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-D604-FH-12**
Registry No.	**H12423, H12424, H12501, H12502, H12503, H12504, H12505**
Time Frame	**14 July 2012 - 13 Dec 2012**

LOCALITY

State	**Virginia**
General Locality	**Approaches to Chesapeake Bay**

2012

CHIEF OF PARTY

LCDR Benjamin K. Evans, NOAA

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Data Acquisition and Processing Report

NOAA Ship *Ferdinand R. Hassler*
Chief of Party: LCDR Benjamin K. Evans, NOAA
Year: 2012
Version: 2.0
Publish Date: 2013-01-07

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 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	Partial offset verification was not performed.	
Most Recent Static Draft Determination	*Date*	2011-07-12
	Method Used	Calculation from design waterline and measured offsets
	Discussion	Design waterline of 3.85 meters and measured offsets to IMU were used to determine static draft of reference point. Draft of ship is operationally managed with ballast to achieve design draft. Uncertainty is estimated at 0.05 meters.
Most Recent Dynamic Draft Determination	*Date*	2012-09-28
	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.

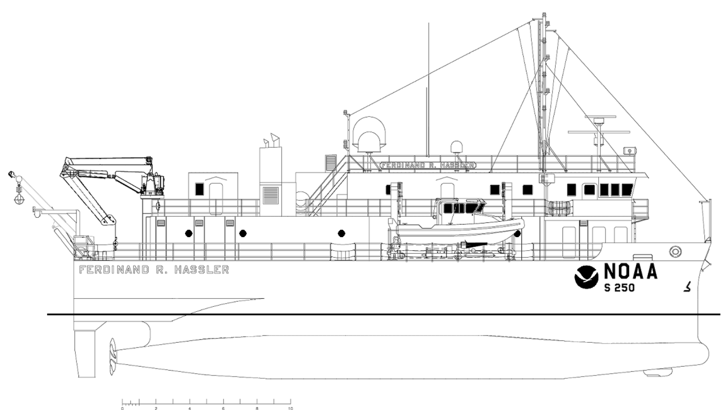

Figure 1: NOAA Ship FERDINAND R. HASSLER, Starboard View

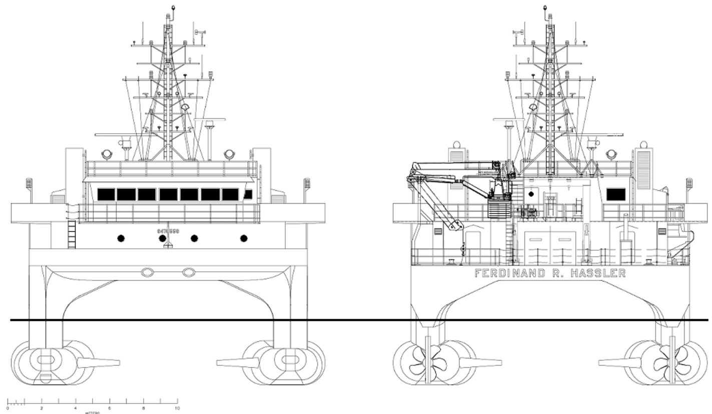

Figure 2: NOAA Ship FERDINAND R. HASSLER, Bow and Hull View

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 8/3/2012 using a known length of line. The SSS cable was re-terminated on 7/27/2012 and a new 12 meter cable mark for the docked and zero measurement was marked and verified on 8/3/2012.

Side scan calibrations were conducted on June 5 and 14, 2012 (Dn157, Dn166) in the vicinity of Sewells Point with towfish SN: 385. A calibration was done in the vicinity of Cape Charles, VA on August 25, 2012 (Dn238) with the re-terminated cable and towfish SN:386. On August 27, 2012 (Dn240) the calibration was repeated with towfish SN: 386 on an buoy offshore of Cape Charles, VA with towfish SN: 386.

In each of these tests a number of lines were run adjacent to a conspicuous feature. The side scan positions are compared with the multibeam positions in the attached reports. At a 95% confidence interval, the positioning error is:
Dn157: 2.7 to 10.2 meters. FAIL.
Dn238: 5.8 to 10.4 meters. FAIL. Currents in the test area are suspected of driving up the error values.
Dn240: 7.9 to 13.4 meters. FAIL. Both current and insufficient vessel run-up to the target is suspected of driving up the error value.

In all cases during survey operation, an area well in excess of 20 meters to each side of a side scan contact was 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	385, 386

Specifications

Frequency	455 kilohertz
Along Track Resolution	(see below)
Across Track Resolution	3.75 centimeters
Max Range Scale	250 meters

Along Track Resolution

Resolution	10 centimeters	20 centimeters	36 centimeters	61 centimeters
Min Range	38 meters	75 meters	150 meters	250 meters
Max Range				

Manufacturer Calibrations

Vessel Installed On	S250
Calibration Date	2012-08-27

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 configure 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 am 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, and time varied gain (TVG) parameters are controlled by the master. The upgrade of this system to dual-ping, FM functionality was accomplished during this project and a number of implementation problems were resolved. This upgrade involved installation of new receive arrays, upgraded firmware, and improved tuning parameters.

At the beginning of the 2012 field season, the topside processor, projector array, and link control unit bottle (LCU) were upgraded to enable FM, dual head operation. Fleet spare 7000 model receivers (port: SN 808052, starboard: SN 2405277) were installed to replace the original receivers that had a number of failed channels and defective electronics. Because the upgraded Alpha Data card required to process the FM signal was not ready at the beginning of the season, the initial patch test and reference surface calibrations on May 30, 2012 (Dn151) were done in the "ping-pong" mode. In this mode, the heads alternate gated continuous wave (CW) pulses to avoid cross talk between the heads. The reference surface results were satisfactory and are shown in Figure 10.

On June 11, 2012 (Dn163) the upgraded Alpha Data card was installed along with additional firmware to enable FM, dual head operation. This system was configured with the port side sweeping down in frequency from 420 to 400 kHz and the starboard side sweeping up in frequency from 380 to 395 kHz.

Initial tests of the system showed unacceptable levels of interference between the two heads. This was communicated to Reson, whose engineers suggested changing the FM parameters. In accordance with these instructions, the port head was configured to sweep down in frequency from 440 to 420 kHz and the starboard head to sweep up in frequency from 380 to 400 kHz. This project was begun with this FM configuration. Because the receiver and transmitters had not been replaced or remounted after the initial patch test and reference surface and no physical offsets had changed, no system accuracy tests were done before commencing this project.

After two days of acquisition, it became clear that there was a persistent vertical offset between the two heads. Tests conducted on July 16 (Dn198) indicated that the FM logic was introducing depth biases. A more comprehensive set of field experiments was conducted on July 17 (Dn199) and show that the FM configuration introduced a depth bias that depended on the FM sweep parameters when compared to the previously verified CW mode. These experiments consisted of a small reference surface run over a flat section of sea floor with the port head configured in six different FM sweep configurations. The largest bias relative to CW of the tested configurations was the 440 to 420 FM sweeps with which the port head had been configured. The results of this experiment are shown in Figure 7. Based on this result, the system was reconfigured to switch the direction of the FM sweeps on both heads; the port head was changed from sweeping down from 440 to 420 kHz to sweeping up from 420 to 440 kHz and the starboard head was switched from sweeping up from 380 to 400 kHz to sweeping down from 400 to 380 kHz. This configuration minimized the bias and largely eliminated the offset between the heads.

