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-A321-FH-14**
Registry No.	**H12696, H12697, H12698**
Time Frame	**17 April 2014 - 30 May 2014**

LOCALITY

State	**Maine, New Hampshire**
General Locality	**Approaches to Portsmouth**

2014

CHIEF OF PARTY

LCDR Marc S. Moser, NOAA

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DATE

Table of Contents

Data Acquisition and Processing Report

NOAA Ship *Ferdinand R. Hassler*
Chief of Party: LCDR Marc S. Moser, NOAA
Year: 2014
Version: 1.0
Publish Date: 2014-06-01

A Equipment

A.1 Survey Vessels

A.1.1 NOAA Ship FERDINAND R. HASSLER

<table>
<tr><td>Name</td><td>NOAA Ship FERDINAND R. HASSLER</td></tr>
<tr><td>Hull Number</td><td>S250</td></tr>
<tr><td>Description</td><td>FERDINAND R. HASSLER is a Small Waterplane Area, Twin-Hull (SWATH) coastal mapping vessel.</td></tr>
<tr><td>Utilization</td><td>Survey</td></tr>
<tr><td>Dimensions</td><td><table><tr><td>LOA</td><td>37.7 meters</td></tr><tr><td>Beam</td><td>18.5 meters</td></tr><tr><td>Max Draft</td><td>3.85 meters</td></tr></table></td></tr>
<tr><td>Most Recent Full Static Survey</td><td><table><tr><td>Date</td><td>2009-11-04</td></tr><tr><td>Performed By</td><td>Raymond C. Impastato, Professional Land Surveyor</td></tr><tr><td>Discussion</td><td>This survey was provided by the shipbuilder, V.T. Halter Marine, and performed in the shipyard prior to delivery.</td></tr></table></td></tr>
<tr><td>Most Recent Partial Static Survey</td><td><table><tr><td>Date</td><td>2012-06-12</td></tr><tr><td>Performed By</td><td>Kevin Jordan, NGS</td></tr><tr><td>Discussion</td><td>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.</td></tr></table></td></tr>
</table>

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 to each sensor mounted on the ship's 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 3.8 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 a true waterline of 3.77 meters. Draft uncertainty is estimated at 0.05 meters. See Section C.2.1.1 for additional discussion.
Most Recent Dynamic Draft Determination	*Date*	2014-04-25
	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. Averages are being calculated from all ERDDM tests since the installation of the buoyancy appendages in 2013. This will help filter out errors located in individual tests.

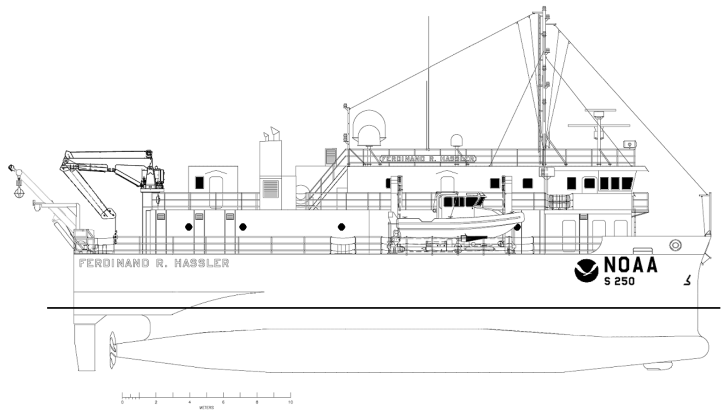

Figure : NOAA Ship FERDINAND R. HASSLER, Starboard View

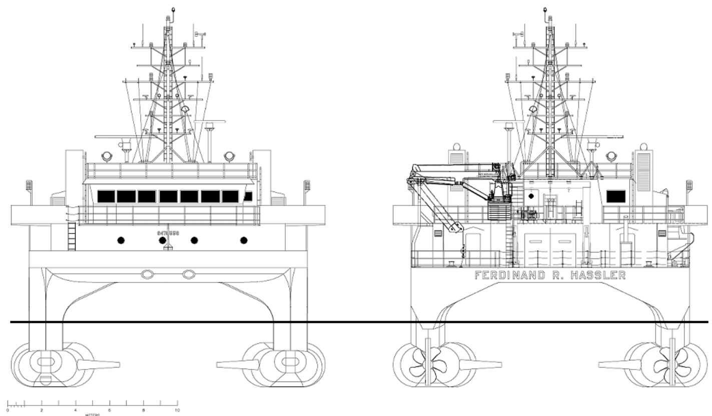

Figure : NOAA Ship FERDINAND R. HASSLER, Bow and Stern View

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 March 3, 2014.

