Table of Contents

Data Acquisition and Processing Report

NOAA Ship *Thomas Jefferson*
Chief of Party: Commander Lawrence T. Krepp
Year: 2013
Version: 1
Publish Date: 2012-12-05

A Equipment

A.1 Survey Vessels

A.1.1 Thomas Jefferson

Name	Thomas Jefferson
Hull Number	S221
Description	The NOAA Ship Thomas Jefferson is a steel hulled vessel built by Halter Marine, Inc, Moss Point, MS.
Utilization	The Thomas Jefferson's primary mission is to acquire hydrographic survey data to update NOAA nautical charts. Based on current draft and sonar configuration, the ship can operate in waters between 30 feet and 246 feet deep.
Dimensions	*LOA*: 208 feet *Beam*: 45 feet *Max Draft*: 17 feet
Most Recent Full Static Survey	Full static survey was not performed.

Most Recent Partial Static Survey	*Date*	2012-02-14
	Performed By	NOAA's National Geodetic Survey
	Discussion	The Thomas Jefferson has never had a full static survey that includes all current antennas, inertial motion units, sonars and towpoints. Instead a series of partial surveys have been conducted across several years. In 2001 a survey of the (then named) USNS Littlehales was conducted by National Aeronautics and Space Agency. The survey measured offsets to several antennas and sonars, and established several benchmarks. Though the antennae and sonars are now defunct,the benchmarks are still in use. In 2003 a survey was conducted by the ship's force to establish the location of the DGPS antennae and the side scan sonar towpoint. In 2005 a survey was conducted by NOAA's National Geodetic Services Division (NGS). This survey verified the placement of the POS M/V IMU and antennas. Several additional permanent benchmarks were also established. In 2006 NGS conducted a survey to include the new RESON 7125 Multibeam Echosounder into the vessel's reference frame.
Most Recent Full Offset Verification	Full offset verification was not performed.	
Most Recent Partial Offset Verification	*Date*	2010-11-01
	Method Used	Confidence Check
	Discussion	In 2010 an error was found in the antennae heights reported by NGS in 2006. The discrepancy was discovered by post-processing GNNS data in POS MMS. The corrected measurement from the antenna to the IMU was added to the CARIS vessel file.

Most Recent Static Draft Determination	*Date*	2013-03-11
	Method Used	Waterline Measurement
	Discussion	Preliminary static draft measurements are made at the beginning of each leg, and every 2 -3 days thereafter. Additional measurements are made as changes in ballasting or loading warrant. Static draft is measured using a sight tube located in Lower Survey Stores. Lower survey stores is not vented to the atmosphere, and as a result, air pressure inside the ship can introduce an error in static draft measurements. A value of 0.1m was entered into the CARIS HVF to account for the uncertainty.
Most Recent Dynamic Draft Determination	*Date*	2013-03-12
	Method Used	Elipsoidal Referenced Dynamic Draft
	Discussion	Dynamic draft was measured using the Elipsoidal Referenced method.

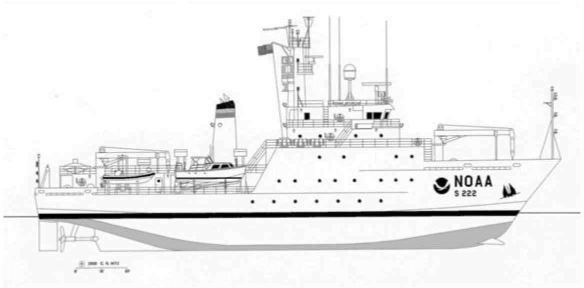

Figure 1: NOAA Ship Thomas Jefferson

A.1.2 Hydrographic Survey Launch 3101

Name	Hydrographic Survey Launch 3101
Hull Number	3101
Description	Launch 3101 is an aluminum hulled vessel. It's primary mission is hydrographic survey, specifically for charting purposes

Utilization	HSL 3101 is equipped to collect bathymetric data, side scan imagery, and water column profiles. It can operate in waters between 12 feet and 246 feet deep.	
Dimensions	*LOA*	31 feet
	Beam	10.6 feet
	Max Draft	5.16 feet
Most Recent Full Static Survey	*Date*	2005-08-19
	Performed By	NOAA's National Geodetic Survey
	Discussion	In 2005 NGS conducted a survey of launch 3101. At this time the position of all sonar transducers, GPS antennae, towpoints, the inertial measurement unit, and several benchmarks were established.
Most Recent Partial Static Survey	*Date*	2010-01-20
	Performed By	NOAA's National Geodetic Survey
	Discussion	In 2010 NGS conducted a verification survey of HSL 3101, during which all POS M/V components were positioned.
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*	2013-03-12
	Method Used	Sight Tube
	Discussion	Static draft is measured on a daily basis via a sight tube located near the IMU. Measurements are conducted using a steel ruler.
Most Recent Dynamic Draft Determination	*Date*	2013-03-20
	Method Used	Elipsoidal Referenced Dynamic Draft
	Discussion	Dynamic draft was measured using the Elipsoidal Referenced method.

Figure 2: Hydrographic Survey Launches 3101 & 3102

A.1.3 Hydrographic Survey Launch 3102

Name	Hydrographic Survey Launch 3102	
Hull Number	3102	
Description	Launch 3101 is an aluminum hulled vessel. It's primary mission is hydrographic survey, specifically for charting purposes	
Utilization	HSL 3101 is equipped to collect bathymetric data, side scan imagery, and water column profiles. It can operate in waters between 12 feet and 246 feet deep.	
Dimensions	*LOA*	31 feet
	Beam	10.6 feet
	Max Draft	5.16 feet
Most Recent Full Static Survey	*Date*	2005-08-25
	Performed By	NOAA's National Geodetic Survey
	Discussion	In 2005 NGS conducted a survey of launch 3102. At this time the position of all sonar transducers, GPS antennae, towpoints, the inertial measurement unit, and several benchmarks were established.

Most Recent Partial Static Survey	*Date*	2010-01-20
	Performed By	NOAA's National Geodetic Survey
	Discussion	In 2010 NGS conducted a verification survey of HSL 3102, at which time all POS M/V components were positioned. In 2011, NGS re-verified the position of the Port and Starboard GPS antennae. This was done after the installation of new mounting brackets.
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*	2013-03-20
	Method Used	Sight Tube
	Discussion	Static draft is measured on a daily basis via a sight tube located near the IMU. Measurements are conducted using a steel ruler.
Most Recent Dynamic Draft Determination	*Date*	2013-03-25
	Method Used	Elipsoidal Referenced Dynamic Draft
	Discussion	Dynamic draft was measured using the Elipsoidal Referenced method.

A.2 Echo Sounding Equipment

A.2.1 Side Scan Sonars

A.2.1.1 Klein 5000

Manufacturer	Klein
Model	5000
Description	The Klein High Speed, High Resolution Side Scan (SSS) Sonar system is a beam-forming acoustic imagery device. The integrated system includes a KLEIN 5500 towfish, a

<table>
<tr><td></td><td>Transceiver/Processing Unit (TPU), and a computer for user interface. Stern-towed units also include a tow cable telemetry assembly. The towfish operates at frequency of 455 kHz and a vertical beam angle of 40°, and can resolve up to 5 discreet received beams per transducer stave. There are two configurations for data acquisition using the KLEIN 5000 system: stern-towed and hull-mounted. S-222 uses exclusively stern towed SSS. HSL 3101 uses a hull-mount configuration. HSL 3102 can be converted from hull-mounted to towed as required. There are also two options for the weight of the towfish: the standard, and a light-weigh variant. The hull mounts on both survey launches can accommodate both standard or a light-weight towfishes, however S222 uses only the standard weight.

Positioning of the Towfish is calculated using CARIS SIPS, and is derived from the amount of cable out, the towfish depth (from the towfish pressure gage), the vessel's Course Made Good (CMG), and the vessel's heading. Towfish altitude is maintained between 8% and 20% of the range scale unless specifically noted in the Descriptive Report. Vessel speed is adjusted during SSS acquisition to ensure that object detection density is met. Confidence checks are performed by noting changes in linear bottom features extending to the outer edges of the digital side scan image, and by verifying aids to navigation or other known features on the side scan record. The resolution of the system is: Along Track: 10cm out to 38 meters 20cm out to 75 meters 36 cm out to 150 meters Across Track: 3.75 cm</td></tr>
<tr><td><i>Serial Numbers</i></td><td>
<table>
<tr><td><i>Vessel Installed On</i></td><td>S-222</td><td>HSL 3101</td><td>HSL 3102</td></tr>
<tr><td><i>TPU s/n</i></td><td>137</td><td>136</td><td>135</td></tr>
<tr><td><i>Towfish s/n</i></td><td>280</td><td>322</td><td>319</td></tr>
</table>
</td></tr>
<tr><td><i>Specifications</i></td><td>
<table>
<tr><td><i>Frequency</i></td><td>455 kilohertz</td></tr>
<tr><td><i>Along Track Resolution</i></td><td>
<table>
<tr><td><i>Resolution</i></td><td>10 centimeters</td><td>20 centimeters</td><td>36 centimeters</td></tr>
<tr><td><i>Min Range</i></td><td>0 meters</td><td>39 meters</td><td>76 meters</td></tr>
<tr><td><i>Max Range</i></td><td>38 meters</td><td>75 nautical miles</td><td>150 meters</td></tr>
</table>
</td></tr>
<tr><td><i>Across Track Resolution</i></td><td>3.75 centimeters</td></tr>
<tr><td><i>Max Range Scale</i></td><td>150 meters</td></tr>
</table>
</td></tr>
<tr><td><i>Manufacturer Calibrations</i></td><td>Manufacturer calibration was not performed.</td></tr>
</table>