These findings were communicated to Reson. Following investigation, Reson engineers discovered a number of problems with the FM implementation including a hardware limitation of 436 kHz on the transmitters and improperly applied pulse shaping functions. Most significantly, when the system was set to sweep down from 440 to 420 kHz, the system actually swept from 418 to 396 kHz because of the hardware limitation of the transmitter. The range offset due to this match filter mismatch was estimated by modeling the transmit and replica pulses and computing the cross-correlation for both a matched and mismatched pair. For the 0.3 ms pulse in use, this yields a 0.13 meter range bias. The result is shown in Figure 8. This estimation is crude and neglects the pulse shaping that may have been applied to the transmit or receive pulse and other details of Reson's signal processing and bottom detection algorithm. However, it is consistent sign and magnitude with the empirical result that the 440 to 420 kHz configuration had range errors on order of 0.1 meters.

To empirically determine the offset between the heads, two 16 meter BASE surface were constructed for all data before the FM parameters were changed; one from the port data and the other containing only the starboard. The surfaces were differenced and the distributions analyzed. This was done for both H12423 and H12424 with the results shown in Figure 8. The error resulting from the match-filter mismatch will be a range error and the resultant depth error will vary across the swath, with a maximum at nadir, a minimum at the outer beams, and varying with the cosine of the launch angle. We have no means of correcting a range error after the fact, so have treated this error as a depth error. On average, the port system yielded depths 0.19 meters shallower than the starboard system on H12423 and 0.26 meters shallower on H12424 with a most probable offset of 0.20 and 0.23 respectively. The long tail of the H12424 distribution is suspected to derive from surface sound velocity errors discussed in greater detail in the survey Descriptive Reports (DR). The port HVF was modified to incorporate a 0.22 meter offset into the static draft measurement for Dn195 through 0410 on Dn200, when the FM parameters were changed.

On August 1, 2012 (Dn214) two new 7200 model receivers were installed (port: SN 2411045, starboard: SN 3411050) replacing the fleet spare systems. On August 13 service pack 3 was installed on both machines. This service pack fixed a number of the deficiencies discovered in July.

No significant FM related biases were evident in a series of tests conducted alongside the pier on August 21 (Dn234). These results are presented in Figure 10 below and show offset values from CW pulse of less than 0.05 meters at all tested FM configurations. Following these tests, the port head was configured to sweep up in frequency from 416 to 436 kHz and the starboard head to sweep down from 396 to 376 kHz. This configuration was retained for the remainder of the project.

A patch test and reference surface were conducted on August 25 (Dn238) in the vicinity of Cape Charles, VA. The results are shown in Figure 11. From the reference surface, depths from the starboard head were on average 0.03 meters shallower than those from the port head with a standard deviation of 0.04 meters. Additional trials of the effect of pulse length on inter-head signal rejection were conducted while at anchor in the vicinity of Cape Charles. Increasing the pulse length is expected to decrease the bandwidth of the FM signal, improve frequency separation between the heads, and improve the performance of the match filter. The interfering signal relative to the desired signal at a number of pulse lengths is shown in Figure 12. Considering the interfering signal as noise, the minimum signal to noise ratio is approximately 5 dB at the shortest pulse lengths increasing to approximately 30 dB at pulse lengths of 1 ms and greater. Pulse length was set at 1 ms for the remainder of the project.

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	808052, 5411045		same	
	Projector 1 s/n	506078		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
	Methods	Reference surface comparison
	Results	A reference surface comparison was run on May 30, 2012 (Dn151) in the vicinity of Cape Charles, VA. The sonars were operated in CW, ping-pong mode. Tidally corrected surfaces were generated for the port and starboard 7125 systems and the surfaces differenced. On average the depths from the starboard head were 0.04 meters deeper than depths from the port head with a standard deviation of 0.04 meters. The location of the patch test is shown in Figure 5. The distribution of differences is shown in Figure 6. .... A reference surface comparison was run on July 17, 2012 (Dn199) on a flat area of H12424 to investigate the impact of FM parameters on depth. The surface was repeated with six FM configurations and the previously verified CW configuration. Distributions of the difference between the FM and CW modes are shown in Figure 7. The largest bias was the frequency sweep from 440-420 kHz. .... A reference surface comparison was run on alongside the pier on August 21, 2012 (Dn234) after installation of new receivers and firmware updates. Results are shown in Figure 10. Biases between various FM configurations and CW were less than 0.05 meters and are indistinguishable from background noise. .... A reference surface comparison was run on August 25, 2012 (Dn238) in the vicinity of Cape Charles, VA. The sonars were operated in dual head FM mode. Tidally corrected surfaces were generated for the port and starboard 7125 systems and the surfaces differenced. On average the depths from the starboard head were 0.04 meters shallower than the depth from the port head with a standard deviation of 0.04 meters; well within specification. The location of the patch test is shown in Figure 5. The distribution of differences is shown in Figure 11. .... On August 17, 2012 (Dn230) a static lead line comparison was performed relative to the ellipsoid. An ellipsoid height was obtained on a fixed mark ashore using static GPS observations. While the ship was alongside the pier at MOC-A, a lead-line was lowered to the sea floor in the field of view of the port 7125 while logging sounding data. The 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 fiberglass survey tape. The logged sonar data was processed through CARIS using standard ERS methods to yield an ellipsoid referenced measurement. Using the iteratively derived GPS antennae offset values discussed in Section C.1.1, the sonar measured depth were 0.03 meters shallower than the lead-line derived depths with an propagated uncertainty of 0.03 meters. This result indicates that the offsets and sonar measurement process are correct to within the measurement error. .... On August 22, 2012 (Dn235) a similar experiment was conducted relative to the waterline. The lead-line was marked at the waterline and the distance from the lead to the mark measured with a fiberglass survey tape. The logged sonar data was processed through Caris using a zero-tide file to yield a waterline referenced measurement. The sonar measured depths were an average of 0.10 meters shallower than the lead-line derived depths with a propagated error of 0.06 meters. This result suggests that 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 of reading the ship's draft marks. ....

Snippets	Sonar has snippets logging capability.

Figure 4: 7125 Housing flush mounted on hull

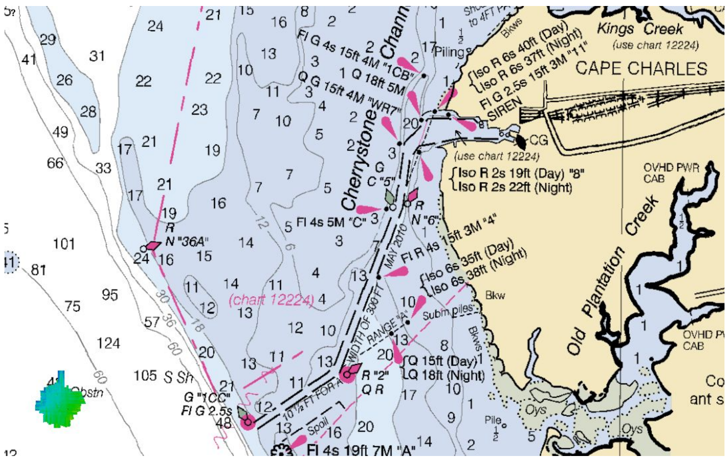

Figure 5: General location of Dn151 Shallow water reference surface in vicinity of Cape Charles, VA.

