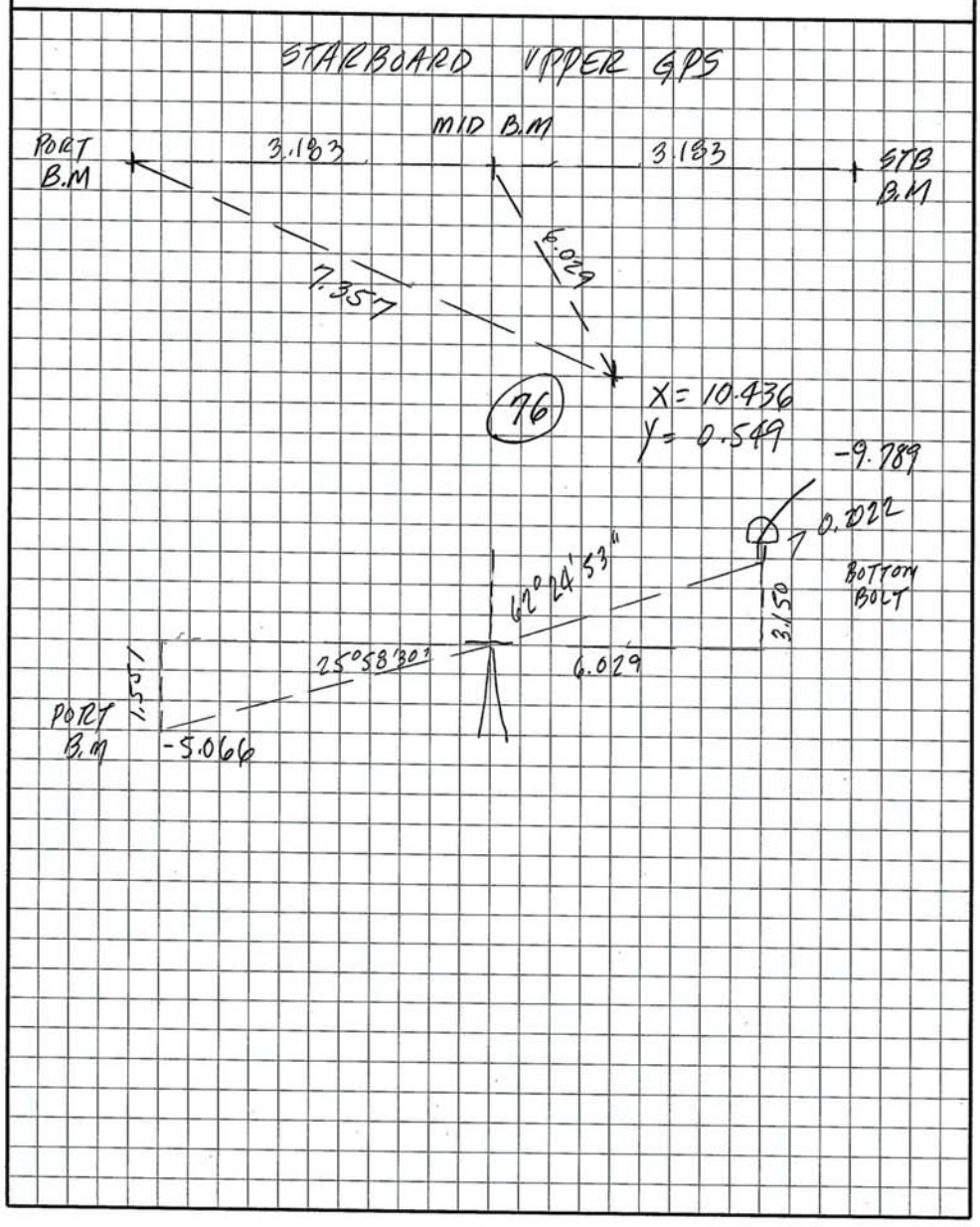
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 6



RAYMOND C. IMPASTATO
PROFESSIONAL
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 7

BACK DECK

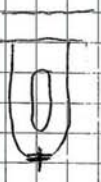
INSTRUMENT ON STARBOARD B.M. B.S. @ PORT B.M.
Z.A = 96° 53' 06"

	HORIZ. ∠	AZIMUTH	ZENITH ∠
℄ BOTTOM OF CENTER BLOCK	318°17'00"		73°49'25"
	318°16'48"		286°10'30"
AVG	318°16'54"	228°16'54"	73°49'28"

INSTRUMENT ON PORT B.M. - B.S. STARBOARD B.M.

℄ BOTTOM OF CENTER BLOCK	41°58'22"	
	41°58'06"	
AVG.	41°58'14"	131°58'14"

"A" FRAME
CENTER BLOCK (BOTTOM)



RAYMOND C. IMPASTATO
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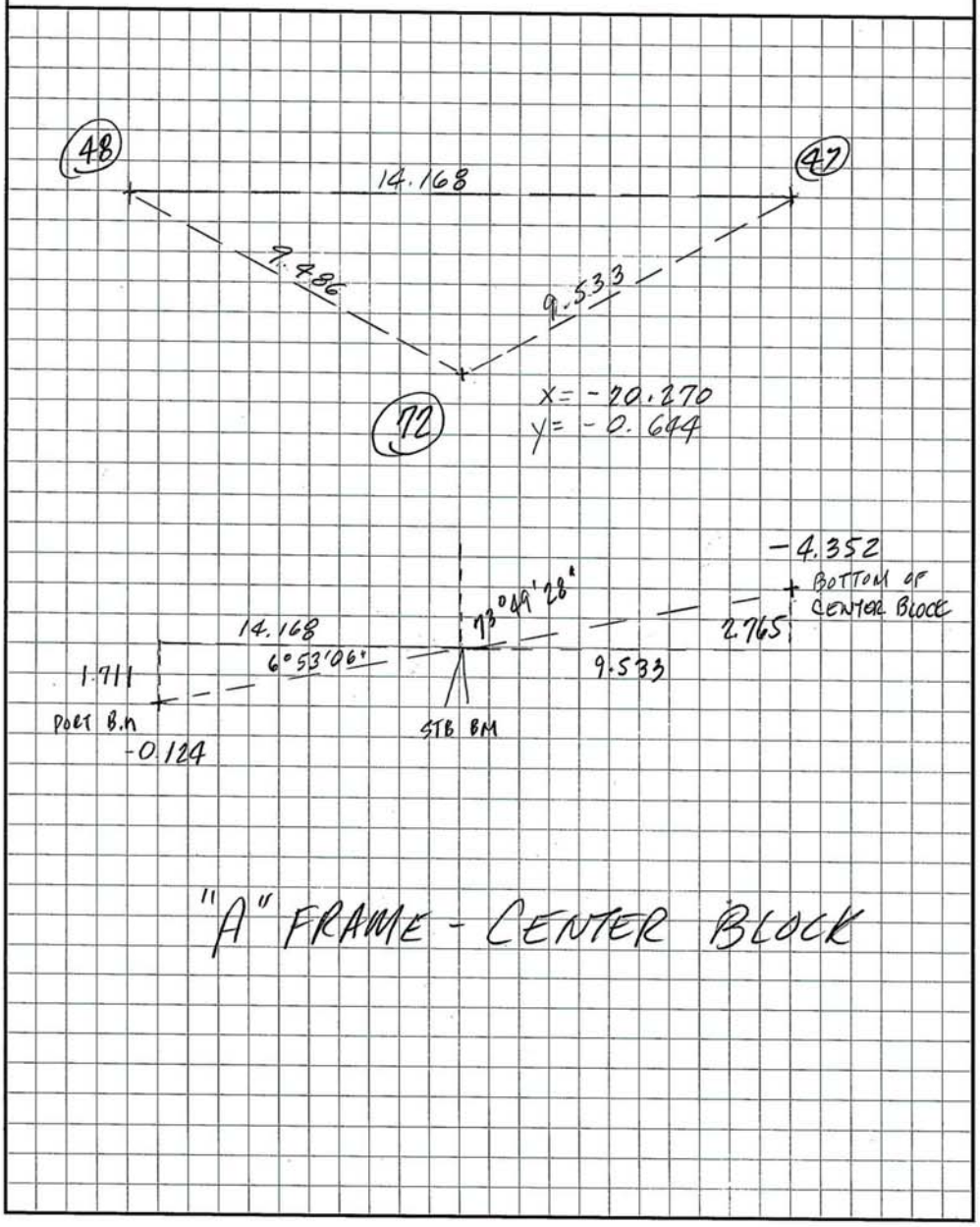
LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LOUISIANA 70460
PHONE NO: (985) 774-1955

SCALE: 1" = NONE

JOB: FERDINAND R. HASSLER
M286 SWATH
PASCAGOULA, MISSISSIPPI
FIELD CREW: R.I. & E.K.
CALCULATED BY: R. IMPASTATO
DATE: 11-4-09 SHEET NO.: 8



"A" FRAME - CENTER BLOCK

U.S. Department of Commerce

National Oceanic & Atmospheric Administration

National Ocean Service

National Geodetic Survey

Field Operations Branch

NOAA SHIP HASSLER

POS ANTENNA and Component Spatial Relationship Survey

Field Report

Kevin Jordan

March, 2011

NOAA Ship Hassler
POS Antenna and Spatial Relationship Survey

PURPOSE

The intention of this survey was to accurately position the relocated POS Antennas and Side Scan Sonar tow point.

PROJECT DETAILS

This survey was conducted on March 29, 2011 on Spring River Island in Pascagoula, MS. NGS was provided data from a previous survey that contained a complete point listing of all components as well as recoverable bench mark stations. The NOAA Ferdinand Hassler was in water causing some instability of the instrument and target reflectors. The tilt compensator had to be bypassed in order to take measurements.

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

TDS Survey Pro Ver. 4.7.1

ForeSight DXM Ver. 3.2.2 was used for post processing.

PERSONNEL

Kevin Jordan NOAA/NOS/NGS/Field Operations Branch 757-441-5478

Doug Adams NOAA/NOS/NGS/Field Operations Branch 757-441-5480

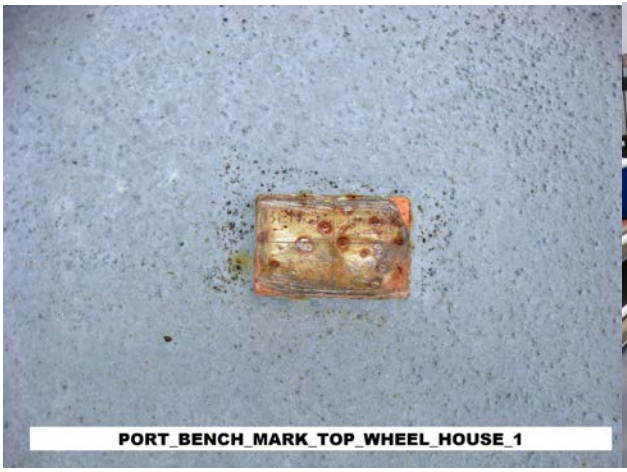
NOAA Ship Hassler
POS Antenna and Spatial Relationship Survey

SURVEY PROCEDURES

RECOVERED STATIONS

MID BENCH MARK TOP WHEEL HOUSE

PORT BENCH MARK TOP WHEEL HOUSE



STARBOARD BENCH MARK TOP WHEEL HOUSE


STARBOARD_BENCH_MARK_TOP_WHEEL_HOUSE_1


STARBOARD_BENCH_MARK_TOP_WHEEL_HOUSE_2

AFT MID BENCH MARK BACK DECK


AFT_MID_BENCH_MARK_BACK_DECK_1


AFT_MID_BENCH_MARK_BACK_DECK_2

PORT BENCH MARK BACK DECK

PORT_BENCH_MARK_BACK_DECK_1

PORT_BENCH_MARK_BACK_DECK_2

STARBOARD BENCH MARK BACK DECK

STARBOARD_BENCH_MARK_BACK_DECK_1

STARBOARD_BENCH_MARK_BACK_DECK_2

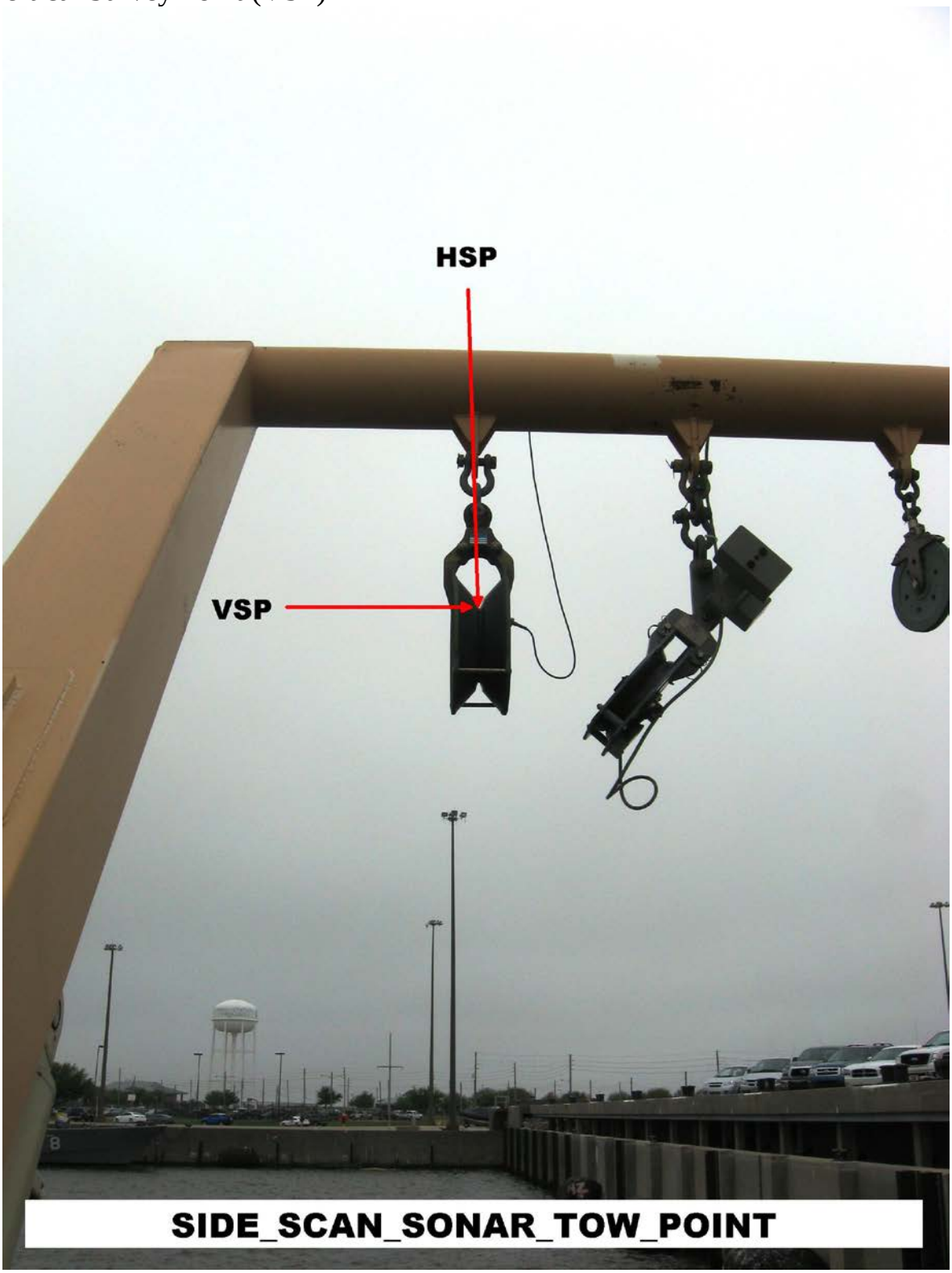
PORT BENCH MARK BRIDGE WING
-NO PHOTOS OF THIS STATION

NEW FEATURES

PORT POS ANTENNA MOUNT

STARBOARD POS ANTENNA MOUNT

SIDE SCAN SONAR TOW POINT
-Horizontal Survey Point (HSP)
-Vertical Survey Point (VSP)



Setup #1
Using the coordinates from the previous survey, the field crew setup the theodolite on the MID BENCH MARK TOP WHEEL HOUSE and initialized on PORT BENCH MARK BRIDGE WING to obtain a starting azimuth. From this setup, we collected the four POS antenna mount locations:

PORT FWD ANTENNA
PORT AFT ANTENNA
STARBOARD FWD ANTENNA
STARBOARD AFT ANTENNA

Positional checks were made to bench mark stations (see attached comparison report):

PORT BENCH MARK TOP WHEEL HOUSE
STARBOARD BENCH MARK TOP WHEEL HOUSE
PORT BENCH MARK BRIDGE WING

A temporary point (TP1) was established on the flying bridge near the stairs in order to collect the location of the SIDE SCAN SONAR TOW POINT.

Setup #2
The field crew setup on TP1 and initialized on the MID BENCH MARK TOP WHEEL HOUSE. From this setup, we collected:

SIDE SCAN SONAR TOW POINT

Positional checks were made to bench mark stations (see attached comparison report):

MID BENCH MARK TOP WHEEL HOUSE
AFT MID BENCH MARK BACK DECK

Setup #3
The field crew setup on AFT MID BENCH MARK BACK DECK and initialized on TP1. Positional checks were made to bench mark stations (see attached comparison report):

PORT BENCH MARK BACK DECK
STARBOARD BENCH MARK BACK DECK

DISCUSSION

All sensor/benchmark coordinates are contained in spreadsheets "NOAA SHIP HASSLER.xls"

The following table includes stations that were observed from more than one setup and for each, an inverse was computed to identify possible setup errors. Each station checked with favorable results.

OBSERVED to PUBLISHED COMPARISON (Units in Meters)			
NAME	Δ **Northing**	Δ **Easting**	Δ **Elevation**
PORT BENCH MARK BRIDGE WING	-0.003	-0.008	0
PORT BENCH MARK TOP WHEEL HOUSE	0.030	-0.015	-0.003
STARBOARD BENCH MARK TOP WHEEL HOUSE	-0.026	0.010	-0.006
MID BENCH MARK TOP WHEEL HOUSE	0.015	0.002	-0.007
AFT MID BENCH MARK BACK DECK	-0.020	-0.030	0.011
PORT BENCH MARK BACK DECK	0.027	-0.002	-0.005
STARBOARD BENCH MARK BACK DECK	-0.015	0.018	-0.011

NEW GPS IMU - NGS 2012

IMU PORT

DESCRIPTION	X	Y	Z
STAR FWD ANT	2.722	9.162	-12.869
STAR AFT ANT	0.719	9.159	-12.895
PORT FWD ANT	2.712	1.05	-12.838
PORT AFT ANT	0.706	1.052	-12.853
STARBOARD BM TOP OF WHEEL HOUSE	10.482	9.395	-10.832
PORT BM TOP OF WHEEL HOUSE	10.482	3.034	-10.807

IMU STBD

DESCRIPTION	X	Y	Z
STAR FWD ANT	2.698	-3.084	-12.87
STAR AFT ANT	0.695	-3.087	-12.896
PORT FWD ANT	2.688	-11.196	-12.839
PORT AFT ANT	0.682	-11.194	-12.854
STARBOARD BM TOP OF WHEEL HOUSE	10.458	-2.851	-10.833
PORT BM TOP OF WHEEL HOUSE	10.458	-9.212	-10.808

PURPOSE

During the 2012 field season it was discovered that previously determined offsets from the original ship survey (Impastato, 2009) were in need of refinements. Results from 2012 post-processed POSPac derived offset solutions and ellipsoidally referenced leadline (ERLL) measurements showed a difference of approximately 20 centimeters in the vertical direction. This error was floating somewhere between the navigation GPS antennas, IMU and transducers. An attempt to track down this error was performed by *Ferdinand R. Hassler* personnel during the drydock period (April 2013) at Colonna's Shipyard in Norfolk, VA.

METHODS

A calibrated optical level was utilized to obtain a closed loop of elevations on important points and sensors around the ship. These elevations are with respect to gravity, in order to transform them to the ship's reference frame (SRF) an additional loop was obtained containing known benchmark elevations. From these benchmark elevations, values for pitch and roll were computed.

The primary sensor loop contained elevations from the starboard forward (primary) POS antenna on the flying bridge to a temporary benchmark (TBM) located on the drydock floor. From the TBM the loop proceeded to close by way of the port forward POS antenna and a final closing shot between the two antennas. This resulted in a closed loop with less than 5 millimeters of calculated misclosure.

The TBM on the drydock floor was utilized for spurs to survey sensors. Each individual sensor was treated separately and closed with a misclosure computed in the calculation spreadsheet. Both IMU's was measured using a level and tape measure from known point via the cable route (7125's and cables were removed for shipyard period). The 7125 elevations were computed from the averaged elevation readings on the inboard and outboard base of frame, accounting for the manufactured 4.5 degree tilt.

A total station was utilized to obtain elevations on all eight draft marks permanently fixed on the ship's hull. A reflectorless (laser) measurement device measured the vertical distance relative to a level gravimetric plane of the instrument.

To obtain results a couple of points were assumed:

1) The ship reference frame is accurately documented and defined from the Impastato ship survey. From the established benchmarks we are able to recreate the ship reference frame and apply pitch/roll calculations correctly.

2) Coordinates provided from Impastato are correct until proven otherwise. We use distances from the master reference block (MRB) for applying the pitch/roll offsets but strongly disagree with many of his z-coordinates. Also, along with #1; benchmarks utilized were crucial in recreating the ships reference frame.

3) Distances from the MRB for applying pitch/roll offsets is close enough to the center of gravity for the vessel to accurately apply pitch and roll.

4) The *Hassler* is located in a floating drydock which is subject to outside influences (e.g. tide, current, wind). However, the influences will affect both drydock and ship at the same rate and therefore be negligible.

RESULTS

Ship Reference Frame:

One of the primary issues with surveying a ship is orientating results obtained via outside reference frames (e.g gravity) into the SRF. During the Impastato ship survey, the surveyor defined the ship's master reference frame by measuring the pitch and roll of each pontoon and averaging these values. From this point he established various benchmarks located around the vessel; including the MRB, IMU plates, transducers and antennas. It is from this original survey benchmarks that enable us to transform coordinates relative to the SRF.

A level loop was run from a benchmark established by FH personnel on the bow of the *Hassler* to two benchmarks established by Impastato on the aft corners. From these three benchmarks we figured the difference of design slope to actual slope for both pitch and roll. The correction was corrected with the distance from the MRB, which is near but not located at the center of gravity (motion) for the vessel. This appears to be the same strategy utilized by Impastato during the original survey.

Ship Sensors:

Through careful analysis of the main level loop and the spurs to each individual sensor located on the pontoons, the following offsets were obtained.

Sensor	**Corrected height from Antenna Base**		**Corrected height from IMU**	
Port IMU (base of plate)	-12.990	Port	--	--
Starboard IMU (base of plate)	-12.990	Starboard	--	--
7125 Port (middle Rx)	-14.203	Port	-1.213	Port
7125 Starboard (middle Rx)	-14.212	Starboard	-1.222	Starboard
7111 (middle Rx)	-14.149	Starboard	-1.159	Starboard
Port VBES	-14.236	Starboard	-1.245	Starboard
Starboard VBES	-14.237	Starboard	-1.247	Starboard

Table 1: 2013 Sensor Offset Results

Comparisons were made from the 2013 sensor offset results with offsets used previously during the 2012 season. Two sets of z-offsets were used during the 2012 season; those obtained through Impastato ship survey coordinates and those obtained through post-processed POSPac results (supported through ERLL results). The results of the delta Z values (2013 minus 2012) are shown below in Table 2.

Sensor	Delta Z (m) (Impastato)	Delta Z (m) (Revised)	Notes and Analysis
Stbd IMU -> Stbd APC	0.225	-0.002	Revised measurements from POSPac and ERLL; 2013 survey values strongly agree with revised results.
Port IMU -> Port APC	0.212	-0.019	Revised measurements from POSPac; 2013 survey values strongly agree with revised results.
Stbd IMU -> 7111 Rx	-0.171	n/a	No revisions were made between the Stbd IMU and 7111 Rx.
Stbd APC -> 7111 Rx	0.176	n/a	No revisions were made between the Stbd APC and 7111 Rx.
Stbd IMU -> 7125S Rx	-0.103	-0.011	Revised measurements were never used; 2013 survey values show disagreement between IMU and sensor.
Stbd APC -> 7125S Rx	0.244	-0.105	Revised measurements from POSPac and ERLL; 2013 survey values show same disagreement between IMU and sensor.
Port IMU -> 7125P Rx	-0.105	0.011	Revised measurements were never used; 2013 survey values show disagreement between IMU and sensor.
Port APC -> 7125P Rx	0.229	-0.123	Revised measurements from POSPac; 2013 survey values show same disagreement between IMU and sensor.

Table 2: Delta Values between 2013 and 2012

Draft Marks:

Field elevation measurements were corrected using the same pitch and roll constants as stated earlier. For this calculation the X/Y locations of the draft marks were obtained from Impastato ship survey.

Forward Port Outboard	Forward Port Inboard	Forward Stbd Inboard	Forward Stbd Outboard
2.57	2.58	2.52	2.52
2.77	2.78	2.71	2.71
2.97	2.98	2.92	2.91
3.16	3.18	3.12	3.11
3.37	3.38	3.32	3.30
3.57	3.58	3.52	3.51
3.77	3.78	3.71	3.71
3.97	3.98	3.92	3.91
4.17	4.18	4.12	4.11
4.37	4.38	4.32	4.31
4.57	4.58	4.52	4.51

After Port Outboard	After Port Inboard	After Stbd Inboard	After Stbd Outboard
2.58	2.58	2.61	2.59
2.78	2.77	2.81	2.80
3.99	2.97	3.01	2.99
3.18	3.17	3.21	3.20
3.38	3.37	3.41	3.40
3.58	3.57	3.61	3.60
3.79	3.78	3.81	3.80
3.98	3.98	4.01	4.00
4.18	4.18	4.21	4.20
4.38	4.38	4.41	4.40
4.58	4.58	4.61	4.60

Table 3: Draft Mark Elevations relative from MRB (z is positive down)

Ship Traverse:

While in our possession the total station instrument was utilized for a ship traverse of existing benchmarks and POS antennas; as well as recreating the original SRF from the Impastato survey. Methods for this traverse were not as complete as was desired due to inadequate equipment and training of personnel. However, the calculations serve as additional checks against prior surveys and because an X/Y position was established on the TBM, help tie all previously discussed methods into a complete survey. More calculations are required on these acquired data once defined goals are obtained.

CONCLUSIONS

Vertical offsets from the level loop agree closely with offsets derived from post-processed POSPac solutions and ERLL calculations resulting in more confidence of both these methods. Hours were spent overlooking Impastato's original survey notes for any indication of possible errors or blunders but none were found. From these results it is safe to say that there were errors and possibly an overall miscommunication of exact reference points for measurement. *Ferdinand R. Hassler*'s 2013 offsets will be defined from an in-depth analysis of these results and subsequent ERLL and reference surfaces to be acquired during Hydrographic Systems Readiness Review 2013.

Draft marks appear to near locations defined by Impastato as well as being generally level with respect to the ship reference frame; however, it appears that there is a disagreement with the forward starboard draft marks.

Offsets: POS MV

Measurement Coord. Sys.	Port IMU to Fwd Port Ant		Stbd IMU to Fwd Stbd Ant		Stbd IMU to Heave		Stbd IMU to Heave	
	Caris	POSMV	Caris	POSMV	Caris	POSMV	Caris	POSMV
x	1.002	2.713	-3.104	2.700	NA	NA	NA	NA
y	2.713	1.002	2.700	-3.104	NA	NA	NA	NA
z	-12.920	-12.920	-12.920	-12.920	NA	NA	NA	NA

Stbd Ant Seperation	
(from calc)	
Scaler Distance	2.000

Port Ant Seperation	
(from calc)	
Scaler Distance	2.006

Stbd Ant Seperation	
(from GAMS Cal)	
Scaler Distance	

Port Ant Seperation	
(from GAMS Cal)	
Scaler Distance	

POSMV offsets are derived from measurements by FH personnel made April 2012 after installation of new lever arm mounts and April 2013 during drydock.

Calculations

Port IMU to Fwd Port Ant			Stbd IMU to Fwd Stbd Ant		
Adapter Plate to top of IMU	x	0.000	Adapter Plate to top of IMU	x	0.000
	y	0.000		y	0.000
	z	0.1236		z	0.1236
(from POSMV V5 User Guide)		(in POSMV)	(from POSMV V5 User Guide)		(in POSMV)
Adapter Plate	x	0.000	Adapter Plate	x	0.000
	y	0.000		y	0.000
	z	0.012		z	0.012
from physical measurement		(in POSMV)	from physical measurement		(in POSMV)
Center of Port IMU Plate to Fwd Port Antenna Base (x/y from 2012 POSPac, z from FH 2013 drydock measurements)	x	2.713	Center of Stbd IMU Plate to Fwd Stbd Antenna Base (x/y from 2012 POSPac, z from FH 2013 drydock measurements)	x	2.700
	y	1.002		y	-3.104
	z	-12.990		z	-12.990
		(in POSMV)			(in POSMV)
Antenna base to phase center	x	0.000	Antenna base to phase center	x	0.000
	y	0.000		y	0.000
	z	-0.066		z	-0.066
(from Trimble diagram)		(in POSMV)	(from Trimble diagram)		(in POSMV)

Top of Port IMU to Fwd Port Ant			Top of Stbd IMU to Fwd Stbd Ant		
Top of Port IMU to aft port ant phase center	x	2.713	Top of Stbd IMU to fwd port ant phase center	x	2.700
	y	1.002		y	-3.104
	z	-12.920		z	-12.920
		(in POSMV)			(in POSMV)

PosPac Derived Offsets

Port IMU to Fwd Port Ant (from 2013 calculations)	
x	2.713
y	1.002
z	-12.920

Stbd IMU to Fwd Stbd Ant (from 2013 calculations)	
x	2.700
y	-3.104
z	-12.920

Port	y	6.123
STBD	y	-6.123

x and z zero

Port IMU to Fwd Port Ant (from PosPac calibration)		
	average	
x		
y		
z		

Stbd IMU to Fwd Stbd Ant (from PosPac calibration)		
	average	
x		
y		
z		

*calculated averages between multiple days

Ref to Center of Rotation
(Top of Stbd IMU to Center of Rotation)

POSMV
-3.705
-6.033
-2.270

(from waterline)
Added to Pos on DN285 2012

Offsets: Port 7125

Measurement Coord. Sys.	Port IMU to Port 7125 (MRU to Trans)	Fwd Port Ant to Port 7125 (Nav to Trans)	Projector to Receiver	Hysweep Offsets	
	Caris	Caris	Reson		Hypack
x	-1.244	-2.246	0.000	Port IMU to Port 7125 Stbd	-1.244
y	0.362	-2.351	-0.441	Fwd	0.362
z	1.349	14.269	0.047	Vertical	3.780
	TILTED 4.5 degrees up to port *Top of IMU is RP (Reference Pt)		(from Reson diagram, entered in Reson Hardware configuration)		TILTED 4.5 degrees up to port (Hypack vertical is positive down from waterline.)