A side scan calibration was conducted on April 25, 2014 (Dn115) in the vicinity of Isles of Shoals, NH, with towfish SN: 386.

In this test a number of lines were run adjacent to known rock. The side scan positions are compared with the multibeam positions in the attached report. The 95% confidence interval of the positioning error is 11.2 meters. This error exceeds the threshold established in the 2014 Field Procedures Manual, and SSS data were not used for contact positioning during acquisition of this project. Side Scan data were only used for more information on potential developments. 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	2014-04-25

Figure : 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. Patch Tests - A patch test for the 400kHz and 200kHz modes was conducted on April 16, 2014 (Dn106) in the vicinity of Isles of Shoals, NH.

<table>
<tr><td></td><td>Reference Surfaces -

A reference surface for the 400kHz and 200kHz modes was conducted on April 16, 2014 (Dn106) in the vicinity of Ipswich Bay, MA.</td></tr>
<tr><td>Serial Numbers</td><td>
<table>
<tr><td>Vessel Installed On</td><td>S250</td><td>same</td></tr>
<tr><td>Processor s/n</td><td>18210412051</td><td>same</td></tr>
<tr><td>Transceiver s/n</td><td>212036</td><td>same</td></tr>
<tr><td>Transducer s/n</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Receiver s/n</td><td>2411045</td><td>same</td></tr>
<tr><td>Projector 1 s/n</td><td>2611093</td><td>same</td></tr>
<tr><td>Projector 2 s/n</td><td>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>1.0 degrees</td><td>Along Track</td><td>2 degrees</td></tr>
<tr><td>Across Track</td><td>0.5 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>
</table>

System Accuracy Tests	*Vessel Installed On*	S250	S250
	Methods	Reference surface comparison	Ellipsoidal Referenced Lead Line and Water Line
	Results	Reference surfaces were performed in the vicinity of Ipswich Bay, MA on April 16, 2014 (Dn106). The location of the reference surfaces are shown in Figure 6. The 7125 400kHz sonars were operated in dual head FM, and single head FM. For the 400kHz systems, the starboard head was on average 0.02 meters deeper with a standard deviation of 0.06.	On March 5, 2014 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 Judd Gregg Marine Research Complex, 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 0.03 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 0.04 meters deeper than lead-line derived depths with a propagated error of 0.06 meters. The uncertainty of the measurement is dominated by the uncertainty in reading ship draft marks. This test was repeated for the starboard 7125 system. Results show the sonar depth 0.01 meters deeper than the lead-line derived depths with a propagated uncertainty of 0.03 meters. For the waterline; sonar measured depths were an average of 0.15 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 : 7125 Housing flush mounted on hull

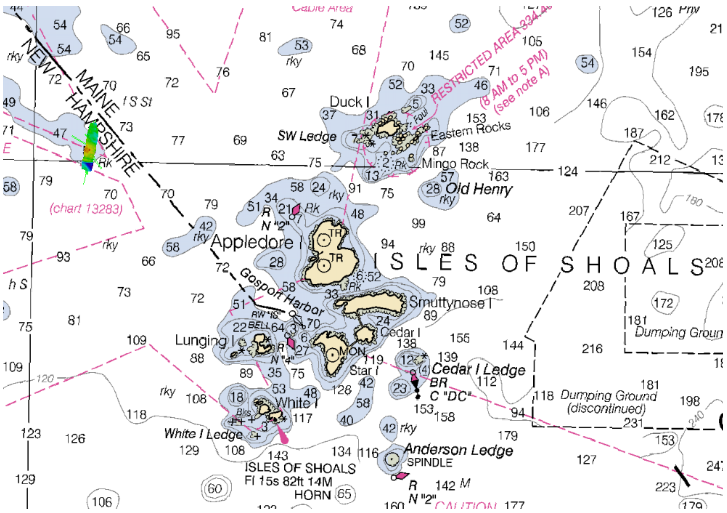

Figure : General location of Dn106 patch test in vicinity of Isles of Shoals, NH. Charted depths are in feet.