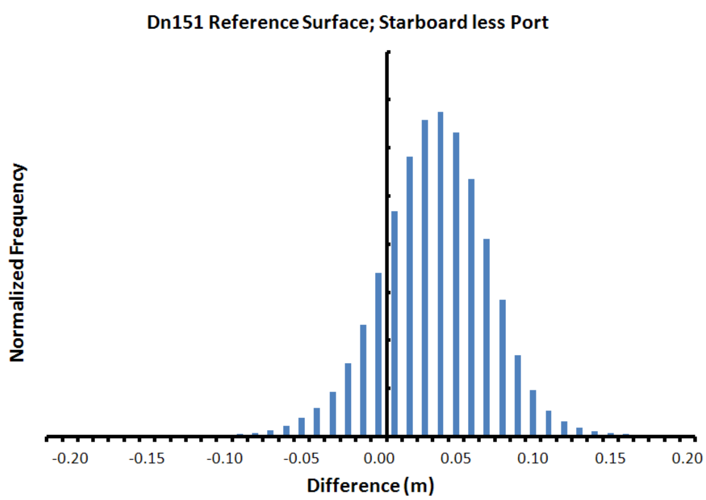

Figure 6: Distribution of depth differences, starboard less port for Dn151 reference surface. Depths from starboard are on average 0.04 meters deeper than depths from port system with a standard deviation of 0.04 meters. Sonars configured in CW, ping-pong mode.

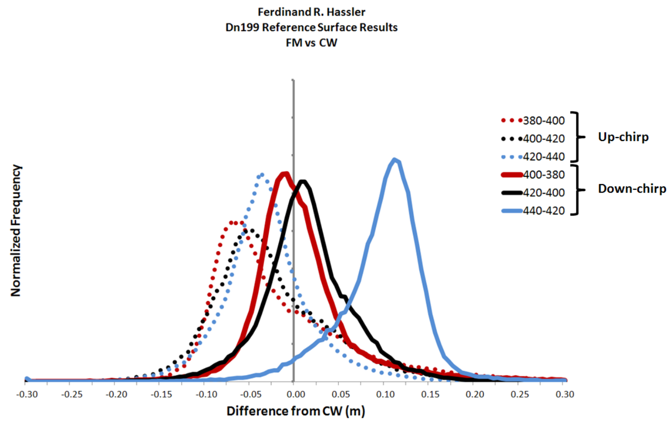

Figure 7: Distribution of depth differences from six FM modes from CW solution. All generated by port head during Dn199 field reference surface.

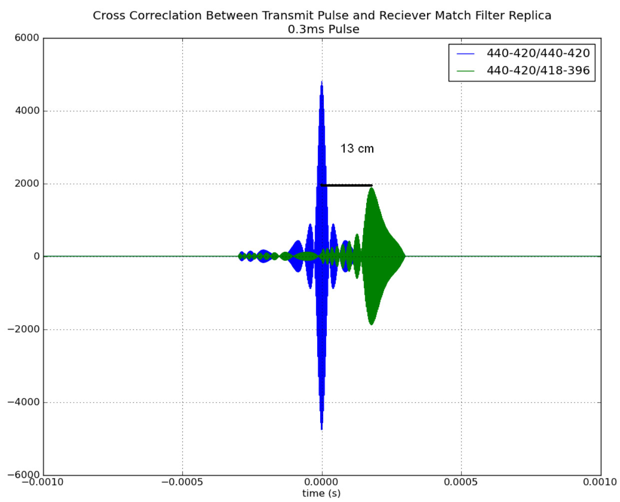

Figure 8: Cross-correlation model of time and range offset due to transmit and replica mismatch. For a FM transmit pulse of 418-396 kHz matched with a 440-420 receive replica, the range offset is 0.13 meters.

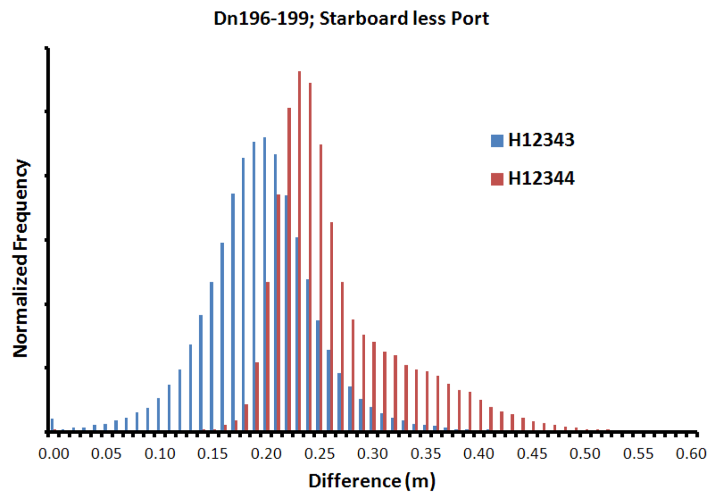

Figure 9: Difference between port and starboard heads due to FM errors. 16 meter resolution estimates of depths from the port system were subtracted from those from the starboard system. The port system yielded depths 0.19 meters shallower than the starboard system on H12423 and 0.26 meters shallower on H12424 with a most probable offset of 0.20 and 0.23 respectively.

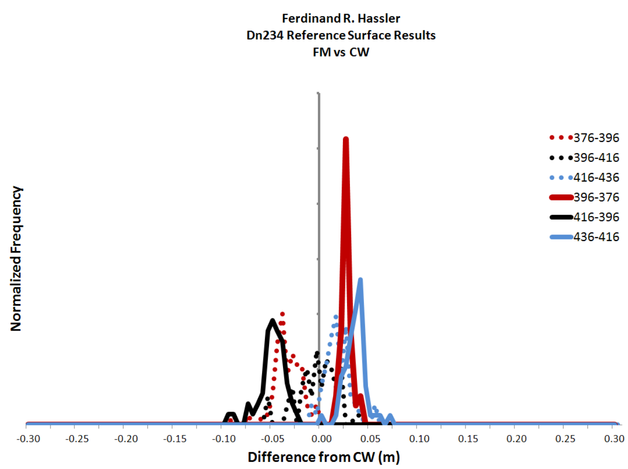

Figure 10: Distribution of depth differences from six FM modes from CW solution. All generated by port head during Dn234 alongside tests. All offset values are less than 0.05 meters.

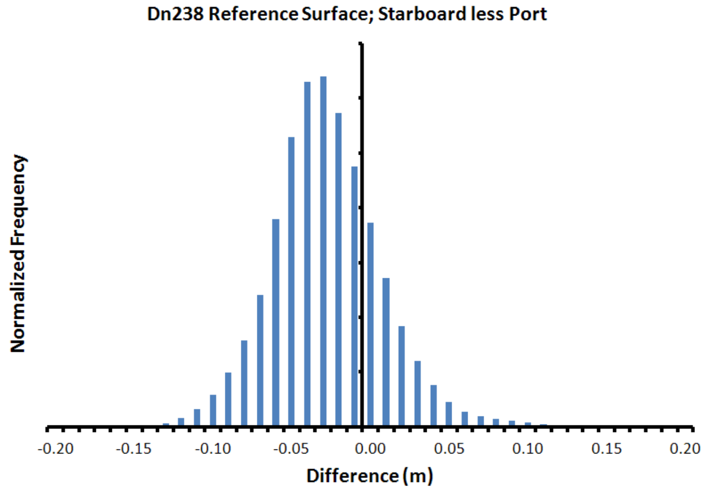

Figure 11: Distribution of depth differences, starboard less port for Dn238 reference surface. Depths from starboard are on average 0.03 meters shallower than depths from port system with a standard deviation of 0.04 meters. Sonars configured in FM simultaneous pinging configuration.