Offsets are derived from Impastato Centerline Survey (2010) and measurements by FH personnel made April 2012 after installation of new lever arm mounts and April 2013 during drydock.

Calculations

Port IMU to Port 7125			Fwd Port Ant to Port 7125			Reson Projector to Receiver			Waterline to Stbd 7125 RP		
Top of IMU to center of IMU Plate	x	0.000	Antenna Phase Center to IMU Ref Pt	x	-1.002		x	0.000	Port IMU RP to Port 7125 RP	x	-1.244
	y	0.000		y	-2.713	Tx RP	y	0.000		y	0.362
	z	0.1356		z	12.920		z	0.000		z	1.349
(from POSMV V5 User Guide)		(in CARIS)	(from POS MV calculation tab)		(in CARIS)	(from Reson diagram)		(in Reson)	(from calculations)		(in CARIS)
Port IMU Plate to Port 7125	x	-1.244	Port IMU RP to Port 7125	x	-1.244		x	0.000	Top Port IMU to Waterline	x	0.000
	y	0.362		y	0.362	Rx RP	y	0.441		y	0.000
	z	1.213		z	1.349		z	-0.047		z	2.431
(x/y from Impastato, Z from 2013 drydock)*		(in CARIS)	(x/y from Impastato, Z from 2013 drydock)		(in CARIS)	(from Reson diagram and 2013 drydock)		(in Reson)	(from waterline spreadsheet)		(in Hypack)

Port IMU to Port 7125			Fwd Port Ant to Port 7125 RP			Reson Projector to Receiver			Waterline to Stbd 7125 RP		
	x	-1.244		x	-2.246		x	0.000		x	-1.244
	y	0.362		y	-2.351		y	-0.441		y	0.362
	z	1.349		z	14.269		z	0.047		z	3.780
		(in CARIS)			(in CARIS)			(in Reson)			(in Hypack)

CALCULATION NOTES

Z calc includes 0.015 m from base to RP

Impastato X/Y measurement locations unknown

0.102	from Reson diagram - Rx width
0.25	from 2013 drydock - Gap between Rx and Tx
0.28	from Reson diagram - Tx length
0.003656	4.5° tilt calculated from Tx diameter
0.046456	4.5° tilt calculated from Tx diameter

Offsets: Starboard 7125

Measurement Coord. Sys.	Stbd IMU to Stbd 7125 (MRU to Trans)	Caris	Fwd Stbd Ant to Stbd 7125 (Nav to Trans)	Caris	Reson Projector to Receiver	Reson	Hysweep Offsets		Hypack
x		1.424		4.528		0.000	Stbd IMU to Stbd 7125	Stbd	1.424
y		0.380		-2.320		-0.437		Fwd	0.380
z		1.358		14.278		0.047		Vertical	3.789
	TILTED 4.5 degrees up to stbd *Top of IMU is RP (Reference Pt)				(from Reson diagram, entered in Reson Hardware configuration)		TILTED 4.5 degrees up to stbd (Hypack vertical is positive down from waterline.)		

Offsets are derived from Impastato Centerline Survey (2010) and measurements by FH personnel made April 2012 after installation of new lever arm mounts and April 2013 during drydock.

Calculations

Stbd IMU to Stbd 7125				Fwd Stbd Ant to Stbd 7125				Reson Projector to Receiver				Waterline to Stbd 7125 RP			
Top of IMU to Center of IMU Plate	x	0.000		Antenna Phase Center to IMU Ref Pt	x	3.104			x	0.000		Stbd IMU RP to Stbd 7125 RP	x	1.424	
	y	0.000			y	-2.700		Tx RP	y	0.000			y	0.380	
	z	0.1356	(in CARIS)		z	12.920	(in CARIS)		z	0.000	(in Reson)		z	1.358	(in CARIS)
(from POSMV V5 User Guide)				(from POS MV calculation tab)				(from Reson diagram)				(from calculations)			
IMU Plate to Stbd 7125	x	1.424		Stbd IMU RP to Stbd 7125	x	1.424			x	0.000		Top Stbd IMU to Waterline	x	0.000	
	y	0.380			y	0.380		Rx RP	y	0.437			y	0.000	
	z	1.222	(in CARIS)		z	1.358	(in CARIS)		z	-0.047	(in Reson)		z	2.431	(in Hypack)
(x/y from Impastato, Z from 2013 drydock)*				(x/y from Impastato, Z from 2013 drydock)				(from Reson diagram and 2013 drydock)*				(from waterline spreadsheet)			

Stbd IMU to Stbd 7125 RP			Fwd Stbd Ant to Stbd 7125 RP			Reson Projector to Receiver			Waterline to Stbd 7125 RP		
x	1.424		x	4.528		x	0.000		x	1.424	
y	0.380		y	-2.320		y	-0.437		y	0.380	
z	1.358	(in CARIS)	z	14.278	(in CARIS)	z	0.047	(in Reson)	z	3.789	(in Hypack)

CALCULATION NOTES

Z calc includes 0.015 m from base to RP

Impastato X/Y measurement locations unknown

0.102	from Reson diagram - Rx width
0.246	from 2013 drydock - Gap between Rx and Tx
0.28	from Reson diagram - Tx length
0.003656	4.5° tilt calculated from Tx diameter
0.046456	4.5° tilt calculated from Tx diameter

Offsets: Starboard 7111

Measurement Coord. Sys.	IMU to 7111 (MRU to Trans)	Fwd Stbd Ant to 7111 (Nav to Trans)	Reson Projector to Receiver	Hysweep Offsets		
	Caris	Caris	Reson			Hypack
x	1.203	4.307	0.000	Stbd IMU to 7111 RP	Stbd	1.203
y	11.608	8.908	-0.499		Fwd	11.608
z	0.977	13.897	-0.269		Vertical	3.408

*Top of IMU is RP (Reference Pt)

(from Reson diagram, entered in Reson Hardware configuration)

(Hypack vertical is positive down from waterline.)

Offsets are derived from Impastato Centerline Survey (2010) and measurements by FH personnel made April 2012 after installation of new lever arm mounts and April 2013 during drydock.

Calculations

Stbd IMU to 7111			Fwd Stbd Ant to 7111 RP			Reson Projector to Receiver			Waterline to 7111 RP		
Top of IMU to Center of IMU Plate	x	0.000	Antenna Phase Center to IMU RP	x	3.104		x	0.000	Top Stbd IMU to 7111 RP	x	1.203
	y	0.000		y	-2.700	Tx RP	y	0.000		y	11.608
	z	0.1356		z	12.920		z	0.000		z	0.977
(from POSMV V5 User Guide)		(in CARIS)	(from POS MV calculation tab)		(in CARIS)	(from Reson diagram)		(in Reson)	(from calculations)		(in CARIS)
IMU Plate to 7111 Rx Face	x	1.203	IMU RP to 7111 Acoustic RP	x	1.203		x	0.000	Top Stbd IMU to Waterline	x	0.000
	y	12.107		y	11.608	Rx RP	y	0.499		y	0.000
	z	1.159		z	0.977		z	0.269		z	2.431
(x/y from Impastato, Reson diagram and 2013 drydock, z from 2013 drvdock)*		(in CARIS)	(x/y from Impastato and Reson diagram, z from 2013 drydock)		(in CARIS)	(from Reson diagram and 2013 drydock)*		(in Reson)	(from waterline spreadsheet)		(in Hypack)
7111 Rx Face to 7111 Acoustic RP	x	0.000									
	y	-0.499									
	z	-0.318									
(from Reson diagram)		(in CARIS)									

Top of Stbd IMU to 7111 RP			Fwd Stbd Ant RP to 7111 RP			Reson Projector to Receiver			Waterline to 7111 RP		
	x	1.203		x	4.307		x	0.000		x	1.203
	y	11.608		y	8.908		y	-0.499		y	11.608
	z	0.977		z	13.897		z	-0.269		z	3.408
		(in CARIS)			(in CARIS)			(in Reson)			(in Hypack)

CALCULATION NOTES

1.203 from Impastato - CL IMU to CL Plate

11.77 from Impastato - CL IMU to CL Plate

0.05341 from Reson diagram - CL Plate to Mounting Bolt

0.434 from Reson diagram - Mounting Bolt to aft Tx

0.65 from Reson diagram - Tx overall length

0.125 from 2013 drydock - Gap between Tx and Rx

0.0982 from Reson diagram - Rx thickness

0.098 from Reson diagram - Tx diameter

Sanity Check

Physical measurement = 11.150 +/- 20 cm

calc measurement = 11.228

diff = -0.078

Offsets: Dual 7125 (HSX only)

Measurement Coord. Sys.	Stbd IMU to Port 7125 (MRU to Trans) - Swath 1	Stbd IMU to Stbd 7125 (MRU to Trans) - Swath 2	Fwd Stbd Ant to Port 7125 (Nav to Trans)	Fwd Stbd Ant to Stbd 7125 (Nav to Trans)
	Caris	Caris	Caris	Caris
x	-13.490	1.424	-10.386	4.528
y	0.338	0.380	-2.362	-2.320
z	1.314	1.358	14.234	14.278

*Top of Stbd IMU is RP (Reference Pt)
Tilted up 4.5 degrees up on both sides

Port 7125 Hysweep Offsets		Hypack
Stbd IMU to Port 7125	Stbd	-13.490
	Fwd	0.338
	Vertical	3.745

TILTED 4.5 degrees up to port

(Hypack vertical is positive down from waterline.)

Stbd 7125 Hysweep Offsets		Hypack
Stbd IMU to Stbd 7125	Stbd	1.424
	Fwd	0.380
	Vertical	3.789

TILTED 4.5 degrees up to stbd

Offsets are derived from Impastato Centerline Survey (2010) and measurements by FH personnel made April 2012 after installation of new lever arm mounts and April 2013 during drydock.

Calculations

Stbd IMU to Port 7125			
top of IMU toCenter of Stbd IMU Plate	x	0.000	
	y	0.000	
	z	0.1356	(in CARIS)
(from POSMV V5 User Guide)			
Stbd IMU Plate to Port IMU Plate	x	-12.246	
	y	-0.024	
	z	-0.035	(in CARIS)
(x/y from Impastato, Z from Drydock) 2013			
Port IMU Plate to Port 7125	x	-1.244	
	y	0.362	
	z	1.213	(in CARIS)
(x/y from Impastato, Z from Drydock) 2013			

Stbd IMU to Stbd 7125			
top of IMU to Center of IMU Plate	x	0.000	
	y	0.000	
	z	0.1356	(in CARIS)
(from POSMV V5 User Guide)			
IMU Plate to Stbd 7125	x	1.424	
	y	0.380	
	z	1.222	(in CARIS)
(x/y from Impastato, Z from Drydock) 2013			

Fwd Stbd Ant to Port 7125			
Fwd Stbd Ant to Stbd IMU RP	x	3.104	
	y	-2.700	
	z	12.920	(in CARIS)
(from POS MV calculation tab)			
Stbd IMU RP to Port 7125	x	-13.490	
	y	0.338	
	z	1.314	(in CARIS)
(x/y from Impastato, Z from 2013 drydock)			

Fwd Stbd Ant to Stbd 7125			
Fwd Stbd Ant to Stbd IMU RP	x	3.104	
	y	-2.700	
	z	12.920	(in CARIS)
(from POS MV calculation tab)			
Stbd IMU RP to Stbd 7125	x	1.424	
	y	0.380	
	z	1.358	(in CARIS)
(x/y from Impastato, Z from 2013 drydock)			

Waterline to Stbd 7125 RP			
Top Stbd IMU to Port 7125 RP	x	-13.490	
	y	0.338	
	z	1.314	(in CARIS)
(from calculcations)			
Top Stbd IMU to Waterline	x	0.000	
	y	0.000	
	z	2.431	(in Hypack)
(from waterline spreadsheet)			

Waterline to Stbd 7125 RP			
Top Stbd IMU to Stbd 7125 RP	x	1.424	
	y	0.380	
	z	1.358	(in CARIS)
(from calculcations)			
Top Stbd IMU to Waterline	x	0.000	
	y	0.000	
	z	2.431	(in Hypack)
(from waterline spreadsheet)			

Stbd IMU to Port 7125 RP		
x	-13.490	
y	0.338	
z	1.314	(in CARIS)

Stbd IMU to Stbd 7125 RP		
x	1.424	
y	0.380	
z	1.358	(in CARIS)

Fwd Stbd Ant to Port 7125 RP		
x	-10.386	
y	-2.362	
z	14.234	(in CARIS)

Fwd Stbd Ant to Stbd 7125 RP		
x	4.528	
y	-2.320	
z	14.278	(in CARIS)

Waterline to Stbd 7125 RP		
x	-13.490	
y	0.338	
z	3.745	(in Hypack)

Waterline to Stbd 7125 RP		
x	1.424	
y	0.380	
z	3.789	(in Hypack)

Note: For dual acquisition 7125, the HSX file contains data from both 7125s but only POSMV data from the stbd POSMV. The port 7125 is swath 1 (beams 1-512) and the stbd 7125 is swath 2 (beams 513 to 1024).

Offsets: ODOM Single Beam

Measurement Coord. Sys.	Stbd IMU to Stbd SB	Caris
x		-0.455
y		4.620
z		1.383

(x/y from Impastato, Z from 2013 drydock) (in CARIS)

Measurement Coord. Sys.	Stbd IMU to Port SB	Caris
x		-12.701
y		4.620
z		1.381

(x/y from Impastato, Z from 2013 drydock) (in CARIS)

Measurement Coord. Sys.	Fwd Stbd Ant to Stbd SB	Caris
x		2.649
y		1.920
z		14.303

Measurement Coord. Sys.	Fwd Stbd Ant to Port SB	Caris
x		-9.597
y		1.920
z		14.301

		Port 7125 Hysweep Offsets	Hypack
Stbd IMU to Stbd SB	Stbd		-0.455
	Fwd		4.620
	Vertical		3.835

TILTED 4.5 degrees up to port

(Hypack vertical is positive down from waterline.)

		Stbd 7125 Hysweep Offsets	Hypack
Stbd IMU to Port SB	Stbd		-12.701
	Fwd		4.620
	Vertical		3.861

TILTED 4.5 degrees up to stbd

Calculations

Stbd IMU to Stbd SB		
top of IMU to Center of IMU Plate	x	0.000
	y	0.000
	z	0.1356

(from POSMV V5 User Guide) (in CARIS)

Stbd IMU to Stbd SB		
Stbd IMU Plate to Stbd SB	x	-0.455
	y	4.620
	z	1.247

(x/y from Impastato, Z from 2013 drydock)* (in CARIS)

Stbd IMU to Port SB		
top of IMU to Center of IMU Plate	x	0.000
	y	0.000
	z	0.1356

(from POSMV V5 User Guide) (in CARIS)

Stbd IMU to Port SB		
Stbd IMU Plate to Port SB	x	-12.701
	y	4.620
	z	1.245

(x/y from Impastato, Z from 2013 drydock)* (in CARIS)

Fwd Stbd Ant to Stbd SB		
Fwd Stbd Ant to Stbd IMU RP	x	3.104
	y	-2.700
	z	12.920

(from POS MV calculation tab) (in CARIS)

Fwd Stbd Ant to Stbd SB		
Stbd IMU to Stbd SB	x	-0.455
	y	4.620
	z	1.383

(x/y from Impastato, Z from 2013 drydock) (in CARIS)

Fwd Stbd Ant to Port SB		
Fwd Stbd Ant to Stbd IMU RP	x	3.104
	y	-2.700
	z	12.920

(from POS MV calculation tab) (in CARIS)

Fwd Stbd Ant to Port SB		
Stbd IMU to Port SB	x	-12.701
	y	4.620
	z	1.381

(x/y from Impastato, Z from 2013 drydock) (in CARIS)

Waterline to Stbd SB RP		
Stbd IMU RP to Stbd SB RP	x	-0.455
	y	4.620
	z	1.383

(from calculations) (in CARIS)

Waterline to Stbd SB RP		
Top Stbd IMU to Waterline	x	0.000
	y	0.000
	z	2.431

(from waterline spreadsheet) (in Hypack)

Waterline to Port SB RP		
Stbd IMU RP to Port SB RP	x	-12.701
	y	4.620
	z	1.381

(from calculations) (in CARIS)

Waterline to Port SB RP		
Top Stbd IMU to Waterline	x	0.000
	y	0.000
	z	2.431

(from waterline spreadsheet) (in Hypack)

Stbd IMU to Stbd SB	
x	-0.455
y	4.620
z	1.383

(in CARIS)

Stbd IMU to Stbd SB	
x	-12.701
y	4.620
z	1.381

(in CARIS)

Fwd Stbd Ant to Port 7125 RP	
x	2.649
y	1.920
z	14.303

(in CARIS)

Fwd Stbd Ant to Stbd 7125 RP	
x	-9.597
y	1.920
z	14.301

(in CARIS)

Waterline to Stbd 7125 RP	
x	-0.455
y	4.620
z	3.835

(in Hypack)

Waterline to Stbd 7125 RP	
x	-12.701
y	4.620
z	3.861

(in Hypack)

Offsets: Klein 5000

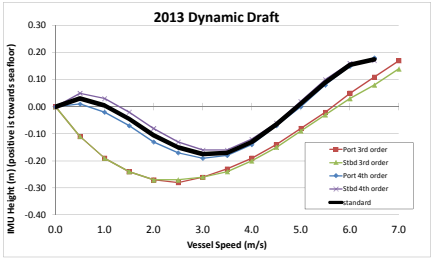
Measurement	Port IMU to TowPoint	
Coord. Sys.		Caris
x		7.161
y		-26.032
z		-9.347

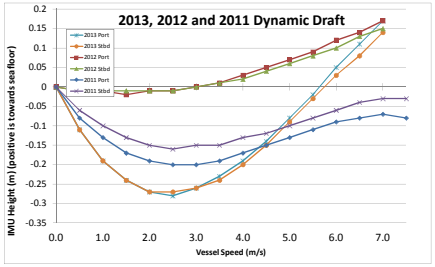
(in CARIS)

2013 Elipsoid Referenced Dynamic Draft Results

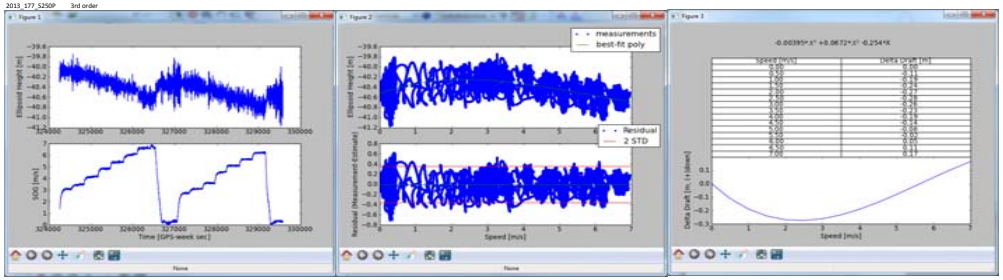
Speed (m/s)	Canards at Zero: Port 3rd Order	Stbd 3rd Order	Port 4th Order	Stbd 4th Order	Standard
0.0	0	0	0	0	**0.00**
0.5	-0.11	-0.11	0.01	0.05	**0.03**
1.0	-0.19	-0.19	-0.02	0.03	**0.01**
1.5	-0.24	-0.24	-0.07	-0.02	**-0.05**
2.0	-0.27	-0.27	-0.13	-0.08	**-0.11**
2.5	-0.28	-0.27	-0.17	-0.13	**-0.15**
3.0	-0.26	-0.26	-0.19	-0.16	**-0.18**
3.5	-0.23	-0.24	-0.18	-0.16	**-0.17**
4.0	-0.19	-0.2	-0.14	-0.12	**-0.13**
4.5	-0.14	-0.15	-0.07	-0.06	**-0.07**
5.0	-0.08	-0.09	0	0.02	**0.01**
5.5	-0.02	-0.03	0.08	0.1	**0.09**
6.0	0.05	0.03	0.15	0.16	**0.16**
6.5	0.11	0.08	0.18	0.17	**0.18**
7.0	0.17	0.14	0.14	0.11	

*********Used 4th order standard values

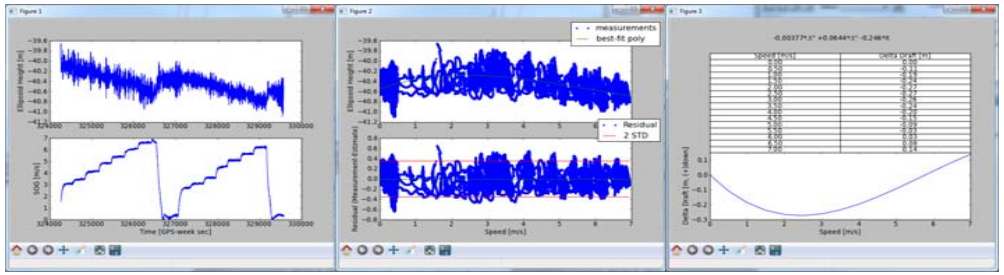




2013_177_S250P 3rd order



2013_177_S250S 3rd order



Waterline to IMU Offset

Date: NA **Personnel:** NA

DESIGN DRAFT OF 3.85 METERS

PORT PONTOON Draft Readings			
Fwd Outboard	3.85	Fwd Inboard	3.85
Aft Outboard	3.85	Aft Inboard	3.85

Port Ave 3.85

STBD PONTOON Draft Readings			
Fwd Inboard	3.85	Fwd Outboard	3.85
Aft Inboard	3.85	Aft Outboard	3.85

Stbd Ave 3.85

Center of IMU Plate to top of IMU

	Port	Stbd
x		
y		
z	-0.1356	-0.1356

IMU Plate to Fwd Outboard 4.6 Draft Mark

	Port	
x		
y		
z	-3.313	(in CARIS)

IMU Plate to Fwd Inboard 4.6 Draft Mark

	Port	
x		
y		
z	-3.308	(in CARIS)

IMU Plate to Aft Outboard 4.6 Draft Mark

	Port	
x		
y		
z	-3.306	(in CARIS)

IMU Plate to Aft Inboard 4.6 Draft Mark

	Port	
x		
y		
z	-3.305	(in CARIS)

From 2013 Drydock Ave -3.308

IMU plate to Fwd Inboard 4.6 Draft Mark

	Stbd	
x		
y		
z	-3.426	(in CARIS)

IMU plate to Fwd Outboard 4.6 Draft Mark

	Stbd	
x		
y		
z	-3.428	(in CARIS)

IMU plate to Aft Inboard 4.6 Draft Mark

	Stbd	
x		
y		
z	-3.344	(in CARIS)

IMU plate to Aft Outboard 4.6 Draft Mark

	Stbd	
x		
y		
z	-3.358	(in CARIS)

From 2013 Drydock Ave -3.389

Fwd Outboard Draft Mark to Waterline

	Port	
x		
y		
z	0.750	(in CARIS)

Fwd Inboard Draft Mark to Waterline

	Port	
x		
y		
z	0.750	(in CARIS)

4.6

Aft Outboard Draft Mark to Waterline

	Port	
x		
y		
z	0.750	(in CARIS)

Aft Inboard Draft Mark to Waterline

	Port	
x		
y		
z	0.750	(in CARIS)

Calculated from draft mark 4.6 to draft readings Ave 0.750

Fwd Inboard Draft Mark to Waterline

	Stbd	
x		
y		
z	0.750	(in CARIS)

Fwd Outboard Draft Mark to Waterline

	Stbd	
x		
y		
z	0.750	(in CARIS)

Aft Inboard Draft Mark to Waterline

	Stbd	
x		
y		
z	0.750	(in CARIS)

Aft Outboard Draft Mark to Waterline

	Stbd	
x		
y		
z	0.750	(in CARIS)

Calculated from draft mark 4.6 to draft readings Ave 0.750

IMU to Fwd Outboard Waterline

	Port	
x		
y		
z	-2.427	(in CARIS)

IMU to Fwd Inboard Waterline

	Port	
x		
y		
z	-2.422	(in CARIS)

IMU to Aft Outboard Waterline

	Port	
x		
y		
z	-2.420	(in CARIS)

IMU to Aft Inboard Waterline

	Port	
x		
y		
z	-2.419	(in CARIS)

Ave -2.694

IMU to Fwd Inboard Waterline

	Stbd	
x		
y		
z	-2.540	(in CARIS)

IMU to Fwd Outboard Waterline

	Stbd	
x		
y		
z	-2.542	(in CARIS)

IMU to Aft Inboard Waterline

	Stbd	
x		
y		
z	-2.458	(in CARIS)

IMU to Aft Outboard Waterline

	Stbd	
x		
y		
z	-2.472	(in CARIS)

Ave -2.639

PORT Waterline to Port IMU

Fwd Outboard	2.4274	Fwd Inboard	2.4224	-1
Aft Outboard	2.4204	Fwd Inboard	2.4194	

Port Ave 2.4224

Port Waterline to Port IMU

Waterline to IMU (m)	x y z (In CARIS)	2.422

STBD Waterline to Stbd IMU

Fwd Inboard	2.5404	Fwd Outboard	2.5424	-1
Fwd Inboard	2.4584	Aft Outboard	2.4724	

Stbd Ave 2.5034

Stbd Waterline to Stbd IMU

Waterline to IMU (m)	x y z (In CARIS)	2.503

PORT, STBD Ave
2.463

Date: 6/14/2013 **Personnel:** Adler, Reed, Moehl
Location: MOC-A Port ERLL/WRLL

PORT PONTOON Draft Readings

Fwd Outboard	3.66	Fwd Inboard	3.65
Aft Outboard	3.92	Aft Inboard	3.91

Port Ave 3.785

Center of IMU Plate to top of IMU: x ; y ; z -0.1675

IMU Plate to Fwd Outboard 4.6 Draft Mark	x ; y ; z -3.313 (in CARIS)	IMU Plate to Fwd Inboard 4.6 Draft Mark	x ; y ; z -3.308 (in CARIS)		
IMU Plate to Aft Outboard 4.6 M Draft Mark	x ; y ; z -3.306 (in CARIS)	IMU Plate to Aft Inboard 4.6 Draft Mark	x ; y ; z -3.305 (in CARIS)		
From 2013 Drydock				Ave	-3.308

Fwd Outboard Draft Mark to Waterline	x ; y ; z 0.940 (in CARIS)	Fwd Inboard Draft Mark to Waterline	x ; y ; z 0.950 (in CARIS)		4.6
Aft Outboard Draft Mark to Waterline	x ; y ; z 0.680 (in CARIS)	Aft Inboard Draft Mark to Waterline	x ; y ; z 0.690 (in CARIS)		
Calculated from draft mark 4.6 to draft readings				Ave	0.815

IMU to Fwd Outboard Waterline	x ; y ; z -2.206 (in CARIS)	IMU to Fwd Inboard Waterline	x ; y ; z -2.191 (in CARIS)		
IMU to Aft Outboard Waterline	x ; y ; z -2.459 (in CARIS)	IMU to Aft Inboard Waterline	x ; y ; z -2.448 (in CARIS)		
				Ave	-2.661

PORT Waterline to Port IMU

Fwd Outboard	2.2055	Fwd Inboard	2.1905	-1
Aft Outboard	2.4585	Fwd Inboard	2.4475	

Port Ave 2.3255

Port Waterline to Port IMU

Waterline to IMU (m): x ; y ; z 2.326 (In CARIS)

STBD PONTOON Draft Readings

Port Fwd Outboard	3.75	Stbd Fwd Outboard	3.59
Port Aft Outboard	3.85	Stbd Aft Outboard	3.78

Stbd Ave 3.743

Center of IMU Plate to top of IMU: x ; y ; z -0.1675

IMU plate to Fwd Inboard 4.6 Draft Mark	x ; y ; z -3.313 (in CARIS)	IMU plate to Fwd Outboard 4.6 Draft Mark	x ; y ; z -3.426 (in CARIS)		
IMU plate to Aft Inboard 4.6 Draft Mark	x ; y ; z -3.306 (in CARIS)	IMU plate to Aft Outboard 4.6 Draft Mark	x ; y ; z -3.344 (in CARIS)		
From 2013 Drydock				Ave	-3.347

Fwd Inboard Draft Mark to Waterline	x ; y ; z 0.850 (in CARIS)	Fwd Outboard Draft Mark to Waterline	x ; y ; z 1.010 (in CARIS)		
Aft Inboard Draft Mark to Waterline	x ; y ; z 0.750 (in CARIS)	Aft Outboard Draft Mark to Waterline	x ; y ; z 0.820 (in CARIS)		
Calculated from draft mark 4.6 to draft readings				Ave	0.858

IMU to Fwd Inboard Waterline	x ; y ; z -2.296 (in CARIS)	IMU to Fwd Outboard Waterline	x ; y ; z -2.249 (in CARIS)		
IMU to Aft Inboard Waterline	x ; y ; z -2.389 (in CARIS)	IMU to Aft Outboard Waterline	x ; y ; z -2.357 (in CARIS)		
				Ave	-2.490

STBD Waterline to Stbd IMU

Fwd Inboard	2.2955	Fwd Outboard	2.2485	-1
Fwd Inboard	2.3885	Aft Outboard	2.3565	

Stbd Ave 2.32225

Stbd Waterline to Stbd IMU

Waterline to IMU (m): x ; y ; z 2.322 (In CARIS)

Appendix II

Echosounder Reports

Ferdinand R. Hassler

Multibeam Echosounder Calibration

S250
Vessel

7/30/2013	211	Approaches to Chesapeake (H12504 obstruction)
Date	Dn	Local Area

Adler, Reed, Mortimer, Moehl
Calibrating Hydrographer(s)

Comments

Starboard 7125 400kHz	Starboard Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check
18215011048		
Sonar Serial Number		Processing Unit Serial Number

TrueHeave filename

BOT_0000-0001					
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_221500	0		
	_222918	180		