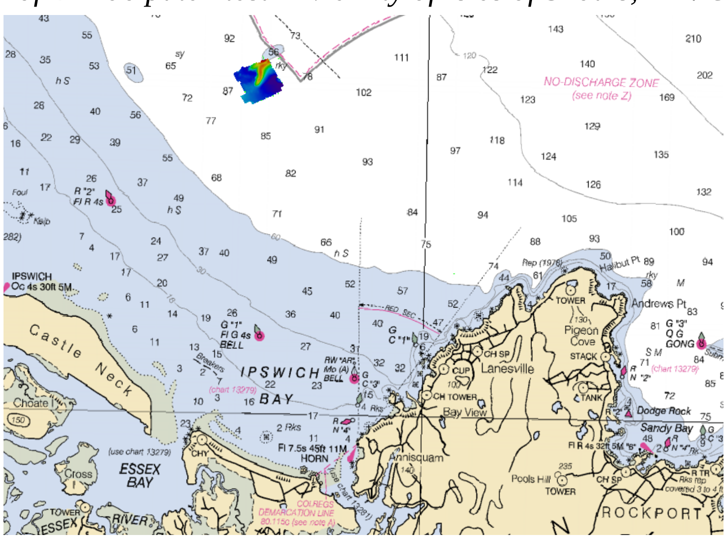

Figure : General location of Dn106 reference surface in vicinity of Ipswich Bay, MA. Charted depths are in feet.

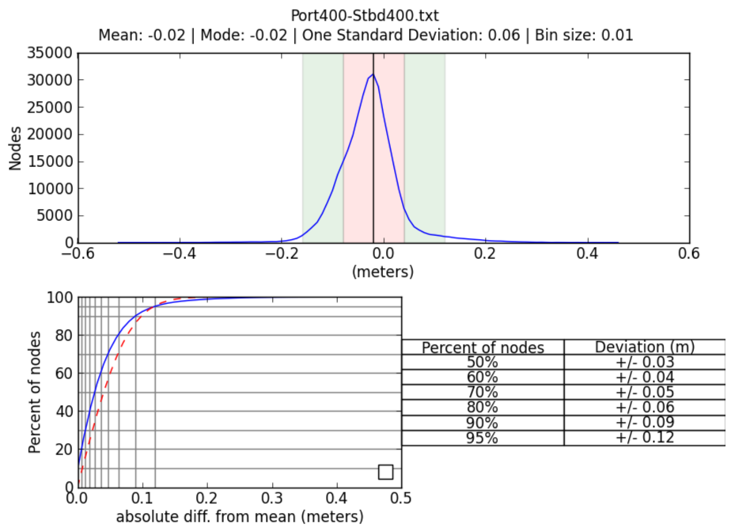

Figure : Distribution of depth differences, port minus starboard for Dn106 reference surface. Depths from starboard are on average 0.02 meters deeper than depths from port system with a standard deviation of 0.06 meters. Sonars configured in FM simultaneous pinging configuration.

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.		
Serial Numbers	*Vessel Installed On*	S250	same
	Processor s/n	18215011048	same
	Transceiver s/n	212035	same
	Transducer s/n	n/a	n/a
	Receiver s/n	85002184	same
	Projector 1 s/n	1111236	same
	Projector 2 s/n	n/a	n/a

Specifications	*Frequency*	400 kilohertz		200 kilohertz	
	Beamwidth	*Along Track*	0.5 degrees	*Along Track*	2 degrees
		Across Track	1 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	System accuracy test was not performed.				
Snippets	Sonar has snippets logging capability.				

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 April 17, 2014 (Dn107) in the vicinity of Boon Island, ME.	
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

<table>
<tr><td rowspan="11">Specifications</td><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>
<tr><td colspan="3"></td></tr>
<tr><td>Manufacturer Calibrations</td><td colspan="3">Manufacturer calibration was not performed.</td></tr>
</table>

System Accuracy Tests	*Vessel Installed On*	S250	S250
	Methods	Reference surface comparison	Ellipsoidal Referenced Lead Line and Water Line
	Results	Reference surfaces were performed in the vicinity of Ipswich Bay, MA on April 16, 2014 (Dn106). The location of the reference surfaces are shown in Figure 6. For the 100kHz system, the 7111 was on average 0.26 meters deeper than depths from the 7125 with a standard deviation of 0.11 meters. This suggests that the offsets for the 7111 may have a slight bias. For the depths that the 7111 will be used this offset will amount to a small percentage of the allowable total vertical uncertainty. The results of this test are shown in Figure 10.	On March 5, 2014 (Dn064) a static lead line comparison was performed relative to the ellipsoid for the 7111 system. Ellipsoid height was obtained on a fixed mark ashore using static GPS observations. While the ship was pierside at Judd Gregg Marine Research Complex, a lead-line was lowered to the sea floor in the 7111 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 0.23 meters deeper 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. The uncertainty of the measurement is dominated by the uncertainty in reading ship draft marks. The results of these tests reinforce the findings of the reference surface results in that offsets for the 7111 may have a slight bias. Again, for the depths that the 7111 will be used this offset will amount to a small percentage of the allowable total vertical uncertainty.
Snippets	Sonar has snippets logging capability.		