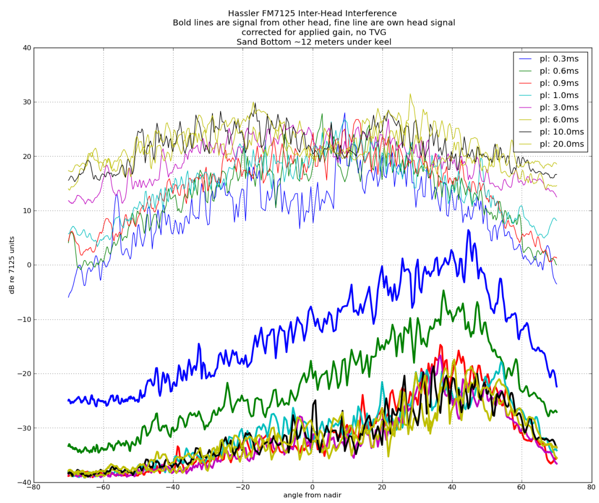

Figure 12: Pulse length and inter-head interference. Fine lines are desired signal, bold lines are interfering signal. At shortest pulse length desired signal is 5 dB above interfering signal. At pulse lengths of 1 ms and greater the signal is approximately 30 dB above the interfering signal.

A.2.2.2 Reson 7125

Manufacturer	Reson
Model	7125

<table>
<tr><td>Description</td><td colspan="5">Starboard system of a dual head configuration. For a description of this system and associated quality control tests, see entry for port 7125.</td></tr>
<tr><td rowspan="7">Serial Numbers</td><td>Vessel Installed On</td><td colspan="2">S250</td><td colspan="2">same</td></tr>
<tr><td>Processor s/n</td><td colspan="2">18215011048</td><td colspan="2">same</td></tr>
<tr><td>Transceiver s/n</td><td colspan="2">212035</td><td colspan="2">same</td></tr>
<tr><td>Transducer s/n</td><td colspan="2">n/a</td><td colspan="2">n/a</td></tr>
<tr><td>Receiver s/n</td><td colspan="2">2405277, 3411050</td><td colspan="2">same</td></tr>
<tr><td>Projector 1 s/n</td><td colspan="2">107060030</td><td colspan="2">same</td></tr>
<tr><td>Projector 2 s/n</td><td colspan="2">n/a</td><td colspan="2">n/a</td></tr>
<tr><td rowspan="11">Specifications</td><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>
<tr><td colspan="5"></td></tr>
<tr><td>Manufacturer Calibrations</td><td colspan="5">Manufacturer calibration was not performed.</td></tr>
<tr><td>System Accuracy Tests</td><td colspan="5">System accuracy test was not performed.</td></tr>
<tr><td>Snippets</td><td colspan="5">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.

Serial Numbers	*Vessel Installed On*		S250
	Processor s/n		1908005
	Transceiver s/n		4506285
	Transducer s/n		807208
	Receiver s/n		1409098
	Projector 1 s/n		Low
	Projector 2 s/n		None
Specifications	*Frequency*		100 kilohertz
	Beamwidth	*Along Track*	1.9 degrees
		Across Track	1.5 degrees
	Max Ping Rate		20 hertz
	Beam Spacing	*Beam Spacing Mode*	Equidistant
		Number of Beams	301
	Max Swath Width		150 degrees
	Depth Resolution		3 centimeters
	Depth Rating	*Manufacturer Specified*	1000 meters
		Ship Usage	500 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.		
System Accuracy Tests	*Vessel Installed On*		S250
	Methods		Reference surface comparison
	Results		A shallow water reference surface comparison was run on May 30, 2012 (Dn151) in the vicinity of Cape Charles, VA in approximately 13 meters of water. Tidally corrected surfaces were generated for the dual head 7125 systems and the 7111. On average, the depths from the 7111 were 0.14 meters shallower than the 7125 with a standard deviation of 0.06 meters. A known artifact in the 7111 bottom detection algorithm is though to account for the bulk of this difference. While these results suggest that the 7111 is marginally acceptable in this depth of water, this system is typically reserved for far deeper water where this offset is negligible. .... A deep water reference surface comparison was run on May 31, 2012 (Dn152) over a wreck in the vicinity of Norfolk Canyon in approximately 80 meters of water. Official tide zones were not available, so inshore zones were extended offshore in the field. Because the primary purpose of these data was to patch test the deep water systems, the lack of good tidal vertical control was of little concern. The lack of good vertical control does introduce significant errors in the reference surface. While this reference surface does indicate compliance with the uncertainty standard for this depth, little value should be placed on this result and the difference from the shallow water results, which had better vertical control.

Snippets	Sonar has snippets logging capability.

Figure 13: 7111 mount and fairing. Sonar is located forward on the starboard hull.

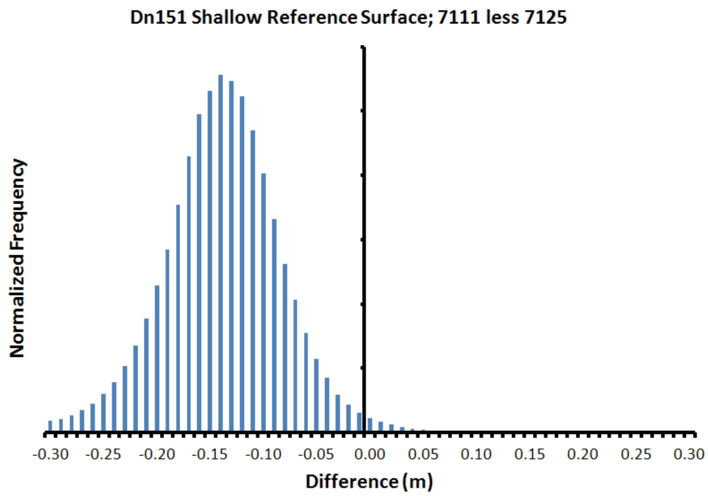

Figure 14: Distribution of depth differences, 7111 less dual head 7125 for Dn151 shallow water (13 meter) reference surface. Depths from 7111 are on average 0.14 meters shallower than depths from the 7125 with a standard deviation of 0.06 meters.

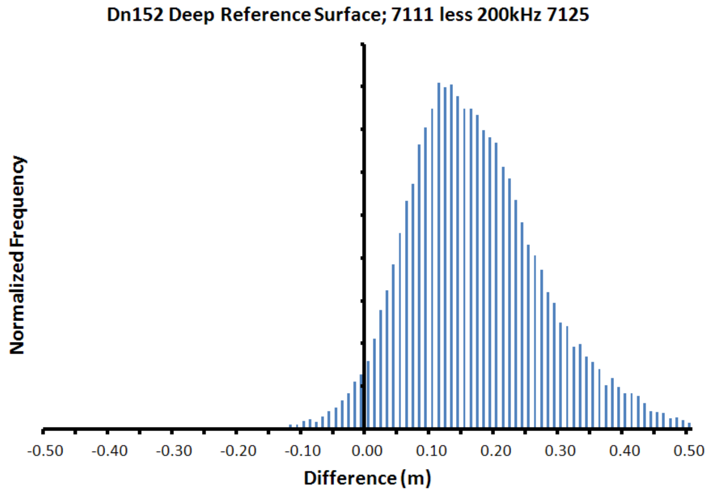

Figure 15: Distribution of depth differences, 7111 less port 200kHz 7125 for Dn152 deep water (80 meter) reference surface. Depths from 7111 are on average 0.17 meters deeper than depths from the 7125 with a standard deviation of 0.34 meters. Tidal vertical control in this area has high errors.

A.2.3 Single Beam Echosounders

A.2.3.1 Odom CV-200

<table>
<tr><td>Manufacturer</td><td colspan="2">Odom</td></tr>
<tr><td>Model</td><td colspan="2">CV-200</td></tr>
<tr><td>Description</td><td colspan="2">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 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 efficiently 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 rowspan="3">Serial Numbers</td><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>
</table>

Specifications	*Frequency*	200 kilohertz		24 kilohertz	
	Beamwidth	*Along Track*	4 degrees	*Along Track*	20 degrees
		Across Track	4 degrees	*Across Track*	20 degrees
	Max Ping Rate	100 hertz		100 kilohertz	
	Depth Resolution	0.01 meters		0.01 meters	
	Depth Rating	*Manufacturer Specified*	200 meters	*Manufacturer Specified*	6000 meters
		Ship Usage	50 meters	*Ship Usage*	700 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.				
System Accuracy Tests	System accuracy test was not performed.				