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_222004	0		
	_222400	180		

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_223428	225		
	_224200	045		

Processing Log

7/31/2013	212	Moehl
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☐

Compute correctors in this order

1. Precise Timing	2. Pitch bias	3. Heading bias	4. Roll bias

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	-0.23	0.00	0.50
Reed	0.00	-0.12	0.00	0.68
Kist				
Averages	0.00	-0.19	0.01	0.51
Standard Deviation	0.00	0.18	0.03	0.22
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.05	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.02	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration **S250**

Vessel

10/242013	297	Approaches to New York H12627
Date	Dn	Local Area

Adler, Reed, Moehl, Kist, Faulkes

Calibrating Hydrographer(s)

Roll Lines Only - troubleshooting offset in NY

Comments

Starboard 7125 400kHz	Starboard Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18215011048	
Sonar Serial Number	Processing Unit Serial Number

TrueHeave filename

SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_211113	180	7.0	
	_211402	0	7.0	

Processing Log

Date	Dn	Personnel
10/24/2013	297	Reed

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☐

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	-0.23	#DIV/0!	0.50
Reed	0.00	-0.12	0.10	0.68
Kist				
Averages	0.00	-0.19	0.10	0.51
Standard Deviation	0.00	0.18	0.01	0.22
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro 0.05 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.02 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration **S250**

Vessel

6/27/2013	178	Cape Charles City Obstruction
Date	Dn	Local Area

Adler, Reed, Mortimer, Moehl

Calibrating Hydrographer(s)

Comments

Starboard 7125 400kHz	Starboard Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18215011048	
Sonar Serial Number	Processing Unit Serial Number

2013_178_S250S.000

TrueHeave filename

BOT_0002.svp	15:50	37:13:50	-076:04:40	9.2	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_131302	0	6.0	
	20130627_132342	180	6.0	
	20130627_133431	0	9.0	
	20130627_134245	180	9.0	
	20130724_001158	065		
	20130724_002125	245		
	20130724_010022	245		

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_150946	0	7.0	
	20130627_151917	180	7.0	
	20130724_010921	065		
	20130724_014536	245		

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_160025	045	5.5	
	20130627_160857	225	5.5	
	20130627_162943	045	9.0	
	20130627_163520	225	9.0	
	20130724_010022	225		
	201301724_001158	045		

Processing Log

Date	Dn	Personnel
6/28/2013	179	Mortimer, Reed, Adler, Moehl

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied**

☑ **SVP applied**

☑ **Tide applied** GPS Tides applied, patch test to the ellipsoid

Zone file

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	0.15	-4.41	0.35
Adler	0.00	0.36	-4.46	0.59
Reed	0.00	-0.02	-4.45	0.66
Mortimer	0.00	0.29	-4.35	0.37
Averages	0.00	-0.28	-0.05	-0.15
Standard Deviation	0.00	0.13	0.09	0.15
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro 0.03 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.02 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration

S250
Vessel

7/31/2013	212	Hudson Canyon
Date	Dn	Local Area

Mohel, Reed, Alder, Kist
Calibrating Hydrographer(s)

Comments

Starboard 7125 200kHz	STBD Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18215011048	
Sonar Serial Number	Processing Unit Serial Number

2013_212_S250S
TrueHeave filename

BOT_0002	1829	39/40/17 N	072/34/06 W	70	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

BOT_0003	1917	39/40/04 N	072/33/51 W	72	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_182114	300	7.5	had roll stab on / delete line
	_182204	300	7.5	
	_182822	120	7.5	

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_183556	300	7.0	
	_184244	120	7.0	

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				use pitch lines

Processing Log

Date	Dn	Personnel
7/31/2013	212	Reed, Adler, Moehl, Kist

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	0.02	0.03	0.70
Reed	0.00	0.06	0.05	0.84
Adler		0.07	0.03	0.88
Averages	0.00	0.05	0.01	0.62
Standard Deviation	0.00	0.07	0.05	0.36
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro 0.08 Value from standard deviation of Heading offset values

MRU Align StdDev Roll/Pitch 0.01 Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration

S250
Vessel

6/27/2013	178	Sheet H12504
Date	Dn	Local Area

Adler, Reed, Mortimer, Moehl
Calibrating Hydrographer(s)

Comments

Port 7125 400kHz	Port Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18210412051	
Sonar Serial Number	Processing Unit Serial Number

TrueHeave filename

SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_214813	0		
	_220438	180		

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_215658	0		
	_215224	180		

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_223428	225		
	_224200	045		

Processing Log

7/31/2013	212	Moehl
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing	2. Pitch bias	3. Heading bias	4. Roll bias

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	-0.39	-0.03	0.40
Reed	0.00	-0.13	-0.03	-0.09
Adler	0.00	-0.51	-0.01	0.22
Kist	0.00	-0.54	-0.03	-0.18
Averages	0.00	-0.39	-0.02	0.09
Standard Deviation	0.00	0.22	0.03	0.29
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.06	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.02	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☐ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration

S250
Vessel

10/24/2013	297	Sheet H12627
Date	Dn	Local Area

Adler, Reed, Moehl, Kist, Faulkes
Calibrating Hydrographer(s)

Roll Only
Comments

Port 7125 400kHz	Port Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18210412051	
Sonar Serial Number	Processing Unit Serial Number

TrueHeave filename

SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_211114	180	7.0	
	_213926	0	7.0	

Processing Log

10/24/2013	297	Reed
Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order

1. Precise Timing	2. Pitch bias	3. Heading bias	4. Roll bias

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	-0.39	#DIV/0!	0.40
Reed	0.00	-0.13	-0.08	-0.09
Adler	0.00	-0.51	-0.08	0.22
Kist	0.00	-0.54	#DIV/0!	-0.18
Averages	0.00	-0.39	-0.08	0.09
Standard Deviation	0.00	0.22	0.00	0.29
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.06	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.02	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration **S250**

Vessel

6/27/2013	178	Cape Charles City Obstruction
Date	Dn	Local Area

Adler, Reed, Mortimer, Moehl

Calibrating Hydrographer(s)

Comments

Port 7125 400kHz	Port Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18210412051	
Sonar Serial Number	Processing Unit Serial Number

2013_178_S250P.000

TrueHeave filename

BOT_0002.svp	15:50	37:13:50	-076:04:40	9.2	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				Use roll lines

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_131254	0	6.0	
	20130627_132342	180	6.0	
	20130627_133431	0	9.0	
	20130627_134245	180	9.0	
	20130724_004951			
	20130724_011804	234		used (dtm)
	20130724_012552	055		used (dtm)

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_152811	0	7.0	
	20130627_154601	180	7.0	
	20130724_001154	056		
	20130724_002125	236		
	20130724_010024	235		
	20130724_012552	056		used (dtm)
	20130724_013533	235		used (dtm)

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	20130627_160024	045	5.5	
	20130627_160856	225	5.5	
	20130627_162944	045	9.0	
	20130627_163519	225	9.0	
	20130724_010024	235		used (dtm)
	20130724_012552	055		used (dtm)

Processing Log

Date	Dn	Personnel
6/28/2013	179	Mortimer, Reed, Adler, Moehl

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied**

☑ **SVP applied**

☑ **Tide applied** GPS Tides applied, patch test to the ellipsoid

Zone file

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	0.52	-0.05	-0.37
Adler	0.00	0.28	0.42	-0.71
Kist	0.00	0.49	-0.03	-0.25
Reed	0.00	0.21	0.10	-0.07
Averages	0.00	0.37	0.11	-0.35
Standard Deviation	0.00	0.18	0.20	0.45
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.10	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.03	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration **S250**

Vessel

7/31/2013	212	Hudson Canyon
Date	Dn	Local Area

Mohel, Reed, Alder, Kist

Calibrating Hydrographer(s)

Comments

Port 7125 200kHz	Port Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check

18210412051	
Sonar Serial Number	Processing Unit Serial Number

2013_212_S250P

TrueHeave filename

BOT_0002	1829	39/40/17 N	072/34/06 W	70	
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

BOT_0003	1917	39/40/04 N	072/33/51 W	72	
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_185301	300	7.0	W/ watercolumn data (25 samples / beam)
	_190059	120	7.0	W/ watercolumn data (100 samples / beam)

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_190929	300	7.0	
	_191605	120	7.0	

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				use pitch lines

Processing Log

Date	Dn	Personnel

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Moehl	0.00	0.13	0.04	0.65
Reed	0.00	0.25	-0.07	-0.24
Adler	0.00	0.31	-0.13	-0.53
Kist	0.00	-0.04	0.15	-0.17
Averages	0.00	0.16	0.00	-0.07
Standard Deviation	0.00	0.18	0.11	0.47
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.10	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.02	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Ferdinand R. Hassler

Multibeam Echosounder Calibration **S250**

Vessel

7/31/2013	212	Hudson Canyon
Date	Dn	Local Area

Adler, Moehl, Kist, Reed

Calibrating Hydrographer(s)

Comments

7111	Stbd Pontoon	
MBES System	MBES System Location	Date of most recent EED/Factory Check
Sonar Serial Number		Processing Unit Serial Number

2013_212_S250S.000->?

TrueHeave filename

Bot_0001 -> Bot_					
SV Cast #1 filename	UTC Time	Lat	Lon	Depth	Ext. Depth
SV Cast #2 filename	UTC Time	Lat	Lon	Depth	Ext. Depth

DGPS = Moriches

NAV TIME LATENCY view parallel to track, one line with induced roll (outerbeam) or same lines bounded slope (nadir) [same direction, different speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks

PITCH view parallel to track, same line (at nadir) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_161200	300	7.0	took long break for training after line completed
	_172910	120	7.0	
	_173745	300	7.0	

HEADING/YAW view parallel to track, offset lines (outerbeams) [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
	_175101	235	7.0	significant crab observed
	_175805	050	7.0	significant crab observed
	_180552	300	7.0	
	_181337	120	7.0	

ROLL view across track, same line [opposite direction, same speed]

SV Cast #	XTF Line Filename	Heading	Speed (kts)	Remarks
				use pitch lines

Processing Log

Date	Dn	Personnel
7/31/2013	212	Mohel, Reed, Alder, Kist

☑ **Data converted --> HDCS_Data in CARIS**

☑ **TrueHeave applied** _____

☑ **SVP applied** _____

☑ **Tide applied** _____

Zone file _____

Lines merged ☑

Data cleaned to remove gross fliers ☑

Compute correctors in this order			
1. Precise Timing	**2. Pitch bias**	**3. Heading bias**	**4. Roll bias**

Do not enter/apply correctors until all evaluations are complete and analyzed.

PATCH TEST RESULTS/CORRECTORS

Evaluators	Latency (sec)	Pitch (deg)	Roll (deg)	Yaw (deg)
Reed	0.00	-0.89	0.00	1.61
Adler		-0.82	-0.06	1.03
Averages	0.00	-0.88	-0.02	0.90
Standard Deviation	#DIV/0!	0.27	0.05	0.59
FINAL VALUES				

Final Values based on

Resulting HVF File Name

MRU Align StdDev gyro	0.13	Value from standard deviation of Heading offset values
MRU Align StdDev Roll/Pitch	0.03	Value from averaged standard deviations of pitch and roll offset values

NARRATIVE

☑ **HVF Hydrographic Vessel File created or updated with current offsets**

Name: **Date:**

Appendix III

Positioning and Attitude System Reports

POSMV 320
INSTALLATION REPORT

Prepared for NOAA
Ferdinand Hassler
S250 SWATH
May, 2011
By

Bruce A. Francis
Applanix
Houston, TX

Company:	**Oak Management**
Attention of:	**Steve Laverty**
Email:	steve.laverty@oakmanagement.com
From:	Bruce A. Francis
Date:	18 May, 2011
Ref.:	**POSMV Installation aboard *Ferdinand Hassler-SWATH***

Applanix Corporation.
17461 Village Green Drive
Houston TX 77040
USA
Tel: (713) 896-9900
Fax: (713) 896-9919
bfrancis@applanix.com
http://www.applanix.com

During the period of May16th to May 18th, 2011 two POSMV systems were commissioned aboard NOAA vessel *Ferdinand Hassler*. The following is a summary of the events and final observations.

Chronology:

May 16th-

Travel from Houston TX to New Orleans LA. Overnight in Gulfport MS with the intention of meeting the ship in the morning to conduct dockside testing in the morning before the ship sets sail in the afternoon. Informed by Steve Laverty there has been a change in plan and the CO wants to depart the dock at 0900 tomorrow instead.

May 17th-

Arrive ship 0730. Brief review of POSMV installation with Briana Welton followed by cursory inspection. Both POSMV systems are up and running with no errors. Collected a set of dockside POSMV data from both systems for processing in POSPAC later today. Plan is to meet at the NOAA facility in Pascagoula at 0630 and transit out to ship in small boat.

May 18th- 0630- Depart Pascagoula for Ferdinand Hassler. Upon arrival commenced system inspection and diagnostics. No faults found. Conducted two GAMS calibrations on both POSMV systems and completed system acceptance testing.

Calibration and testing results:

1. The GAMS calibration was completed on May 18th and checked against the calculations derived from the survey report. Further comparisons are required but it appears that the survey calculations differ somewhat from the GAMS measured values.

Notes:

As a result of post processing the data set collected during commissioning, it was discovered that the POSMV IMU's were actually reversed at the back of the POSMV PCS units. Because of the symmetry in the two systems, these errors were not immediately obvious during the trials; however the lever arm errors were apparent in the data set. After physically changing the IMU inputs the processed calibration data was now reasonable when compared to the measured survey results. A new GAMS calibration was performed by the NOAA personnel after the IMU cables were returned to the correct orientation and the information below is based upon the correct orientation.

Recommendations:

While the large separation between the GPS antennas across decks will improve heading accuracy, there is a possibility that flexure in the ship will cause poor GAMS performance as the baseline vectors may become unstable. We were unable to fully test this configuration in a calm sea but if this turns out to be the case after the ship experiences a modest increase in sea state, the solution might be to extend the separation between the antennas on the individual mounts and switch the antenna input to the POS from cross decks to using the pairs from each side to their corresponding POS unit. The minimum separation should be 1 meter whereas now the distance is only about 0.6m and slightly too short to expect normal GAMS performance.

Submitted By:
Bruce A. Francis
Customer Support Engineer
Marine Products
713-896-9900
bfrancis@applanix.com

Vessel Name	Ferdinand R. Hassler
Year Built	2010
POSMV Location	**Port Side**
PCS Serial Number	3187
IMU Serial Number Top Hat	804 (Cable S/N 105)
Hardware Version	3.3-7
Firmware Version	5.03
POS IP Address Subnet Mask	129.100.2.231 255.255.0.0
POS PC Address Subnet Mask	129.100.2.234 255.255.255.0
Survey Software	Hypack 11.0.8.0
Multibeam System	Reson 7125

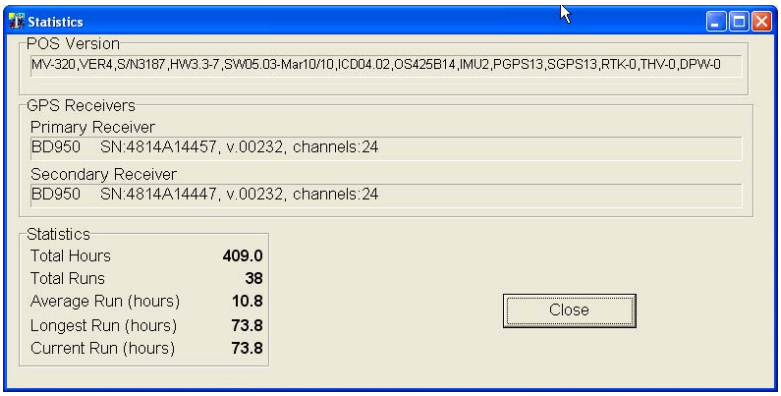
Port System Lever Arms: (Units are in Meters)

Point	X Axis	Y Axis	Z Axis	Notes
Reference point	0.0	0.0	0.0	PORT IMU
Ref to IMU	0.0	0.0	0.0	PORT IMU
Ref to Primary GPS	1.395	1.05	-13.084	Port Aft antenna
Ref to Secondary GPS	1.418	9.188	-13.080	Strb Aft antenna
Ref to AUX GPS	N/A	N/A	N/A	Not surveyed
Ref to Vessel	0.0	0.0	0.0	POS NMEA, message point of validity at target on IMU.
IMU frame w.r.t Ref frame	0.0	0.0	0.0	Rotation of IMU frame in comparison to ships frame.
Ref to Heave (COR)	0.0	0.0	0.0	Center of gravity (rotation) Information not available.
Ref to Sensor 1	0.0	0.0	0.0	Point of validity of HPR +Posn-Valid at IMU
Ref to Sensor 2	0.0	0.0	0.0	Point of validity-HPR +Posn-Valid at IMU

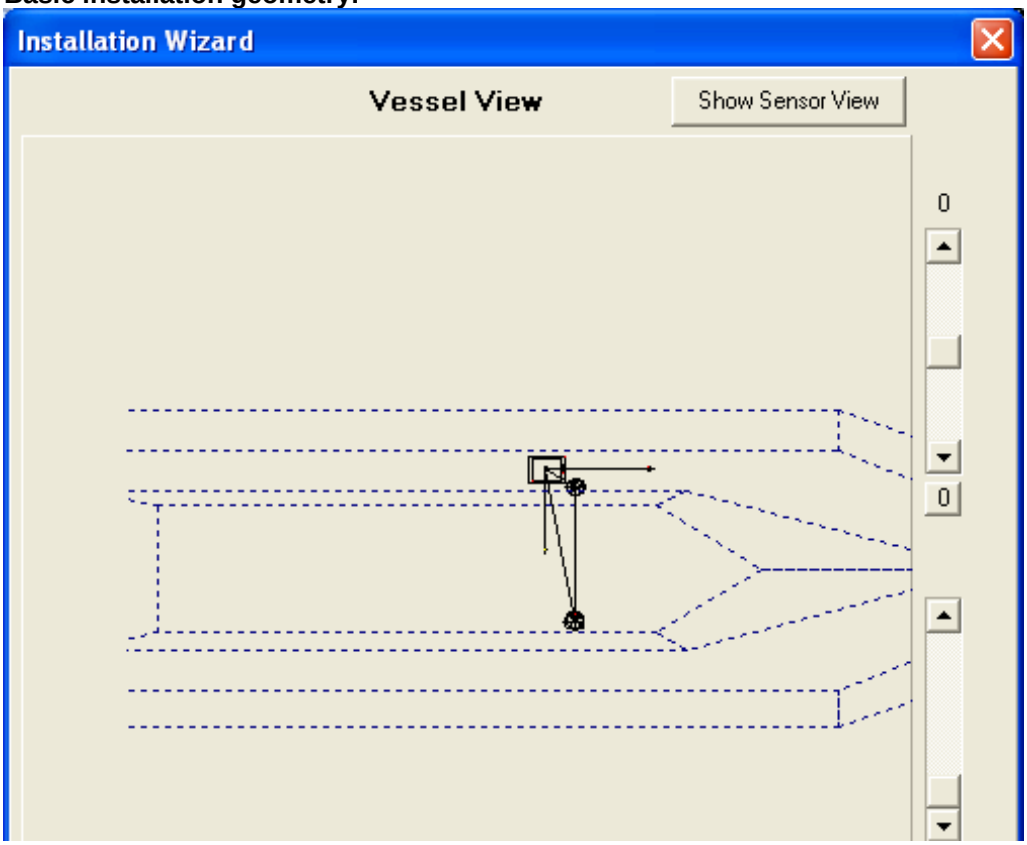
General System information:

Options included- RTK (RTK-0); True Heave (THV-0); (DPW-0) Password protection Disabled

Port POSMV



Basic installation geometry:

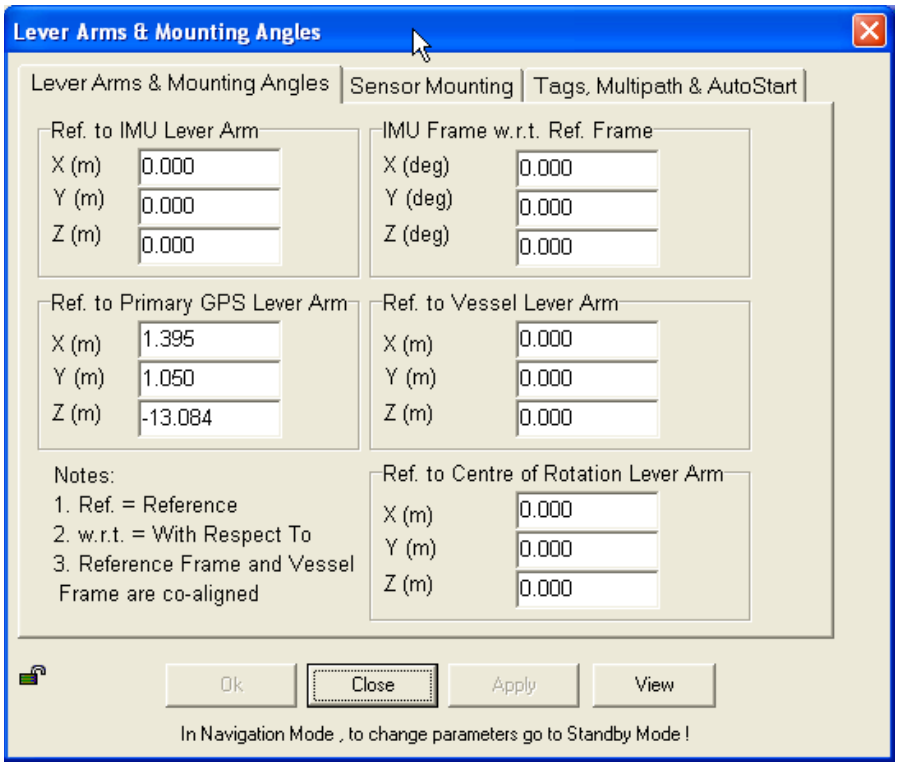


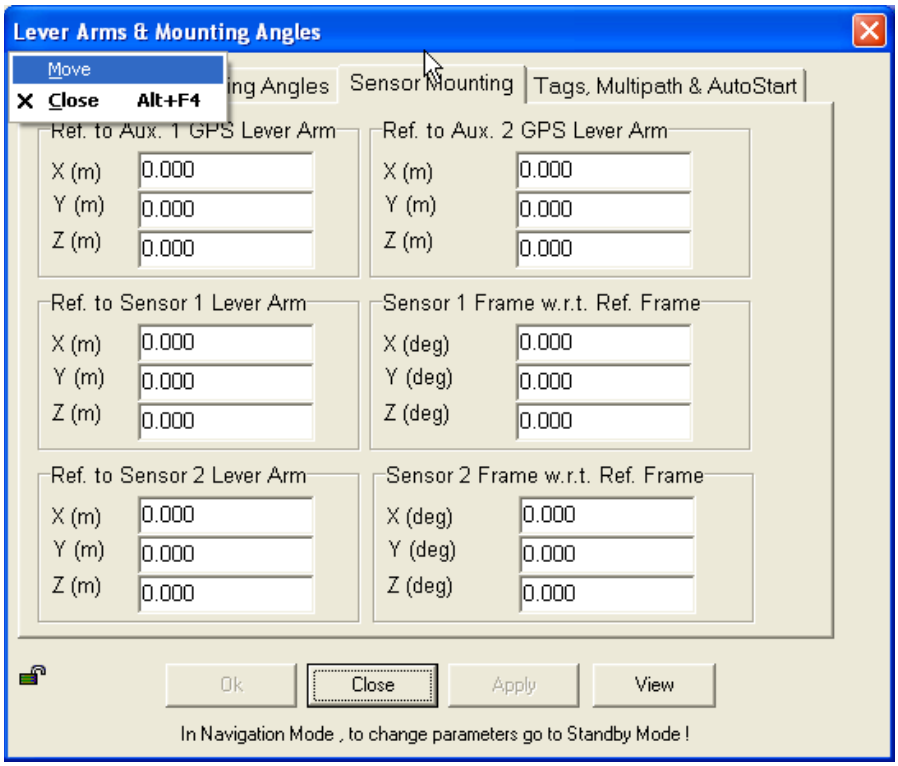
```
POSRT Data Extraction Utility [Jun 15 2011]
Copyright (c) 2008-2011 Applanix Corporation.  All rights reserved.
Date : 07/25/11    Time : 15:12:36
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
First POS file      : E:\Clients config, IP, & test results\NOAA\NOAA
Swath\Final_Data_IMUcorrect\For Bruce Frances\2011_152_S250_Port_A_GAMS.000
Last POS file       : E:\Clients config, IP, & test results\NOAA\NOAA
Swath\Final_Data_IMUcorrect\For Bruce Frances\2011_152_S250_Port_A_GAMS.000
Output path         : C:\Documents and Settings\bfrancis\My Documents\POSPac
MMS\Unnamed(1)\Swath Port IMU\Extract
Output kernel       : Swath Port IMU
Start time          : 0.000
End time            : 999999.000
VNAV output modulus : 1
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307750.275 : The First Group 99: Versions & Statistics
   System Version:
     Product-Model: MV-320; Version: VER4; Serial Number: S/N3187;
     Hardware Version: HW3.3-7;
     Software Release Version-Date: SW05.03-Mar10/10;
     ICD release version: ICD04.02;
     Operating System Version: OS425B14;
     IMU Type: IMU2; Primary GPS Type: PGPS13; Secondary GPS Type: SGPS13;
     Option mnemonic-Expiry Time: DMI0;
     Option mnemonic-Expiry Time: GIM0;
     Option mnemonic-Expiry Time: RTK-0;
     Option mnemonic-Expiry Time: THV-0;
     Option mnemonic-Expiry Time: DPW-0;
   Primary GPS Version: BD950         SN:4814A14457, v.00232, channels:24;
   Secondary GPS Version: BD950       SN:4814A14447, v.00232, channels:24;
   Total Hours          :    561.4; Number of Runs:     53
   Average Length of Run:   10.6; Longest Run:  126.2; Current Run:   12.1;
--------------------------------------------------------------------------------
307750.275 : Diffcorr2 time1 gap: start 0.0, end 307750.2749
307750.280 : IMU type: IMU2  Data rate = 200 Hz
307750.280 : Extracting Group 4 : Time-tag data
307750.290 : SNV status changed to 0  (Full Nav)
307751.070 : Primary GNSS receiver type is GNSS13.
307751.090 : Secondary GNSS receiver type is GNSS13.
307755.275 : GenB( 9):  GAMS solution in use CLEARED.
307756.275 : GenB( 9):  GAMS solution in use SET.
307758.275 : GenB( 9):  GAMS solution in use CLEARED.
--------------------------------------------------------------------------------
307759.275 : Message 50: Transition to NAVIGATE mode.
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 37: Base 1 setup
   Input data type expected: RTCM 1 or 9
   Datum Type: NAD83
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 38: Base 2 setup
   Input data type expected: RTCM 1 or 9
   Datum Type: WGS84
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 20: General parameters
   Time and distance tag types:          2  1
   Autostart selection:                   ENABLED
   Reference-IMU lever arm:              -0.008  -0.031  0.130
   Reference-primary GPS lever arm:      1.395  1.050  -13.084
   Reference-auxiliary 1 GPS lever arm:  0.000  0.000  0.000
```

```
   Reference-auxiliary 2 GPS lever arm:  0.000  0.000  0.000
   Reference-IMU mounting angles:        0.000  0.000  0.000
   Reference-vehicle mounting angles:    0.000  0.000  0.000
   Multipath environment:                 LOW
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
307759.275 : Message 22: Aiding sensor install parameters
   DMI scale factor:                   0.00
   Reference-DMI lever arm:            0.00    0.00    0.00
   DVS scale factor correction:        1.00
   Reference-DVS lever arm:            0.00    0.00    0.00
   Reference-DVS attitude:             0.00    0.00    0.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 24: User accuracy parameters
   User position accuracy:       2.00
   User velocity accuracy:       0.50
   User attitude accuracy:       0.05
   User heading accuracy:        0.05
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 106: Heave ratios
   Heave Bandwidth (sec):  12.000
   Heave Damping Ratio:  0.707
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 120: Heave and sensor 1&2 install parameters
   Reference->Sensor1 alignment angles (R,P,Y) in degrees:  0.00  0.00  0.00
   Reference->Sensor2 alignment angles (R,P,Y) in degrees:  0.00  0.00  0.00
   Reference->Sensor1 lever arm in meters:                  0.00  0.00  0.00
   Reference->Sensor2 lever arm in meters:                  0.00  0.00  0.00
   Reference->Center of Rotation in meters:                    0.00  0.00  0.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 121: Vessel Installation Parameters
   Reference-Vessel in meters:                           0.00  0.00  0.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 32: PCS IP address
   IP Address (Network part 1): 129
   IP Address (Network part 2): 100
   IP Address (Host part 1):    1
   IP Address (Host part 2):    232
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 56: General data
   Initial status:     COARSE_LEVEL
   Initial position:   30.339734242 -88.576108929 -24.927
   Initial distance:   0.00
   Initial attitude:   0.000 0.000 0.000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307759.275 : Message 21: GAMS install parameters
   A-B antenna separation:        8.112
   A-B baseline vector:           -0.060 8.112 0.021
   Heading error for calibration: 0.50
   A-B azimuth correction:        0.000
--------------------------------------------------------------------------------
Available subsystems                  :  IMU
                                      :  Primary GNSS
                                      :  Secondary GNSS
                                      :  Differential Corrections
Vehicle to reference alignment angles :  0.000  0.000  0.000
Multipath setting                     :  LOW
Reference to IMU lever arm            : -0.008 -0.031  0.130
Reference to IMU alignment angles     :  0.000  0.000  0.000
Reference to primary GNSS lever arm   :  1.395  1.050 -13.084
GAMS antenna separation               :  8.104
GAMS baseline vector                  :  0.152  8.103 -0.004
```

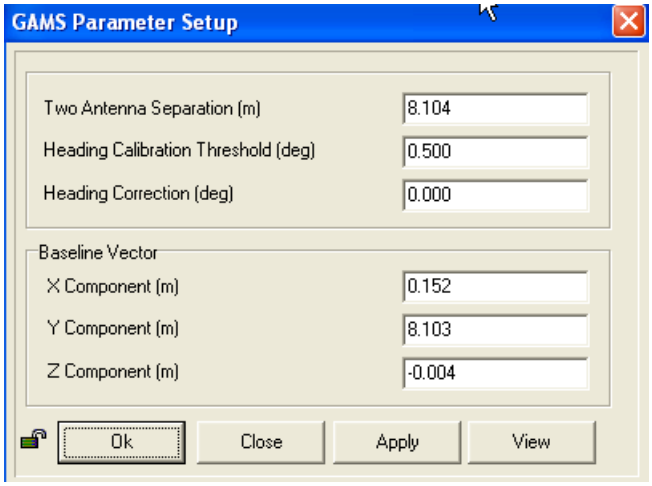
```
GAMS heading calibration threshold    :  0.500
GAMS heading correction               :  0.000
```