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

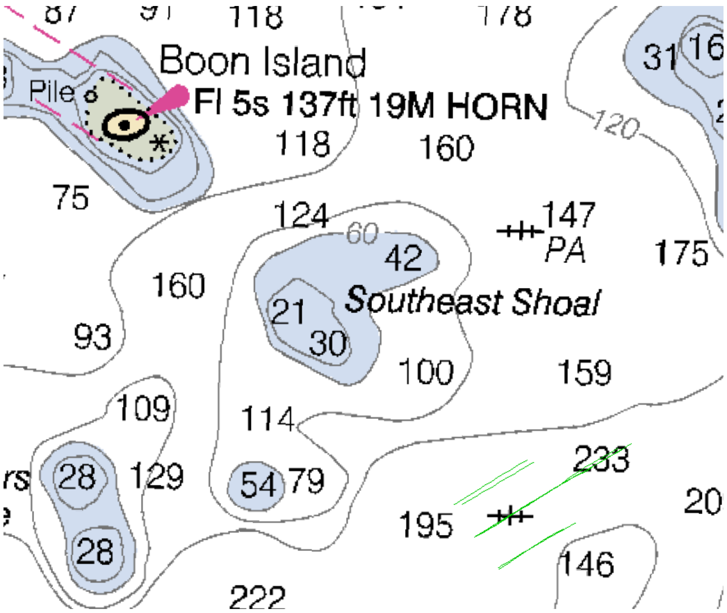

Figure : General location of Dn107 patch test in vicinity of Boon Island, ME. Charted depths are in feet.

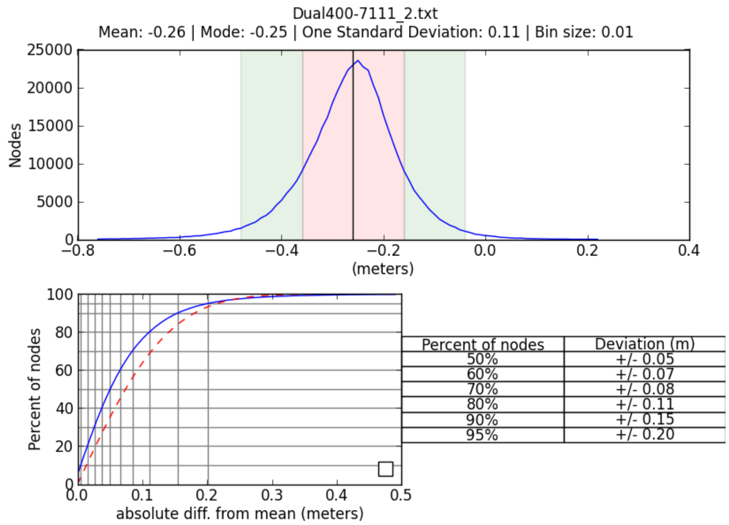

Figure : Distribution of depth differences, dual-head 400kHz 7125 less 7111 for Dn106 reference surface. Depths from 7111 are on average 0.26 meters deeper than depths from the 7125 with a standard deviation of 0.11 meters.

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 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.
Serial Numbers	*Vessel*: S250 *Processor s/n*: 3038 *Transducer s/n*: unknown

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	*Vessel Installed On*	S250			
	Methods	Sounding systems comparison			
	Results	Sounding comparisons were made while at anchor using the dual-frequency vertical beam echosounder, both port and starboard 7125 systems, the 7111, divers least depth gauge and lead line on April 15, 2014. Sea state was choppy with an estimated 1-2 foot seas. 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 0.49 meters deeper than the lead line measurement, 0.23 meters deeper than the Port 7125 measurements, 0.13 meters deeper than the Starboard 7125 measurements and 0.04 meters deeper than the 7111 . 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.			