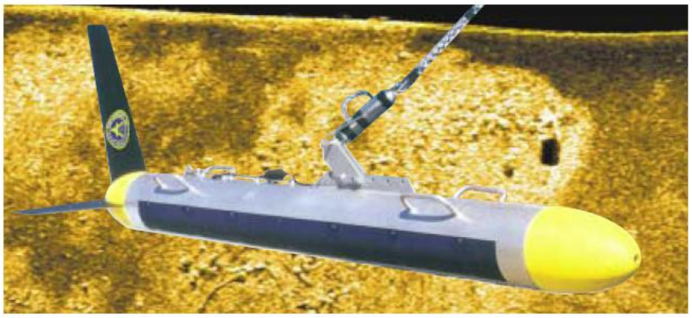

Figure 3: Klein 5000 Side Scan Sonar towfish

A.2.2 Multibeam Echosounders

A.2.2.1 RESON 7125-ROV

Manufacturer	RESON
Model	7125-ROV
Description	The RESON SeaBat 7125-ROV system is a single-frequency, digital recording Multibeam echosounder. It is hull mounted on the Thomas Jefferson S-222. The integrated system includes a 400 kHz Projector unit, a Receiver unit, a Link Control Unit (LCU), and a topside 7-P Sonar Processor Unit (TPU). The projector and receiver are set up in a Mills Cross configuration. The 7125-ROV produces a 128° across track swath that is resolved into 512 discreet beams by the receive array. Each beam has a resolution of 1.0° across track, and 0.5° along track. Sound velocity at the face of the transducer is provided by and integrated AML Smart SV&T sound velocimeter. This system will be discussed in further detail in the Sound Velocity Equipment Section of this report. Ping rate, range, power, gain and pulse width all varied with the depth of the area being surveyed. The 7-P Sonar Processor Unit has the following software versions installed: 7K Center: INSERT IO VERSION, 7K UI VERSION. Bathymetric data from the 7125-ROV is used to provide object detection and complete coverage in shallow water.

Serial Numbers	*Vessel Installed On*		S-222
	Processor s/n		50357
	Transceiver s/n		50872 (LCU Bottle)
	Transducer s/n		n/a
	Receiver s/n		808042
	Projector 1 s/n		19082203
	Projector 2 s/n		None
Specifications	*Frequency*		400 kilohertz
	Beamwidth	*Along Track*	1 degrees
		Across Track	0.5 degrees
	Max Ping Rate		50 hertz
	Beam Spacing	*Beam Spacing Mode*	Equidistant
		Number of Beams	512
	Max Swath Width		128 degrees
	Depth Resolution		5 millimeters
	Depth Rating	*Manufacturer Specified*	200 meters
		Ship Usage	100 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.		
System Accuracy Tests	*Vessel Installed On*		S-222
	Methods		Comparison with Leadline
	Results		On DN071 soundings from the RESON 7125-ROV were compared to the soundings taken from a leadline. The average difference was 0.22m, with the ship consistently shoal of the lead line depths.
Snippets	Sonar has snippets logging capability.		

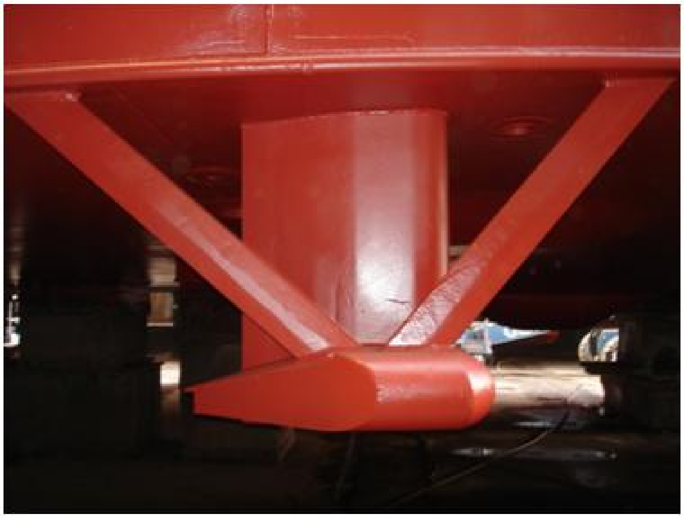

Figure 4: Housing for ship mounted RESON 7125-ROV

A.2.2.2 RESON SeaBat 7125-SV1

Manufacturer	RESON
Model	SeaBat 7125-SV1
Description	The RESON SeaBat 7125-SV1 system is a dual-frequency, digital recording Multibeam echosounder. Identical systems are installed on HSLs 3101 and 3102 using a RESON sled mount which is attached to a retractable arm. The integrated system includes a 200 kHz Projector unit, a 400 kHz Projector unit, a Receiver unit, and a topside 7-P Sonar Processor Unit (TPU). The projectors and receiver are set up in a Mills Cross configuration. The 7125-SV1 produces a 128° across track swath that is resolved into 512 discreet beams by the receive array. The 400 kHz frequency has a 0.54° across-track resolution and 1° along-track resolution. The 200 kHz frequency has a 1.1° across-track resolution and 2.2° along-track resolution. Sound velocity at the face of the transducer is provided by an integrated RESON SV-71 sound velocimeter. This system will be discussed in further detail in the Sound Velocity Equipment Section of this report. The RESON 7125-SV1 can be configured for roll stabilization. In roll-stabilized mode, the sonar can operate in environments with up to +/- 10 degrees of roll without degrading system performance. Ping rate, range, power, gain and pulse width all varied with the depth of the area being surveyed. The 7-P Sonar Processor Unit has the following software versions installed: 7K Center: INSERT IO VERSION, 7K UI VERSION. Bathymetric data from the 7125-SV1 is used to provide object detection and complete coverage in shallow water.

Serial Numbers	*Vessel Installed On*	HSL 3101		HSL 3102	
	Processor s/n	1812018		1812031	
	Transceiver s/n	n/a		n/a	
	Transducer s/n	n/a		n/a	
	Receiver s/n	1409071		0309006	
	Projector 1 s/n	4408356		2909185	
	Projector 2 s/n	2308097		2208005	
Specifications	*Frequency*	400 kilohertz		200 kilohertz	
	Beamwidth	*Along Track*	1.0 degrees	*Along Track*	2.2 degrees
		Across Track	0.54 degrees	*Across Track*	1.1 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*	512
	Max Swath Width	128 degrees		128 degrees	
	Depth Resolution	6 millimeters		6 millimeters	
	Depth Rating	*Manufacturer Specified*	200 meters	*Manufacturer Specified*	300 meters
		Ship Usage	100 meters	*Ship Usage*	250 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.				
System Accuracy Tests	*Vessel Installed On*	HSL 3101 & 3102			
	Methods	Reference Surface			
	Results	On Day Number 090, both survey launches acquired data over a reference surface. The data from each launch was gridded into a CUBE surface, and the CUBE surfaces differenced. Out of 151,077 comparison points 140,797 nodes were within 10cm, and 9,737 have zero depth difference.			
Snippets	Sonar has snippets logging capability.				

Figure 4: Sled for launch mounted RESON 7125-SV

A.2.3 Single Beam Echosounders

A.2.3.1 ODOM Echotrac CV-200

Manufacturer	ODOM		
Model	Echotrac CV-200		
Description	The Odom Echotrac CV-200 is a dual frequency digital recording echosounder. Identical systems are hull mounted on HSLs 3101 and 3102.		
Serial Numbers	*Vessel*	HSL 3101	HSL 3102
	Processor s/n	003260	002917
	Transducer s/n	TR2160	TR7698

Specifications	*Frequency*	24 kilohertz		200 kilohertz	
	Beamwidth	*Along Track*	20 degrees	*Along Track*	4 degrees
		Across Track	20 degrees	*Across Track*	4 degrees
	Max Ping Rate	20 hertz		20 hertz	
	Depth Resolution	0.01 meters		0.01 meters	
	Depth Rating	*Manufacturer Specified*	1500 meters	*Manufacturer Specified*	200 meters
		Ship Usage	1000 meters	*Ship Usage*	150 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.				
System Accuracy Tests	System accuracy test was not performed.				

Figure 5: Housing for launch mounted ODOM transducer

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	Ships Force
Model	n/a
Description	The lead line aboard the Thomas Jefferson is a Standard lead line, constructed and calibrated in accordance with Appendix-1 of NOAA's Field Procedures Manual (2012 ed)
Serial Numbers	TJ.C.032912, TJ Mar 2011, TJ 072012, TJB14MAR2011, Silver Washer
Calibrations	*see table below*
Accuracy Checks	No accuracy checks were performed.
Correctors	None of the Thomas Jefferson's leadlines required correctors.
Non-Standard Procedures	Non-standard procedures were not utilized.

Serial Number	TJ.C.032912	TJ Mar 2011	TJ 072012	TJB14MAR2011	Silver Washer
Date	2013-02-28	2013-02-28	2013-02-28	2013-02-28	2013-02-28
Procedures	The leadline was calibrated against a steel measuring tape.	The leadline was calibrated against a steel measuring tape.	The leadline was calibrated against a steel measuring tape.	The leadline was calibrated against a steel measuring tape.	The leadline was calibrated against a steel measuring tape.