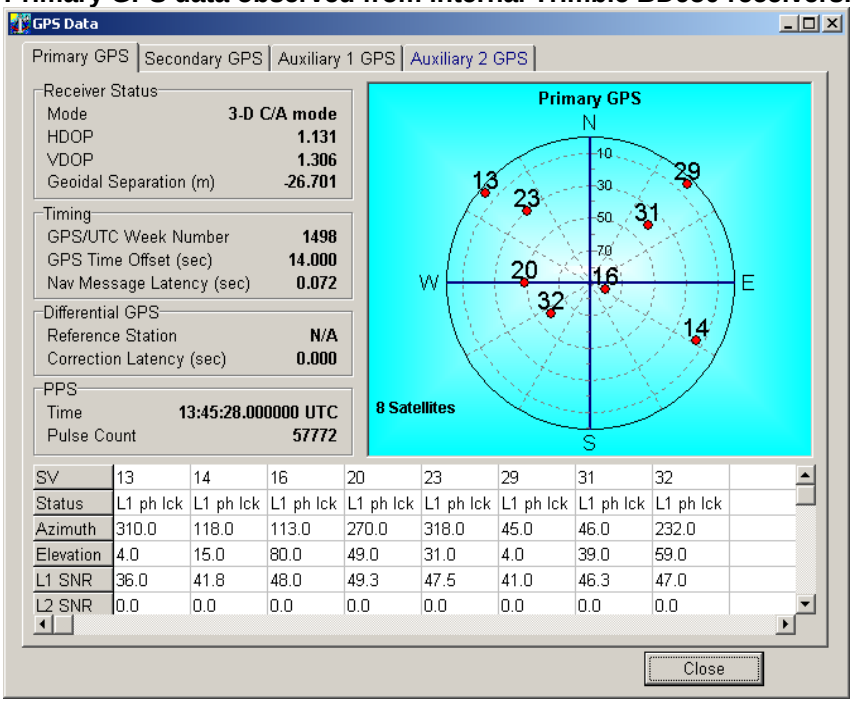


Observed GAMS values derived from the field calibration:

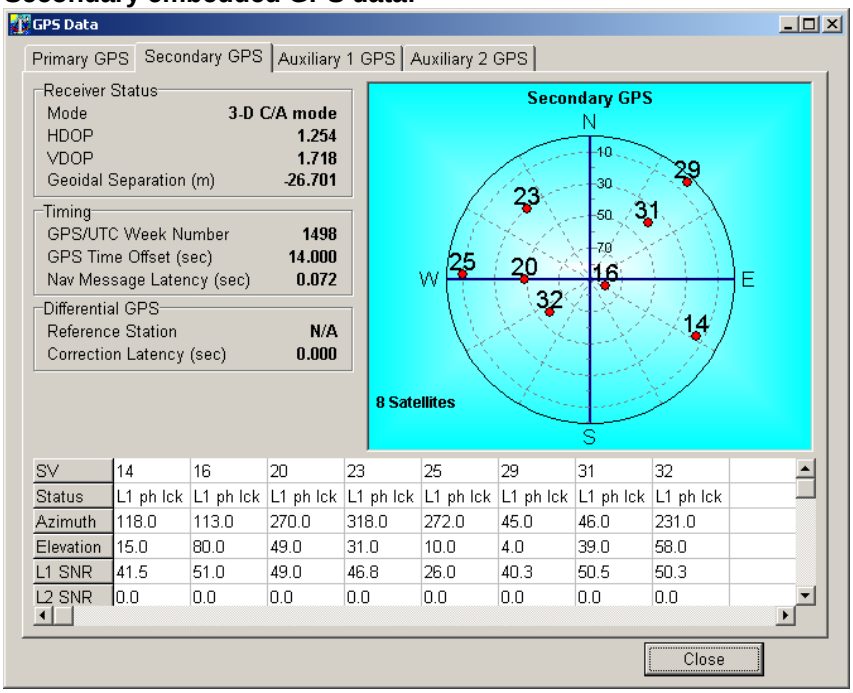
Port GAMS Cal #1



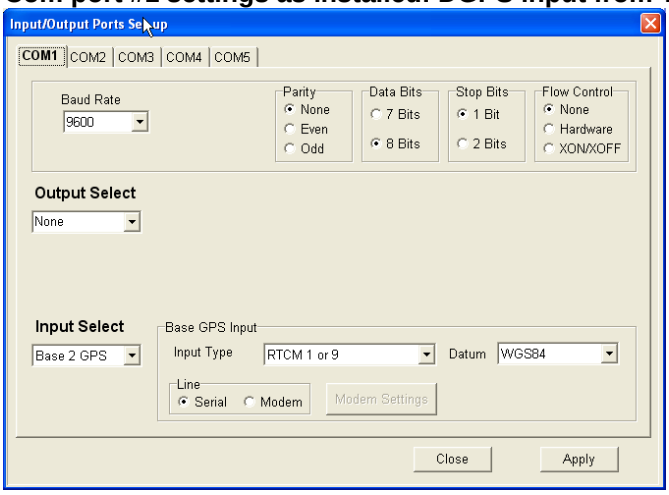
Primary GPS data observed from internal Trimble BD950 receivers.



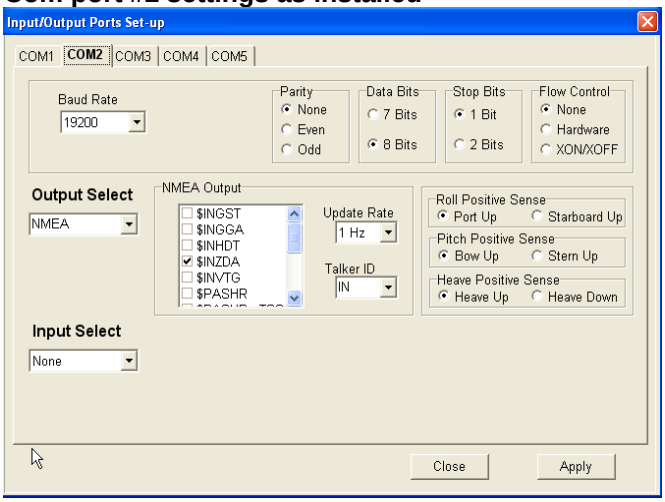
Secondary embedded GPS data:



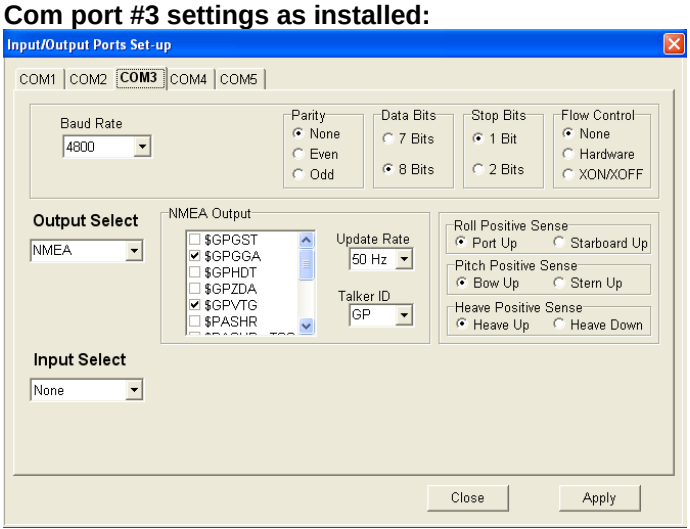
Com port #1 settings as installed: DGPS input from Trimble SPS Receiver.



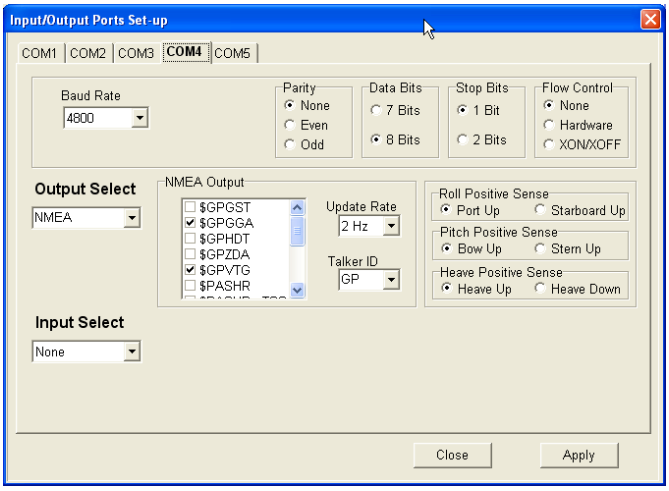
Com port #2 settings as installed



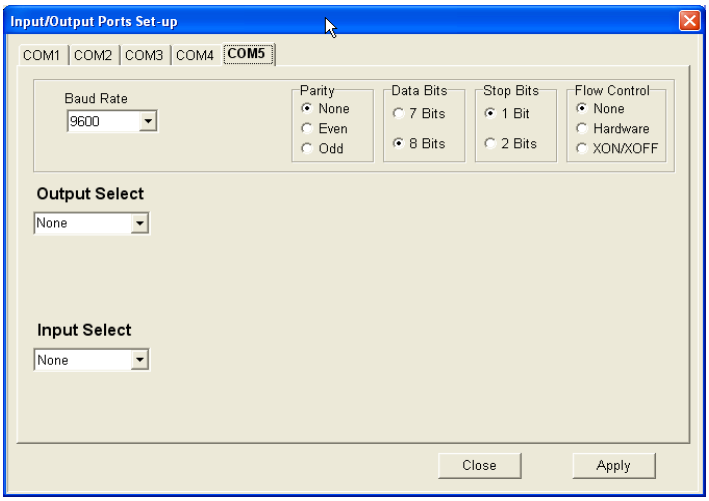
Com port #3 settings as installed:



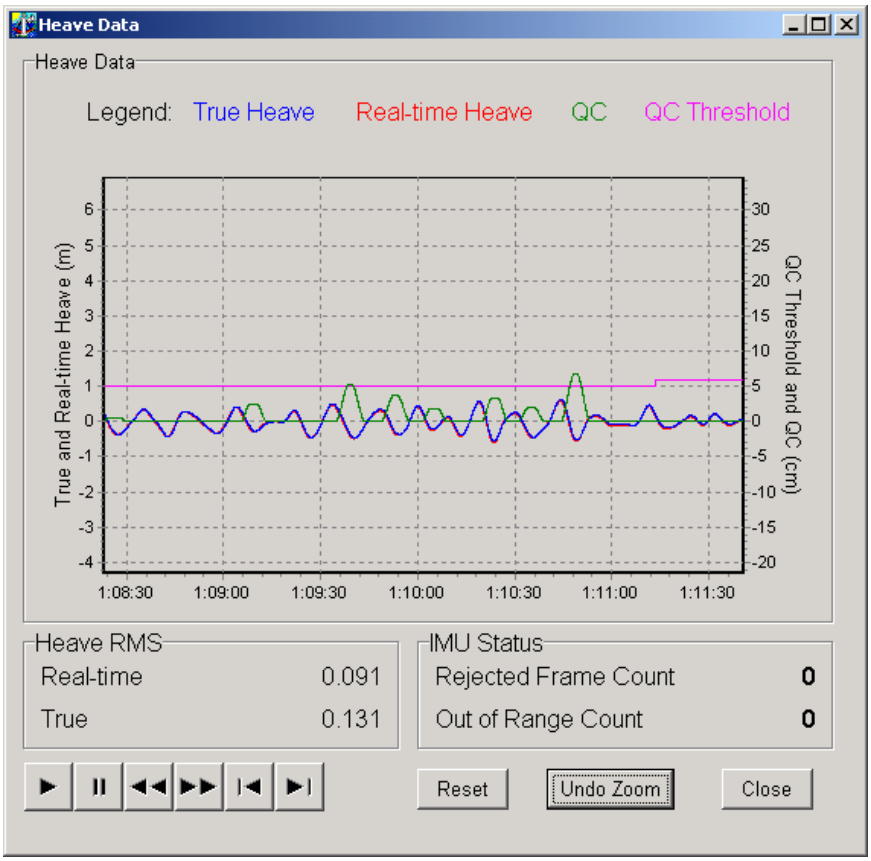
Com port #4 settings as installed:



Com port #5 settings as installed

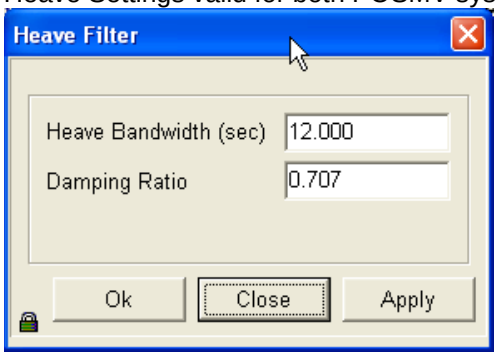


Heave data plot:

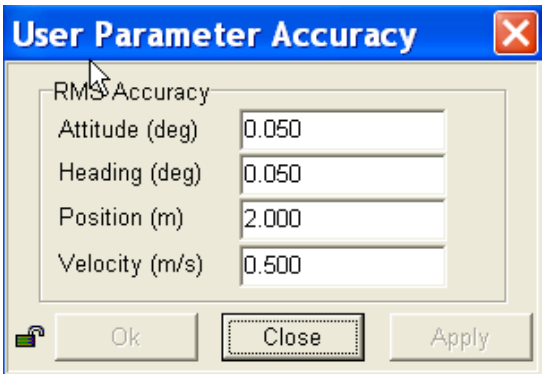


The heave plot above shows the relationship between the Real-time (RT) heave and the True (or delayed TH) heave measurements. The green line relates to quality control (QC) and represents the difference between the two values. When the delta between the RT and TH exceeds 5cm or 5% of total heave (pink line) then the radio light on the main controller screen will turn from green to red but does not affect the real-time heave data being collected. Quite often this occurs after the vessel makes a turn or an abrupt change in speed and is not necessarily cause for alarm. The heave filter has a 105 second buffer so the event which may have caused the impulse happened in the past. A red light merely calls the users attention to the difference and may also suggest that the filter settings need to be refined if the QC value is continually out of bounds.

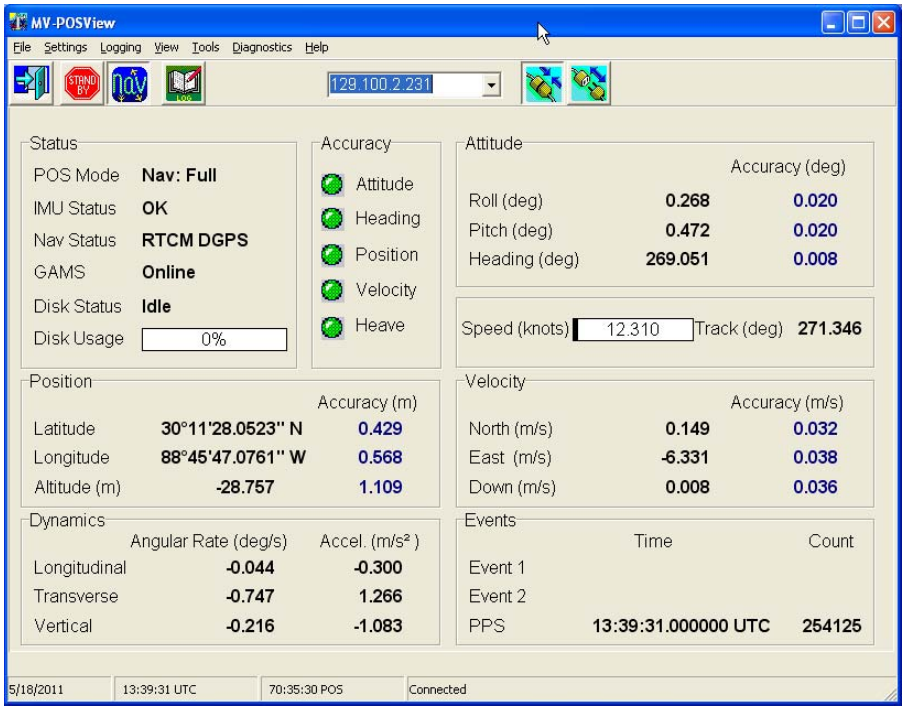
Note: The TrueHeave data filter is delayed about 3 minutes from the TH value. Also, Group 111 & 113 must be enabled in the Ethernet Real-time logging page. In addition, this filter should be adjusted as required for changes in the local swell conditions.
Heave Settings valid for both POSMV systems.



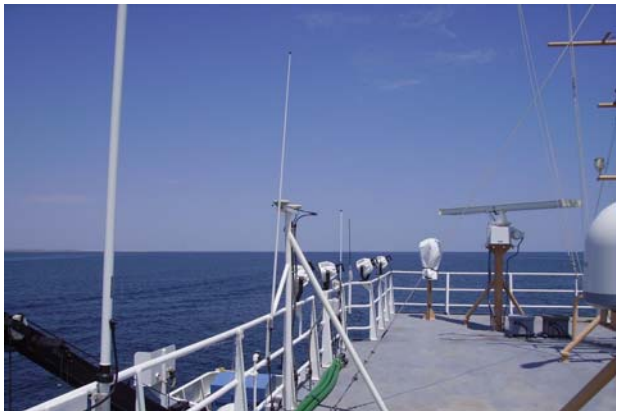
The main controller screens below shows normal POSMV operation. POS Mode is FULL indicating that all user accuracy settings have been satisfied. Note, when using RTK the position threshold should be set to a smaller value i.e. 0.100m or whatever is specified in the survey parameters. Exceeding any of the limits below will cause one of the radio lights to turn red and the POS mode will no longer report "Full Navigation" This however only affects the flag in the GGA or GGK message and not the performance.



Port POSMV Final Navigation



Port side antenna and IMU mounting:

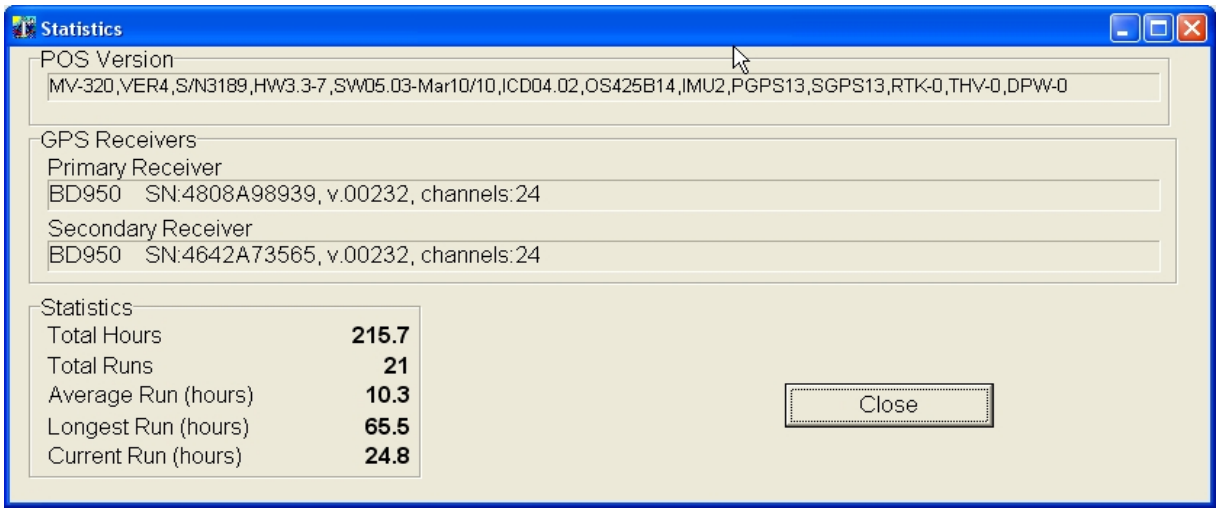


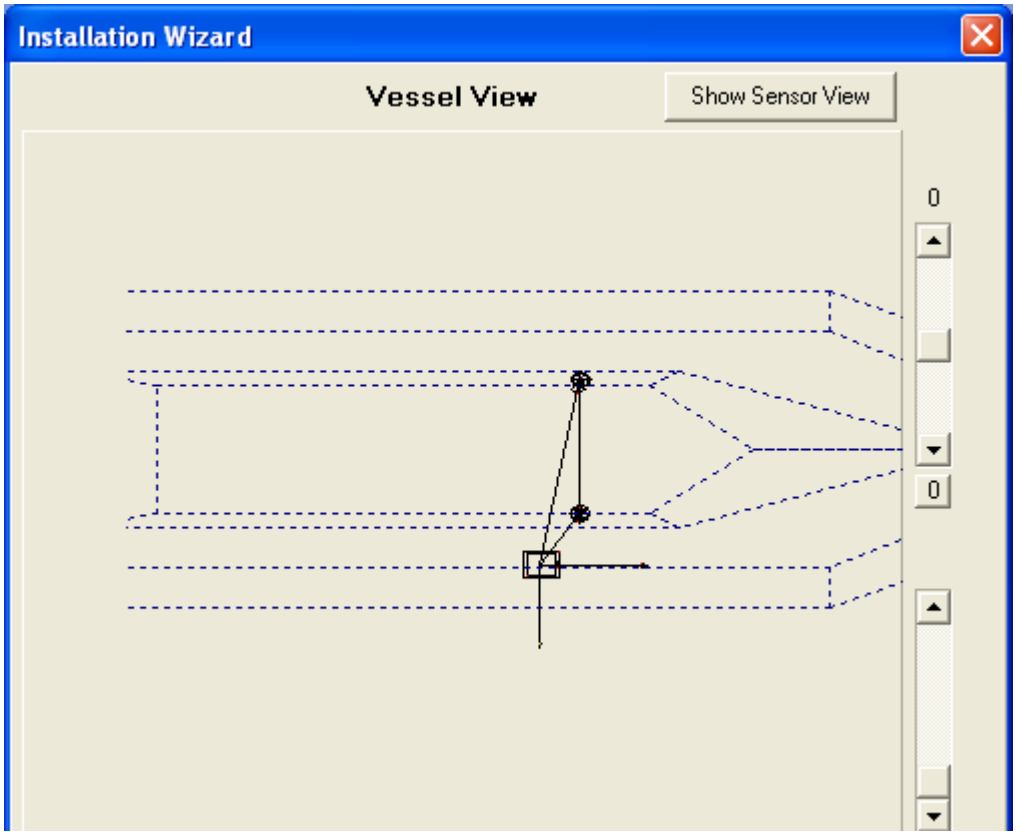
Vessel Name	Ferdinand R. Hassler
Year Built	2010
POSMV Location	**STRB Side**
PCS Serial Number	3189
IMU Serial Number Top Hat	803 (Cable S/N 104)
Hardware Version	3.3-7
Firmware Version	5.03
POS IP Address Subnet Mask	129.100.1.231 255.255.0.0
POS PC Address Subnet Mask	129.100.1.234 255.255.255.0
Survey Software	Hypack 11.0.8.0
Multibeam System	Reson 7125

Port System Lever Arms: (Units are in Meters)

Point	X Axis	Y Axis	Z Axis	Notes
Reference point	0.0	0.0	0.0	STRB IMU
Ref to IMU	0.0	0.0	0.0	STRB IMU
Ref to Primary GPS	1.929	-11.199	-13.084	Port FWD antenna
Ref to Secondary GPS	1.953	-3.056	-13.083	Strb FWD antenna
Ref to AUX GPS	N/A	N/A	N/A	Not surveyed
Ref to Vessel	0.0	0.0	0.0	POS NMEA, message point of validity at target on IMU.
IMU frame w.r.t Ref frame	0.0	0.0	0.0	Rotation of IMU frame in comparison to ships frame.
Ref to Heave (COR)	0.0	0.0	0.0	Center of gravity (rotation) Information not available.
Ref to Sensor 1	0.0	0.0	0.0	Point of validity of HPR +Posn-Valid at IMU
Ref to Sensor 2	0.0	0.0	0.0	Point of validity-HPR +Posn-Valid at IMU

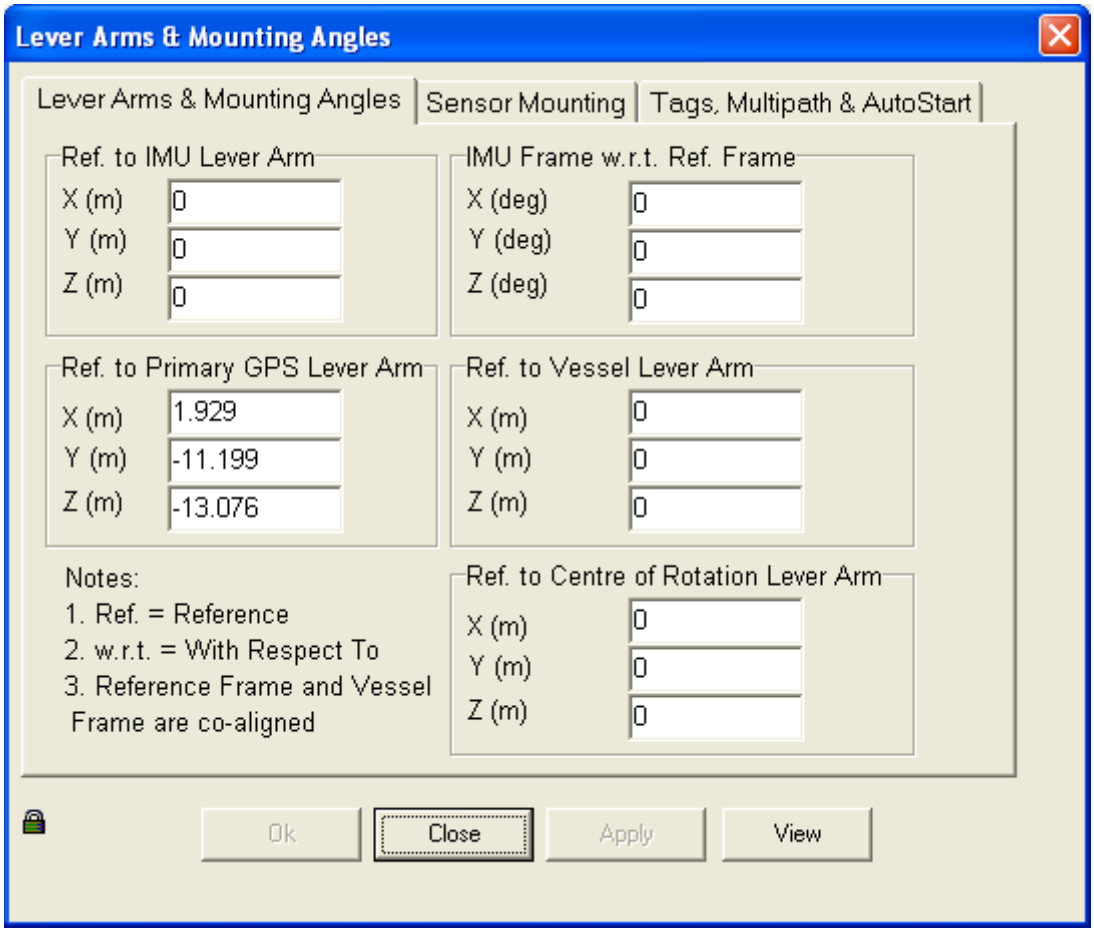
STRB POSMV

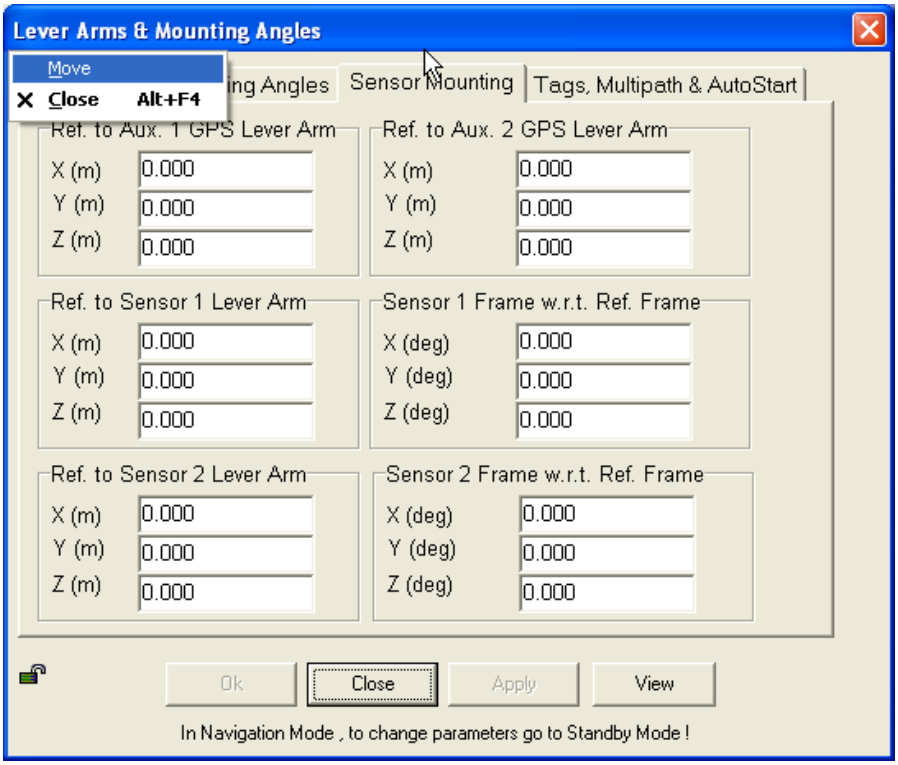

Statistics
POS Version
MV-320,VER4,S/N3189,HW3.3-7,SW05.03-Mar10/10,ICD04.02,OS425B14,IMU2,PGPS13,SGPS13,RTK-0,THV-0,DPW-0
GPS Receivers
Primary Receiver
BD950 SN:4808A98939, v.00232, channels:24
Secondary Receiver
BD950 SN:4642A73565, v.00232, channels:24
Statistics
Total Hours 215.7
Total Runs 21
Average Run (hours) 10.3
Longest Run (hours) 65.5
Current Run (hours) 24.8
Close