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	2012-05-23	2012-05-23
	Procedures	The wet lead line was stretched on relatively flat ground and compared with a fiberglass survey tape. Values were recorded of true measurements at lead line markings.	The wet lead line was stretched on relatively flat ground and compared with a fiberglass 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 V4
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.

<table>
<tr><td rowspan="7">PCS</td><td>Manufacturer</td><td colspan="3">Applanix</td></tr>
<tr><td>Model</td><td colspan="3">POS/MV 320 V4</td></tr>
<tr><td>Description</td><td colspan="3">Rack mounted POS control system located in charting lab.</td></tr>
<tr><td>Firmware Version</td><td colspan="3">3.37</td></tr>
<tr><td>Software Version</td><td colspan="3">5.1.0.2</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td colspan="2">S250 (port hull)</td></tr>
<tr><td>PCS s/n</td><td colspan="2">3187</td></tr>
<tr><td rowspan="7">IMU</td><td>Manufacturer</td><td colspan="3">Applanix</td></tr>
<tr><td>Model</td><td colspan="3">LN200</td></tr>
<tr><td>Description</td><td colspan="3">Inertial measurement system consisting of three orthogonal accelerometers and three orthogonal fiber-optic gyroscopes. Located in the port hull near 7125 wet end.</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td colspan="2">S250 (port hull)</td></tr>
<tr><td>IMU s/n</td><td colspan="2">804</td></tr>
<tr><td rowspan="2">Certification</td><td>IMU s/n</td><td colspan="2">804</td></tr>
<tr><td>Certification Date</td><td colspan="2">2011-05-18</td></tr>
<tr><td rowspan="7">Antennas</td><td>Manufacturer</td><td colspan="3">Trimble</td></tr>
<tr><td>Model</td><td colspan="3">Zepher I</td></tr>
<tr><td>Description</td><td colspan="3">GPS 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 these two antennae is approximately 2 meters.</td></tr>
<tr><td rowspan="4">Serial Numbers</td><td>Vessel Installed On</td><td>S250 Port Fwd</td><td>S250 Port Aft</td></tr>
<tr><td>Antenna s/n</td><td>60240385</td><td>60244128</td></tr>
<tr><td>Port or Starboard</td><td>Port</td><td>Port</td></tr>
<tr><td>Primary or Secondary</td><td>Primary</td><td>Secondary</td></tr>
<tr><td rowspan="2">GAMS Calibration</td><td>Vessel</td><td colspan="3">S250</td></tr>
<tr><td>Calibration Date</td><td colspan="3">2012-05-29</td></tr>
<tr><td rowspan="2">Configuration Reports</td><td>Vessel</td><td colspan="3">S250</td></tr>
<tr><td>Report Date</td><td colspan="3">2011-05-18</td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td>Applanix</td></tr>
<tr><td>Model</td><td>POS MV Version 4</td></tr>
<tr><td>Description</td><td>Tightly coupled GPS and inertial positioning and attitude sensing system for starboard hull. Inertial motion unit (IMU) is located below water line close to the starboard side 7125 wet end. GPS antennae are located on flying bridge of S250.</td></tr>
<tr><td>PCS</td><td><table>
<tr><td>Manufacturer</td><td>Applanix</td></tr>
<tr><td>Model</td><td>POS MV Version 4</td></tr>
<tr><td>Description</td><td>Rack mounted POS control system located in charting lab.</td></tr>
<tr><td>Firmware Version</td><td>3.37</td></tr>
<tr><td>Software Version</td><td>5.1.0.2</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Vessel Installed On</td><td>S250 (starboard hull)</td></tr>
<tr><td>PCS s/n</td><td>3189</td></tr>
</table></td></tr>
</table></td></tr>
<tr><td>IMU</td><td><table>
<tr><td>Manufacturer</td><td>Applanix</td></tr>
<tr><td>Model</td><td>LN200</td></tr>
<tr><td>Description</td><td>Inertial measurement system consisting of three orthogonal accelerometers and three orthogonal fiber-optic gyroscopes. Located in starboard hull near 7125 wet end.</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Vessel Installed On</td><td>S250 (starboard hull)</td></tr>
<tr><td>IMU s/n</td><td>803</td></tr>
</table></td></tr>
<tr><td>Certification</td><td><table>
<tr><td>IMU s/n</td><td>803</td></tr>
<tr><td>Certification Date</td><td>2011-09-26</td></tr>
</table></td></tr>
</table></td></tr>
</table>

<table>
<tr><td rowspan="7">Antennas</td><td>Manufacturer</td><td colspan="3">Trimble</td></tr>
<tr><td>Model</td><td colspan="3">Zepher I</td></tr>
<tr><td>Description</td><td colspan="3">GPS 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.</td></tr>
<tr><td rowspan="4">Serial Numbers</td><td>Vessel Installed On</td><td>S250 Stbd Fwd</td><td>S250 Stbd Aft</td></tr>
<tr><td>Antenna s/n</td><td>60243047</td><td>60243869</td></tr>
<tr><td>Port or Starboard</td><td>Starboard</td><td>Starboard</td></tr>
<tr><td>Primary or Secondary</td><td>Primary</td><td>Secondary</td></tr>
<tr><td rowspan="2">GAMS Calibration</td><td>Vessel</td><td colspan="3">S250 Starboard</td></tr>
<tr><td>Calibration Date</td><td colspan="3">2012-05-29</td></tr>
<tr><td rowspan="2">Configuration Reports</td><td>Vessel</td><td colspan="3">S250</td></tr>
<tr><td>Report Date</td><td colspan="3">2011-09-26</td></tr>
</table>

A.4.2 DGPS

<table>
<tr><td>Description</td><td colspan="3">Hemisphere PGS MBX Kit</td></tr>
<tr><td rowspan="5">Antennas</td><td>Manufacturer</td><td colspan="2">Hemisphere</td></tr>
<tr><td>Model</td><td colspan="2">MBX-4</td></tr>
<tr><td>Description</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S250</td></tr>
<tr><td>Antenna s/n</td><td>1113139440044</td></tr>
</table>

<table>
<tr><td rowspan="6">Receivers</td><td>Manufacturer</td><td colspan="2">Hemisphere</td></tr>
<tr><td>Model</td><td colspan="2">MBX-4</td></tr>
<tr><td>Description</td><td colspan="2"></td></tr>
<tr><td>Firmware Version</td><td colspan="2">1.0</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S250</td></tr>
<tr><td>Antenna s/n</td><td>1118144550001</td></tr>
</table>

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

<table>
<tr><td>Description</td><td colspan="4">Internal logging conductivity, temperature, and depth measuring devices. SeaCat 19-02 (Sn196093-1060) was removed from HASSLER property on 8/16/2012.</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S250</td><td>S250</td><td>S250</td></tr>
<tr><td>CTD s/n</td><td>19P65591-6918</td><td>19P32914-4480</td><td>19P36399-4642</td></tr>
<tr><td rowspan="3">Calibrations</td><td>CTD s/n</td><td>6918</td><td>4480</td><td>4642</td></tr>
<tr><td>Date</td><td>2011-10-17</td><td>2012-04-03</td><td>2012-04-10</td></tr>
<tr><td>Procedures</td><td>Initial Calibration for new equipment</td><td>Routine calibration service</td><td>Routine calibration service</td></tr>
</table>

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 Micro-CTD (SN: 7760) was removed on August 1, 2012 and replaced with FAIRWEATHER's spare AML Smart SV&P (SN:5466). This system was replaced with FAIRWEATHER's primary AML Smart SV&P sensor (SN: 5229) on October 11, 2012 (Dn285). The Micro-CTD (SN: 007760) was reinstalled following repair on December 7, 2012 (Dn342).