Figure : 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

Manufacturer	In-Situ Inc.
Model	Rugged TROLL 100 / Rugged BaroTROLL
Description	The Rugged TROLL 100 is a non-vented (absolute) data logger that measures and records changes in water level, pressure, and temperature. When post-processed with an accompanying CTD cast and tide value, accurate least depths on submerged objects can be obtained. The Rugged BaroTROLL is a data logger used to measure and record barometric pressure, which is used to compensate for changes in water level due to barometric fluctuations. Typically the BaroTROLL is not used for dive operations but may prove to be beneficial for least depth investigations in the future.
Serial Numbers	349000 - Rugged TROLL 100 349047 - Rugged BaroTROLL
Calibrations	No calibrations were performed.
Accuracy Checks	*Serial Number*: 349000 *Date*: 2014-04-15 *Procedures*: Sounding System Comparison - The DLDG was taped to the leadline while recording and submerged to the seafloor for a measurement. A cast was taken during the comparison and the data gathered were processed using Velocipy. The DLDG results were 0.13 meters deeper than the leadline measurement, 0.13 and 0.23 meters shallower than the port and starboard 7125 values, respectively.
Correctors	Correctors were not determined.
Non-Standard Procedures	Non-standard procedures were not utilized.

A.3.2 Lead Lines

Manufacturer	Unknown
Model	Traditional
Description	FERDINAND R. HASSLER is equipped with one lead line. Lead lines are used for measurements near shore over submerged shoals and for echosounder depth comparisons.
Serial Numbers	RA6S
Calibrations	No calibrations were performed.
Accuracy Checks	*Serial Number*: RA6S *Date*: 2014-03-03 *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.
Correctors	From the table of values obtained during the accuracy checks a table of correctors was calculated. This table is stored locally aboard the FERDINAND R. HASSLER and referenced when appropriate.
Non-Standard Procedures	Non-standard procedures were not utilized.

Figure : 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

<table>
<tr><td rowspan="5">Antennas</td><td>Manufacturer</td><td colspan="2">Trimble</td><td></td></tr>
<tr><td>Model</td><td colspan="3">382AP GNSS</td></tr>
<tr><td>Description</td><td colspan="3">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.</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S250 Port (forward)</td><td>S250 Port (aft)</td></tr>
<tr><td colspan="3"><table>
<tr><td>Antenna s/n</td><td>8848</td><td>8839</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>
</table></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">2014-04-15</td></tr>
<tr><td>Configuration Reports</td><td colspan="4">POS/MV configuration reports were not produced.</td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td colspan="3">Applanix</td></tr>
<tr><td>Model</td><td colspan="3">POS/MV 320 V5</td></tr>
<tr><td>Description</td><td colspan="3">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. The V5 system was installed on July 29, 2013.</td></tr>
<tr><td rowspan="7">PCS</td><td>Manufacturer</td><td colspan="2">Applanix</td></tr>
<tr><td>Model</td><td colspan="2">POS/MV 320 V5</td></tr>
<tr><td>Description</td><td colspan="2">Rack mounted POS control system located in charting lab.</td></tr>
<tr><td>Firmware Version</td><td colspan="2">7.61</td></tr>
<tr><td>Software Version</td><td colspan="2">7.60</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S250 Starboard</td></tr>
<tr><td>PCS s/n</td><td>5807</td></tr>
</table>

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	2014-04-15		
Configuration Reports	POS/MV configuration reports were not produced.			

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>
<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

Manufacturer	Laser Technology Inc
Model	TruPulse 360R
Description	Rugged and waterproof laser rangefinder which provides full measurement capabilities of distances, heights and azimuths.
Serial Numbers	2557
DQA Tests	DQA test was not performed.

Figure : TruPulse 360R Laser Rangefinder

A.4.5 Other Positioning and Attitude Equipment

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

A.5 Sound Speed Equipment

A.5.1 Sound Speed Profiles

A.5.1.1 CTD Profilers

A.5.1.1.1 Sea-Bird 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	2014-03-13	2014-02-22	2014-02-25
	Procedures	Routine calibration service	Routine calibration service	Routine calibration service

Figure : Ferdinand R. Hassler CTD inventory

A.5.1.2 Sound Speed Profilers

A.5.1.2.1 Brooke Ocean MVP-200

Manufacturer	Brooke Ocean
Model	MVP-200

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 outfitted on September 27th, 2013. The AML Micro-CTD sensor was installed March 3rd after returning from calibration 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	2014-02-26	2014-02-26
	Procedures	Routine calibration service	Routine calibration service

Figure : MVP control station & winch

Figure : 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, and as a backup sound speed input available for beam steering of the multibeam 7125 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 Reson 7111 and SCS acquisition server.
Serial Numbers	*Vessel Installed On*: S250 Port / S250 Starboard *Sound Speed Sensor s/n*: 4553332-0276 / 4553332-0277