Installation Wizard
Vessel View
Show Sensor View
0
0

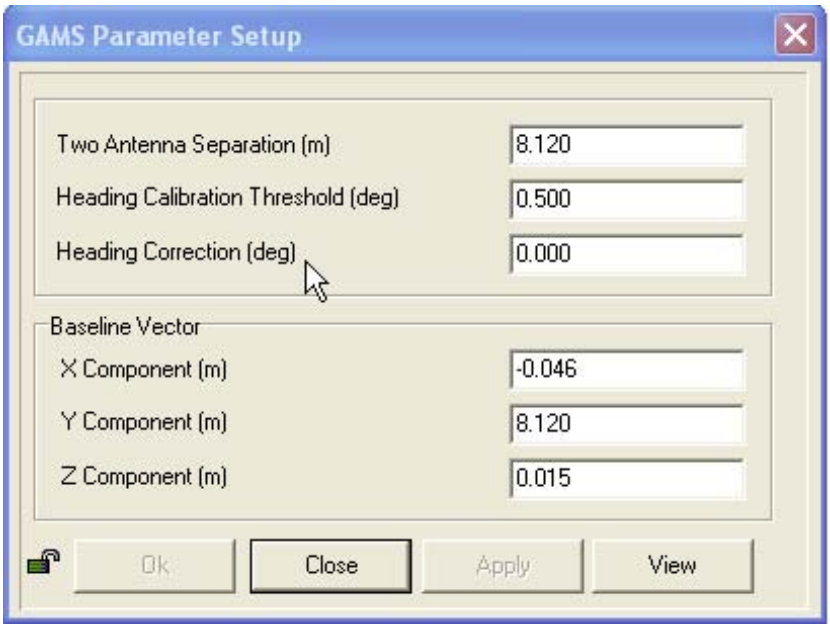
```
POSRT Data Extraction Utility [Jun 15 2011]
Copyright (c) 2008-2011 Applanix Corporation.  All rights reserved.
Date : 07/25/11    Time : 15:12:36
------------------------------------------------------------------------------
------------------------------------------------------------------------------
First POS file      : E:\Clients config, IP, & test results\Swath 250 Testing\Final
Report Files\Final_Data_IMUcorrect\For Bruce Frances\2011_152_S250_Stbd_GAMS.000
Last POS file       : E:\Clients config, IP, & test results\Swath 250 Testing\Final
Report Files\Final_Data_IMUcorrect\For Bruce Frances\2011_152_S250_Stbd_GAMS.003
Output path         : C:\Documents and Settings\bfrancis\My Documents\POSPac
MMS\Unnamed(2)\Mission 1\Extract
Output kernel       : Mission 1
Start time          : 0.000
End time            : 999999.000
VNAV output modulus : 1
------------------------------------------------------------------------------
Opening file: E:\Clients config, IP, & test results\Swath 250 Testing\Final Report
Files\Final_Data_IMUcorrect\For Bruce Frances\2011_152_S250_Stbd_GAMS.000
307625.639 : Output time 1 is in UTC time
307625.639 : Output time 2 is in POS time
307625.639 : Output distances are in POS distance
307625.639 : IMU type: IMU2  Data rate = 200 Hz
307625.639 : Extracting Group 4 : Time-tag data
307625.649 : SNV status changed to 0  (Full Nav)
307626.069 : Primary GPS receiver type is GPS13.
307626.094 : Secondary GPS receiver type is GPS13.
307626.144 : Extracting Group 10: The General Status & FDIR data.
307626.144 : GenA( 2):  IIN quadrant resolved SET.
307626.144 : GenA( 3):  IIN fine align active SET.
307626.144 : GenA( 4):  IIN navigator initialized SET.
307626.144 : GenA( 5):  IIN navigator alignment active SET.
307626.144 : GenA( 7):  IIN full navigation solution SET.
307626.144 : GenA( 8):  IIN initial position valid SET.
307626.144 : GenA(16):  RAM config != NVM SET.
307626.144 : GenB( 0):  IIN user attitude performance SET.
307626.144 : GenB( 1):  IIN user heading performance SET.
307626.144 : GenB( 2):  IIN user position performance SET.
307626.144 : GenB( 3):  IIN user velocity performance SET.
307626.144 : GenB( 8):  GAMS installation parameters valid SET.
307626.144 : GenB( 9):  GAMS solution in use SET.
307626.144 : GenB(10):  GAMS solution OK SET.
307626.144 : GenB(16):  Primary GPS configuration file sent SET.
307626.144 : GenB(18):  Primary GPS in CA mode SET.
307626.144 : GenB(23):  Primary GPS observables in use SET.
307626.144 : GenB(24):  GAMS secondary GPS observables in use SET.
307626.144 : GenC( 6):  RTCM Type 1 or 9 in use SET.
307626.144 : GenC(13):  IIN in RTCM DGPS aided mode SET.
307626.144 : FDIR1(13): Ephemeris missing SET.
------------------------------------------------------------------------------
307626.144 : The First Group 99: Versions & Statistics
   System Version:
     Product-Model: MV-320; Version: VER4; Serial Number: S/N3189;
     Hardware Version: HW3.3-7;
     Software Release Version-Date: SW05.03-Mar10/10;
     ICD release version: ICD04.02;
     Operating System Version: OS425B14;
     IMU Type: IMU2; Primary GPS Type: PGPS13; Secondary GPS Type: SGPS13;
     Option mnemonic-Expiry Time: DMI0;
     Option mnemonic-Expiry Time: GIM0;
     Option mnemonic-Expiry Time: RTK-0;
     Option mnemonic-Expiry Time: THV-0;
     Option mnemonic-Expiry Time: DPW-0;
   Primary GPS Version: BD950    SN:4808A98939, v.00232, channels:24;
   Secondary GPS Version: BD950  SN:4642A73565, v.00232, channels:24;
   Total Hours          :    789.9; Number of Runs:     66
   Average Length of Run:   12.0; Longest Run:   84.0; Current Run:   12.2;
------------------------------------------------------------------------------
307626.144 : Diffcorr2 time1 gap: start 0.0, end 307626.1439
```

```
--------------------------------------------------------------------------------
307633.139 : Message 50: Transition to NAVIGATE mode.
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 37: Base 1 setup
   Input data type expected: RTCM 1 or 9
   Datum Type: NAD83
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 38: Base 2 setup
   Input data type expected: RTCM 1 or 9
   Datum Type: WGS84
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 20: General parameters
   Time and distance tag types:          2  1
   Autostart selection:                   ENABLED
   Reference-IMU lever arm:              -0.008  -0.031  0.130
   Reference-primary GPS lever arm:      1.929  -11.199  -13.076
   Reference-auxiliary 1 GPS lever arm:  0.000  0.000  0.000
   Reference-auxiliary 2 GPS lever arm:  0.000  0.000  0.000
   Reference-IMU mounting angles:        0.000  0.000  0.000
   Reference-vehicle mounting angles:    0.000  0.000  0.000
   Multipath environment:                 LOW
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 24: User accuracy parameters
   User position accuracy:       2.00
   User velocity accuracy:       0.50
   User attitude accuracy:       0.05
   User heading accuracy:        0.05
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 106: Heave ratios
   Heave Bandwidth (sec):  12.000
   Heave Damping Ratio:  0.707
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 120: Heave and sensor 1&2 install parameters
   Reference-Sensor1 alignment angles (R,P,Y) in degrees:  0.000  0.000  0.000
   Reference-Sensor2 alignment angles (R,P,Y) in degrees:  0.000  0.000  0.000
   Reference-Sensor1 lever arm in meters:                  0.000  0.000  0.000
   Reference-Sensor2 lever arm in meters:                  0.000  0.000  0.000
   Reference-Centre of Rotation in meters:                 0.000  0.000  0.000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 121: Vessel Installation Parameters
   Reference-Vessel in meters:                             0.00  0.00  0.00
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 32: PCS IP address
   IP Address (Network part 1): 129
   IP Address (Network part 2): 100
   IP Address (Host part 1):    1
   IP Address (Host part 2):    231
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 56: General data
   Initial status:     COARSE_LEVEL
   Initial position:   30.339738973 -88.576114608 -17.526
   Initial distance:   0.00
   Initial attitude:   0.000 0.000 0.000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
307633.139 : Message 21: GAMS install parameters
   A-B antenna separation:        8.122
   A-B baseline vector:           0.170 8.120 -0.003
   Heading error for calibration: 0.50
   A-B azimuth correction:        0.000
--------------------------------------------------------------------------------
```

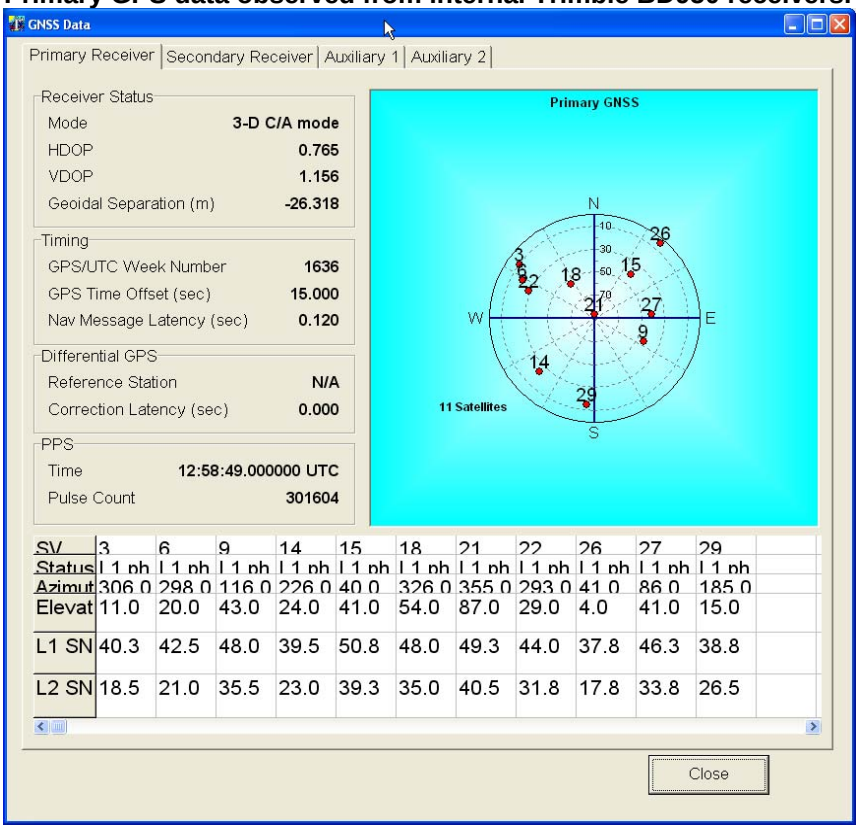

Lever Arms & Mounting Angles
Lever Arms & Mounting Angles
Sensor Mounting
Tags, Multipath & AutoStart
Ref. to IMU Lever Arm
X (m) 0
Y (m) 0
Z (m) 0
IMU Frame w.r.t. Ref. Frame
X (deg) 0
Y (deg) 0
Z (deg) 0
Ref. to Primary GPS Lever Arm
X (m) 1.929
Y (m) -11.199
Z (m) -13.076
Ref. to Vessel Lever Arm
X (m) 0
Y (m) 0
Z (m) 0
Notes:
1. Ref. = Reference
2. w.r.t. = With Respect To
3. Reference Frame and Vessel Frame are co-aligned
Ref. to Centre of Rotation Lever Arm
X (m) 0
Y (m) 0
Z (m) 0
Ok
Close
Apply
View



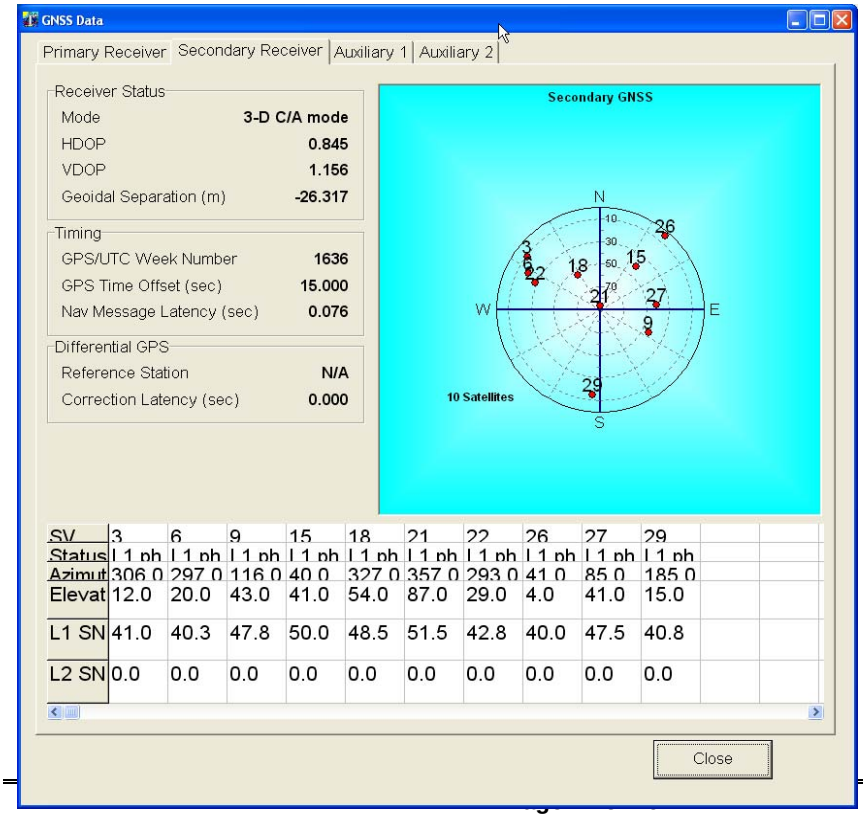
Observed GAMS values derived from the field calibration:
STRB GAMS Cal #1



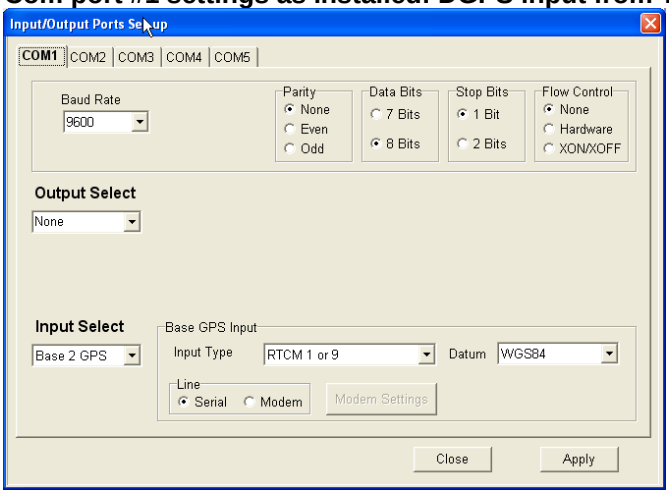
Primary GPS data observed from internal Trimble BD950 receivers.



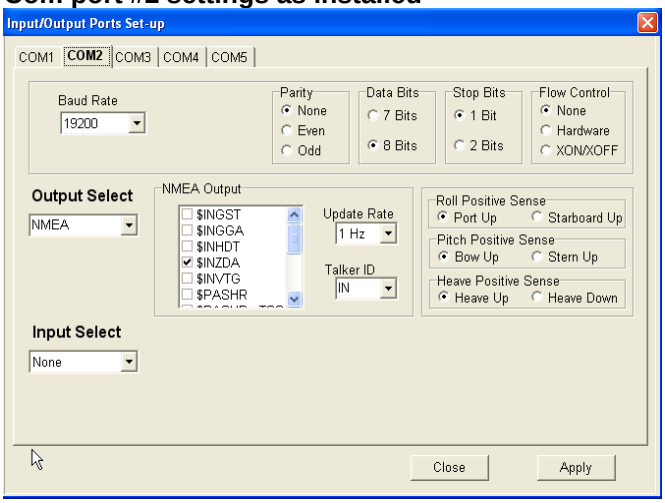
Secondary embedded GPS data:



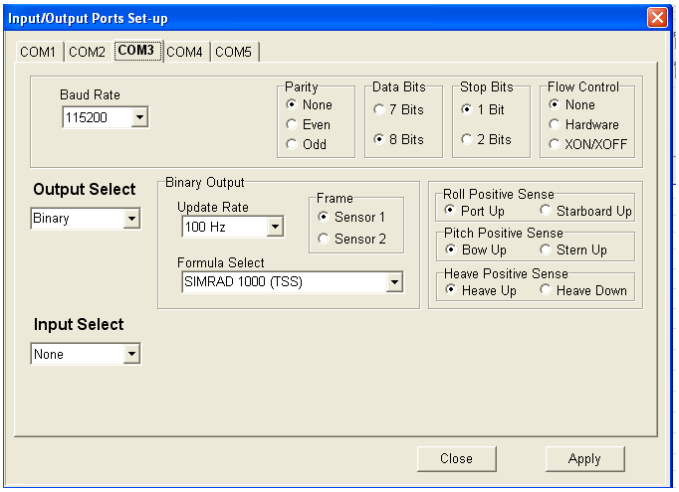
Com port #1 settings as installed: DGPS input from Trimble SPS Receiver.



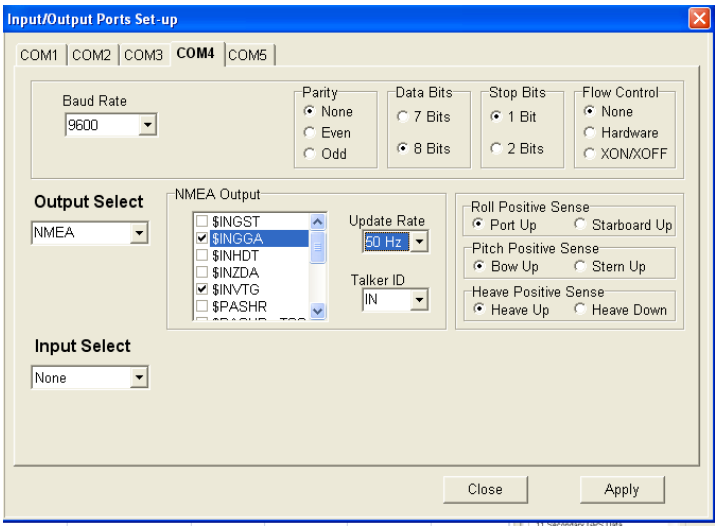
Com port #2 settings as installed



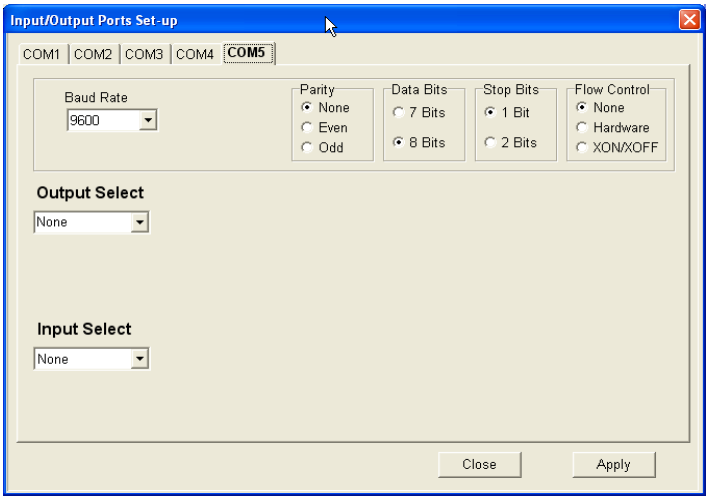
Com port #3 settings as installed:



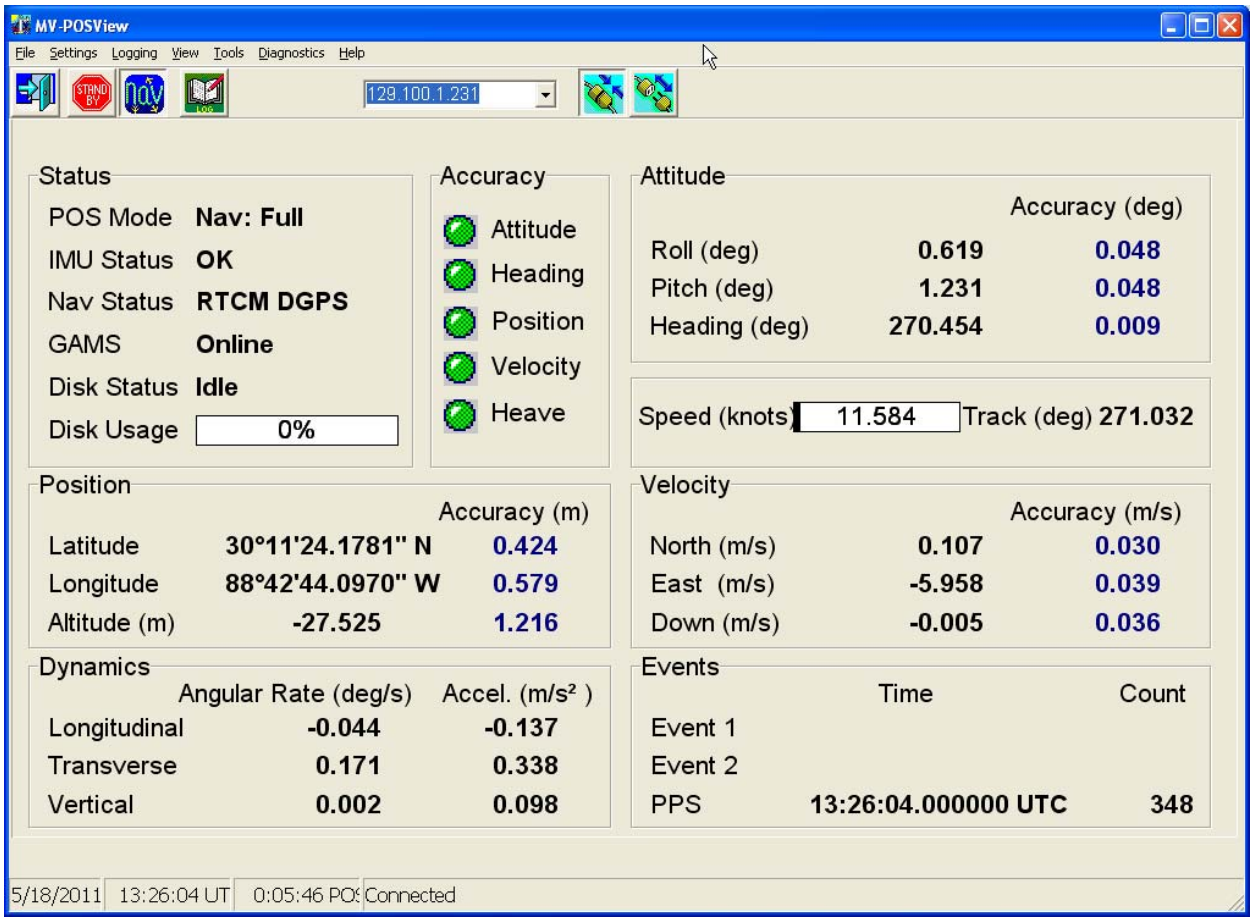
Com port #4 settings as installed:



Com port #5 settings as installed



STRB POSMV Final Navigation



STRB side antenna and IMU mounting:

STRB IMU Mount

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Certificate of Compliance

This document certifies that the system below meets the stated requirements.

Product	**MV V5**
Model	**320**
Sales Order #	**SO-010674**

Hardware Item	Part No	Serial No
POS	**SAMVPCS02RM**	**5806**
IMU TOP HAT	**10004878**	**2423_423310**

Requirement: **µPOS SA System Acceptance Test #PRO-WI-000094**

Result: **Passed**

Authorised signature: _____

Date: June 26. 2013

85 Leek Crescent Richmond Hill, Ontario Canada L4B 3B3
Tel: (905) 709-4600 **Fax:** (905) 709-6027 **Web:** www.applanix.com

applanix
A TRIMBLE COMPANY

Certificate of Compliance

This document certifies that the system below meets the stated requirements.

Product	**MV V5**
Model	**320**
Sales Order #	**SO-010674**

Hardware Item	Part No	Serial No
POS	**SAMVPCS02RM**	**5807**
IMU TOP HAT	**10004878**	**2424_424204**

Requirement: **µPOS SA System Acceptance Test #PRO-WI-000094**

Result: **Passed**

Authorised signature: _____

Date: June 26. 2013

85 Leek Crescent Richmond Hill, Ontario Canada L4B 3B3
Tel: (905) 709-4600 **Fax:** (905) 709-6027 **Web:** www.applanix.com

NOAA POS/MV Calibration Report

Fill out all fields! See previous years as an example.

Yellow areas require screen grabs!

Ship: Ferdinand R. Hassler **Vessel:** S250

Date: 6/26/2013 **Dn:** 177

Personnel: Adler, Reed, Mortimer, Moehl

PCS Serial # 3187 **IMU Serial #** 804

IP Address: 129.100.1.232

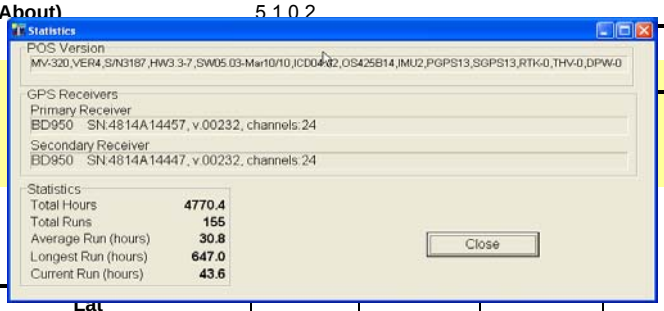
POS controller Version (Use Menu Help > About) 5.1.0.2

POS Version (Use Menu View > Statistics)

GPS Receivers

Primary Receiver Serial #:

Secondary Receiver Serial #:



Calibration area

Location: East of Cape Charles

Approximate Position:

Lat			
Lon			

DGPS Beacon Station: Driver, VA **DGPS Receiver Serial#:** MBX-4

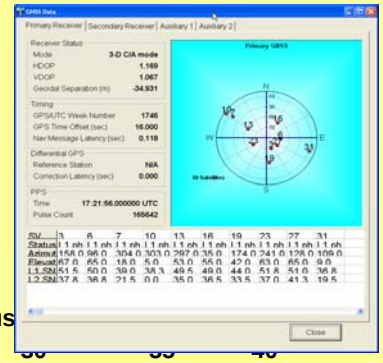
Frequency: 289kHz

Satellite Constellation

(Use View> GPS Data)

Primary GPS

Insert screen grabs



HDOP

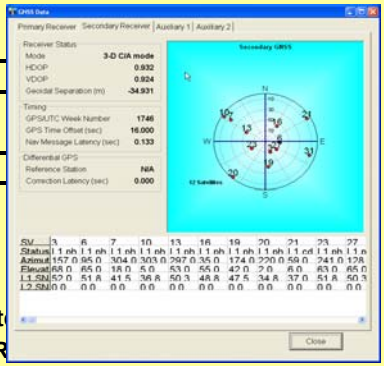
VDOP

Sattelites in us

L1 SNR >

Secondary GPS

Note any differences from Primary GPS Receiver



HDOP

VDOP

Sattelit

L1 SNR

PDOP 1.741

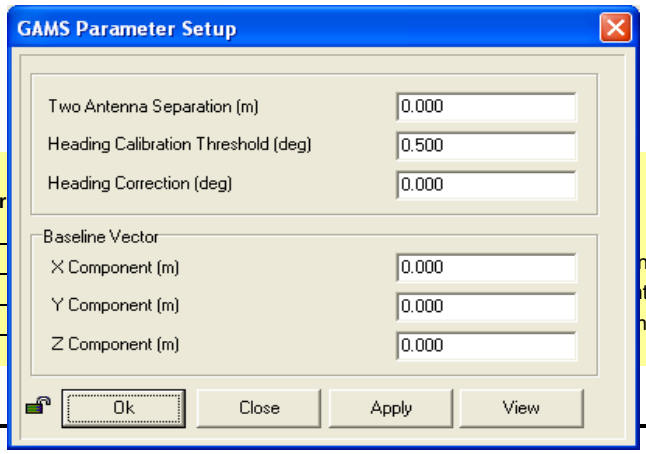
3.352

(Use View> GAMS Solution)

POS/MV Configuration

Settings

Gams Parameter Setup



User Entr

nt (m)

t (m)

nt (m)

Configuration Notes:

POS/MV Calibration

Calibration Procedure:

(Refer to POS MV V4 Installation and Operation Guide, 4-25)

Start time: _____
End time: _____
Heading accuracy achieved for calibration: _____

Calibration Results:

Gams Parameter Setup (Use Settings > Installation > GAMS Intallation)

POS/MV Post-Calibration Values

		Baseline Vector	
	Two Antenna Separation (m)		X Component (m)
	Heading Calibration Threshold		YComponent (m)
	Heading Correction		Z Component (m)

GAMS Status Online _____
Save Settings _____

Calibration Notes: _____

Save POS Settings on PC (Use File > Store POS Settings on PC)
File Name: _____

General Notes:

The POS/MV uses a Right-Hand Orthogonal Reference System

The right-hand orthogonal system defines the following:

- The x-axis is in the fore-aft direction in the appropriate reference frame.
- The y-axis is perpendicular to the x-axis and points towards the right (starboard) side in the appropriate reference frame.
- The z-axis points downwards in the appropriate reference frame.

The POS/MV uses a Tate-Bryant Rotation Sequence

Apply the rotation in the following order to bring the two frames of reference into complete alignment:

a) Heading rotation - apply a right-hand screw rotation θz about the z-axis to align one frame with the other.

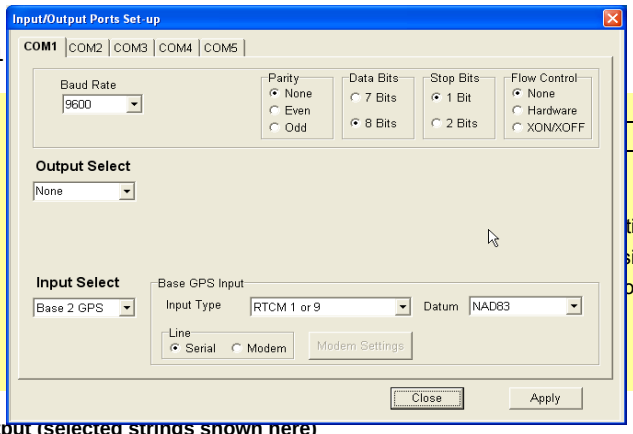
b) Pitch rotation - apply a right-hand screw rotation θy about the once-rotated y-axis to align one frame with the other.

c) Roll rotation - apply a right-hand screw rotation θx about the twice-rotated x-axis to align one frame with the other.