Serial Numbers

Vessel Installed On	S250	S250	S250
Sound Speed Profiler s/n	7760	5466	5229

Calibrations

Sound Speed Profiler s/n	7760	5466	5229
Date	2012-04-04	2010-12-22	2010-01-07
Procedures	Routine calibration service	Routine calibration service	Routine calibration service

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 sonar systems. 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 port and starboard 7125 systems and the 7111.
Serial Numbers	*Vessel Installed On*: S250 Port / S250 Stbd *Sound Speed Sensor s/n*: 4553332-0276 / 4553332-0277

Calibrations	*Sound Speed Sensor s/n*	4553332-0276	4553332-0277
	Date	2012-04-11	2012-04-11
	Procedures	Routine calibration service	Routine calibration service

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

No horizontal control equipment was utilized for data acquisition.

A.6.2 Vertical Control Equipment

No vertical control equipment was utilized for data acquisition.

A.7 Computer Hardware and Software

A.7.1 Computer Hardware

Manufacturer	Dell
Model	T3400
Description	Processing and Acquisition Computers

Serial Numbers	*Computer s/n*	FH-PROC1 Service Tag # 1PKVTK1	FH-PROC2 Service Tag # 3PSUTK1	FH-PROC3 Service Tag # 4P5VTK1	FH-PROC4 Service Tag # 2P5VPK1	FH-ACQ1 Service Tag # 101WTK1	FH-ACQ2 Service Tag # 201WTK1
	Operating System	Windows XP	Windows XP	Windows XP	Windows XP	Windows XP	Windows XP
	Use	Processing	Processing	Processing	Processing	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	1
Hotfix	1
Installation Date	2012-04-02
Use	Processing
Description	Data processing

Manufacturer	CARIS
Software Name	HIPS/SIPS
Version	7.1
Service Pack	2
Hotfix	1
Installation Date	2012-08-20
Use	Processing
Description	Data processing

Manufacturer	CARIS

Software Name	HIPS/SIPS
Version	7.1
Service Pack	2
Hotfix	2
Installation Date	2012-09-10
Use	Processing
Description	Data processing

Manufacturer	CARIS
Software Name	HIPS/SIPS
Version	7.1
Service Pack	2
Hotfix	3
Installation Date	2012-10-22
Use	Processing
Description	Data Processing

Manufacturer	CARIS
Software Name	Bathy Data Base Editor
Version	3.2
Service Pack	2
Hotfix	4
Installation Date	2012-05-11
Use	Processing
Description	Data analysis and feature management

Manufacturer	CARIS
Software Name	Bathy Data Base Editor
Version	3.2
Service Pack	2
Hotfix	7
Installation Date	2012-08-20
Use	Processing
Description	Data analysis and feature management

Manufacturer	CARIS
Software Name	Plot Composer
Version	5.2
Service Pack	
Hotfix	
Installation Date	2012-06-01
Use	Processing
Description	Mapping and plotting software

Manufacturer	Applanix
Software Name	POSPac
Version	5.4
Service Pack	1
Hotfix	
Installation Date	2012-04-02
Use	Processing
Description	Position and Attitude processing software

Manufacturer	Applanix
Software Name	POSPac
Version	6.1
Service Pack	
Hotfix	
Installation Date	2012-09-10
Use	Processing
Description	Position and Attitude processing software

Manufacturer	NOAA
Software Name	Pydro
Version	12.3
Service Pack	r3864
Hotfix	
Installation Date	2012-05-11
Use	Processing
Description	Feature management, correlation, and report generator

Manufacturer	NOAA
Software Name	Pydro
Version	12.9
Service Pack	r3952
Hotfix	
Installation Date	2012-10-22
Use	Processing
Description	Feature management, correlation, and report generator

Manufacturer	NOAA
Software Name	Velocipy
Version	12.3
Service Pack	r3864
Hotfix	
Installation Date	2012-05-11
Use	Acquisition and Processing
Description	Sound velocity download and processing software

Manufacturer	NOAA
Software Name	Velocipy
Version	12.9
Service Pack	r3952
Hotfix	
Installation Date	2012-10-22
Use	Acquisition and Processing
Description	Sound velocity download and processing software

Manufacturer	Pitney Bowes
Software Name	MapInfo
Version	10.5
Service Pack	
Hotfix	
Installation Date	2011-08-24
Use	Acquisition and Processing

Description	GIS software

Manufacturer	IVS 3D
Software Name	Fledermaus
Version	7.3
Service Pack	0a
Hotfix	
Installation Date	2011-08-08
Use	Processing
Description	Data modeling

Manufacturer	Hypack
Software Name	Hypack/Hysweep
Version	11
Service Pack	
Hotfix	
Installation Date	2011-03-16
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	5.1.0.2
Service Pack	
Hotfix	
Installation Date	2011-04-05

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. The Hypack logged .7k snippet backscatter record is not available for the dual head 7125 configuration. 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.

Until 1745 on June 21, 2012 (Dn173) surface sound speed from the starboard TSG-45 is fed into all Reson machines via RS232 serial connections. After that time, the port TSG-45 was configured to feed sound speed to all Reson machines.

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 instruction. 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 oceanographic 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 and fourty minuts based on the observed variability between casts.

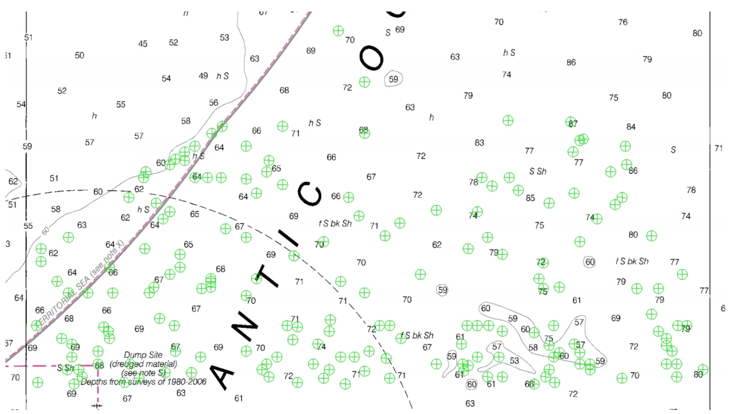

Figure 22: Example of sound speed samples taken in a survey area

B.1.3.2 Surface Sound Speed

Seabird TSG 45 thermosalinograph is used for determination of sea surface conductivity and temperature and calculate surface sound speed. The sound speed is then output to the Reson 7111 and both 7125 processing units.

B.1.4 Horizontal and Vertical Control

B.1.4.1 Horizontal Control

Applanix POS/MV files are logged using both the internal 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 internally 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 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 and/or HVCR 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 7125s, snippet size is set to 25 samples in water depths less than 50 meters and to 50 samples in depths greater than 50 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, POS view, Reson and Sonar Pro 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 swath editor and in subset mode 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 surfaces 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.

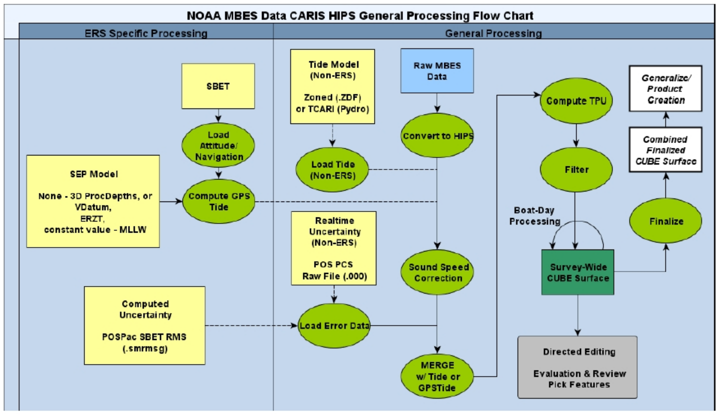

Figure 23: MBES flow diagram

B.2.1.2 Single Beam Echosounder

Single beam echosounders are not planned to be utilized during the 2012 field season other than for testing purposes.

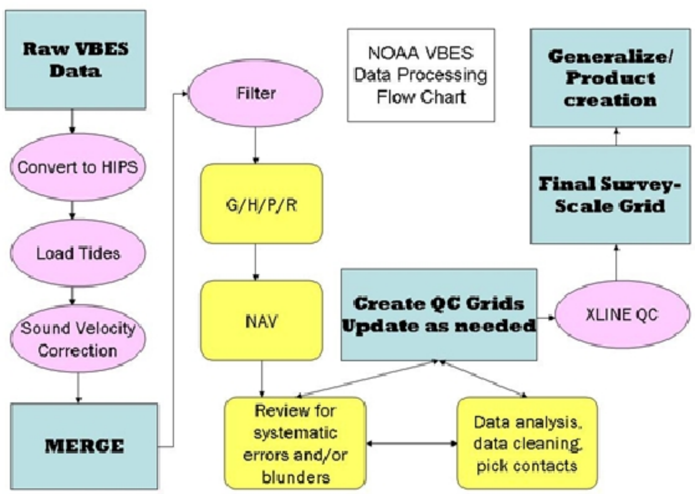

Figure 24: VBES flow diagram

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 closely examined for targets. Targets are selected and saved as contacts to a contact file for each line of SSS data. Contact selection includes measuring apparent height and width, selecting contact position and creating a contact snapshot image. Targets are exported to Pydro for correlation and processing. Significant targets (as defined in Section 6.3.2 of the Specifications and Deliverables) are surveyed 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.

Side scan sonar coverage is determined by creating mosaics using Mosaic Editor in CARIS SIPS. This processed imagery data is stored in SIPS as Georeferenced Backscatter Rasters, or GeoBaRs. From GeoBaRs, mosaics are created which can be examined and edited in Mosaic Editor.

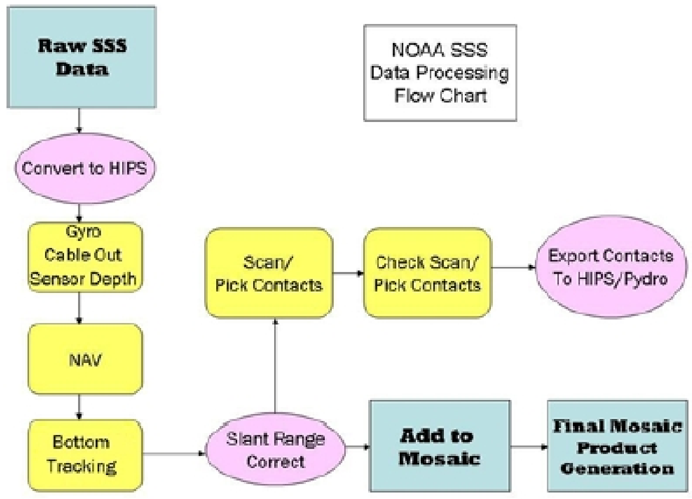

Figure 25: SSS flow diagram

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, AML Micro-CTD and Smart SV&P 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 control, specific information is included in the Descriptive Report and/or the project's Horizontal and Vertical Control Report.

If internally logged TrueHeave files contain IMU data gaps apparent during post processing then externally logged files may be examined and used if free from gaps. If this is the case the externally logged file 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 NOAA's Pydro 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 .7k 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 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 and Appendix 4 - CARIS HVF Uncertainty Values of the 2011 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*	0.05 meters
		y	0.050 meters
		z	0.050 meters
	MRU Alignment	*Gyro*	0.460 degrees
		Pitch	0.060 degrees
		Roll	0.060 degrees
	Vessel	*Speed*	0.050 meters/second
		Loading	0.050 meters
		Draft	0.050 meters
		Delta Draft	0.000 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*	0.05 meters
		y	0.050 meters
		z	0.050 meters
	MRU Alignment	*Gyro*	0.710 degrees
		Pitch	0.100 degrees
		Roll	0.100 degrees
	Vessel	*Speed*	0.050 meters/second
		Loading	0.050 meters
		Draft	0.050 meters
		Delta Draft	0.000 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*	0.00 meters
		y	0.000 meters
		z	0.000 meters
	MRU Alignment	*Gyro*	0.510 degrees
		Pitch	0.160 degrees
		Roll	0.160 degrees
	Vessel	*Speed*	0.030 meters/second
		Loading	0.040 meters
		Draft	0.050 meters
		Delta Draft	0.000 meters
Vessel	S250 (Starboard)		
Echosounder	Reson 7125 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.02 degrees
		Heave	5 % Amplitude 0.05 meters
		Pitch	0.02 degrees
		Roll	0.02 radians
	Navigation Position	1 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*	0.05 meters
		y	0.05 meters
		z	0.05 meters

	MRU Alignment	*Gyro*	0.07 degrees
		Pitch	0.31 degrees
		Roll	0.31 degrees
	Vessel	*Speed*	0.05 meters/second
		Loading	0.05 meters
		Draft	0.05 meters
		Delta Draft	0.05 meters

B.4.2 Deviations

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

Additional Discussion

During the patch tests conducted on August 27, 2012 (Dn237), 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.

For the port 7125, the MRU gyro alignment uncertainty value is 0.1 degrees with the new method compared with 0.71 degrees with the previous method. The Roll/ Pitch MRU alignment uncertainty is 0.01 degrees with the new method compared to 0.1 degrees with the previous method.

For the starboard 7125, the MRU gyro alignment uncertainty value is 0.1 degrees with the new method compared with 0.07 degrees with the previous method. The Roll/ Pitch MRU alignment uncertainty is 0.01 degrees with the new method compared to 0.31 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.

The POS GPS antennae were reconfigured before the beginning of the field season. In the previous year the antennae pairs had spanned the ship. The reconfiguration moved both port antennae to the port side and both starboard antennae to the starboard side. Each antennae pair is mounted to a 2 meter length of channel extrusion and mounted in a fore and aft orientation. A partial survey of the new antennae locations to benchmarks on the 02 level were done by ship personnel with fiberglass tape and differential leveling. The offsets were then remeasured by a NGS representative with a total station. The two surveys agreed with each other within 0.04 meters. The POS IMU to antennae offsets were also solved for using iterative solutions of the position and offsets using six days of logged underway navigation data in POSPac.

The difference between the surveyed offsets and the iteratively derived offsets were 0.02 to 0.07 meters in the x and y directions, but approximately 0.23 meters in the z (vertical) for both the port and starboard antennae. The ellipsoid referenced leadline experiment described in section A.2.2 confirmed that the POSPac derived vertical offset values agreed with the leadline measured values within 0.03 meters with a measurement uncertainty of 0.03 meters. Accordingly, the POSPac derived offsets for x,y, and z have been used as the IMU to antennae offsets in POS and for all navigation post-processing, and are tabulated below. This result suggests an error in the original 2009 survey. The uncertainty of the original survey is not well documented.

C.1.1.3 Vessel Offset Correctors

Vessel	S250 Port		
Echosounder	Reson 7125 400 kilohertz		
Date	2012-05-01		
Offsets	*MRU to Transducer*	*x*	-1.244 meters
		y	0.362 meters
		z	1.486 meters
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	-2.246 meters
		y	-2.351 meters
		z	14.373 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	4.500 degrees
		Roll2	
Vessel	S250 Starboard		
Echosounder	Reson 7125 400 kilohertz		
Date	2012-05-01		
Offsets	*MRU to Transducer*	*x*	1.424 meters
		y	0.380 meters
		z	1.493 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	4.528 meters
		y	-2.320 meters
		z	14.364 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	-4.5 degrees
		Roll2	
Vessel	S250		
Echosounder	Reson 7111 100 kilohertz		
Date	2011-07-20		
Offsets	*MRU to Transducer*	*x*	1.203 meters
		y	11.678 meters
		z	1.180 meters
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	4.282 meters
		y	8.999 meters
		z	13.702 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	S250		
Echosounder	Odom Echotrac CV200 24 kilohertz		
Date	2012-05-01		
Offsets	*MRU to Transducer*	*x*	-0.455 meters
		y	4.620 meters
		z	1.325 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.000 meters
		y	0.000 meters
		z	0.000 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	

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

<table>
<tr><td>Vessel</td><td colspan="3">S250</td></tr>
<tr><td>Echosounder</td><td colspan="3">Klein 5250 455 kilohertz</td></tr>
<tr><td>Date</td><td colspan="3">2011-05-26</td></tr>
<tr><td rowspan="4">Layback</td><td rowspan="3">Towpoint</td><td>x</td><td>7.161 meters</td></tr>
<tr><td>y</td><td>-26.032 meters</td></tr>
<tr><td>z</td><td>-9.347 meters</td></tr>
<tr><td>Layback Error</td><td colspan="2">0.00 meters</td></tr>
</table>

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 3.85 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 3.85 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. 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 2012 FPM on September 28, 2012 (Dn272). An area was selected offshore of Cape Charles 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 third order polynomial results for the dynamic draft curves from the port and starboard side were averaged. These results were significantly different from the 2011 values, with a 0.15 meter difference at typical survey speeds from the prior year. The 2012 results are shown in Figure 26 and have been applied to all data acquired in this project.

C.2.2.3 Dynamic Draft Correctors

Vessel	S250
Date	2012-01-01

Dynamic Draft Table

Speed	0 meters/second	3 meters/second	3.5 meters/second	4.0 meters/second	4.5 meters/second	5 meters/second	5.5 meters/second	6.0 meters/second	6.5 meters/second	7.0 meters/second
Draft	0 meters	0 meters	0.01 meters	0.03 meters	0.05 meters	0.07 meters	0.09 meters	0.11 meters	0.14 meters	0.16 meters

Additional Discussion

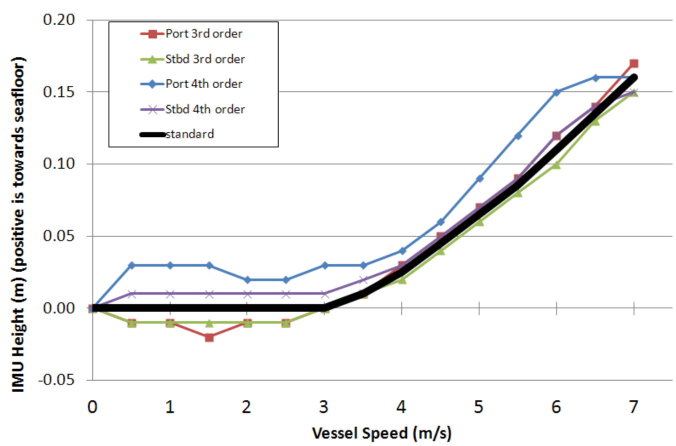

Figure 26: Dynamic draft derived from ERDDM methods. Positive values are displacements of the IMU towards the sea floor. Thin lines are results from port and starboard head for third and fourth order polynomial fits. Black bold line is dynamic draft value used for both hulls.

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 2011 FPM.

C.3.3 System Alignment Correctors

Vessel	S250	
Echosounder	Reson 7125 Starboard 400 kilohertz	
Date	2012-01-01	
Patch Test Values	*Navigation Time Correction*	0.00 seconds
	Pitch	-0.02 degrees
	Roll	0.05 degrees
	Yaw	2.62 degrees
	Pitch Time Correction	0.00 seconds
	Roll Time Correction	0.00 seconds
	Yaw Time Correction	0.00 seconds
	Heave Time Correction	0.00 seconds
Vessel	S250	
Echosounder	Reson 7125 Starboard 400 hertz	
Date	2012-08-01	
Patch Test Values	*Navigation Time Correction*	0 seconds
	Pitch	1.5 degrees
	Roll	-0.030 degrees
	Yaw	0.230 degrees
	Pitch Time Correction	0 seconds
	Roll Time Correction	0 seconds
	Yaw Time Correction	0 seconds
	Heave Time Correction	0 hertz
Vessel	S250	
Echosounder	Reson 7125 Port 400 kilohertz	
Date	2012-01-01	

<table>
<tr><td rowspan="8">Patch Test Values</td><td>Navigation Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Pitch</td><td>1.10 degrees</td></tr>
<tr><td>Roll</td><td>-0.01 degrees</td></tr>
<tr><td>Yaw</td><td>2.61 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Vessel</td><td colspan="2">S250</td></tr>
<tr><td>Echosounder</td><td colspan="2">Reson 7125 Port 400 kilohertz</td></tr>
<tr><td>Date</td><td colspan="2">2012-08-01</td></tr>
<tr><td rowspan="8">Patch Test Values</td><td>Navigation Time Correction</td><td>0 seconds</td></tr>
<tr><td>Pitch</td><td>1.5 degrees</td></tr>
<tr><td>Roll</td><td>-0.03 degrees</td></tr>
<tr><td>Yaw</td><td>0.230 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0 seconds</td></tr>
<tr><td>Vessel</td><td colspan="2">S250</td></tr>
<tr><td>Echosounder</td><td colspan="2">Reson 7125 Port 200 kilohertz</td></tr>
<tr><td>Date</td><td colspan="2">2012-01-01</td></tr>
<tr><td rowspan="8">Patch Test Values</td><td>Navigation Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Pitch</td><td>-0.28 degrees</td></tr>
<tr><td>Roll</td><td>-0.03 degrees</td></tr>
<tr><td>Yaw</td><td>1.97 degrees</td></tr>
<tr><td>Pitch Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Roll Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Yaw Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Heave Time Correction</td><td>0.00 seconds</td></tr>
<tr><td>Vessel</td><td colspan="2">S250</td></tr>
<tr><td>Echosounder</td><td colspan="2">Reson 7111 100 kilohertz</td></tr>
<tr><td>Date</td><td colspan="2">2012-05-31</td></tr>
</table>

Patch Test Values	*Navigation Time Correction*	0.00 seconds
	Pitch	-0.62 degrees
	Roll	-0.13 degrees
	Yaw	1.58 degrees
	Pitch Time Correction	0.00 seconds
	Roll Time Correction	0.00 seconds
	Yaw Time Correction	0.00 seconds
	Heave Time Correction	0.00 seconds

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.

On October 11, 2012 (Dn285) the heave lever arm was changed 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 surveys 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 vessel 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 sheets 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-D304-FH-12, Approaches to Chesapeake Bay, 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 (4/2012); Hydrographic Survey Technical Directives 2010-2, 2011-3, 2012-1; and the Field Procedures Manual for Hydrographic Surveying (4/2012).

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 H12423, H12424, H12501, H12502, H12503, H12504, and H12505 which were completed in 2012.

Approved and Forwarded:

LT Samuel F. Grenaway, NOAA
Field Operations Officer

LCDR Benjamin K. Evans, NOAA
Chief of Party