Figure 6: Lead line used aboard Thomas Jefferson and her survey launches

A.3.3 Sounding Poles

Manufacturer	CST Burger
Model	n/a
Description	The Thomas Jefferson has two non-traditional sounding poles. Both poles are round steel with a plasticized covering, capped by a weighted metal shoe. Each pole is 4 meters in length, with graduations at 0.25m.
Serial Numbers	TJ-SP-1, TJ-SP-2
Calibrations	*Serial Number*: TJ-SP-1 / TJ-SP-2 *Date*: 2013-02-28 / 2013-02-28 *Procedures*: The sounding pole was calibrated using a steel tape. / The Sounding Pole was calibrated using a steel tape.
Accuracy Checks	No accuracy checks were performed.
Correctors	None of the Thomas Jefferson's sounding poles required correctors.
Non-Standard Procedures	Non-standard procedures were not utilized.

Serial Number	TJ-SP-1	TJ-SP-2
Date	2013-02-28	2013-02-28
Procedures	The sounding pole was calibrated using a steel tape.	The Sounding Pole was calibrated using a steel tape.

Figure 7: Sounding pole used aboard Thomas Jefferson and her survey launches

A.3.4 Other Manual Sounding Equipment

No additional manual sounding equipment was utilized for data acquisition.

A.4 Positioning and Attitude Equipment

A.4.1 Applanix POS/MV

Manufacturer	Applanix (a Trimble company)
Model	320 v.4
Description	The POS M/V is a GPS-aided inertial positioning system that provides position and orientation data to external equipment. It is composed of an Inertial Measurement Unit, two GNSS receivers, and a POS Computing System (PCS) unit. Roll, pitch, and Heave values are measured by the Inertial Measurement Unit (IMU). Position is derived from the tightly-coupled GPS/IMU integration. Heading is determined by blending data from the GNSS antennas, with heading estimates by the IMU.

PCS	*Manufacturer*	Applanix			
	Model	320 v.4			
	Description	The PCS blends raw acceleration measurements from the IMU, with positional information from the GPS antennas and RTCM beacon, creating a tightly-coupled position and orientation solution. The PCS outputs a one Pulse Per Second (PPS) signal by integrated systems to accurately time-stamp data.			
	Firmware Version	HW2.8-7			
	Software Version	5.1.0.2			
	Serial Numbers	*Vessel Installed On*	S222	HSL 3101	HSL 3102
		PCS s/n	2321	2330	2562
IMU	*Manufacturer*	Applanix			
	Model	LN 200			
	Description	The POS M/V Inertial Measurement Unit (IMU) is used to record the amount of heave, pitch, and roll experienced by the vessel. The Unit is located at the vessel's central reference point, and is strapped down to the vessel. Since the IMU is fixed to the vessel, the motion experienced by the IMU is, by definition, the same motion experienced by the vessel. The IMU housing contains three orthogonally placed accelerometers, which sense acceleration in the x, y, and z directions. It also contains three orthogonally placed gyros, which sense angular rate of motion around the three axis. The measured amount of acceleration and rate of rotation is then used to find the degree of pitch, roll, and heave experienced by the vessel. Data from the IMU is also combined with data from the GNSS antennas to calculate vessel heading. For further discussion, refer to the Antenna section of this report.			
	Serial Numbers	*Vessel Installed On*	S-222	HSL 3101	HSL 3102
		IMU s/n	146	352	358
	Certification	*IMU s/n*	146	352	356
		Certification Date	2010-02-02	2010-02-02	2010-02-02

Antennas	*Manufacturer*	Trimble
	Model	The Thomas Jefferson S-222 and HSL 3102 have Zephyr antennae, HSL 3101 has a Zephyr Model 2 antennea.
	Description	The POS M/V system includes two GNSS antennas, each of which provides carrier phase level positioning information. In addition to providing robust positional information, the antenna's level of accuracy is also used to improve the system's heading accuracy. By using carrier phase level positioning, the system has enough resolution to position one antenna relative to the other. The positions are then used to calculate the North-East-Down vector between the Primary and the Secondary antennas. Combining the North-East-Down vector with the measured distance between antennas allows the system to resolve the IMU's heading. These heading estimates are blended with heading estimates made by the IMU, providing an extremely accurate heading solution. All three platforms used a IAPPK solution to verify the antenna separation found during the initial GAMS calibration. For the Thomas Jefferson the initial values compared well to the post-processed separations, and the initial values were used. For both HSL's 3101 & 3102 the post-processed separation was found to be more accurate, and the post-processed values were used. As a result of ERS processing during the HSRR and the beginning of acquisition on H12482 it was determined the alignment of the POS antennas with respect to the vessel frame needed to be updated for all three platforms. This was evident in the Calibrated Installation Parameters report generated by the GNSS processor in POS MV 6.1. The X, Y, and Z antenna values were settling in on values that differed from the installation parameter values entered in MV/POSView from last season. Through an iterative process by which calibrated installation parameters were applied and the SBET re-processed using the GNSS processor, precise values for the antenna positions with respect to the IMU were determined and updated for the Thomas Jefferson S-222, HSL 3101 and HSL 3102.
	Serial Numbers	

Vessel Installed On	S-222	S-222	HSL 3101	HSL 3101	HSL 3102	HSL 3102
Antenna s/n	1440925406	0440925560	60162971	60162956	0440918400	30895407
Port or Starboard	Port	Starboard	Port	Starboard	Port	Starboard
Primary or Secondary	Primary	Secondary	Primary	Secondary	Primary	Primary

GAMS Calibration	*Vessel*	S-222	3101	3102
	Calibration Date	2012-03-12	2012-03-25	2012-03-20

<table>
<tr><td>Configuration Reports</td><td><table>
<tr><td>Vessel</td><td>S-222</td><td>HSL 3101</td><td>HSL 3102</td></tr>
<tr><td>Report Date</td><td>2013-02-12</td><td>2013-02-12</td><td>2012-12-05</td></tr>
</table></td></tr>
</table>

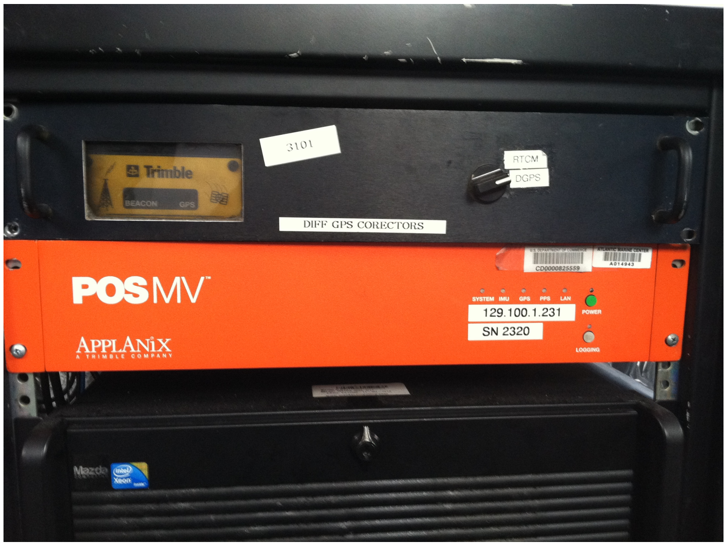

Figure 8: POS M/V CPU

A.4.2 DGPS

<table>
<tr><td>Description</td><td>The Trimble SPS351 receiver uses RTCM DGPS corrections either broadcast free by IALA Beacon stations, from SBAS (Satellite Based Augmentation Systems) or via an external radio or Internet connection from a DGPS reference station.</td></tr>
<tr><td>Antennas</td><td><table>
<tr><td>Manufacturer</td><td>Trimble</td></tr>
<tr><td>Model</td><td>GA530</td></tr>
<tr><td>Description</td><td>RTCM DGPS antenna that is designed to be placed on a rover unit. The antenna receives L1, L2, Beacon, OmniSTAR, and SBAS signals.</td></tr>
<tr><td>Serial Numbers</td><td><table>
<tr><td>Vessel Installed On</td><td>S-222</td><td>HSL 3101</td><td>HSL 3102</td></tr>
<tr><td>Antenna s/n</td><td></td><td>12987</td><td>13008</td></tr>
</table></td></tr>
</table></td></tr>
</table>

<table>
<tr><td rowspan="6">Receivers</td><td>Manufacturer</td><td colspan="4">Trimble</td></tr>
<tr><td>Model</td><td colspan="4">SPS351</td></tr>
<tr><td>Description</td><td colspan="4">The Trimble SPS351 receiver uses RTCM DGPS corrections either broadcast free by IALA Beacon stations, from SBAS (Satellite Based Augmentation Systems) or via an external radio or Internet connection from a DGPS reference station.</td></tr>
<tr><td>Firmware Version</td><td colspan="4">4.47</td></tr>
<tr><td rowspan="2">Serial Numbers</td><td>Vessel Installed On</td><td>S-222</td><td>3101</td><td>3102</td></tr>
<tr><td>Antenna s/n</td><td>5229D53057</td><td>5229D53059</td><td>5229d53050</td></tr>
</table>

Figure 10: Trimble DGPS GA530 Antenna mounted on S-222

Figure 11: Trimble DGPS receiver installed on S-222.