SETTINGS

Input/Output Ports

COM1

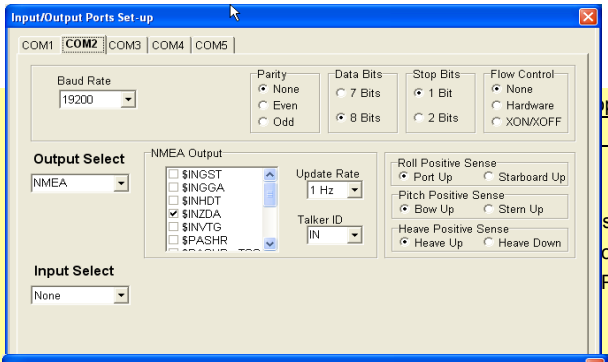


tive Sense
itive Sense
ositive Sense

NMEA Output (selected strings shown here)

	$INVTG		$PASHR TB		$INZDA
	$INGST		$PASHR TSS		$INGGK
	$INGGA		$PRDID TB		$UTC
	$INHDT		$PRDID TSS		

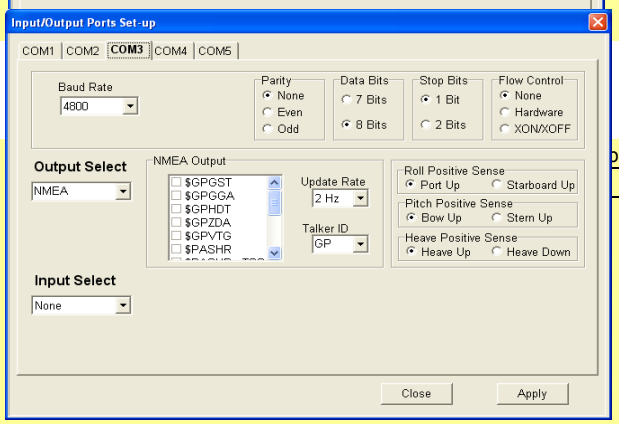
COM2



p

itive Sense
ositive Sense
Positive Sense

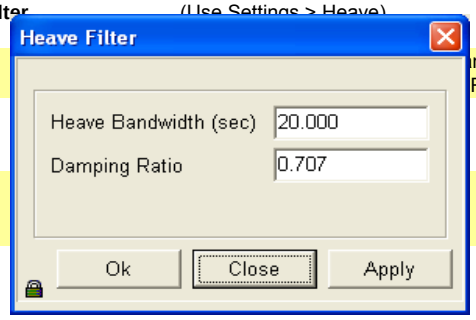
COM3

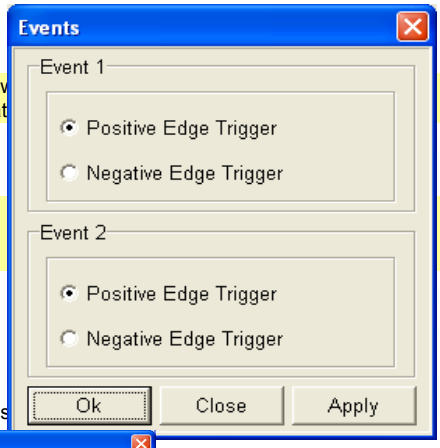


p

SETTINGS Continued

Heave Filter (Use Settings > Heave)





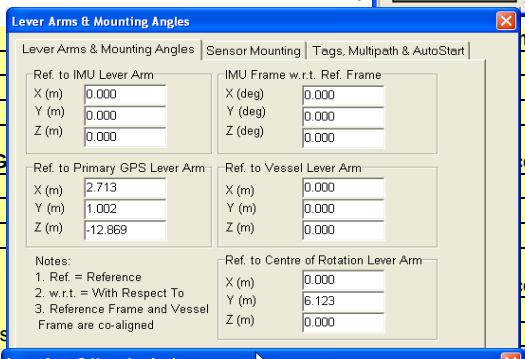
Events

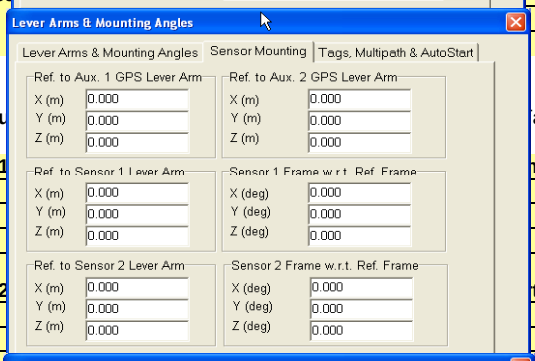
1

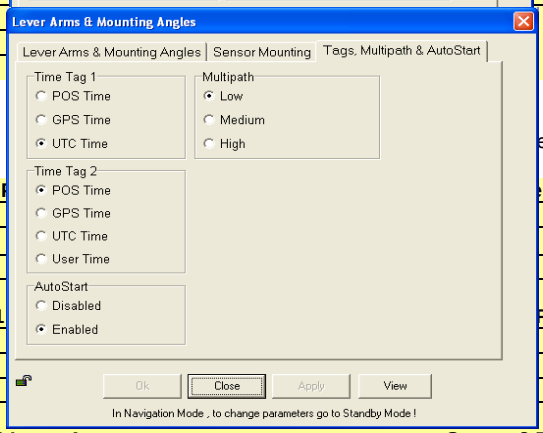
2

INSTALLATION (Use Settings > Installation)

Lever Arms and Mounting Angles (Use Settings







Reference frame and ves

Tags, Multipath and Au (Tags, Multipath and Auto Start)

Time Tag 1

Low
Medium
High

Time Tag 2

Disabled
Enabled

Sensor Mounting (Sensor Mounting)

Reference to Aux. 1 GP **to Aux. 2 GPS Lever Arm**

X (m)
Y (m)
Z (m)

Reference to Sensor 1 **Frame w.r.t. Reference Frame**

X (deg)
Y (deg)
Z (deg)

Reference to Sensor 2 Lever Arm

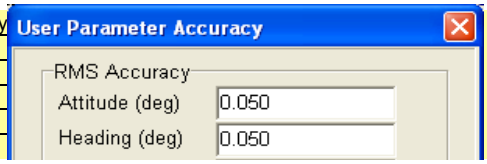
X (m)
Y (m)
Z (m)

Sensor 2 Frame w.r.t. Reference Frame

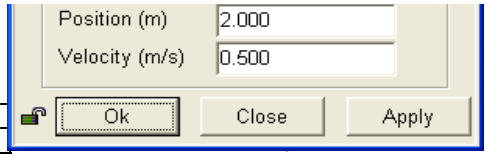
X (deg)
Y (deg)
Z (deg)

User Parameter Accuracy (Use Settings > Installation > User Accuracy)

RMS Accuracy



Frame Control



Use GAMS enabled

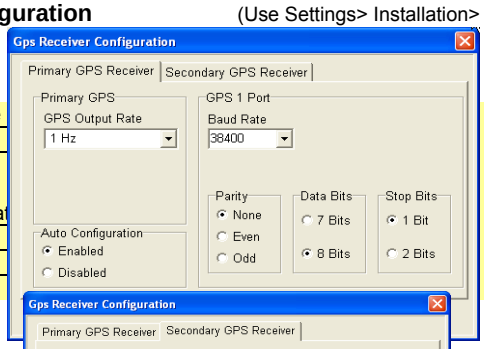
GPS Receiver Configuration

(Use Settings> Installation> GPS Receiver Configuration)

Primary GPS Receiver

Baud Rate

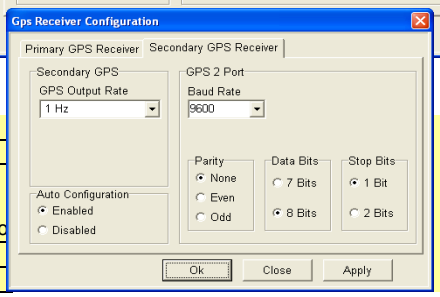
Auto Configurat



Secondary GPS Receiver

Baud Rate

Auto Configuratio



The GAMS calibration was run on the fly before acquisition began with the new POS-MV V5's. Due to the on-the-fly nature; the usual HSRR form was not completely filled out. However, all relevant information was recorded by the watch stander at the time of acquisition.

Date: 7/30/2013 Dn: 211

Personnel: Adler, Moehl, Kist

Location: Approaches to Chesapeake, outside south channel

PDOP = 1.6 Heading accuracy achieved: 0.245

All other settings were set up as before on the POS-MV V4.

NOAA POS/MV Calibration Report

Fill out all fields! See previous years as an example.

Yellow areas require screen grabs!

Ship: Ferdinand R. Hassler **Vessel:** S250

Date: 6/26/2013 **Dn:** 177

Personnel: Adler, Reed, Mortimer, Moehl

PCS Serial # 3189 **IMU Serial #** 803

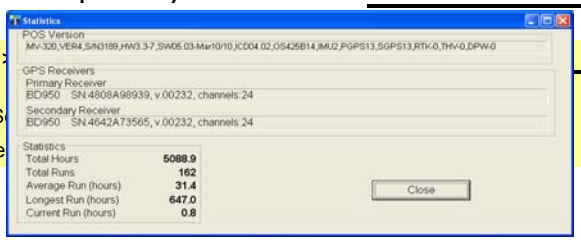
IP Address: 129.100.1.231

POS controller Version (Use Menu Help > About) 5.1.0.2

POS Version (Use Menu View >
GPS Receivers

Primary Receiver S

Secondary Receive



Calibration area

Location: East of Cape Charles

Approximate Position: **Lat** **Lon**

DGPS Beacon Station: Driver, VA **DGPS Receiver Serial#:** MBX-4

Frequency: 289kHz

Satellite Constellation

(Use View> GPS Data)

Primary GPS

Insert screen grabs

Secondary GPS

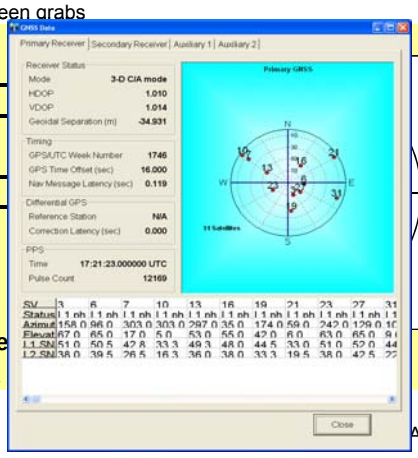
Note any differences from Primary GPS Receiver

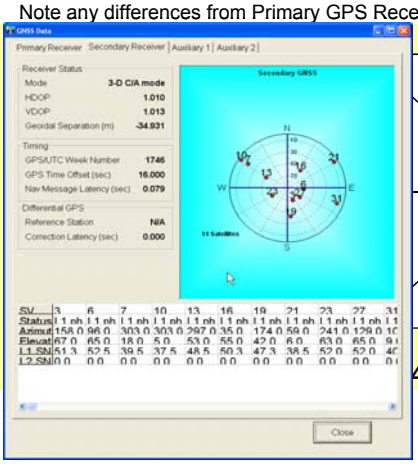
HDOP

VDOP

Sattelite

L1 SNR





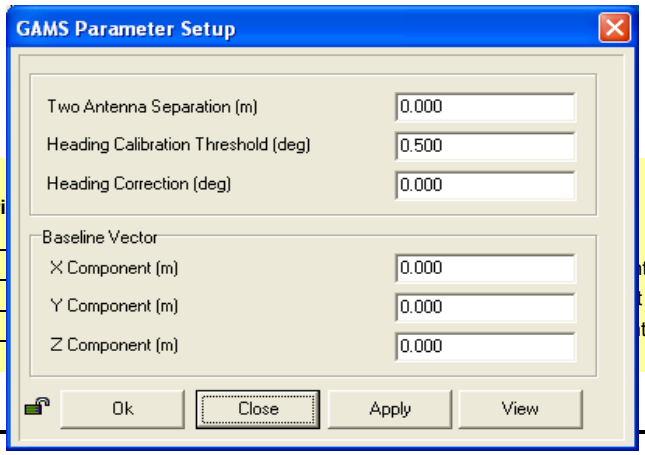
40

PDOP AMS Solution)

POS/MV Configuration

Settings

Gams Parameter Setup



User Entri

t (m)

t (m)

t (m)

Configuration Notes:

POS/MV Calibration

Calibration Procedure: (Refer to POS MV V4 Installation and Operation Guide, 4-25)

Start time: 1938.3
End time:
Heading accuracy achieved for calibration: 0.22

Calibration Results:

Gams Parameter Setup (Use Settings > Installation > GAMS Intallation)

POS/MV Post-Calibration Values

		Baseline Vector	
	Two Antenna Separation (m)		X Component (m)
	Heading Calibration Threshold		YComponent (m)
	Heading Correction		Z Component (m)

GAMS Status Online
Save Settings

Calibration Notes:

Save POS Settings on PC (Use File > Store POS Settings on PC)
File Name:

General Notes:

The POS/MV uses a Right-Hand Orthogonal Reference System

The right-hand orthogonal system defines the following:

- The x-axis is in the fore-aft direction in the appropriate reference frame.
- The y-axis is perpendicular to the x-axis and points towards the right (starboard) side in the appropriate reference frame.
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The POS/MV uses a Tate-Bryant Rotation Sequence

Apply the rotation in the following order to bring the two frames of reference into complete alignment:

a) Heading rotation - apply a right-hand screw rotation θz about the z-axis to align one frame with the other.

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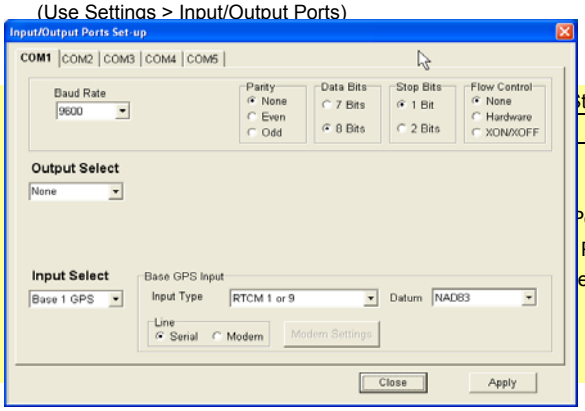
c) Roll rotation - apply a right-hand screw rotation θx about the twice-rotated x-axis to align one frame with the other.

SETTINGS

Input/Output Ports (Use Settings > Input/Output Ports)

COM1



top

Positive Sense

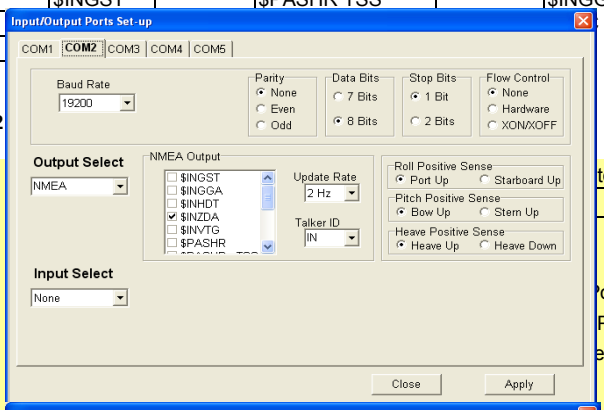
Positive Sense

e Positive Sense

NMEA Output (selected strings shown here)

	$INVTG		$PASHR TB		$INZDA
	$INGST		$PASHR TSS		$INGGK

COM2



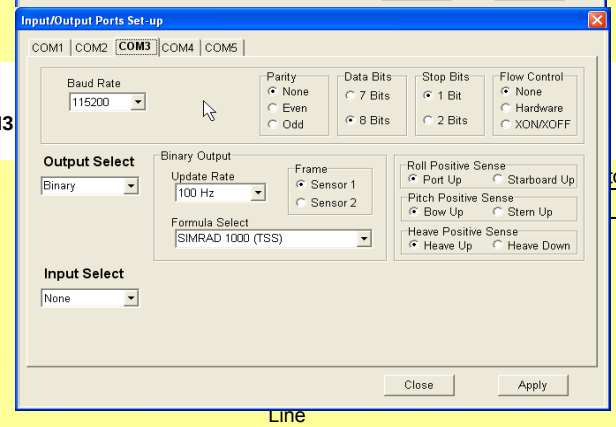
top

Positive Sense

Positive Sense

e Positive Sense

COM3

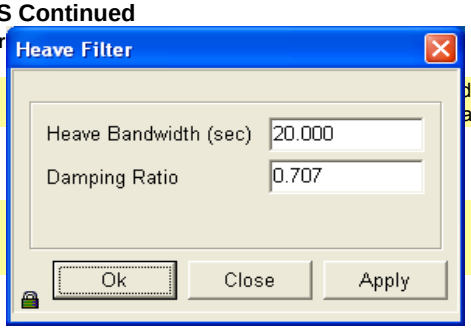


top

Line

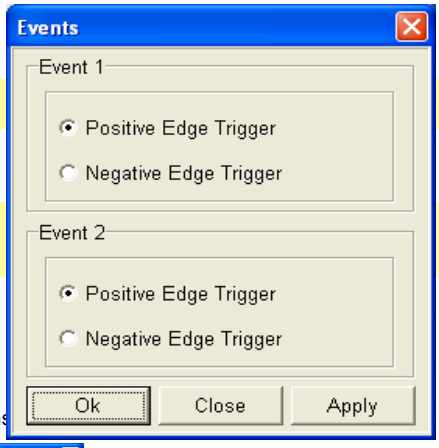
SETTINGS Continued

Heave Filter



dwidth
atio

Events

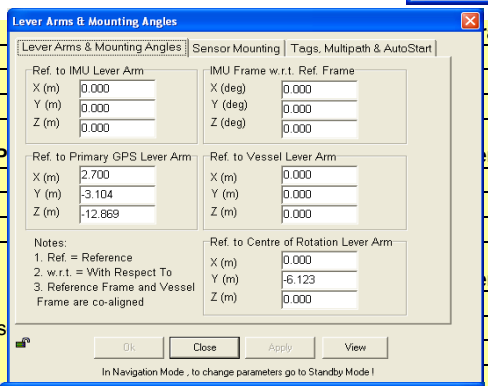


1

2

INSTALLATION (Use Settings > Installation)

Lever Arms and Mounting Angles (Use Settings > Ins



Reference to IMU

ame w.r.t Reference Frame

X (deg)
Y (deg)
Z (deg)

Reference to Primary GP

nce to Primary Vessel Lever Arm

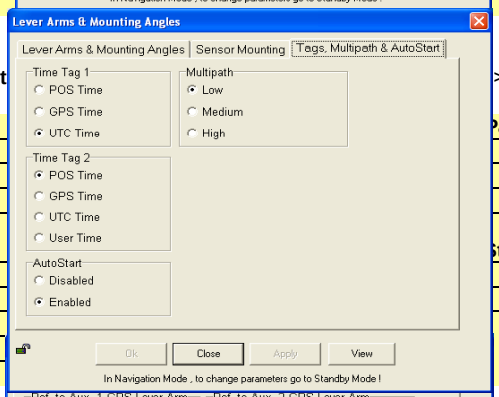
X (m)
Y (m)
Z (m)

nce to Centre of Rotation Lever Arm

X (m)
Y (m)
Z (m)

Reference frame and vess

Tags, Multipath and Aut > Tags, Multipath and Auto Start)



Time Tag 1

Time Tag 2

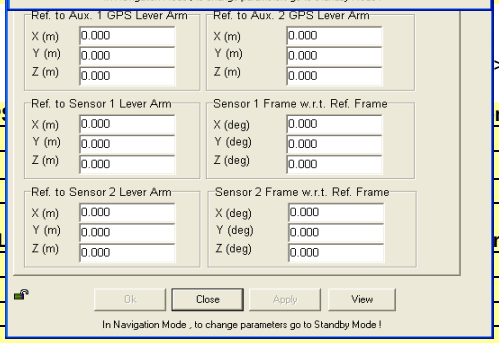
Path

Low
Medium
High

tart

Disabled
Enabled

Sensor Mounting > Sensor Mounting)



Reference to Aux. 1 GP

nce to Aux. 2 GPS Lever Arm

X (m)
Y (m)
Z (m)

Reference to Sensor 1 L

r 1 Frame w.r.t. Reference Frame

X (deg)
Y (deg)
Z (deg)

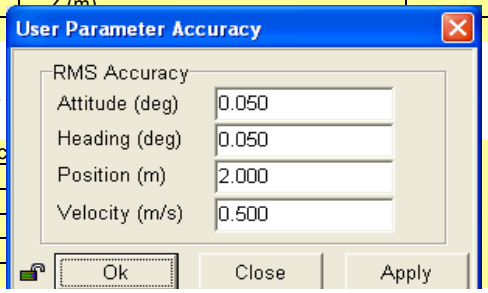
Reference to Sensor 2 Lever Arm

X (m)
Y (m)
Z (m)

Sensor 2 Frame w.r.t. Reference Frame

X (deg)
Y (deg)
Z (deg)

User Parameter Accuracy User Accuracy)



RMS Accurac

Frame Control (Use Tools > Config)

	User Frame	Primary GPS Measurement	
	IMU Frame	Auxiliary GPS Measurement	

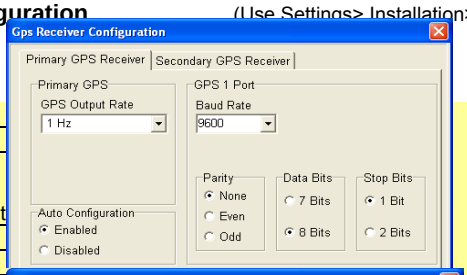
Use GAMS enabled

GPS Receiver Configuration (Use Settings> Installation> GPS Receiver Configuration)

Primary GPS Receiver

Baud Rate

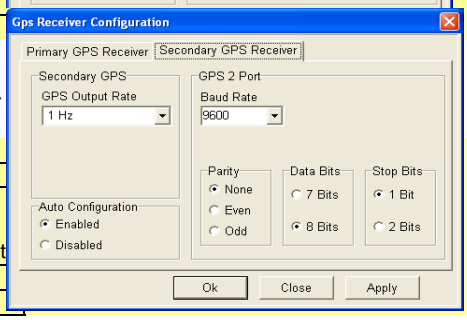
Auto Configurat



Secondary GPS Receiver

Baud Rate

Auto Configurat



The GAMS calibration was run on the fly before acquisition began with the new POS-MV V5's. Due to the on-the-fly nature; the usual HSRR form was not completely filled out. However, all relevant information was recorded by the watch stander at the time of acquisition.

Date: 7/30/2013 Dn: 211

Personnel: Adler, Moehl, Kist

Location: Approaches to Chesapeake, outside south channel

PDOP = 1.6 Heading accuracy achieved: 0.245

All other settings were set up as before on the POS-MV V4.

Appendix IV

Sound Speed Sensor Reports

Certificate of Conformity

Customer:	NOAA - Marine Operations Center Atlantic
AML Reference Number:	Sales Order #32448
Customer PO Number:	EE1338M13SU0888
Asset Serial Number:	008609
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Housing Depth Rating:	1000 dbar / meters
Additional Description:	

Certification Date (dd/mm/yyyy): 5/9/2013

Certified By:

Robert Haydock
President
AML Oceanographic

AML Oceanographic certifies that the equipment described above has been tested in accordance with the product's technical specifications, brochures and / or relevant drawings. Housing depth rating refers to the maximum deployment depth of this instrument; on-board sensors may further restrict this range. AML Oceanographic certifies that calibrations on this instrument have been completed with equipment referenced to traceable standards.

Instrument configuration files and soft copy certificates are available at our on-line Customer Centre at www.AMLoceanographic.com/support

AML Oceanographic
2071 Malaview Avenue, Sidney B.C. V8L 5X6 CANADA
T: +1-250-656-0771 F: +1-250-655-3655 Email: service@AMLoceanographic.com

Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008609
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Temperature
Calibration Range:	-2 to +45 Deg C
Calibration RMS Error:	.0006
Calibration ID:	008609 006895 400672 040913 130959
Installed On:	

Coefficient A:	-1.616296E+1	Coefficient H:	0.000000E+0
Coefficient B:	1.684108E-3	Coefficient I:	0.000000E+0
Coefficient C:	-3.748911E-8	Coefficient J:	0.000000E+0
Coefficient D:	9.902842E-13	Coefficient K:	0.000000E+0
Coefficient E:	-1.609277E-17	Coefficient L:	0.000000E+0
Coefficient F:	1.519287E-22	Coefficient M:	0.000000E+0
Coefficient G:	-5.513578E-28	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 4/9/2013

Certified By:

Robert Haydock

President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. Please note that Xchange™ sensor-heads may be installed on assets other than the one listed above; this calibration certificate will still be valid when used on other such assets. If this instrument or sensor has been recalibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary. Older generation instruments may require configuration files, which are available for download at our Customer Centre at www.AMLoceanographic.com/support

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Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008609
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Pressure
Calibration Range:	1000dbar
Calibration RMS Error:	.0402
Calibration ID:	008609 005117 008610 280813 113307
Installed On:	

Coefficient A:	-1.231444E+2	Coefficient H:	0.000000E+0
Coefficient B:	0.000000E+0	Coefficient I:	2.299408E-9
Coefficient C:	0.000000E+0	Coefficient J:	0.000000E+0
Coefficient D:	0.000000E+0	Coefficient K:	0.000000E+0
Coefficient E:	1.899598E-2	Coefficient L:	0.000000E+0
Coefficient F:	0.000000E+0	Coefficient M:	-3.129018E-14
Coefficient G:	0.000000E+0	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 28/8/2013

Certified By:

Robert Haydock

President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. Please note that Xchange™ sensor-heads may be installed on assets other than the one listed above; this calibration certificate will still be valid when used on other such assets. If this instrument or sensor has been recalibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary. Older generation instruments may require configuration files, which are available for download at our Customer Centre at www.AMLoceanographic.com/support

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Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008609
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Conductivity
Calibration Range:	0 to 79 mS/cm
Calibration RMS Error:	.0024
Calibration ID:	008609 006895 500349 040913 130959
Installed On:	

Coefficient A:	-9.799962E-3	Coefficient H:	-3.388081E-14
Coefficient B:	5.996294E-7	Coefficient I:	0.000000E+0
Coefficient C:	-4.226755E-9	Coefficient J:	0.000000E+0
Coefficient D:	1.053693E-11	Coefficient K:	0.000000E+0
Coefficient E:	3.151113E-5	Coefficient L:	0.000000E+0
Coefficient F:	-1.928069E-9	Coefficient M:	0.000000E+0
Coefficient G:	1.359085E-11	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 4/9/2013

Certified By:

Robert Haydock

President, AML Oceanographic

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Certificate of Conformity

Customer:	NOAA - Marine Operations Center Atlantic
AML Reference Number:	Sales Order #32448
Customer PO Number:	EE1338M13SU0888
Asset Serial Number:	008610
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Housing Depth Rating:	1000 dbar / meters
Additional Description:	

Certification Date (dd/mm/yyyy): 5/9/2013

Certified By:

Robert Haydock
President
AML Oceanographic

AML Oceanographic certifies that the equipment described above has been tested in accordance with the product's technical specifications, brochures and / or relevant drawings. Housing depth rating refers to the maximum deployment depth of this instrument; on-board sensors may further restrict this range. AML Oceanographic certifies that calibrations on this instrument have been completed with equipment referenced to traceable standards.

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T: +1-250-656-0771 F: +1-250-655-3655 Email: service@AMLoceanographic.com

Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008610
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Temperature
Calibration Range:	-2 to +45 Deg C
Calibration RMS Error:	.0012
Calibration ID:	008610 006891 400000 040913 130945
Installed On:	008610

Coefficient A:	-1.602931E+1	Coefficient H:	0.000000E+0
Coefficient B:	1.641995E-3	Coefficient I:	0.000000E+0
Coefficient C:	-3.434131E-8	Coefficient J:	0.000000E+0
Coefficient D:	8.412781E-13	Coefficient K:	0.000000E+0
Coefficient E:	-1.220503E-17	Coefficient L:	0.000000E+0
Coefficient F:	9.987001E-23	Coefficient M:	0.000000E+0
Coefficient G:	-2.737331E-28	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 4/9/2013

Certified By:

Robert Haydock

President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. Please note that Xchange™ sensor-heads may be installed on assets other than the one listed above; this calibration certificate will still be valid when used on other such assets. If this instrument or sensor has been recalibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary. Older generation instruments may require configuration files, which are available for download at our Customer Centre at www.AMLoceanographic.com/support

AML Oceanographic
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Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008610
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Pressure
Calibration Range:	1000 dBar
Calibration RMS Error:	.0737
Calibration ID:	008610 005117 008610 280813 113343
Installed On:	008610

Coefficient A:	-1.255179E+2	Coefficient H:	0.000000E+0
Coefficient B:	0.000000E+0	Coefficient I:	-3.600100E-9
Coefficient C:	0.000000E+0	Coefficient J:	0.000000E+0
Coefficient D:	0.000000E+0	Coefficient K:	0.000000E+0
Coefficient E:	1.919673E-2	Coefficient L:	0.000000E+0
Coefficient F:	0.000000E+0	Coefficient M:	1.790184E-14
Coefficient G:	0.000000E+0	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 28/8/2013

Certified By:

Robert Haydock

President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. Please note that Xchange™ sensor-heads may be installed on assets other than the one listed above; this calibration certificate will still be valid when used on other such assets. If this instrument or sensor has been recalibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary. Older generation instruments may require configuration files, which are available for download at our Customer Centre at www.AMLoceanographic.com/support

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Certificate of Calibration

Customer:	NOAA - Marine Operations Center Atlantic
Asset Serial Number:	008610
Asset Product Type:	Micro CTD, Titanium, MVP, with Extended Temp & Cond Range
Calibration Type:	Conductivity
Calibration Range:	0 to 79 mS/cm
Calibration RMS Error:	.0034
Calibration ID:	008610 006891 500346 040913 130945
Installed On:	008610

Coefficient A:	-9.621067E-3	Coefficient H:	-6.139943E-15
Coefficient B:	3.672003E-7	Coefficient I:	0.000000E+0
Coefficient C:	-1.561394E-9	Coefficient J:	0.000000E+0
Coefficient D:	1.934082E-12	Coefficient K:	0.000000E+0
Coefficient E:	3.054307E-5	Coefficient L:	0.000000E+0
Coefficient F:	-1.165715E-9	Coefficient M:	0.000000E+0
Coefficient G:	4.956807E-12	Coefficient N:	0.000000E+0

Calibration Date (dd/mm/yyyy): 4/9/2013

Certified By:

Robert Haydock

President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. Please note that Xchange™ sensor-heads may be installed on assets other than the one listed above; this calibration certificate will still be valid when used on other such assets. If this instrument or sensor has been recalibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary. Older generation instruments may require configuration files, which are available for download at our Customer Centre at www.AMLoceanographic.com/support

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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:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P32914-4480

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: 2/21/2013 **Drift since last cal:** +0.00010 **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.