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	2014-03-19	2014-03-10
	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. SVP-70 probe 2011276, which would normally be on the Port hull, was not installed for this project.		
Serial Numbers	*Vessel Installed On*	S250 Starboard hull	S250 Port hull
	Sound Speed Sensor s/n	2011278	2011276
Calibrations	*Sound Speed Sensor s/n*	2011278	2011276
	Date	2014-03-12	2014-03-26
	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. Comparison casts between a SeaCat 19+ and the MVP are conducted once a project or if any issues with the MVP sensor are suspected. The results of these tests are included in the Separates section of each survey. In addition, the two TSGs and two SVP-70 sensors are fed into NOAA SCS software for real-time monitoring and post-processing if warranted. Surface sound speed comparisons were performed each day between an MVP cast and the TSGs and Starboard SVP-70.

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

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

<table>
<tr><td>Manufacturer</td><td>Dell</td></tr>
<tr><td>Model</td><td>T3400</td></tr>
<tr><td>Description</td><td>Acquisition Computers</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Computer s/n</td><td>FH-ACQ1 Service Tag # 101WTK1</td><td>FH-ACQ2 Service Tag # 201WTK1</td><td>FH-ACQ3 Service Tag # 6P5VTK1</td></tr>
<tr><td>Operating System</td><td>Windows 7</td><td>Windows 7</td><td>Windows 7</td></tr>
<tr><td>Use</td><td>Acquisition</td><td>Acquisition</td><td>Acquisition</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td>Cybertron PC</td></tr>
<tr><td>Model</td><td>Generic</td></tr>
<tr><td>Description</td><td>Processing Computer</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Computer s/n</td><td>FH-PROC5 Service Tag # FQC-00765</td></tr>
<tr><td>Operating System</td><td>Windows 7</td></tr>
<tr><td>Use</td><td>Processing</td></tr>
</table></td></tr>
</table>

A.7.2 Computer Software

Manufacturer	CARIS
Software Name	HIPS/SIPS
Version	8.1
Service Pack	7
Hotfix	
Installation Date	2014-03-12
Use	Processing
Description	Data Processing

Manufacturer	CARIS
Software Name	HIPS/SIPS
Version	8.1
Service Pack	8
Hotfix	
Installation Date	2014-05-24
Use	Processing
Description	Data Processing. Software update installed for bug fixes, primarily surface generation issues for high resolution (2-meter or higher) surfaces.

Manufacturer	CARIS
Software Name	Bathy BASE Editor
Version	4.0
Service Pack	9
Hotfix	
Installation Date	2014-03-12
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	6.2
Service Pack	1
Hotfix	
Installation Date	2014-03-12
Use	Processing
Description	Position and Attitude processing software

Manufacturer	NOAA
Software Name	Pydro
Version	14.6
Service Pack	r4689
Hotfix	
Installation Date	2014-05-16
Use	Processing
Description	Feature management, correlation, and report generator

Manufacturer	NOAA
Software Name	Velocipy
Version	14.6
Service Pack	r4689
Hotfix	
Installation Date	2014-05-16
Use	Acquisition and Processing
Description	Sound velocity download and processing software

Manufacturer	Pitney Bowes
Software Name	MapInfo
Version	11.5
Service Pack	
Hotfix	

Installation Date	2014-03-12
Use	Acquisition and Processing
Description	GIS software

Manufacturer	IVS 3D
Software Name	Fledermaus
Version	7
Service Pack	3
Hotfix	6
Installation Date	2014-01-10
Use	Processing
Description	Data modeling

Manufacturer	Hypack
Software Name	Hypack/Hysweep
Version	2014
Service Pack	0
Hotfix	16
Installation Date	2014-02-18
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	7.6
Service Pack	

Hotfix	
Installation Date	2013-07-26
Use	Acquisition
Description	Positioning

Manufacturer	Synergy
Software Name	Synergy
Version	1.4.14
Service Pack	
Hotfix	
Installation Date	2014-02-17
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. A custom mount equipped with camera and light was designed for the acquisition of video of the seafloor. This allows for the classification of bottom samples without successfully obtaining a sediment sample. Prior to May 14, 2014 this technique was limited to bottom sample locations at depths less than 40 meters. An additional camera housing was acquired on May 14 that allows this technique to be utilized in depths up to 274 meters.

Figure : Ponar grab sampler

Figure : Camera with custom mount allowing for high quality video of the seafloor

A.8.1.2 Go Pro Hero 3

Manufacturer	Go Pro
Model	Hero 3
Description	Video camera rigged as a drop camera to function along with grab sampler. The camera contains a 12 MP sensor capable of 1440p at 48fps. This camera supplements the data gathered with the grab sampler, and allows the field unit to

	provide data from null samples from the sediment sampler. All bottom samples are submitted with still pictures taken from the video.

Figure : Go Pro video camera.

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/Hysweep 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 changes during acquisition are minimal.

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 20.

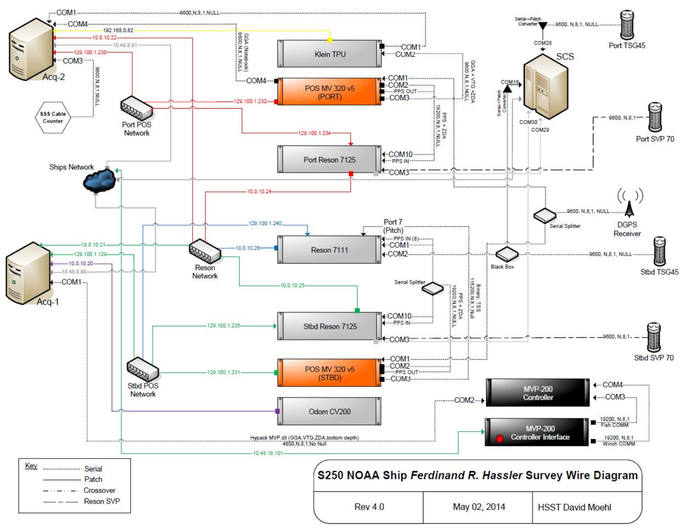

Figure : Ship survey systems wiring diagram

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 four hours based on the observed variability between casts and is discussed in the Descriptive Report of each survey.

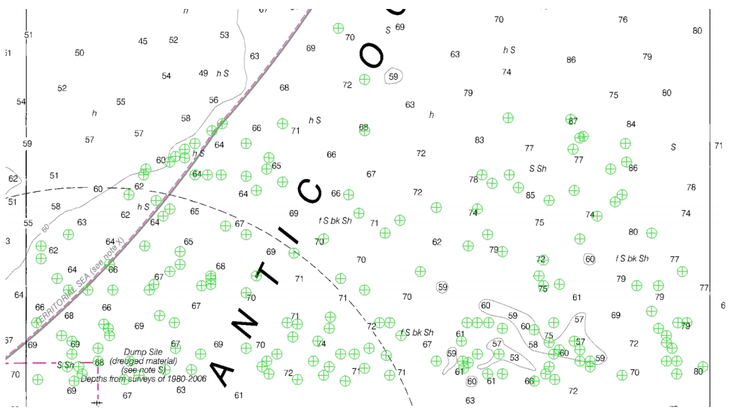

Figure : Example of sound speed samples taken in a survey area

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. Data from all surface sound speed sensors are fed into SCS for real time comparison and are recorded during MVP or CTD casts to perform surface sound speed DQAs. Surface sound speed DQAs were performed once a day for each surface sound speed sensor.

B.1.4 Horizontal and Vertical Control

B.1.4.1 Horizontal Control

Applanix POS/MV files are logged using both the USB logging function and 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 and midnight 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.

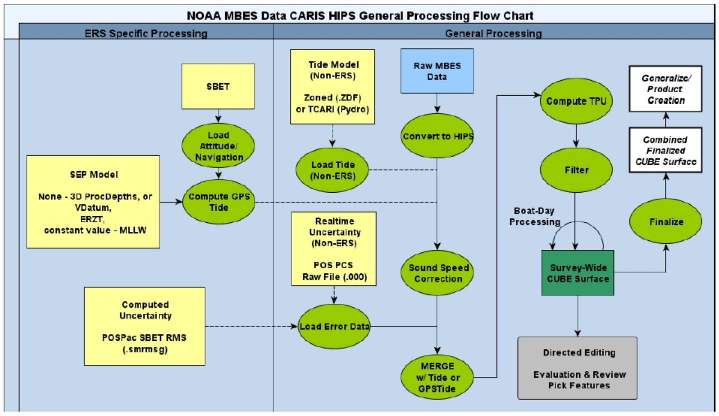

Figure : MBES flow diagram

B.2.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not processed.

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

Quality control logs are used to track and communicate problems from during 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.

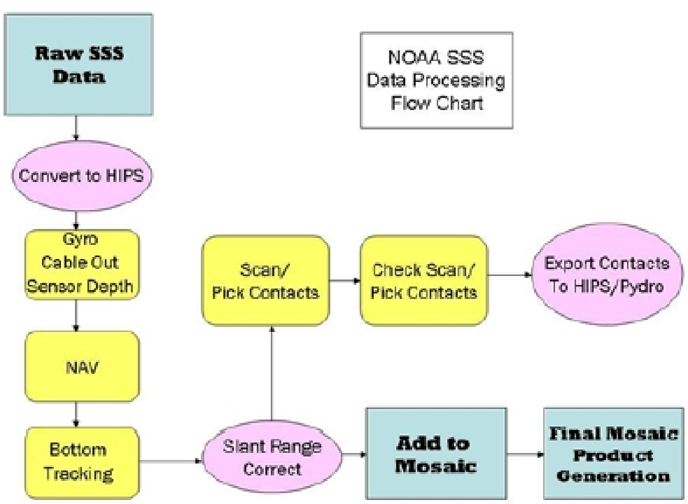

Figure : SSS flow diagram

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 : 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 : 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 : 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 : no figure

B.2.5 Feature Verification

Features are processed using CARIS BASE Editor 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 : 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 : 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 Field 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 m/s
		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*	0.027 degrees
		Pitch	0.04 degrees
		Roll	0.04 degrees
	Vessel	*Speed*	0.050 m/s
		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 m/s
		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 m/s
		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 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*	0.090 degrees
		Pitch	0.030 degrees
		Roll	0.030 degrees
	Vessel	*Speed*	0.050 m/s
		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 400 kilohertz		
Date	2013-07-01		
Offsets	*MRU to Transducer*	*x*	-1.244 meters
		y	0.362 meters
		z	1.349 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-2.246 meters
		y	-2.351 meters
		z	14.269 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	4.500 degrees
		Roll2	
Vessel	S250 Starboard		
Echosounder	Reson 7125 400 kilohertz		
Date	2013-07-01		

Offsets	*MRU to Transducer*	*x*	1.424 meters
		y	0.380 meters
		z	1.358 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	4.528 meters
		y	-2.320 meters
		z	14.278 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	-4.500 degrees
		Roll2	
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 3.77 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 3.77 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 2014 FPM on April 25, 2014 (Dn115). An area was selected offshore of Hampton, NH 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, 2012, and values, with a 0.05 meter difference at typical survey speeds from the prior year. Figures 28 and 29 show the 2014 results, also included in the attached appendices, and comparisons between 2011 - 2014.

C.2.2.3 Dynamic Draft Correctors

Vessel	S250							
Date	2014-04-25							
Dynamic Draft Table	*Speed*	0.0 m/s	0.5 m/s	1.0 m/s	1.5 m/s	2.0 m/s	2.5 m/s	3.0 m/s	3.5 m/s
	Draft	0.000 meters	-0.01 meters	0 meters	-0.02 meters	-0.05 meters	-0.06 meters	-0.07 meters	-0.07 meters
Vessel	S250							
Date	2014-04-25							
Dynamic Draft Table	*Speed*	4.0 m/s	4.5 m/s	5.0 m/s	5.5 m/s	6.0 m/s	6.5 m/s	7.0 m/s	
	Draft	-0.05 meters	-0.02 meters	0.02 meters	0.06 meters	0.10 meters	0.12 meters	0.11 meters	

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	2014-04-16	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.130 degrees
	Roll	0.090 degrees
	Yaw	0.880 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	2014-04-16	

Patch Test Values	*Navigation Time Correction*: 0.000 seconds *Pitch*: -0.050 degrees *Roll*: 0.080 degrees *Yaw*: 0.900 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	2014-04-16
Patch Test Values	*Navigation Time Correction*: 0.000 seconds *Pitch*: 0.280 degrees *Roll*: -0.080 degrees *Yaw*: -0.0310 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	2014-04-16
Patch Test Values	*Navigation Time Correction*: 0.000 seconds *Pitch*: 0.170 degrees *Roll*: -0.100 degrees *Yaw*: -0.550 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	2014-04-16

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.86 degrees
	Roll	0.010 degrees
	Yaw	1.170 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 Delayed Heave" 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 Horizontal and Vertical Control Report (HVCR) was not created for this project.

Newer methods for handling vertical control are being developed and, if utilized, are explained in more detail in the 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-A321-FH-14, Approaches to Portsmouth, 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 (4/2014); Hydrographic Survey Technical Directives 2014-1, 2014-2, 2014-3; and the Field Procedures Manual for Hydrographic Surveying (4/2014).

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 H12696, H12697, and H12698 which were completed in 2014.

Approved and Forwarded:

Adam Reed
2014.07.31 16:57:29 Z

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Field Operations Officer

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