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 Electronics SBE 19+

Manufacturer	Sea-Bird Electronics			
Model	SBE 19+			
Description	The Thomas Jefferson S-222, HSL 3101, and HSL 3102 all use Sea-Bird Electronics SeaCat SBE19+ Conductivity, Temperature, and Depth (CTD) Profilers to collect vertical sound speed profiles. The speed of sound is calculated from temperature, salinity, and pressure measurements. Temperature is measured directly. Salinity is calculate from measured electrical conductivity. Depth is calculated strain gage pressure. The system is configured for a sampling rate of 0.5 seconds. Aboard the HSLs the profiler is deployed by hand. Aboard S-222 the profiler is either hand deployed, or deployed via a winch, depending on the depth of water.			
Serial Numbers	*Vessel Installed On*	S-222	HSL 3101	HSL 3102
	CTD s/n	19P60744-6667	19P33589-4486	19P33589-4487
Calibrations	*CTD s/n*	19P60744-6667	19P33589-4487	19P33589-4486
	Date	2013-01-07	2013-01-31	2013-01-09
	Procedures	Calibrations performed by Sea-Bird Electronics	Calibrations performed by Sea-Bird Electronics.	Calibrations performed by Sea-Bird Electronics

Figure 11: Sea-Bird 19+ CTD used aboard Thomas Jefferson S-222 and her survey launches.

A.5.1.1.2 Sea-Bird Electronis SBE 19

Manufacturer	Sea-Bird Electronis
Model	SBE 19
Description	The Thomas Jefferson S-222 uses a Sea-Bird Electronics SeaCat SBE19 Conductivity, Temperature, and Depth (CTD) Profilers to collect vertical sound speed profiles. The speed of sound is calculated from temperature, salinity, and pressure measurements. Temperature is measured directly. Salinity is calculate from measured electrical conductivity. Depth is calculated strain gauge pressure. The system is configured for a sampling rate of 0.5 seconds. Depending on the depth of water, the profiler is either deployed by hand, or using a winch.
Serial Numbers	*Vessel Installed On*: S-222 *CTD s/n*: 192472-0285

Calibrations	*CTD s/n*	192472-0285
	Date	2012-12-18
	Procedures	Calibrations performed by Sea-Bird Electronics

Figure 12: Sea-Bird 19 CTD used aboard Thomas Jefferson S-222.

A.5.1.1.3 Brooke Ocean Technology Moving Vessel Profiler 100

Manufacturer	Brooke Ocean Technology	
Model	Moving Vessel Profiler 100	
Description	The Thomas Jefferson S-222 uses a Brooke Ocean Moving Vessel Profiler (MVP) to collect vertical sound speed profiles. The integrated system consists of a computer controlled high-speed winch with cable metering, a conductor cable, and a free-fall fish (FFF). Housed in the FFF is an Applied Microsystems SV&P Smart Sensor (see SV&P below). The profiler is deployed at survey speed via the winch.	
Serial Numbers	*Vessel Installed On*	S222
	CTD s/n	See SV&P sensors below

Calibrations	No CTD profiler calibrations were performed.

Figure 13: MVP winch aboard NOAA Ship Thomas Jefferson

A.5.1.2 Sound Speed Profilers

A.5.1.2.1 AML Oceanographic AML Smart SV&P Probe

Manufacturer	AML Oceanographic
Model	AML Smart SV&P Probe
Description	The Thomas Jefferson S-222 uses a AML Smart SV&P Probe to collect speed of sound profiles via the Brooks Ocean Technology MVP. The speed of sound is measured directly using a 'time-of-flight' sensor. Depth is calculated strain gage pressure.
Serial Numbers	*Vessel Installed On*: S-222, S-222 *Sound Speed Profiler s/n*: 4988, 5340

Calibrations	*Sound Speed Profiler s/n*	5340	4988
	Date	2013-01-09	2013-01-14
	Procedures	Calibrations performed by AML Oceanographic.	Calibrations performed by AML Oceanographic.

Figure 14: AML Smart SV&P Probe used in the MVP free-fall fish.

A.5.2 Surface Sound Speed

A.5.2.1 AML Oceanographic AML Smart SV&T Probe

Manufacturer	AML Oceanographic
Model	AML Smart SV&T Probe
Description	The Thomas Jefferson S-222 uses an AML Smart SV&T Probe to collect the speed of sound at the face of the RESON 7125-ROV transducer. The sensor is mounted in an insulated sea chest, and a pump is used to collect water from near the transducer. The speed of sound is measured directly using a 'time-of-flight' sensor. Temperature

	is measured with a thermistor, however this measurement is not needed by the RESON. Sound speed values are outputted real-time to the RESON 7125-ROV system.			
Serial Numbers	*Vessel Installed On*	S-222	S-222	S-222
	Sound Speed Sensor s/n	4823	5649	7591
Calibrations	*Sound Speed Sensor s/n*	4823	5649	7591
	Date	2013-01-14	2013-01-11	2012-12-05
	Procedures	Calibration was performed by AML Oceanographic.	Calibration was performed by AML Oceanographic.	Calibration was performed by AML Oceanographic.

Figure 15: AML Smart SV&T probe used for surface sound speed aboard Thomas Jefferson S-222.

A.5.2.2 RESON SV-70

Manufacturer	RESON
Model	SV-70
Description	HSL 3101 and 3102 us a RESON SV-70 to collect the speed of sound at the face of the RESON 7125-SV1 transducers. The sensor is bolted to the mounting sled, near

<table>
<tr><td></td><td>the face of the transducer. The speed of sound is measured directly using a 'time-of-flight' sensor, and integrated directly into the RESON processing unit.</td></tr>
<tr><td><i>Serial Numbers</i></td><td><table>
<tr><td><i>Vessel Installed On</i></td><td>HSL 3101</td><td>HSL 3102</td></tr>
<tr><td><i>Sound Speed Sensor s/n</i></td><td>1312075</td><td>3511349</td></tr>
</table></td></tr>
<tr><td><i>Calibrations</i></td><td><table>
<tr><td><i>Sound Speed Sensor s/n</i></td><td>1312075</td><td>3511349</td></tr>
<tr><td><i>Date</i></td><td>2012-12-18</td><td>2008-05-05</td></tr>
<tr><td><i>Procedures</i></td><td>Calibration was performed by RESON, Inc.</td><td>Calibration was performed by RESON, Inc.</td></tr>
</table></td></tr>
</table>

Figure 16: RESON SV71 Sound Velcoity Probe used for surface sound speed aboard HSL 3101 & 3102

A.6 Horizontal and Vertical Control Equipment

A.6.1 Horizontal Control Equipment

A.6.1.1 Base Station Equipment

No base station equipment was utilized for data acquisition.

A.6.1.2 Rover Equipment

No rover equipment was utilized for data acquisition.

Additional Discussion

The Horizontal Datum for all projects is the North American Datum of 1983 (NAD83). During data acquisition and initial processing, horizontal control for all survey data is derived from Differentially corrected GPS, using USCG differential correctors. Differential beacons are chosen based on their proximity to the survey grounds and the signal-to-noise ratio of the beacons if more than one beacon is near the survey grounds.

During post processing, horizontal control for MBES data is replaced with a Smooth Best Estimate Trajectory (SBET) positioning. SBETs are created by adding ephemeris correctors and clock correctors to the original DGPS positions. The ephemis and clock data is downloaded from a network of Continuously Operated Reference Stations (CORS) stations that enclose the survey area.

A.6.2 Vertical Control Equipment

No vertical control equipment was utilized for data acquisition.

Additional Discussion

Vertical Datum for all projects is Mean Lower Low Water (MLLW). Vertical control is applied to bathymetry using one of three methods:

1: Zoned Tides. When using zoned tides water levels are supplied by NWLON tide stations. Vertical correctors are then applied to bathymetric data using a grid of discrete tide zones.

2: TCARI Tides: Tidal Constituents and Residuals Interpolator (TCARI) is an alternative to discrete zoning. Instead of a grid, TCARI uses the shoreline to generate a Triangulated Irregular Network (TIN) surface that encompasses the survey area. Water levels and residuals from tide stations in the area are used to populate each cell in the TIN, resulting in a smoother tide solution than can be achieved by discrete zoning.

3: ERZT: Ellipsoid-Referenced Zoned Tides derives vertical heights from the post-processed SBETs. See the Horizontal Control section of this report for deeper discussion of SBETs.

The form of Vertical Control used for each survey will be listed in section C.1 of the Descriptive Report.

A.7 Computer Hardware and Software

A.7.1 Computer Hardware

Manufacturer	Dell
Model	Precision T3400
Description	These computers use an Intel Core2 Duo or Quad processors. They are used for post-processing and development of deliverables and use the following programs: CARIS HIPS/SIPS, CARIS Bathy DataBase, HSTP Pydro suite, MapInfo, Fledermaus, POSPac MMS, and the full Microsoft Office Suite.

Serial Numbers	*Computer s/n*	BJKBZK1 (Survey01)	2KKBZK1 (Survey02)	34B6L41 (Survey03)	4JKBZK1 (Survey04)	5KKBZK1 (Survey05)	6705VK1 (Survey06)	7KJKBZK1 (Survey07)	GZQG2VK1 (Survey08)	CKKBZK1 (Chief_IOSurvey)	9JKBZK1 (TJ-OPSSurvey)	8KKBZK1 (TJ-IOSurvey)
	Operating System	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1
	Use	Processing	Processing	Processing	Processing	Processing	Processing	Processing	Processing	Processing	Processing	Processing

Manufacturer	Brooks Ocean Technology	
Model	MV100	
Description	The MVP100 computer is used to run the software that controls the MVP fish. It is also used to process CTD casts.	
Serial Numbers	*Computer s/n*	B23-03877 (MVP Computer)
	Operating System	Microsoft Windows XP Professional 2003, Service Pack 3
	Use	Acquisition

Manufacturer	Dell	
Model	Precision 3400	
Description	The Klein computer is used to view the SonarPro interface and to acquire SSS data in the .sdf format (S222 only).	
Serial Numbers	*Computer s/n*	CDVFZK1 (TJ-Klein SSS)
	Operating System	Microsoft Windows XP Professional 2003, Service Pack 3
	Use	Acquisition

Manufacturer	Dell
Model	OPTIPLEX 760

Description	Caris is used to store the network key for all CARIS HIPS/SIPS and CARIS BASe Editor software.	
Serial Numbers	*Computer s/n*	97J0VK1 (TJ-CARIS1)
	Operating System	Microsoft Windows 7, service pack 1
	Use	Processing

Manufacturer	Dell			
Model	Mazda 4204			
Description	The following computers are aboard S-222, HSL 3101, and HSL 3102. They are used to: - to run the Hypack/Hysweep interface, and record multibeam data in the .HSX format; - to run the POS M/V interface, and record POS M/V data in the .000 format; - to run the ODOM eChart interface, and record vertical beam data in the .raw format (HSL 3101 and 3102 only; S222 uses a separate computer); - to run the SonarPro interface, and record side scan data in the .SDF format (HSL 3101 and 3102 only, S22 uses a separate computer). The computer installed aboard S222 is also equipped with a the software suite used to post-process data.			
Serial Numbers	*Computer s/n*	BTO09883066600262 (TJ-Hypack64)	BTO1109883089900263 (TJ-Launch-8012)	BTO1109883089900260 (TJ Launch 8014)
	Operating System	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1	Microsoft Windows 7, service pack 1
	Use	Acquisition and Processing	Acquisition	Acquisition

Manufacturer	RESON			
Model	SeaBat			
Description	The follow computers are aboard HSL 3101 and 3102 and S222. They are used to run the RESON interface, and to send data to the Hypack/Hysweep computers.			
Serial Numbers	*Computer s/n*	RXP093107092655	RESON	E85-03013 (TJ-STBD7125)
	Operating System	Windows XP Professional 2002, Service Pack 3	Windows XP Professional 2002, Service Pack 3	Windows XP Professional 2002, Service Pack 1
	Use	Acquisition	Acquisition	Acquisition

A.7.2 Computer Software

Manufacturer	CARIS

Software Name	HIPS/SIPS
Version	8.0.0
Service Pack	n/a
Hotfix	n/a
Installation Date	2013-03-28
Use	Processing
Description	CARIS HIPS (Hydrographic Information Processing System) is used for all initial processing of multibeam and vertical beam echosounder bathymetry data. The program applies vessel offsets to the raw sonar data, corrects for tide and sound velocity, and calculates a Total Propagated Uncertainty (TPU) for each sounding. Individual soundings are then processed into a CUBE (Combined Uncertainty and Bathymetry Estimator) grid. CARIS SIPS (Side scan Information Processing System) is used for all processing of side-scan sonar imagery, including cable layback correction, slant range correction, contact selection, towpoint entry, and mosaic generation.

Manufacturer	CARIS
Software Name	BASE Editor
Version	4.0.0
Service Pack	2
Hotfix	2
Installation Date	2013-01-01
Use	Processing
Description	CARIS BASE Editor is used for quality control of multibeam and vertical beam surfaces, and for management of survey features. CUBE and Uncertainty grids are imported, then reviewed for depth fliers and systematic errors, and agreement with adjoining surveys. Multibeam contacts (designated soundings), side-scan sonar contacts, and detached position contacts are analyzed, grouped, and assigned S-57 classification.

Manufacturer	NOAA OCS HSTP
Software Name	PYDRO
Version	v12.9
Service Pack	r3965
Hotfix	none
Installation Date	2013-01-03
Use	Processing
Description	HSTP PYDRO is a suite of programs used to process survey data, and to generate reports. FETCHTIDES: is used to create a .tid file from NWLON tide station

	data. PYDRO: can be used to classify side-scan sonar and Multibeam bathymetry contacts and manage survey features, however this functionality has largely been replaced by CARIS BASE Editor. PYDRO is still used for the generation of chartlets, the generation of Danger to Navigation reports, and to process TCARI tides. VELOCIPY: is a program used for processing sound velocity casts. This program converts the hexadecimal SeaCat data to ASCII, and converts the ASCII data into a depth-binned sound velocity file. MVP data is recorded in a .txt format, and can be binned via Velocipy without conversion to ASCII. The resulting .svp files are applied to MBES and VBES data during post processing to correct for sound velocity variation within the water column. XmlDR: is used to generate Descriptive Reports for each survey.

Manufacturer	HYPACK, Inc
Software Name	Hypack 2013
Version	none
Service Pack	none
Hotfix	none
Installation Date	2013-02-10
Use	Acquisition
Description	HYPACK is used to acquire VBES data in a *.raw format, and detached positions, in a *.tgt format. It is also used for vessel navigation during data acquisition. HYSWEEP is a module for HYPACK used to acquire RESON 7125 MBES data in a *.HSX format. It receives input from: the Reson 7125; the AML Smart SV&T probe, or RESON SV70 & SV71 probes; and the Applanix POS/MV systems.

Manufacturer	Applanix
Software Name	MMS
Version	6.1.4553.15282
Service Pack	none
Hotfix	none
Installation Date	2013-01-03
Use	Processing
Description	Applanix MMS is used to create SBETs, which provide horizontal and vertical control to bathymetric data. For a full discussion see sections A.6.1 and A.6.2 of this report.

Manufacturer	Applanix
Software Name	POSVIEW
Version	5.1.0.2

Service Pack	none
Hotfix	none
Installation Date	2013-01-03
Use	Acquisition
Description	The MV-POSView controller program is used to configure and operate the POS MV attitude and positioning system. This program is also used to record the POS/ MV .000 files used to produce the SBET files post-applied in CARIS to improve attitude and navigation.

Manufacturer	Brooks Ocean
Software Name	MVP
Version	2.351
Service Pack	n/a
Hotfix	n/a
Installation Date	2013-01-03
Use	Acquisition and Processing
Description	The MVP program is used to control the MVP winch and fish.

Manufacturer	PittneyBowes
Software Name	MAPINFO PROFESSIONAL
Version	11.5
Service Pack	none
Hotfix	none
Installation Date	2013-01-28
Use	Acquisition
Description	MapInfo is the Geographic Information System (GIS) software package used to plan survey lines, review hydrographic data, and create preliminary chartlet plots. HYDRO_MI is a OCS HSTP product and exists as a set of tools that aid hydrographic acquisition planning.

Manufacturer	QPS, Inc.
Software Name	Fledermaus
Version	7.3.4
Service Pack	Build 3
Hotfix	n/a
Installation Date	2013-04-02
Use	Processing

Description	Fledermaus is used to process backscatter mosaics.

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

A.8.1.1 Ponar Wildco # 1728

Manufacturer	Ponar Wildco
Model	# 1728
Description	The Ponar Wildco is a winch-deployed bottom sampler used aboard S222.

Figure 17: Ponar style grab sampler used aboard NOAA Ship Thomas Jefferson

A.8.1.2 Kahlsico Mud Snapper 214WA100

Manufacturer	Kahlsico Mud Snapper
Model	214WA100
Description	The Kahlsico Mud Snapper is a hand held bottom sampler that is used aboard HSL 3101 and 3102.

Figure 18: Snapper type grab sampler used aboard HSL 3101 & 3102.

B Quality Control

B.1 Data Acquisition

B.1.1 Bathymetry

B.1.1.1 Multibeam Echosounder

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

- Monitors the RESON SeaBat interface for errors and data quality;

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

- Monitors the Hysweep interface using the following sub windows: 3-D sounding points, Multibeam;

- Monitors the vessel speed and adjusts as necessary to ensure density specifications are met.

HSL 3101 and 3102 acquire MBES data using polygons, with coverage being monitered via HYPACK's mosaic feature. Holidays are acquired as they occur, with a final quality control check for density rareifactions occuring near the completion of acqusition. The ship acquires all MBES data using pre-planned lines, with a mosiac in the background, with holidays being noted as they occur. Near the end of mainscheam acqusition, a quality control check for density rarifactions is completed, and all gaps in coverage are acquired.

B.1.1.2 Single Beam Echosounder

All Vertical Beam data is logged using ODOM eChart in the .bin and .raw formats. The .raw contains the depth data, the .bin files contain water column data. During acquisition the hydrographer:

- Monitors real-time data in the ODOM eChart window;

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

B.1.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

B.1.2 Imagery

B.1.2.1 Side Scan Sonar

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

- Monitors range, towfish height, heading, pitch, roll, latitude, longitude, speed, pressure, and temperature;

- Adjusts towfish height, in accordance with Field Procedures Manual.

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

The Thomas Jefferson S-222 uses an Applied Microsystems SV&P probe installed inside an MVP free-fall fish to acquire sound speed profiles. Profiles aboard the ship are are acquired at 30 - 60 minute intervals. HSL 3101 and 3102 both use a Sea-Bird SBE19+ CTD to collect sound speed profiles, generally at 2 - 4 hour intervals. Casts are also conducted when changing survey areas, or when a chanve of weather, tide, or current warrant. The launch crew also moniters the real-time display of the Reson SVP 71for drastic changes in the surface sound velocity indicative of the need for a new cast.Aboard all platforms, the hydrographer processes each cast immediately, then reviews it for erroneous data.

Figure :

B.1.3.2 Surface Sound Speed

The Thomas Jefferson S-222 uses an Applied Microsystems Smart SV&T probe to find the speed of sound at the RESON transducer face. HSL 3101 and 3102 use a RESON SV-71 to acquire sound speed at the transducer face. The accuracy of each surface sound speed device is checked against the closest CTD data point after every CTD cast.

B.1.4 Horizontal and Vertical Control

B.1.4.1 Horizontal Control

The Thomas Jefferson S-222 and her survey launches all use Differentially-corrected GPS via a USCG DGPS beacon to establish horizontal position for all data acquisition and initial processing. The frequency of the assigned beacon is programmed into the Trimble DGPS receiver. The minimum number of satellites, their minimum elevation above the horizon, and the age of pseudo range correctors are also set using TSIP Talker. During acquisition, differential correctors are sent to the Applanix POS M/V via serial connection. Total positional accuracy is monitored inside the MV-POSView window.

During post-processing horizontal positioning can be shifted to an Inertially Aided Post-Processed Kinematic (IAPPK) solution. The solution is created by combining GPS/GNSS satellite ephemeris and clock data with positional information downloaded from a network of Continually Operating Reference Stations (CORS).

The resulting positional data is corrected for the effects of atmospheric interference on the GPS signal. The corrected GPS position is then combined with the vessel's inertial data using the POSPac MMS program to create a Smoothed Best Estimate of Trajectory (SBET). The resulting position can be used to apply higher quality navigation information to the processed data.

B.1.4.2 Vertical Control

Vertical Control methods for each project are specified in the project instructions, and utilize one of three possible methods:

Zoned Tides: when using zoned tides vertical control is based on one or more NWLON stations operated by CO-OPS. Co-range and co-phase measurements from the NWLON stations are used to break the project area into zones, each of which has a distinct time-of-tide and range-of-tide corrector. CO-OPS provides the field unit a CARIS compatible file which takes observed water levels from surrounding gauges, computes the time and range correctors for each zone, and uses the zoned data to reduce bathymetric soundings to MLLW. Sometimes it is necessary to install temporary, tertiary tide stations to supplement data from existing NWLON stations in order to adequately model tides. After completion of a survey area, CO-OPS verifies all zoning and water level data.

TCARI Tides: Tidal Constituent and Residual Interpretor is an alternative to discrete zoning. A TCARI grid is a triangulated network that uses two or more water level gauges to create a weighted network across the survey area. Each point on the grid has a discrete tidal interpolation that is based on the horizontal nearness of a water level gauge, the harmonic constants of the area, and the residual water levels. Bathymetric data is then reduced to MLLW using the TCARI tool in Pydro. Like zoned tides, CO-OPS verifies TCARI grids and observed water levels at the conclusion of each survey.

GPS Tide: The IAPPK solution described in the Horizontal Control section can also be used to provide vertical control. Using this method the bathymetric data is initially reduced to the Ellipsoid using the highly accurate positional data. It is later reduced to MLLW using a separation model called VDATUM, which is provided to the field unit by NOAA's Hydrographic Services Division.

B.1.5 Feature Verification

The following work flow is used to develop and verify features:

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

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

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

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

- All developments are examined for significances. Objects found to be significant are flagged with a designated sounding, and become part of the Final Feature File.

B.1.6 Bottom Sampling

Bottom samples are collected in accordance with the recommended bottom sample plan provided in each survey's shoreline Project Reference File (PRF). The potential sample sites are examined by the command and potentially culled based on the actual depths found during survey operations. Additional sample sites may also be added.

Aboard HSL 3101 & 3102 bottom samples are collected using the Kahlsico Mud Snapper, while the Thomas Jefferson uses the winch-deployed Ponar Wildco. Once obtained, samples are analyzed for sediment type and classified with S57 attribution using CARIS BASE Editor. In the event that no sample is obtained after three attempts, the nature of the surface is characterized as "unknown". Samples are discarded after field analysis is complete.

B.1.7 Backscatter

Current cuidance from Field Procedures Manual calls for field units to acquire and submit multibeam backscatter in snippet mode when feasible. The Thomas Jefferon's current policy is to ensure quality by processing one line of backscatter per platform, per day.

All backscatter data is logged using Hypack/Hysweep in the .7k format. During acquisition the hydrographer:

- Uses a Saturation Monitor program to evaluate the sonar's power and gain settings plotted against a saturation point;

- Ensures that the RESON data does not saturate;

- Keeps sonar adjustments to a minimum to reduce the likelihood of artifacts in the resulting backscatter product.

B.1.8 Other

No additional data were acquired.

B.2 Data Processing

B.2.1 Bathymetry

B.2.1.1 Multibeam Echosounder

The development of IAPPK positioning has created two separate work flows for multibeam data. One is based on traditional tide methods, and one is based on Ellipsoid Referenced Survey methods. All data is converted into a .HSX format and processed using CARIS HIPS, however the application of navigation, heave, and positional data varies.

The work flow for traditionally processed surveys follows:

- Convert raw .HSX into the CARIS HIPS HDCS format;

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

- Apply TrueHeave, tide, and speed of sound correctors;

- Compute Total Propagated Error. Uncertainty values applied to the data follow recommendations of NOAA's FPM (ed 2013) Appendix 4. The exception is MRU alignment uncertainties, which are calculated using the standard deviation of all angular biases found during a patch test. Tidal zoning and sound speed error modeling is computed on a per-project basis, and is detailed in section B.2.2 of the Descriptive Report;

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

- Review the CUBE grids for holidays;

- Create an initial holiday line plan;

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

- Examine all surfaces for erroneous surface designation and evidence of systematic errors. Also identify features and look for evidence of shoaling;

- Significant features are flagged 'designated', forcing the CUBE algorithm to honor the depth of the sounding;

- Create finalized grids. In finalization, the standard deviation for each node in the surface is multiplied by 1.96 to provide the 95% (2-sigma) standard deviation is compared to the computed Total Vertical Uncertainty (TVU) for each node. The larger of the two values is retained as the finalized Uncertainty for each node.

The work flow for ERS processed surveys follows:

- Convert raw data .HSX data into the CARIS HIPS HDCS format;

- Load TrueHeave correctors;

- Create a Smooth Best Estimate of Trajectory (SBET) file, and the associated error file using POSPac MMS;

- Review SBETs for erroneous data and poor satellite solution;

- Load Attitude/Navigation data;

- Load Error Data;

- Compute GPS Tide;

- Apply sound velocity correctors;

- Compute Total Propagated Error. Uncertainty values applied to the data follow recommendations of NOAA's FPM (ed 2013) Appendix 4. The exception is MRU alignment uncertainties, which are calculated using the standard deviation of all angular biases found during a patch test. Tidal zoning and sound speed error modeling is computed of a per-project basis, and is detailed in section B.2.2 of the Descriptive Report;

- Create CUBE grids. Grid resolution is dictated by the type of coverage required (Complete Coverage vs. Object Detection), and the depth of water. Disambiguation method is NOAA CUBE Parameters. Compliance with HSSD griddling requirements is strictly observed;

- Review the CUBE grids for holidays;

- Create an initial holiday line plan;

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

- Examine all surfaces for erroneous surface designation and evidence of systematic errors. Also identify features and look for evidence of shoaling;

- Significant features are flagged 'designated', forcing the CUBE algorithm to honor the depth of the sounding;

- Create finalized grids. Again, in finalization, the standard deviation for each node in the surface is multiplied by 1.96 to provide the 95% (2-sigma) standard deviation is compared to the computed Total Vertical Uncertainty (TVU) for each node. The larger of the two values is retained as the finalized Uncertainty for each node.

Figure :

B.2.1.2 Single Beam Echosounder

All VBES data is converted using CARIS. The work flow follows:

- Convert raw .bin and .raw data using CARIS HIPS;

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

- Apply TrueHeave, tide, and speed of sound correctors;

- Compute Total Propagated Error. Uncertainty values applied to the data follow recommendations of NOAA's FPM (ed 2013) Appendix 4. The exception is MRU alignment uncertainties, which are calculated using the standard deviation of all angular biases found during a patch test. Tidal zoning and sound speed error modeling is computed of a per-project basis, and is detailed in section B.2.2 of the Descriptive Report;

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

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

- Create CARIS BASE Uncertainty weighted grids at 4-meter resolution;

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

Figure :

B.2.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not processed.

B.2.1.4 Specific Data Processing Methods

B.2.1.4.1 Methods Used to Maintain Data Integrity

All bathymetric data is moved through the CARIS HIPS processing pileline using a step-by-step method. Data integrity is maintained through the use of acqusition and processing logs, which track: acqusition of each line of data; conversion of the data; examination of ancilary sensor(navigation and attitude); and the application of heave, tides, SVP, and TPU. When processing an ERS survey, an additional log tracking the quality of SBETs is used.

B.2.1.4.2 Methods Used to Generate Bathymetric Grids

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

MBES data is gridded using the CUBE algorithm. Resolution is dictated by the Project Instructions, as well as section 5.2.2 of the HSSD. The disambiguation method used is always Density and Local. The settings used for Capture Distance Scale, Horizontal Error Scaler, and Capture Distance Minimum are those listed in section 4.2.1.1.1.1 of the FPM. After creation, Uncertainty and CUBE grids go through a quality control process. During this process, the Depth, Uncertainty, and Density child layers are examined for compliance with NOAA specifications. After the grids passes quality control, they are finalized. Uncertainty values for finalized surface come from the greater of either Uncertainty, or Standard Deviation.

B.2.1.4.3 Methods Used to Derive Final Depths

Methods Used	Cleaning Filters Gridding Parameters Surface Computation Algorithms
Description	Filters are used on a case-by-case basis as determined by the hydrographer. Refer to the Descriptive Report for more information.

B.2.2 Imagery

B.2.2.1 Side Scan Sonar

- Convert raw .sdf data using CARIS SIPS;

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

- Re-compute towfish navigation. This is when towpoint offsets and horizontal layback is applied to the data;

- Slant range correct each line of data;

- A primary reviewer scans each line for significant contacts;

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

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

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

- Create individual mosaics for 100% and 200% coverage. Examine for coverage;

- If necessary, create a holiday line plan.

Figure :

B.2.2.2 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not processed.

B.2.2.3 Specific Data Processing Methods

B.2.2.3.1 Methods Used to Maintain Data Integrity

Daily confidence checks were completed to ensure integrity of data. These checks were completed by ensonifing a target in the outer limits of the range scale on either side of towfish. When this target was seen on the trace within ten meters of the target's actual position (the positional accuracy of a towed system), it was understood that data integrity was maintained. Additionally, integrity is controlled through the use of acquisition and processing logs.

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

Object detection from side-scan imagery is obtained by acquiring the entire survey area two times, with survey lines in the second coverage offset halfway between the lines from the first coverage. This results in 200% Side-Scan Coverage with line spacing based on 80% of the range scale. To ensure positional accuracy, a side-scan certification test is performed. Multiple passes are made on a discrete feature (1m cube when possible) that ensonifies the feature with each transducer at a distance approximately 15%, 50%, and 80% of the range scale in use. A total of 12 passes are made and the feature must be detected in at least 10 of the 12 pass. All survey lines are then processed and a contact created for the feature. Contact positions are plotted and compared to the actual position of the feature. The contacts must be within 5m of the actual position for hull-mounted systems and 10m for towed systems.

B.2.2.3.3 Methods Used to Verify Swath Coverage

Side-scan sonar coverage is determined by creating mosaics using Mosaic Editor in CARIS SIPS. Each 100% of coverage is evaluated independently for gaps in coverage. Any holidays noted in the mosaics must be re-acquired in a manner that will ensonify the area from the same incidence angle as originally intended.

B.2.2.3.4 Criteria Used for Contact Selection

For water depths less than 20m, contact heights of 1m or greater are considered significant. For water depths 20m or greater, contact heights of 10% of the water depth are considered significant. A feature is created for each significant contact.

B.2.2.3.5 Compression Methods Used for Reviewing Imagery

No compression methods were used for reviewing imagery.

B.2.3 Sound Speed

B.2.3.1 Sound Speed Profiles

Sound speed profiles are acquired by two types of devices: CTD and MVP. Downloading and processing of all sound speed data is performed using Velocipy, a part of the HSTP supplied Pydro program suite.

B.2.3.1.1 Specific Data Processing Methods

B.2.3.1.1.1 Caris SVP File Concatenation Methods

All sound speed profiles are concatenated into Master files using Velocpy.

Figure :

B.2.3.2 Surface Sound Speed

Surface sound speed data were not processed.

B.2.4 Horizontal and Vertical Control

B.2.4.1 Horizontal Control

Fixed USCG DGPS stations are used for all real time horizontal information. If IAPPK positioning is used, the POSPac files are processed into SBETs using POSPac MMS.

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 :

B.2.5 Feature Verification

Feature verification begins during initial data processing. When conducting Side Scan surveys the data is converted and scanned for contacts using 2 independent reviewers. All significant contacts are then developed using a MBES. When conducting Multibeam surveys, or when reviewing MBES developments over Side Scan Sonar contacts, the least depths over navigationally significant features are flagged as 'designated soundings', then imported into CARIS BASE Editor. Inside BASE Editor, each significant contact is given an S-57 attribution, and the hydrographer recommends charting action. The final deliverable is a Final Feature File (FFF) .000 format.

Figure :

B.2.6 Backscatter

All backscatter data is logged in HYPACK's .7k format, using datagram version 2. At the time of this report NOAA fiield units are not required to process backscatter data, however the Thomas Jefferson's policy is to process one line per platform, per day in order to conduct quality control checks. All processing of backscatter is done using the FMGT module of the QPS Fledermaus package.

Figure :

B.2.7 Other

No additional data were processed.

B.3 Quality Management

Prior to each Field year the Thomas Jefferson and her survey launches performs an annual Hydrographic Survey Readiness Review, during which all Multibeam sonars, Vertical Beam sonars, Side Scan sonars, Positioning systems, sound speed measuring devices, lead lines, and leveling equipment are calibrated.

Prior to acquisition, the hydrographer ensures that all charted Features and AWOIS items are in the Composite Source File (CSF), and reviews the coverage requirements.

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

During post-processing, navigation and attitude data is scanned using CARIS HIPS and SIPS. Side Scan data is then scanned for significant features by two separate individuals. Multibeam data is binned into a BASE surface using the CUBE algorithm, then undergoes directed editing using the Standard Deviation, Depth, Uncertainty, and hypothesis Count child layers. The IHO allowed uncertainty is also calculated for each surface node, and compared against the actual uncertainty. The resulting "IHOness" layer is reviewed. Any systematic errors, problems in density, or areas of high uncertainty are addressed in the Descriptive Report.

Before any data is to be submitted it is reviewed by at least three experienced hydrographers who are signatories to the Descriptive Report.

B.4 Uncertainty and Error Management

CARIS computes TPU based on both the static and dynamic measurements of the vessel and survey-specific information including tidal zoning uncertainty estimates and sound speed measurement uncertainties. Static offset values are entered into the CARIS *.hvf file. Dynanamic tida/ERS and sound speed uncertainties are entered using the CARIS Compute TPU tool. Where TCARI tides are used, uncertainty is calculated and applied during application of TCARI tidal correctors to HDCS data.

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/ERS and sound speed are entered and used over the duration of the 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 2013 FPM.

B.4.1.3 TPU Values

Vessel	S-222		
Echosounder	Reson SeaBat 7125 ROV 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.0 % Amplitude 0.050 meters
		Pitch	0.050 degrees
		Roll	0.050 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	0.015 meters
	MRU Alignment	*Gyro*	0.100 degrees
		Pitch	0.100 degrees
		Roll	0.100 degrees
	Vessel	*Speed*	0.530 meters/second
		Loading	0.050 meters
		Draft	0.100 meters
		Delta Draft	0.050 meters
Vessel	3101		
Echosounder	Reson SeaBat 7125 SV 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.0 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		0.800 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*	0.015 meters
		y	0.015 meters
		z	0.050 meters

	MRU Alignment	*Gyro*	0.100 degrees
		Pitch	0.100 degrees
		Roll	0.100 degrees
	Vessel	*Speed*	0.530 meters/second
		Loading	0.020 meters
		Draft	0.020 meters
		Delta Draft	0.020 meters
Vessel	3102		
Echosounder	Reson SeaBat 7125 SV 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.0 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	0.800 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	0.100 degrees
		Roll	0.100 degrees
	Vessel	*Speed*	0.530 meters/second
		Loading	0.020 meters
		Draft	0.020 meters
		Delta Draft	0.020 meters

B.4.2 Deviations

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

C Corrections To Echo Soundings

C.1 Vessel Offsets and Layback

C.1.1 Vessel Offsets

C.1.1.1 Description of Correctors

All offsets for the Thomas Jefferson S-222 and her survey launches were derived from full and/or partial surveys performed by NGS personnel. All offsets are tracked and updated as needed.

C.1.1.2 Methods and Procedures

All sensor offsets for Thomas Jefferson S-222 were measured with respect to the vessel's reference point, then translated to the IMU. The offsets for HSL 3101 and 3102 are measured with respect to the vessel's IMU. Offset values are entered into each platform's CARIS HIPS Hydrographic Vessel File (HVF), with the exception of the x,y,z offsets between the Primary GPS Antenna and the IMU. The distance between Primary antenna and IMU is entered into POSView, which then feeds position relative to the IMU to all integrated sonars. All other offsets are applied to data during the SVP and/or Merge steps in processing of bathymetric data. Offsets are applied to Side Scan Sonar data during the Recompute Towfish Navigation step.

C.1.1.3 Vessel Offset Correctors

Vessel	S-222		
Echosounder	RESON 7125-ROV 400 kilohertz		
Date	2012-02-14		
Offsets	*MRU to Transducer*	*x*	-0.472 meters
		y	0.072 meters
		z	0.541 meters
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	0.201 meters
		y	0.944 meters
		z	4.343 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.0 degrees
		Roll2	
Vessel	HSL 3101		
Echosounder	ODOM CV200 200 kilohertz		
Date	2010-01-20		
Offsets	*MRU to Transducer*	*x*	-1.030 meters
		y	0.947 meters
		z	0.198 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.239 meters
		y	1.682 meters
		z	3.952 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.0 degrees
		Roll2	
Vessel	3101		
Echosounder	RESON 7125-SV 400 kilohertz		
Date	2010-01-20		
Offsets	*MRU to Transducer*	*x*	-0.522 meters
		y	-0.033 meters
		z	0.545 meters
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	0.201 meters
		y	0.944 meters
		z	4.343 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.0 degrees
		Roll2	
Vessel	HSL 3102		
Echosounder	ODOM CV200 200 kilohertz		
Date	2010-01-20		
Offsets	*MRU to Transducer*	*x*	-1.004 meters
		y	0.867 meters
		z	0.140 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-0.035 meters
		y	1.709 meters
		z	3.954 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.0 degrees
		Roll2	
Vessel	HSL 3102		
Echosounder	RESON 7125-SV 400 kilohertz		
Date	2010-01-20		
Offsets	*MRU to Transducer*	*x*	-0.522 meters
		y	-0.033 meters
		z	0.545 feet
		x2	
		y2	
		z2	

	Nav to Transducer	*x*	0.299 meters
		y	0.958 meters
		z	4.324 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.0 degrees
		Roll2	

C.1.2 Layback

C.1.2.1 Description of Correctors

Towfish positioning is provided to CARIS HIPS using cable-out values registered by the Totco cable counter and recorded in the Sonar Pro SDF files. SonarPro uses Payout and Towfish Depth to compute towfish positions. The towfish position is calculated from the position of the tow point using the cable-out value received by SonarPro from the cable payout meter, the towfish pressure depth (sent via a serial interface from the KLEIN 5000 TPU to the SonarPro software), and the Course Made Good (CMG) of the vessel. This method assumes that the cable is in a straight line. Therefore, no catenary algorithm is applied at the time of acquisition, but in processing, CARIS SIPS applies a 0.9 coefficient to account for the catenary.

C.1.2.2 Methods and Procedures

Layback error is calculated by running a side-scan certification test. This test consists of running parallel to a known feature at varying ranges from nadir to ensonify the target in the near-field (approx 15% of range scale in use), mid-field (approx 50 % of range scale in use), and far-field (approx 85% of the range scale in use). The test requires that each side of the sonar ensonify the feature at each of these areas in the swath. Then the test is repeated in a direction that is orthogonal to the original set of lines such that the feature is ensonified a total of 12 times. A successful test will detect the feature in at least 10 of the 12 passes. For hull-mounted systems, the selected contact positions must be within 5m; for towed systems, the contact positions must be within 10m. Layback error is the amount of correction that must be applied to minimize the distance between contact positions.

C.1.2.3 Layback Correctors

Vessel	S-222		
Echosounder	Klein 5000 455 kilohertz		
Date	2013-01-01		
Layback	*Towpoint*	*x*	6.37 meters
		y	-42.55 meters
		z	-4.80 meters

	Layback Error	-2.25 meters	
Vessel	HSL 3101		
Echosounder	Klein 5000 455 kilohertz		
Date	2013-01-01		
Layback	*Towpoint*	*x*	0.494 meters
		y	0.054 meters
		z	-0.832 meters
	Layback Error	0.0 meters	
Vessel	HSL 3102		
Echosounder	Klein 5000 455 kilohertz		
Date	2013-01-01		
Layback	*Towpoint*	*x*	-0.463 meters
		y	0.054 meters
		z	-0.832 meters
	Layback Error	0.0 meters	

C.2 Static and Dynamic Draft

C.2.1 Static Draft

C.2.1.1 Description of Correctors

Static draft for each vessel is measured via a sight tube. For the ship, a system of marks have been surveyed into the ship's reference point. A steel ruler is used to measure from one of these marks and the waterline height is calculated. A common waterline for the ship when fully loaded with fuel and ballasted normally is approximately 35cm below the reference point of the ship, but the waterline may change by as much as +/- 30cm over the course of a field season. On the launches, the waterline is measured by placing a steel ruler directly on the reference mark and measuring directly from the sight tube. The waterline is almost constant on the launches despite fuel levels or normal loading. The normal range for waterline on each launch is 22.5 cm to 23.5 cm above the reference point.

C.2.1.2 Methods and Procedures

Waterline measurements are recorded daily on HSL 3101 and 3102. The waterline for S-222 is measured at least weekly. When feasible, waterline measurements are taken before and after fueling or ballasting of the ship. The values are kept in a static draft log and periodically updated in the HVF. Once applied in the HVF, all affected lines have SVP re-applied and are then merged so that the updated waterline measurements will be applied.

C.2.2 Dynamic Draft

C.2.2.1 Description of Correctors

Dynamic draft for Thomas Jefferson S-222 and her survey launches were measured using the Post-Processed Kinematic GPS method outlined in section 1.4.2.1.2.1 of NOAA's FPM.

C.2.2.2 Methods and Procedures

See attached report for a full description of procedures

C.2.2.3 Dynamic Draft Correctors

Vessel	S-222																
Date	2013-03-12																
Dynamic Draft Table	*Speed*	0.0 meters/ second	0.5 meters/ second	1.0 meters/ second	1.5 meters/ second	2.0 meters/ second	2.5 meters/ second	3.0 meters/ second	3.5 meters/ second	4.0 meters/ second	4.5 meters/ second	5.0 meters/ second	5.5 meters/ second	6.0 meters/ second			
	Draft	0.0 meters	-0.03 meters	-0.03 meters	-0.02 meters	0.01 feet	0.04 meters	0.07 meters	0.1 meters	0.13 meters	0.18 meters	0.230 meters	0.310 meters	0.43 meters			
Vessel	HSL 3101																
Date	2013-03-20																
Dynamic Draft Table	*Speed*	0.0 meters/ second	0.5 meters/ second	1.0 meters/ second	1.5 meters/ second	2.0 meters/ second	2.5 meters/ second	3.0 meters/ second	3.5 meters/ second	4.0 meters/ second	4.5 meters/ second	5.0 meters/ second	5.5 meters/ second	6.0 meters/ second	6.5 meters/ second		
	Draft	0.0 meters	0.0 meters	0.01 meters	0.01 meters	0.02 meters	0.03 meters	0.04 meters	0.04 meters	0.04 meters	0.03 meters	0.01 meters	-0.02 meters	-0.06 meters	-0.110 meters		
Vessel	HSL 3102																
Date	2013-03-25																
Dynamic Draft Table	*Speed*	0.0 meters/ second	0.5 meters/ second	1.0 meters/ second	1.5 meters/ second	2.0 meters/ second	2.5 meters/ second	3.0 meters/ second	3.5 meters/ second	4.0 meters/ second	4.5 meters/ second	5.0 meters/ second	5.5 meters/ second	6.0 meters/ second	6.5 meters/ second	7.0 meters/ second	7.5 meters/ second
	Draft	0.0 meters	0.0 meters	0.01 meters	0.02 meters	0.03 meters	0.04 meters	0.05 meters	0.06 meters	0.07 meters	0.07 meters	0.06 meters	0.04 meters	0.02 meters	-0.02 meters	-0.08 meters	-0.15 meters

C.3 System Alignment

C.3.1 Description of Correctors

On Day Number 071 the RESON 7125-ROV system aboard the Thomas Jefferson was patch tested in order to resolve residual biases between the sonar reference frame and the positioning system reference frame. On Day Number 090 the 400kHz RESON 7125-SV systems aboard HSL's 3101 and 3102 were also patch tested.

C.3.2 Methods and Procedures

See report for a full description.

C.3.3 System Alignment Correctors

<table>
<tr><td><i>Vessel</i></td><td colspan="2">S222</td></tr>
<tr><td><i>Echosounder</i></td><td colspan="2">RESON 7125-ROV 400 hertz</td></tr>
<tr><td><i>Date</i></td><td colspan="2">2013-03-12</td></tr>
<tr><td rowspan="8"><i>Patch Test Values</i></td><td><i>Navigation Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Pitch</i></td><td>-1.58 degrees</td></tr>
<tr><td><i>Roll</i></td><td>0.32 degrees</td></tr>
<tr><td><i>Yaw</i></td><td>-0.42 degrees</td></tr>
<tr><td><i>Pitch Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Roll Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Yaw Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Heave Time Correction</i></td><td>0 seconds</td></tr>
</table>

C.3.4 System Alignment Correctors

<table>
<tr><td><i>Vessel</i></td><td colspan="2">HSL 3101</td></tr>
<tr><td><i>Echosounder</i></td><td colspan="2">RESON 7125-SV 400 kilohertz</td></tr>
<tr><td><i>Date</i></td><td colspan="2">2013-03-31</td></tr>
<tr><td rowspan="8"><i>Patch Test Values</i></td><td><i>Navigation Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Pitch</i></td><td>1.07 degrees</td></tr>
<tr><td><i>Roll</i></td><td>0.53 degrees</td></tr>
<tr><td><i>Yaw</i></td><td>-0.72 degrees</td></tr>
<tr><td><i>Pitch Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Roll Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Yaw Time Correction</i></td><td>0 seconds</td></tr>
<tr><td><i>Heave Time Correction</i></td><td>0 seconds</td></tr>
</table>

C.3.5 System Alignment Correctors

Vessel	HSL 3102
Echosounder	RESON 7125-SV 400 kilohertz
Date	2013-03-31

Patch Test Values	*Navigation Time Correction*	0 seconds
	Pitch	-0.36 degrees
	Roll	-0.84 degrees
	Yaw	0.53 degrees
	Pitch Time Correction	0 seconds
	Roll Time Correction	0 seconds
	Yaw Time Correction	0 seconds
	Heave Time Correction	0 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 .7k file. 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 postprocessed 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.

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

Aboard the Thomas Jefferson the MVP free-fall fish is used to collect sound speed profiles. Aboard HSL 3101 and 3102 hand-deployed seabird CTD units are used to take sound of speed profiles.

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

C.6.2.1 Description of Correctors

Aboard the Thomas Jefferson S222 surface sound speed is measured using an AML Smart SV&T probe mounted inside a tank. The tank draws water from the approximate location of the RESON 7125-ROV transducer face. HSL 3101 and 3102 both use a RESON SV-71 probe mounted near the transducer face to measure the surface sound speed

C.6.2.2 Methods and Procedures

The speed of sound at the transducer face is fed directly to the RESON 7125-ROV and 7125-SV topside processing units. It is then passed to HYPACK/HYSWEEP, which records the value in the .HSX file.

D. Approval Sheet

This Data Acquisition and Processing Report is respectfully submitted for the following project:

OPR-B363-TJ-13 Approaches to Block Island Sound, RI & CT

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 (2013), Hydrographic Survey Technical Directives through HTD 2013-04, and the Field Procedures Manual (2013).

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

This DAPR applies to all surveys completed in 2013 for the projects listed above.

Approved and Forwarded:

Megan R. Guberski LT/NOAA

Leiutenant Megan R. Guberski, NOAA
Operations Officer

Commander Lawrence T. Krepp, NOAA
Commanding Officer