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SENSOR SERIAL NUMBER: 4480
CALIBRATION DATE: 21-Feb-13

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

COEFFICIENTS:

```
g = -9.840920e-001
h =  1.354693e-001
i = -2.445297e-004
j =  3.737361e-005

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

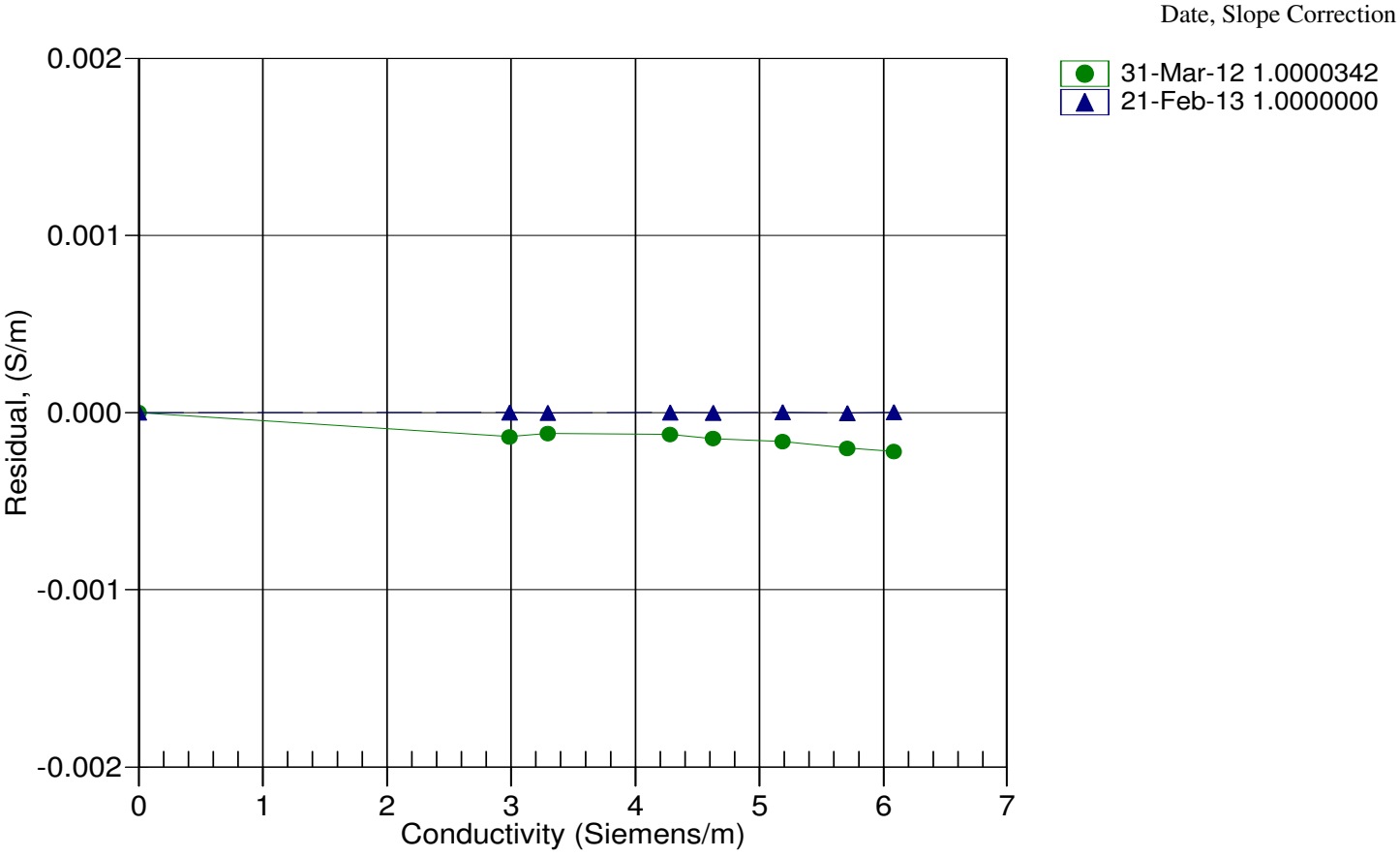
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2699.11	0.0000	0.00000
1.0000	34.9500	2.98630	5418.29	2.9863	0.00000
4.5000	34.9237	3.29386	5623.54	3.2939	-0.00000
15.0000	34.8770	4.27827	6234.39	4.2783	0.00000
18.5000	34.8674	4.62441	6435.10	4.6244	-0.00000
24.0000	34.8569	5.18400	6746.63	5.1840	0.00000
29.0000	34.8509	5.70735	7025.12	5.7073	-0.00000
32.4999	34.8470	6.08073	7217.03	6.0807	0.00000

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



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SENSOR SERIAL NUMBER: 4480
CALIBRATION DATE: 20-Feb-13

SBE19plus PRESSURE CALIBRATION DATA
5076 psia S/N 3336

COEFFICIENTS:

PA0 =	1.128466e+000	PTCA0 =	5.242175e+005
PA1 =	1.569411e-002	PTCA1 =	1.632429e+000
PA2 =	-6.760475e-010	PTCA2 =	8.402568e-002
PTEMPA0 =	-6.692981e+001	PTCB0 =	2.508287e+001
PTEMPA1 =	5.114088e+001	PTCB1 =	-2.500000e-005
PTEMPA2 =	-4.158643e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.62	525154.0	1.7	14.70	0.00
1026.89	589823.4	1.7	1026.73	-0.00
2039.27	654881.4	1.8	2039.15	-0.00
3051.44	720307.0	1.8	3051.52	0.00
4063.30	786079.0	1.8	4063.41	0.00
5075.05	852207.2	1.8	5074.89	-0.00
4063.27	786078.2	1.8	4063.40	0.00
3051.05	720281.5	1.8	3051.12	0.00
2038.97	654864.8	1.8	2038.88	-0.00
1026.65	589818.8	1.8	1026.65	0.00
14.62	525154.7	1.8	14.69	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.98	525242.95
29.00	1.91	525217.54
24.00	1.80	525186.78
18.50	1.69	525159.19
15.00	1.62	525144.39
4.50	1.41	525110.03
1.00	1.34	525101.18

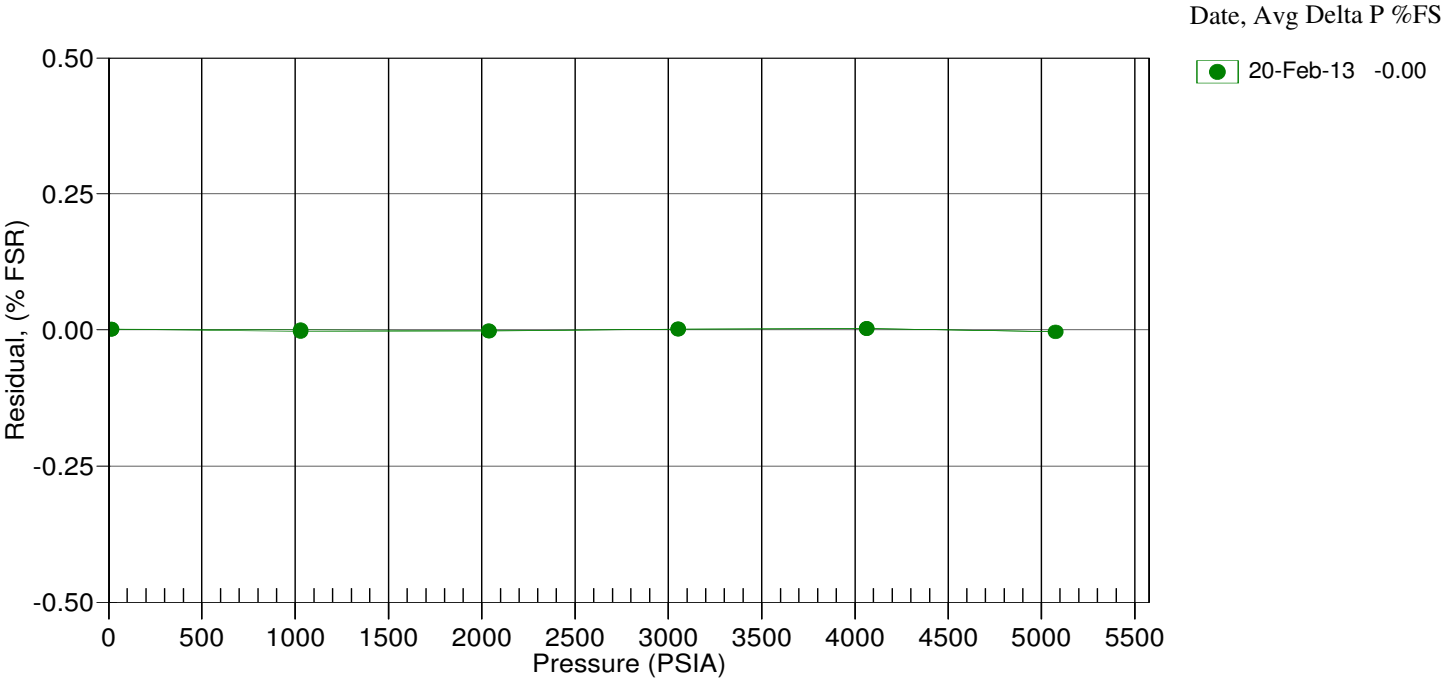
TEMP(ITS90)	SPAN(mV)
-5.00	25.08
35.00	25.08

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.

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SENSOR SERIAL NUMBER: 4480
CALIBRATION DATE: 21-Feb-13

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.261198e-003
a1 = 2.596548e-004
a2 = 3.906321e-007
a3 = 1.341833e-007

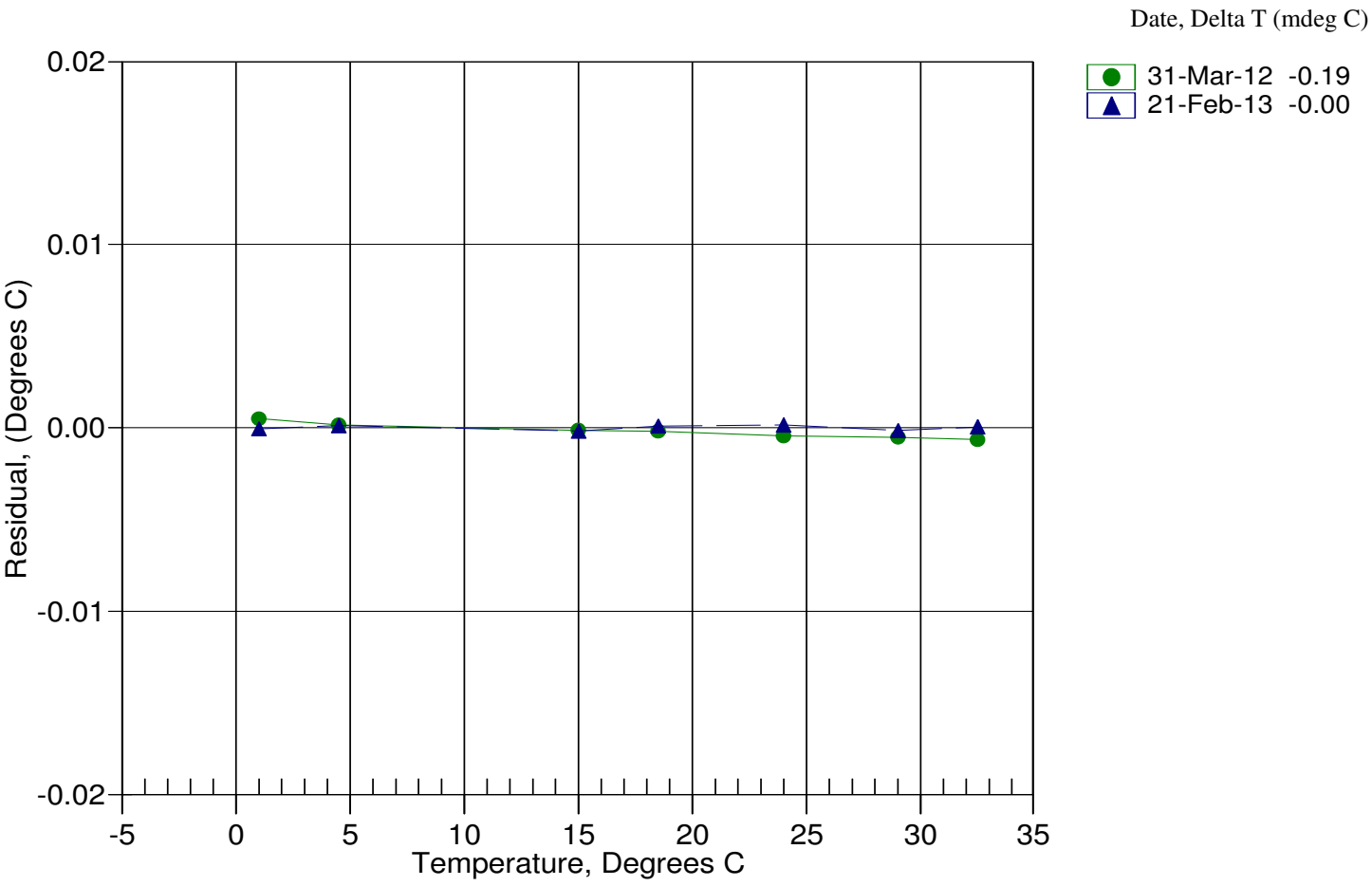
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	619145.322	0.9999	-0.0001
4.5000	549771.339	4.5001	0.0001
15.0000	377667.831	14.9998	-0.0002
18.5000	331463.542	18.5001	0.0001
24.0000	268745.983	24.0002	0.0002
29.0000	221011.136	28.9999	-0.0001
32.4999	192176.373	32.4999	0.0000

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

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

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

Residual = instrument temperature - bath temperature



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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P32914-4480

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: 2/21/2013 Drift since last cal: +0.00021 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P36399-4642

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: 2/21/2013 **Drift since last cal:** 0.0000 **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.

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SENSOR SERIAL NUMBER: 4642
CALIBRATION DATE: 21-Feb-13

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

COEFFICIENTS:

g = -1.027504e+000
h = 1.276730e-001
i = -1.844672e-004
j = 2.917455e-005

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

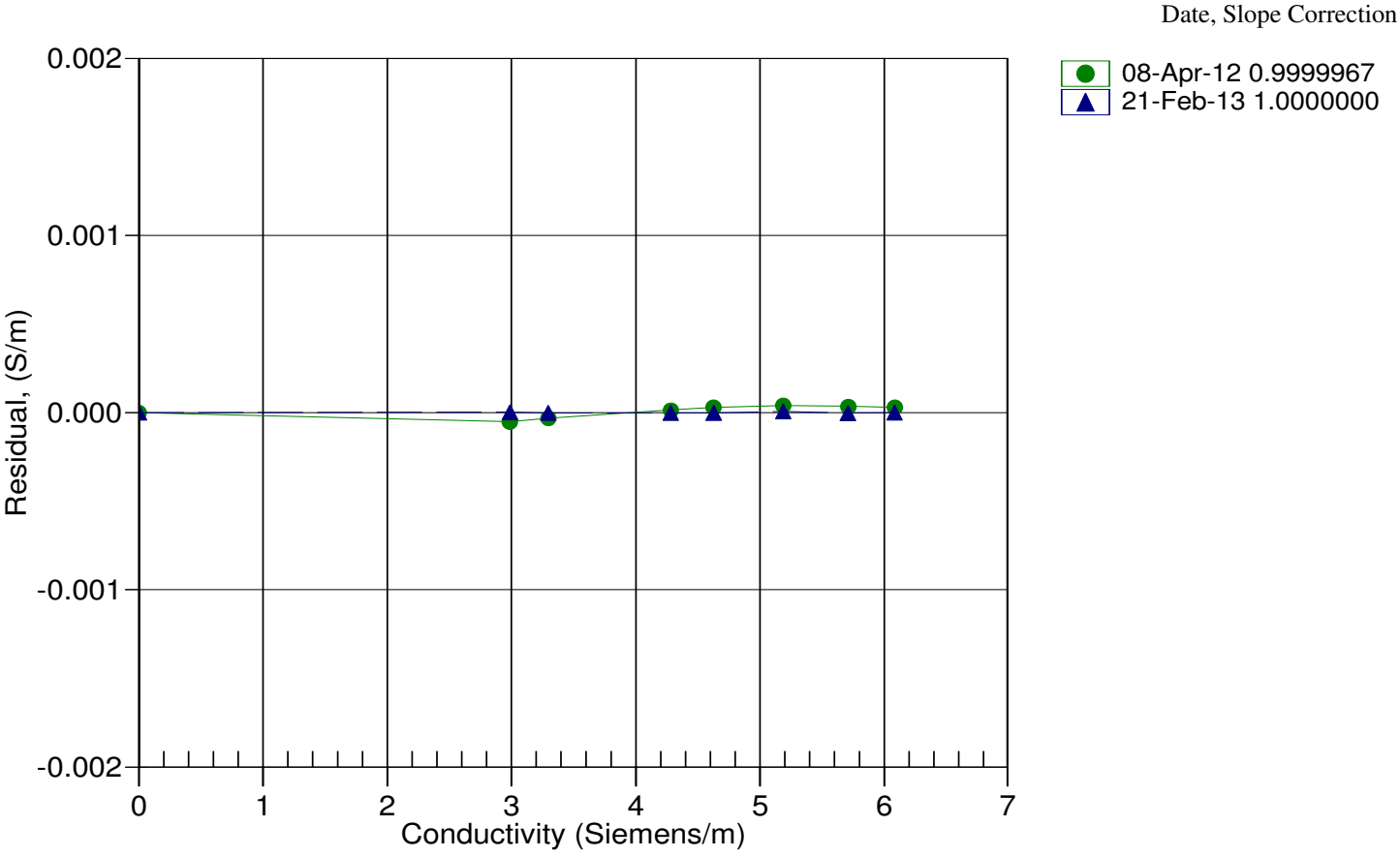
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2840.10	0.0000	0.00000
1.0000	34.9500	2.98630	5609.55	2.9863	0.00000
4.5000	34.9237	3.29386	5819.80	3.2939	-0.00000
15.0000	34.8770	4.27827	6446.05	4.2783	-0.00000
18.5000	34.8674	4.62441	6651.97	4.6244	-0.00000
24.0000	34.8569	5.18400	6971.70	5.1840	0.00001
29.0000	34.8509	5.70735	7257.64	5.7073	-0.00000
32.4999	34.8470	6.08073	7454.74	6.0807	-0.00000

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



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SENSOR SERIAL NUMBER: 4642
CALIBRATION DATE: 12-Feb-13

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 5632

COEFFICIENTS:

PA0 =	6.361379e-001	PTCA0 =	5.323160e+005
PA1 =	1.547553e-003	PTCA1 =	2.214437e+001
PA2 =	7.068208e-012	PTCA2 =	-1.515019e-001
PTEMPA0 =	-7.494654e+001	PTCB0 =	2.569025e+001
PTEMPA1 =	4.812371e+001	PTCB1 =	-3.500000e-004
PTEMPA2 =	-1.644541e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.62	541760.0	2.0	14.62	0.00
104.92	600055.0	2.0	104.89	-0.01
204.94	664596.0	2.0	204.89	-0.01
304.93	729105.0	2.0	304.90	-0.01
404.94	793584.0	2.0	404.92	-0.00
504.95	858013.0	2.0	504.93	-0.00
404.93	793610.0	2.0	404.97	0.01
304.91	729137.0	2.0	304.95	0.01
204.93	664630.0	2.0	204.94	0.00
104.92	600090.0	2.0	104.94	0.01
14.62	541765.0	2.0	14.62	0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.25	542119.97
29.00	2.18	542074.14
24.00	2.07	542003.21
18.50	1.96	541917.24
15.00	1.88	541857.86
4.50	1.66	541658.25
1.00	1.59	541580.16

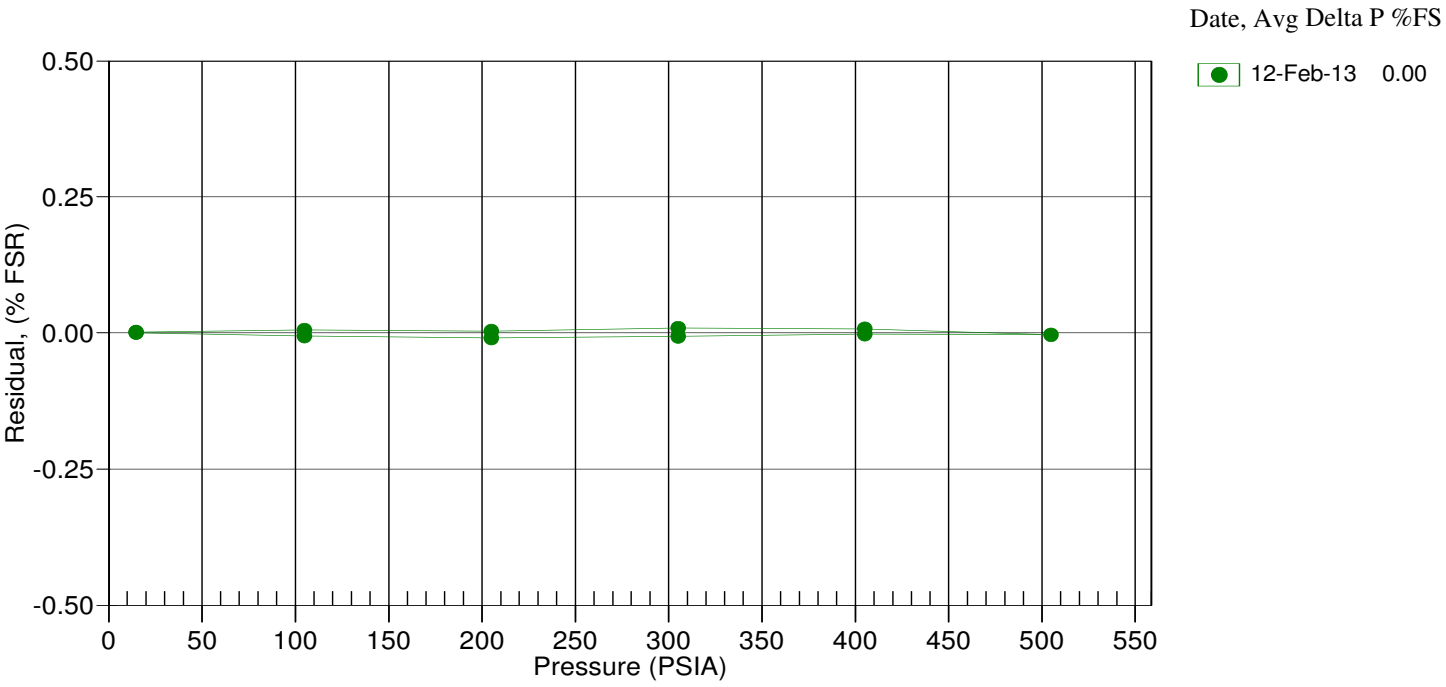
TEMP(ITS90)	SPAN(mV)
-5.00	25.69
35.00	25.68

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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SENSOR SERIAL NUMBER: 4642
CALIBRATION DATE: 21-Feb-13

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.189296e-003
a1 = 2.752200e-004
a2 = -1.004240e-006
a3 = 1.917300e-007

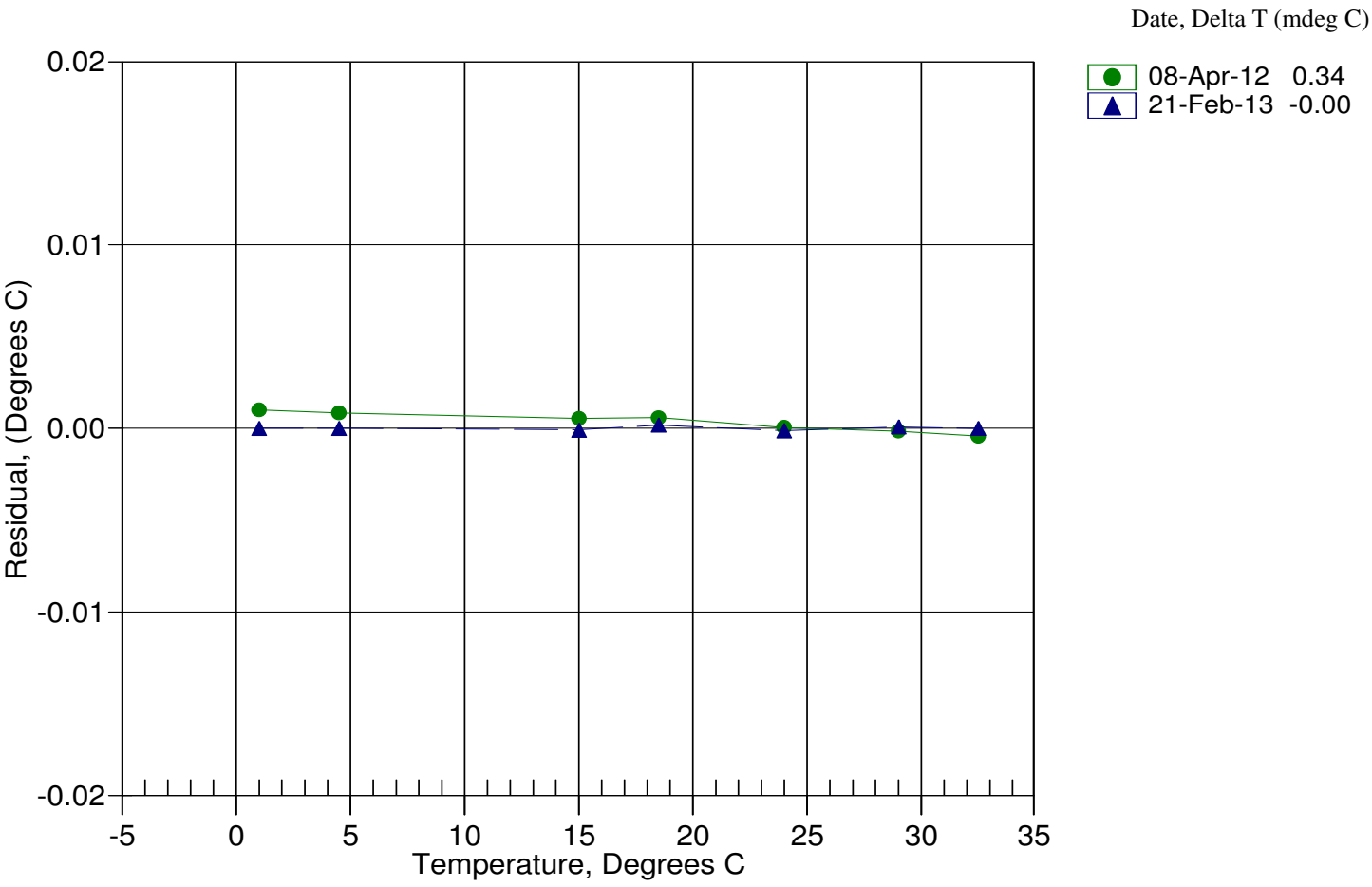
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	625334.864	1.0000	-0.0000
4.5000	556565.881	4.5000	0.0000
15.0000	385279.797	14.9999	-0.0001
18.5000	339088.017	18.5002	0.0002
24.0000	276209.712	23.9999	-0.0001
29.0000	228180.576	29.0001	0.0001
32.4999	199092.797	32.4999	-0.0000

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

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

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

Residual = instrument temperature - bath temperature



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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P36399-4642

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: 2/21/2013 Drift since last cal: -0.00039 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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

Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P65591-6918

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: 2/21/2013 **Drift since last cal:** -0.00050 **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.

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SENSOR SERIAL NUMBER: 6918
CALIBRATION DATE: 21-Feb-13

SBE19plusV2 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.857831e-001
h =  1.554019e-001
i = -3.372723e-004
j =  4.919322e-005

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

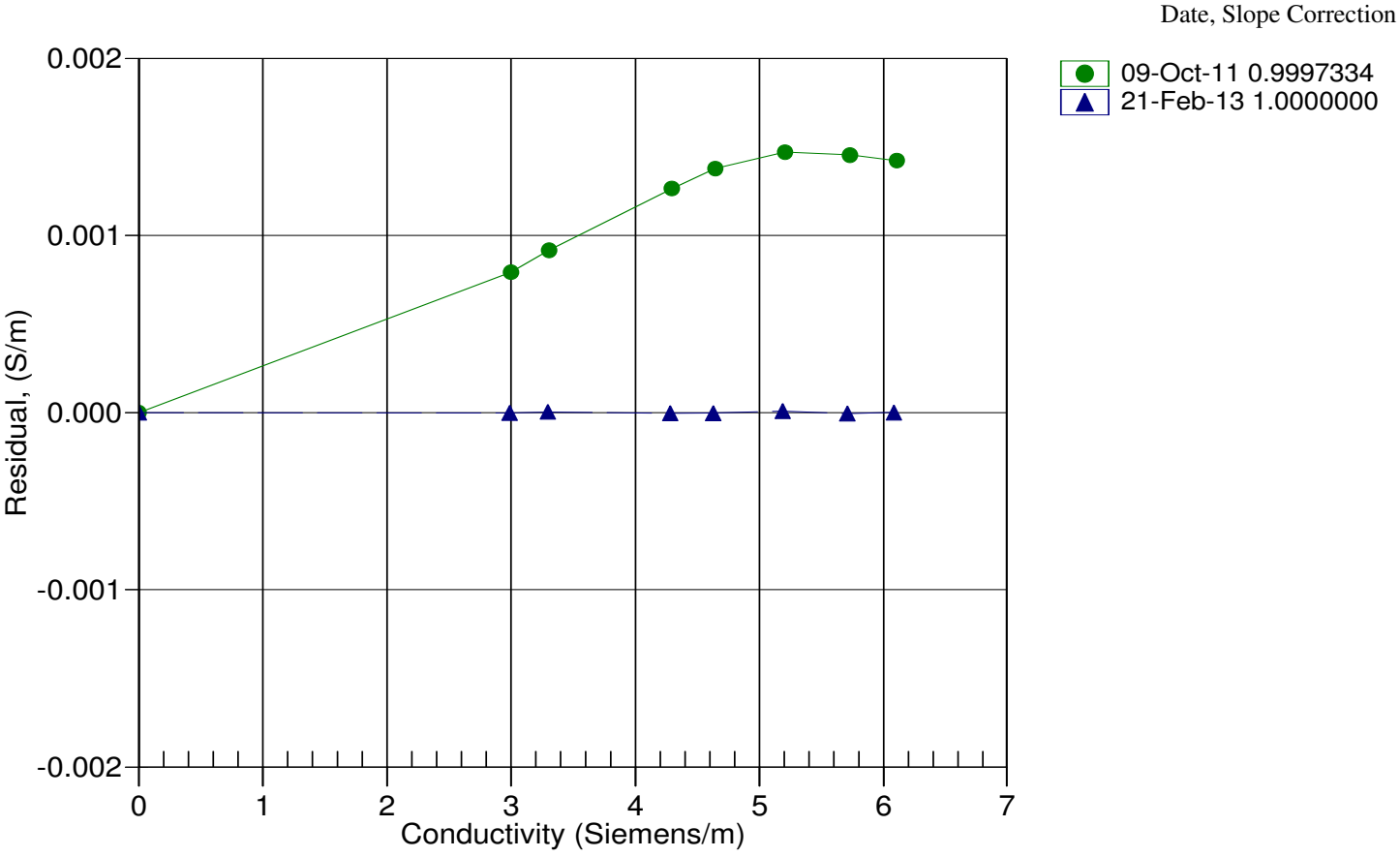
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2522.99	0.0000	0.00000
1.0000	34.9500	2.98630	5062.98	2.9863	-0.00000
4.5000	34.9237	3.29386	5254.81	3.2939	0.00000
15.0000	34.8770	4.27827	5825.77	4.2783	-0.00000
18.5000	34.8674	4.62441	6013.40	4.6244	-0.00000
24.0000	34.8569	5.18400	6304.64	5.1840	0.00001
29.0000	34.8509	5.70735	6565.01	5.7073	-0.00001
32.4999	34.8470	6.08073	6744.44	6.0807	0.00000

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



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SENSOR SERIAL NUMBER: 6918
CALIBRATION DATE: 20-Feb-13

SBE19plusV2 PRESSURE CALIBRATION DATA
508 psia S/N 3313900

COEFFICIENTS:

PA0 =	9.896364e-002	PTCA0 =	5.244489e+005
PA1 =	1.548011e-003	PTCA1 =	4.872239e+000
PA2 =	6.074867e-012	PTCA2 =	-1.058173e-001
PTEMPA0 =	-5.589951e+001	PTCB0 =	2.490900e+001
PTEMPA1 =	5.523046e+001	PTCB1 =	-1.400000e-003
PTEMPA2 =	-6.499467e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.69	533902.0	1.4	14.66	-0.01
104.96	592150.0	1.4	104.97	0.00
204.98	656614.0	1.4	204.96	-0.00
304.99	721057.0	1.4	304.97	-0.00
405.01	785472.0	1.4	404.99	-0.00
505.00	849842.0	1.4	504.99	-0.00
404.98	785484.0	1.4	405.01	0.01
304.98	721079.0	1.4	305.01	0.01
205.00	656634.0	1.4	205.00	-0.00
105.00	592156.0	1.4	104.98	-0.00
14.62	533897.0	1.4	14.66	0.01

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	1.63	534126.92
29.00	1.57	534133.29
24.00	1.47	534137.48
18.50	1.37	534134.87
15.00	1.30	534129.58
4.50	1.11	534099.87
1.00	1.04	534086.20

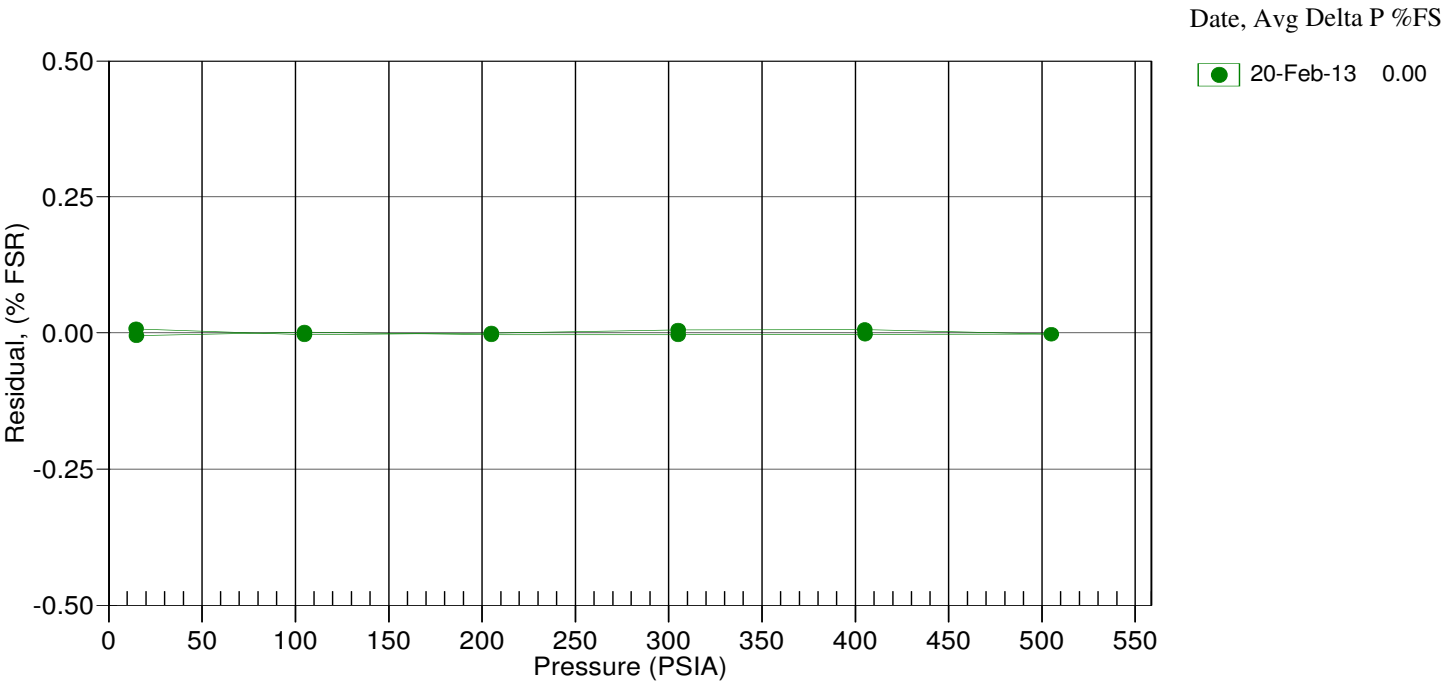
TEMP(ITS90)	SPAN(mV)
-5.00	24.92
35.00	24.86

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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SENSOR SERIAL NUMBER: 6918
CALIBRATION DATE: 21-Feb-13

SBE19plusV2 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.287679e-003
a1 = 2.705728e-004
a2 = -1.142888e-006
a3 = 1.804726e-007

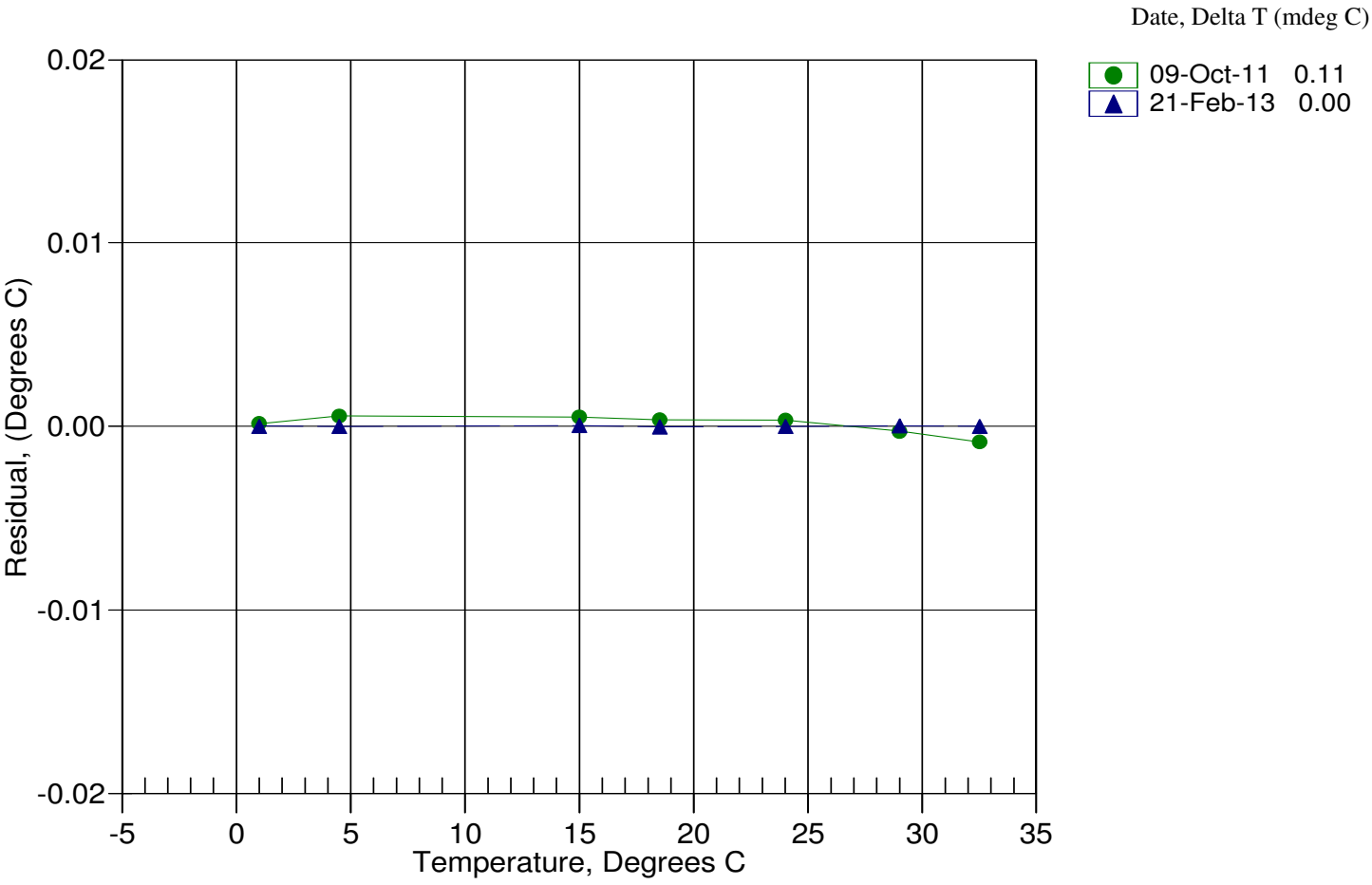
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	563939.441	1.0000	0.0000
4.5000	497022.831	4.5000	-0.0000
15.0000	333856.390	15.0000	0.0000
18.5000	290801.644	18.5000	-0.0000
24.0000	232902.322	24.0000	-0.0000
29.0000	189281.017	29.0000	0.0000
32.4999	163135.119	32.4999	-0.0000

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

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

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

Residual = instrument temperature - bath temperature



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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/21/2013
Model Number	SBE 19Plus	**Serial Number:**	19P65591-6918

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: 2/21/2013 Drift since last cal: +0.00008 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/28/2013
Model Number	SBE 45	**Serial Number:**	4553332-0276

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: 2/28/2013 **Drift since last cal:** -0.00170 **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.

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SENSOR SERIAL NUMBER: 0276
CALIBRATION DATE: 28-Feb-13

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -1.001879e+000
h =  1.571774e-001
i = -2.802980e-004
j =  4.780569e-005

CPcor = -9.5700e-008
CTcor =  3.2500e-006
WBOTC =  4.2855e-007
```

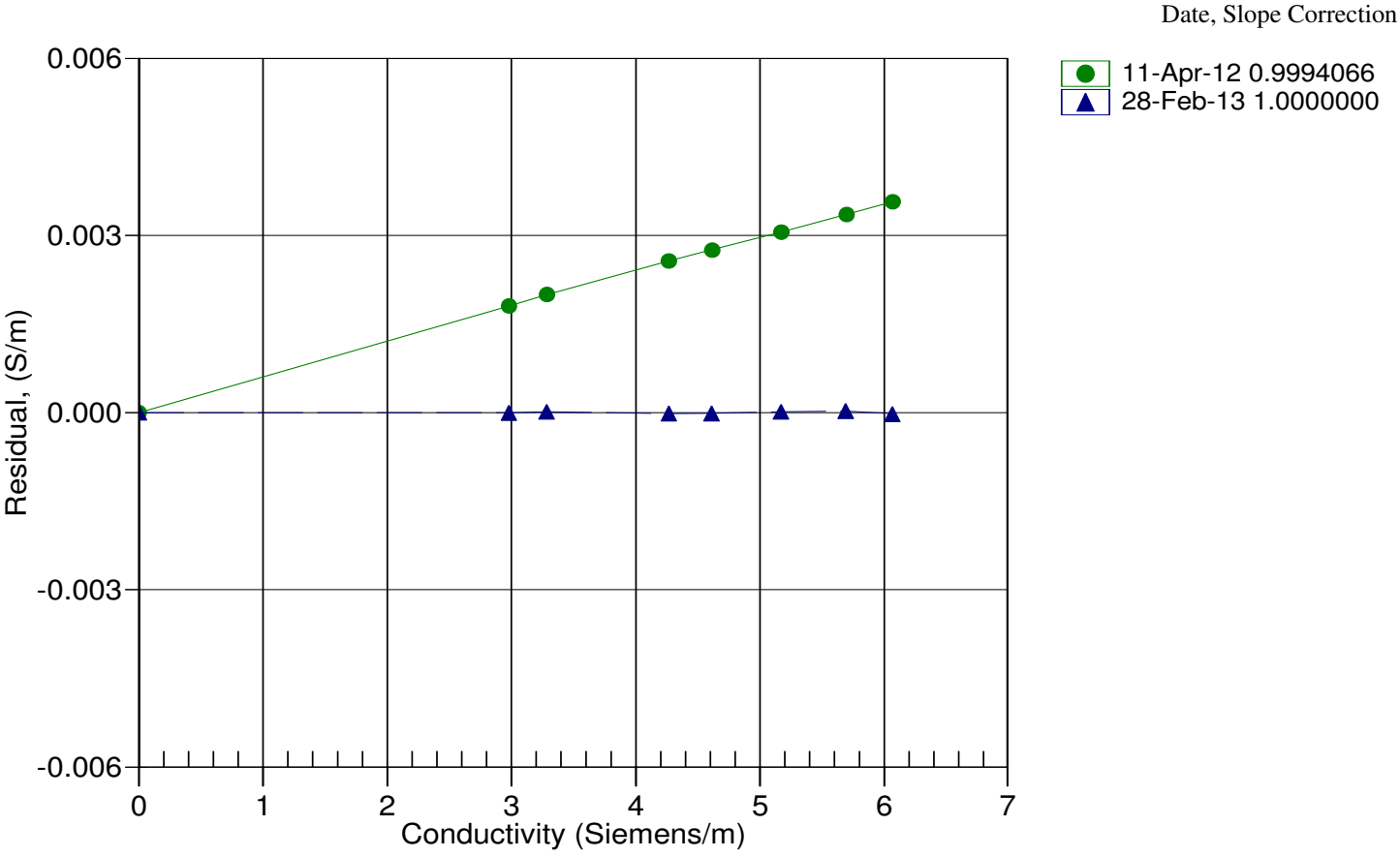
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2527.95	0.00000	0.00000
1.0000	34.8154	2.97590	5033.86	2.97589	-0.00000
4.5001	34.7933	3.28278	5223.80	3.28279	0.00001
15.0000	34.7509	4.26444	5788.86	4.26442	-0.00002
18.5000	34.7420	4.60958	5974.58	4.60956	-0.00001
24.0000	34.7323	5.16751	6262.87	5.16753	0.00001
28.9997	34.7264	5.68922	6520.58	5.68924	0.00002
32.5001	34.7243	6.06177	6698.33	6.06175	-0.00002

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 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



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SENSOR SERIAL NUMBER: 0276
CALIBRATION DATE: 28-Feb-13

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

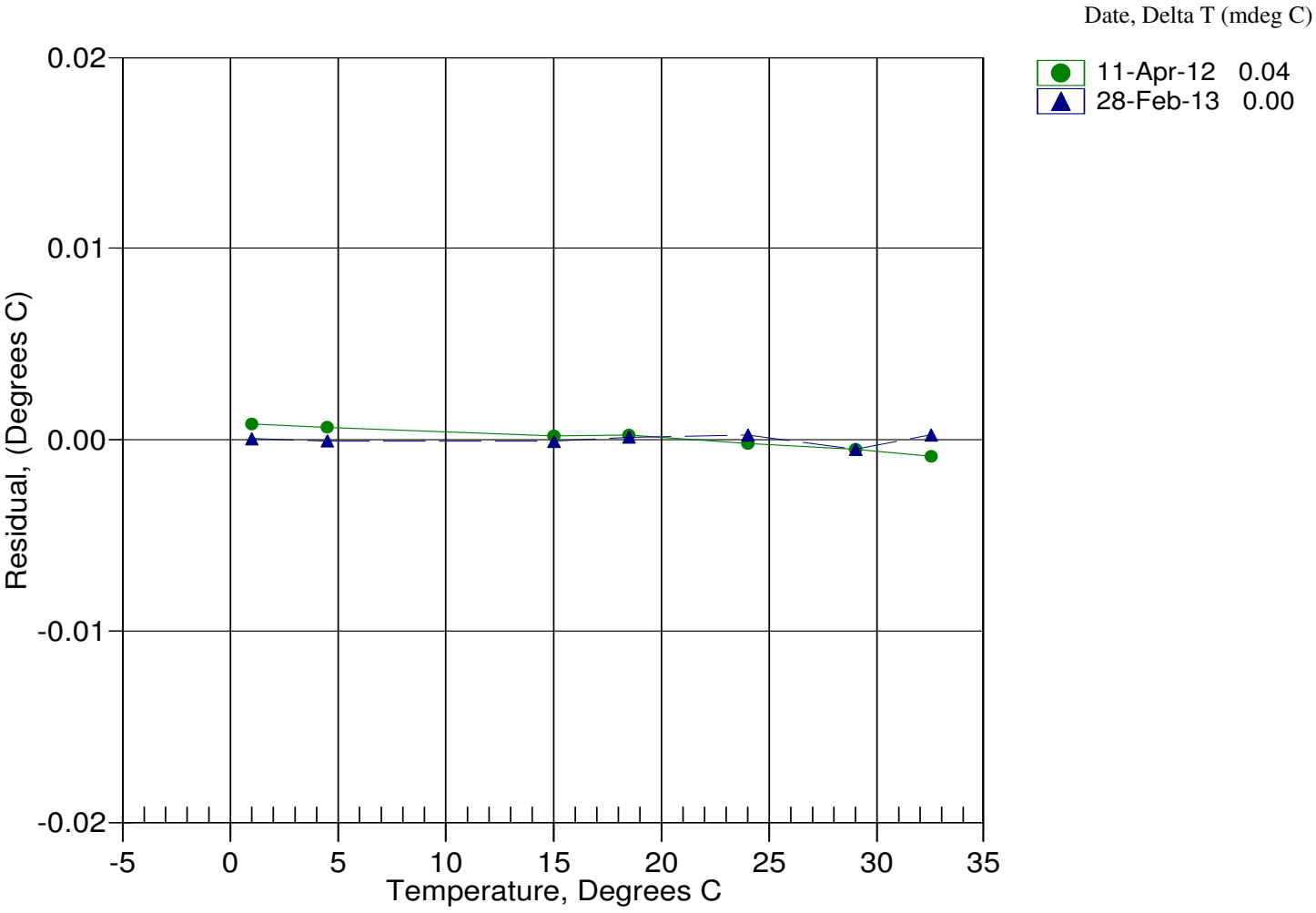
ITS-90 COEFFICIENTS

a0 = 7.319125e-005
a1 = 2.662731e-004
a2 = -1.861429e-006
a3 = 1.352567e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	695550.9	1.0000	0.0000
4.5001	593258.4	4.5000	-0.0001
15.0000	375473.6	14.9999	-0.0001
18.5000	324399.0	18.5001	0.0001
24.0000	259362.0	24.0002	0.0002
28.9997	212936.3	28.9992	-0.0005
32.5001	186084.7	32.5004	0.0003

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

Residual = instrument temperature - bath temperature



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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/28/2013
Model Number	SBE 45	**Serial Number:**	4553332-0276

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: 2/28/2013 Drift since last cal: -0.00005 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/28/2013
Model Number	SBE 45	**Serial Number:**	4553332-0277

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: 2/28/2013 **Drift since last cal:** -0.00060 **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.

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SENSOR SERIAL NUMBER: 0277
CALIBRATION DATE: 28-Feb-13

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.782419e-001
h =  1.536406e-001
i = -3.557364e-004
j =  5.226581e-005

CPcor = -9.5700e-008
CTcor =  3.2500e-006
WBOTC =  4.2855e-007
```

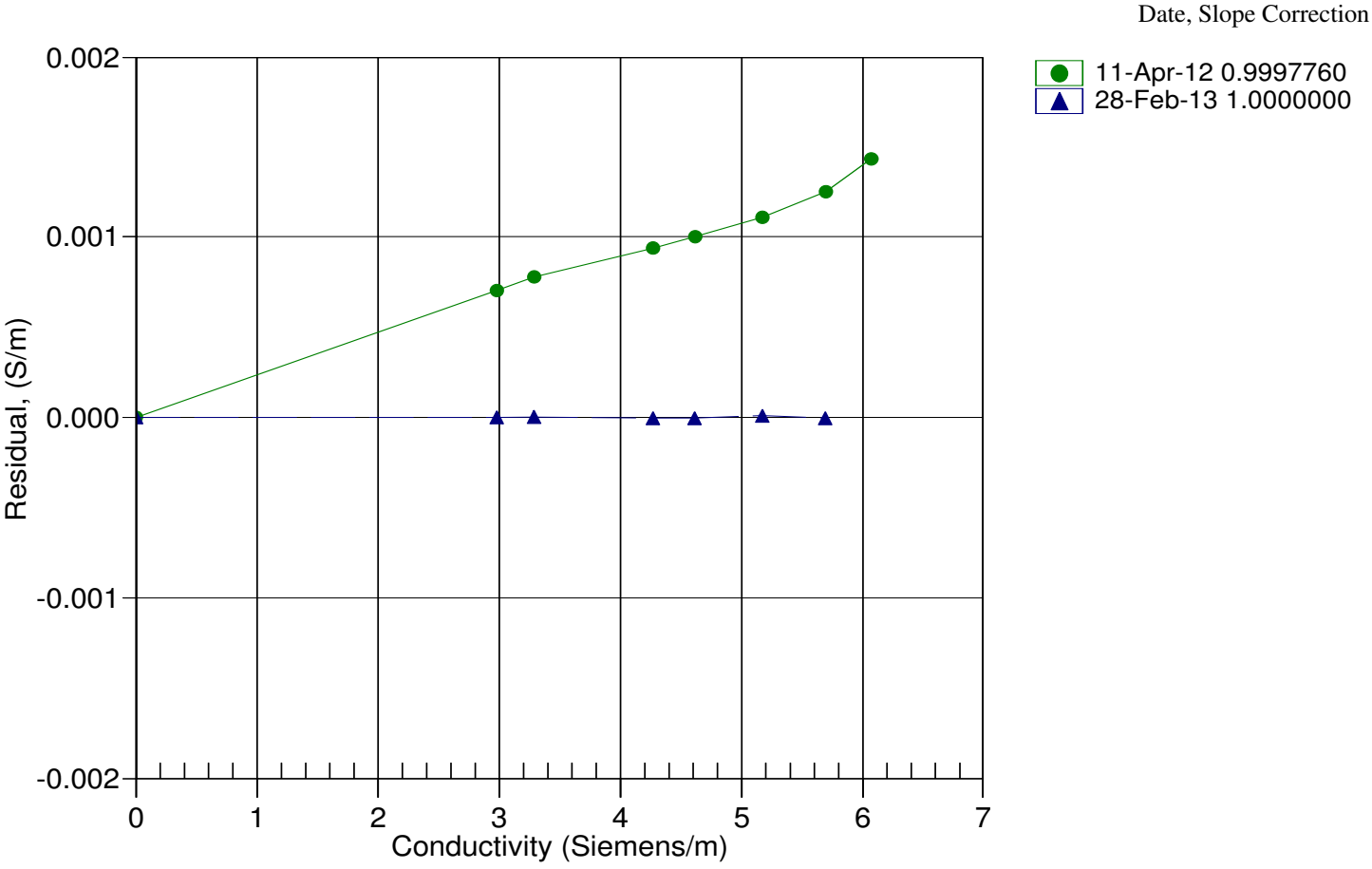
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREO (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2527.95	0.00000	0.00000
1.0000	34.8154	2.97590	5080.68	2.97590	0.00000
4.5001	34.7933	3.28278	5273.56	3.28278	0.00000
15.0000	34.7509	4.26444	5847.17	4.26443	-0.00000
18.5000	34.7420	4.60958	6035.61	4.60957	-0.00000
24.0000	34.7323	5.16751	6328.06	5.16752	0.00001
28.9997	34.7264	5.68922	6589.42	5.68921	-0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 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



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SENSOR SERIAL NUMBER: 0277
CALIBRATION DATE: 28-Feb-13

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

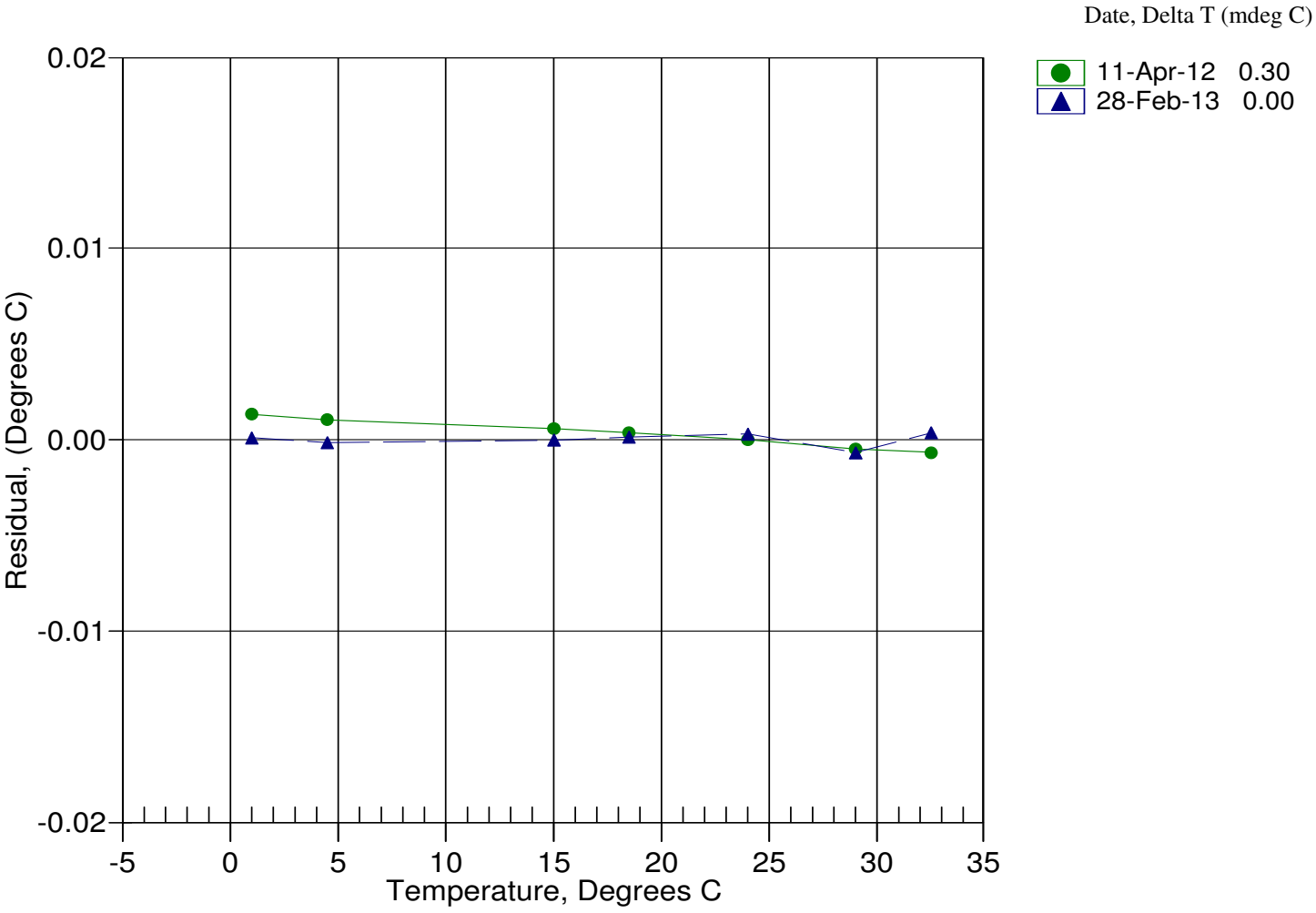
ITS-90 COEFFICIENTS

a0 = 9.741662e-005
a1 = 2.657622e-004
a2 = -1.821791e-006
a3 = 1.353495e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	638629.1	1.0001	0.0001
4.5001	544707.0	4.4999	-0.0002
15.0000	344732.6	15.0000	-0.0000
18.5000	297836.4	18.5001	0.0001
24.0000	238119.1	24.0003	0.0003
28.9997	195493.2	28.9990	-0.0007
32.5001	170836.7	32.5004	0.0003

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

Residual = instrument temperature - bath temperature



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Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	73178	**Date of Report:**	2/28/2013
Model Number	SBE 45	**Serial Number:**	4553332-0277

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.

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'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 2/28/2013 Drift since last cal: -0.00034 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments: