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

Data Acquisition & Processing Report

Type of Survey:	Navigable Area
Project Number:	OPR-D304-TJ-18
Time Frame:	May - May 2018

LOCALITY

State(s):	North Carolina
General Locality:	NC Coastline

2018

CHIEF OF PARTY
CDR Christiaan van Westendorp, NOAA

LIBRARY & ARCHIVES

Date:

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NOAA Ship *Thomas Jefferson*
Chief of Party: CDR Christiaan van Westendorp, NOAA
Year: 2018
Version: 1.0
Publish Date: 2018-07-17

A System Equipment and Software

A.1 Survey Vessels

A.1.1 NOAA Ship THOMAS JEFFERSON (WTEA)

Vessel Name	NOAA Ship THOMAS JEFFERSON (WTEA)	
Hull Number	S222	
Description	S222 is a steel hulled hydrographic survey ship built by Halter Marine, Inc., Moss Point, MS.	
Dimensions	*LOA*	208 ft
	Beam	45 ft
	Max Draft	17 ft
Most Recent Full Static Survey	*Date*	2016-09-01
	Performed By	The IMTEC Group, Ltd.

A.1.2 Hydrographic Survey Launch 2903 (HSL 2903)

Vessel Name	Hydrographic Survey Launch 2903 (HSL 2903)	
Hull Number	2903	
Description	HSL 2903 is an aluminum hulled hydrographic survey launch built in 2017 by Willard Marine, Inc. HSL 2903 is designed and equipped to collect bathymetric data, side scan imagery, and water column profiles.	
Dimensions	*LOA*	28 ft
	Beam	10 ft
	Max Draft	4 ft

Most Recent Full Static Survey	*Date*	2017-05-01
	Performed By	National Ocean Service - National Geodetic Survey (NGS) - Field Operations Branch
Most Recent Partial Offset Verification	*Date*	2018-05-04
	Method	Physical confirmation of measurements.

A.1.3 Hydrographic Survey Launch 2904 (HSL 2904)

Vessel Name	Hydrographic Survey Launch 2904 (HSL 2904)	
Hull Number	2904	
Description	HSL 2904 is an aluminum hulled hydrographic survey launch built in 2017 by Willard Marine, Inc. HSL 2904 is designed and equipped to collect bathymetric data, side scan imagery, and water column profiles.	
Dimensions	*LOA*	28 ft
	Beam	10 ft
	Max Draft	4 ft
Most Recent Full Static Survey	*Date*	2017-05-01
	Performed By	National Ocean Service - National Geodetic Survey (NGS) - Field Operations Branch
Most Recent Partial Offset Verification	*Date*	2018-05-04
	Method	Physical confirmation of measurements.

A.2 Echo Sounding Equipment

A.2.1 Multibeam Echosounders

A.2.1.1 Kongsberg Maritime AS EM2040

Manufacturer	Kongsberg Maritime AS
Model	EM2040

<table>
<tr><td><i>Description</i></td><td>The Kongsberg EM2040 MBES is a high resolution shallow water MBES. The system is capable of operating at 200, 300, or 400 kHz frequencies, can provide across-track swath width up to 5.5 times water depth, provides single or multi-sector modes of operations, and can be used in depths up to 600 meters.

The standard practice aboard THOMAS JEFFERSON is to operate the EM2040 on S222 with a maximum swath width of 120 degrees and in Single Center Sector mode per HSTB recommendations.

The EM2040 is operated at the 300 kHz frequency for normal shallow water operations.

See the NOAA Ship THOMAS JEFFERSON EM710 and EM2040 Acceptance Testing Report included in the Appendices for a detailed discussion about the EM2040 system on S222.</td></tr>
<tr><td><i>Inventory</i></td><td>
<table>
<tr><td><i>S222</i></td><td>
<table>
<tr><td><i>Component</i></td><td>Processor</td><td>Transceiver</td><td>Receiver</td><td>Projector</td></tr>
<tr><td><i>Model Number</i></td><td>EM2040</td><td>EM2040</td><td>EM2040</td><td>EM2040</td></tr>
<tr><td><i>Serial Number</i></td><td>CZC3410L1L</td><td>40072</td><td>334</td><td>236</td></tr>
<tr><td><i>Frequency</i></td><td>N/A</td><td>200-400 kHz</td><td>200-400 kHz</td><td>200-400 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td></tr>
</table>
</td></tr>
<tr><td><i>2903</i></td><td>
<table>
<tr><td><i>Component</i></td><td>Processor</td><td>Transducer</td><td>Receiver</td></tr>
<tr><td><i>Model Number</i></td><td>EM2040</td><td>EM2040</td><td>EM2040</td></tr>
<tr><td><i>Serial Number</i></td><td>CZC746864F</td><td>281</td><td>392</td></tr>
<tr><td><i>Frequency</i></td><td>200-400 kHz</td><td>200-400 kHz</td><td>200-400 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-17</td><td>2018-05-17</td><td>2018-05-17</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-05-17</td><td>2018-05-17</td><td>2018-05-17</td></tr>
</table>
</td></tr>
<tr><td><i>2904</i></td><td>
<table>
<tr><td><i>Component</i></td><td>Processor</td><td>Transducer</td><td>Receiver</td></tr>
<tr><td><i>Model Number</i></td><td>EM2040</td><td>EM2040</td><td>EM2040</td></tr>
<tr><td><i>Serial Number</i></td><td>CZ7468666</td><td>282</td><td>393</td></tr>
<tr><td><i>Frequency</i></td><td>200-400 kHz</td><td>200-400 kHz</td><td>200-400 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-07-12</td><td>2018-07-12</td><td>2018-07-12</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-07-12</td><td>2018-07-12</td><td>2018-07-12</td></tr>
</table>
</td></tr>
</table>
</td></tr>
</table>

A.2.1.2 Kongsberg Maritime AS EM710

Manufacturer	Kongsberg Maritime AS
Model	EM710

<table>
<tr><td><i>Description</i></td><td>The Kongsberg EM710-MK2 is a high resolution MBES system. The system is capable of operating at frequencies from 65 to 100 kHz for operations in shallow waters, can operate at frequencies down to 40 kHz for deep water operations, can provide across-track swath width up to 5.5 times water depth, provides single or multi-sector modes of operations, and can be used in depths up to 2800 meters.

The standard practice aboard THOMAS JEFFERSON is to operate the EM710 with a maximum swath width of 120 degrees per HSTB recommendations. The EM710 offers several modes of operations corresponding to survey depths; standard practice aboard the THOMAS JEFFERSON is to set the EM710 system to automatically operate in the mode of operation most appropriate for working depths.

See the NOAA Ship THOMAS JEFFERSON EM710 and EM2040 Acceptance Testing Report included in the Appendices for a detailed discussion about the EM2040 system on S222.</td></tr>
<tr><td><i>Inventory</i></td><td><table><tr><td><i>S222</i></td><td><table>
<tr><td><i>Component</i></td><td>Projector</td><td>Receiver</td><td>Processor</td></tr>
<tr><td><i>Model Number</i></td><td>EM 710</td><td>EM 710</td><td>EM 710</td></tr>
<tr><td><i>Serial Number</i></td><td>235</td><td>172</td><td>CZC3407HFV</td></tr>
<tr><td><i>Frequency</i></td><td>40-100 kHz</td><td>40-100 kHz</td><td>40-100 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-05-04</td><td>2018-05-04</td><td>2018-05-04</td></tr>
</table></td></tr></table></td></tr>
</table>

A.2.2 Single Beam Echosounders

No single beam echosounders were utilized for data acquisition.

A.2.3 Side Scan Sonars

A.2.3.1 Klein Marine Systems, Inc. 5000 v2

Manufacturer	Klein Marine Systems, Inc.
Model	5000 v2

<table>
<tr><td><i>Description</i></td><td colspan="4">The Klein 5000 v2 Side Scan Sonar (SSS) system is a beam-forming acoustic imagery device. The integrated system includes a Klein 5000 towfish, a Transceiver/Processing Unit (TPU), and a computer for user interface. Stern-towed units also include a tow cable telemetry assembly. The towfish operates at a frequency of 455kHz and a vertical beam angle of 40°, and can resolve up to 5 discrete received beams per transducer stave. The system is capable of ranges of up to 250 meters. The Klein 5000 v2 model can also be used to collect bathymetric data using acoustic phase differencing technology. The Klein 5000 v2 systems are only used to collect SSS imagery on THOMAS JEFFERSON.

The Klein 5000 v2 is deployed in a stern-towed configuration on S222.

All Klein systems were upgraded with new TPUs in 2017.</td></tr>
<tr><td rowspan="6"><i>Inventory</i></td><td rowspan="6"><i>S222</i></td><td><i>Component</i></td><td>TPU</td><td>Towfish</td></tr>
<tr><td><i>Model Number</i></td><td>5000 v2</td><td>5000 v2</td></tr>
<tr><td><i>Serial Number</i></td><td>778</td><td>385</td></tr>
<tr><td><i>Frequency</i></td><td>455 kHz</td><td>455 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td><td>2018-05-04</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-05-04</td><td>2018-05-04</td></tr>
</table>

A.2.3.2 Klein Marine Systems, Inc. 5000

<table>
<tr><td><i>Manufacturer</i></td><td colspan="4">Klein Marine Systems, Inc.</td></tr>
<tr><td><i>Model</i></td><td colspan="4">5000</td></tr>
<tr><td><i>Description</i></td><td colspan="4">The Klein 5000 system used on S222 is an older version of the 5000 v2 system. The specifications of the 5000 system are identical to the 5000 v2 system in all substantial aspects relating to system performance. The towfish units on 5000 systems are smaller than the towfish units for the 5000 v2 system and are deployed on the HSLs in a hull-mounted configuration.

All Klein systems were upgraded with new TPUs in 2017.</td></tr>
<tr><td rowspan="6"><i>Inventory</i></td><td rowspan="6"><i>2903</i></td><td><i>Component</i></td><td>TPU</td><td>Towfish</td></tr>
<tr><td><i>Model Number</i></td><td>5000</td><td>5000</td></tr>
<tr><td><i>Serial Number</i></td><td>009</td><td>319</td></tr>
<tr><td><i>Frequency</i></td><td>455 kHz</td><td>455 kHz</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td><td>2018-05-04</td></tr>
<tr><td><i>Accuracy Check</i></td><td>2018-05-04</td><td>2018-05-04</td></tr>
</table>

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

No lead lines were utilized for data acquisition.

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 Horizontal and Vertical Control Equipment

A.4.1 Base Station Equipment

No base station equipment was utilized for data acquisition.

A.4.2 Rover Equipment

No rover equipment was utilized for data acquisition.

A.4.3 Water Level Gauges

No water level gauges were utilized for data acquisition.

A.4.4 Levels

No levels were utilized for data acquisition.

A.4.5 Other Horizontal and Vertical Control Equipment

No other equipment were utilized for data acquisition.

A.5 Positioning and Attitude Equipment

A.5.1 Positioning and Attitude Systems

A.5.1.1 Applanix Corporation POS MV 320 Version 5

Manufacturer	Applanix Corporation
Model	POS MV 320 Version 5

Description	The Applanix POS MV 320 Version 5 (Position and Orientation System for Marine Vessels, hereafter 'POS MV v5') is a GNSS Inertial Navigation System that provides high frequency and highly accurate vessel trajectory (both navigation/position and attitude/ orientation) data. The system incorporates data from an Inertial Motion Unit (IMU) and dual multi-constellation Global Navigation Satellite System (GNSS) receivers. Advanced proprietary Kalman Filtering techniques are used to provide a blended navigation and trajectory solution in real-time that is both highly accurate and reliable. The POS MV v5 also computes vessel heave (both instantaneous and delayed heave values). The POS MV v5 system is integrated with all acquisition systems on all platforms. Data from the POS MV v5 is applied to echosounder data in real-time and logged for post-processing and/or archiving. The POS MV v5 produces attitude data in three axes (roll, pitch, and heading) to an accuracy of 0.02° or better. Real-time heave measurements supplied by the POS/MV maintain an accuracy of 5% of the measured vertical displacement or 5 cm (whichever is greater) for vertical motions less than 20 seconds in period. The standard practice on THOMAS JEFFERSON is to configure the Heave Bandwidth filter with a damping coefficient of 0.707 and to apply a high pass filter that is determined by the longest swell period encountered on the survey grounds. The POS MV v5 also calculates a 'delayed heave' value (Applanix calls this 'TrueHeave'). The Applanix delayed heave algorithm uses a delayed filtering technique to eliminate many of the artifacts present in real time heave data. Applanix delayed heave measurements maintain an accuracy of 2% of the measured vertical displacement or 2 cm (whichever is greater) for vertical motions less than 20 seconds in period. Delayed heave measurements are logged and applied to MBES data in post processing. A graphical user interface provides visual representations and summary statistics of data quality in real-time. Performance parameters are monitored by acquisition hydrographers in real-time and checked against HSSD requirements. Position and trajectory data from the POS MV v5 system is applied in both real-time and post-processed applications. Navigation and attitude data is applied to all echosounder data in real-time. Raw data from the POS MV v5 can also be post-processed after acquisition to achieve trajectory solutions that are more accurate than those achieved in real-time by using forward/backward processing methods. Post-processing is conducted using the Applanix POSPac Mobile Mapping Suite (MMS) software suite. Post-processing methodology is described elsewhere in this document.

Inventory	*S222*	*Component*	IMU	PCS
		Model Number	LN200 (v4)	POS MV 320 v5
		Serial Number	1047	6497
		Calibration	2018-05-04	2018-05-04
	2903	*Component*	IMU	PCS
		Model Number	LN200 (v3)	POS MV 320 v5
		Serial Number	131	8927
		Calibration	2018-05-04	2018-05-04
	2904	*Component*	IMU	PCS
		Model Number	LN200 (v4)	POS MV 320 v5
		Serial Number	356	8958
		Calibration	2018-05-04	2018-05-04

A.5.2 DGPS

DGPS equipment was not utilized for data acquisition.

A.5.3 GPS

GPS equipment was not utilized for data acquisition.

A.5.4 Laser Rangefinders

Laser rangefinders were not utilized for data acquisition.

A.5.5 Other Positioning and Attitude Equipment

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

A.6 Sound Speed Equipment

A.6.1 Moving Vessel Profilers

A.6.1.1 Rolls-Royce Group ODIM Brooke Ocean MVP100 Moving Vessel Profiler (MVP)

<table>
<tr><td><i>Manufacturer</i></td><td colspan="3">Rolls-Royce Group ODIM Brooke Ocean</td></tr>
<tr><td><i>Model</i></td><td colspan="3">MVP100 Moving Vessel Profiler (MVP)</td></tr>
<tr><td><i>Description</i></td><td colspan="3">S222 is equipped with a Rolls-Royce Group Brooke Ocean MVP100 Moving Vessel Profiler (MVP). The MVP system consists of a sensor towfish, a conductor/tow cable, a computer controlled high speed hydraulic winch, and a cable metering system. A Conductivity-Temperature-Depth (CTD) or direct-read sound speed sensor is housed in the sensor towfish and interfaced with the ship acquisition system via the conductor/tow cable. The MVP system provides a means of collecting full water-column data while S222 remains underway.

The MVP system on S222 has 320 m of cable and can be used to take water-column profiles of approximately 150 m in depth at speeds of approximately 10 kts.

The MVP product line is now owned by AML Oceanographic.</td></tr>
<tr><td rowspan="4"><i>Inventory</i></td><td rowspan="4"><i>S222</i></td><td><i>Component</i></td><td>MVP System</td></tr>
<tr><td><i>Model Number</i></td><td>MVP 100</td></tr>
<tr><td><i>Serial Number</i></td><td>N/A</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td></tr>
</table>

A.6.2 CTD Profilers

A.6.2.1 Sea-bird Electronics SBE 19plus

Manufacturer	Sea-bird Electronics
Model	SBE 19plus

<table>
<tr><td><i>Description</i></td><td>The Sea-Bird Electronics SBE 19plus SeaCAT profiler measures conductivity, temperature, and depth (CTD) in marine and/or freshwater environments. The SBE 19plus is rated for use at depths of up to 600 meters and is capable of sampling at a rate of 4 measurements per second. CTD values are used to calculate the speed of sound through the water column.
SBE 19plus profilers are the primary means of obtaining water column data on HSL 2903 and HSL 2904.
SBE 19plus profilers are used primarily as a backup means of obtaining water column data and/or deep-water water column data on S222.</td></tr>
<tr><td><i>Inventory</i></td><td><table>
<tr><td><i>Component</i></td><td>CTD</td></tr>
<tr><td><i>Model Number</i></td><td>SBE 19plus</td></tr>
<tr><td><i>Serial Number</i></td><td>4487</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td></tr>
<tr><td><i>Component</i></td><td>CTD</td></tr>
<tr><td><i>Model Number</i></td><td>SBE 19plus</td></tr>
<tr><td><i>Serial Number</i></td><td>4343</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-27</td></tr>
<tr><td><i>Component</i></td><td>CTD</td></tr>
<tr><td><i>Model Number</i></td><td>SBE 19plus</td></tr>
<tr><td><i>Serial Number</i></td><td>6667</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-27</td></tr>
</table></td></tr>
</table>

A.6.2.2 AML Oceanographic AML Micro CTD

Manufacturer	AML Oceanographic
Model	AML Micro CTD
Description	The Micro CTD is a sensor used to measure conductivity, temperature and depth of water. The Micro CTD provides conductivity measurements at a resolution of 0.0015 mS/cm with an accuracy of 0.01 mS/cm, temperature measurements at a resolution of 0.001 degree C with an accuracy of plus/minus 0.005 degree C, and pressure at a resolution of 0.1 dBar with an accuracy of plus/minus 0.05 % of measurement. The AML Micro CTD is attached to the MVP100 towfish on S222 to provide water column data to the ship data acquisition system.

<table>
<tr><td><i>Inventory</i></td><td><table>
<tr><td><i>Component</i></td><td>Probe</td></tr>
<tr><td><i>Model Number</i></td><td>AML Micro CTD</td></tr>
<tr><td><i>Serial Number</i></td><td>8613</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td></tr>
</table></td></tr>
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A.6.2.3 AML Oceanographic AML MVP-X

<table>
<tr><td><i>Manufacturer</i></td><td>AML Oceanographic</td></tr>
<tr><td><i>Model</i></td><td>AML MVP-X</td></tr>
<tr><td><i>Description</i></td><td>The AML MVP-X is a multi-parameter sensor designed specifically for use with the AML Moving Vessel Profiler (MVP) models. The MVP-X is highly configurable and is compatible with all AML Xchange (tm) oceanographic sensors. The MVP-X configuration used on S222 includes conductivity, temperature and pressure sensors: the conductivity sensors provide a sensor range of 0-90 mS/cm, a resolution of 0.001 mS/cm, with an accuracy of plus/minus 0.01 mS/cm; the temperature sensors provide a sensor range of -5 to +45 Deg C, a resolution of 0.001 Deg C, with an accuracy of plus/minus 0.005 Deg C; the pressure sensors provide a sensor range of 0 to 1000 dBar, a resolution of 0.02% of measurement, with an accuracy of 0.05% of measurement. The main instrument housings on the MVP-X units are rated for operation at pressures up to 6000 dBar.

The AML MVP-X units are not normally deployed and are used as backup sensors to the MicroCTD used in the MVP100 sensor towfish.</td></tr>
<tr><td><i>Inventory</i></td><td><table>
<tr><td><i>Component</i></td><td>Probe</td><td>Probe</td></tr>
<tr><td><i>Model Number</i></td><td>AML MVP-X</td><td>AML MVP-X</td></tr>
<tr><td><i>Serial Number</i></td><td>9001</td><td>9006</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td><td>2018-05-04</td></tr>
</table></td></tr>
</table>

A.6.3 Sound Speed Sensors

A.6.3.1 Teledyne Reson (formally RESON A/S) Reson SVP-70 and SVP-71 Sound Speed Sensors

Manufacturer	Teledyne Reson (formally RESON A/S)
Model	Reson SVP-70 and SVP-71 Sound Speed Sensors

<table>
<tr><td><i>Description</i></td><td colspan="3">The Reson SVP-70 and SVP-71 are direct-read sound velocity measurement devices. The SVP devices obtain sound speed measurements by directly measuring the travel time of sound pulses along a set 125 mm transmission path. The SVP systems are capable of reading sound speeds from 1350 to 1800 m/s with a resolution of 0.01 m/s (±0.15m/s) at a sampling rate of 20 Hz.

The SVP-70 and SVP-71 provide identical sound speed measurement capabilities and differ only in housing construction and operational depth ratings; the housing of the SVP-70 is made entirely of titanium while the SVP-71 housing is made of hard anodized sea-water resistant aluminum.

The Reson SVPs provide real-time surface sound speed data to the Kongsberg MBES systems on HSL 2903 and HSL 2904. An SVP is mounted close to the EM2040 transducers on each launch.</td></tr>
<tr><td rowspan="8"><i>Inventory</i></td><td rowspan="4"><i>2903</i></td><td><i>Component</i></td><td>Probe</td></tr>
<tr><td><i>Model Number</i></td><td>SVP-71</td></tr>
<tr><td><i>Serial Number</i></td><td>4211067</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td></tr>
<tr><td rowspan="4"><i>2904</i></td><td><i>Component</i></td><td>Probe</td></tr>
<tr><td><i>Model Number</i></td><td>SVP-70</td></tr>
<tr><td><i>Serial Number</i></td><td>1013077</td></tr>
<tr><td><i>Calibration</i></td><td>2018-05-04</td></tr>
</table>

A.6.3.2 Valeport Limited Modus SVS

Manufacturer	Valeport Limited
Model	Modus SVS
Description	The Modus SVS is a thru-hull sound velocity sensor. The sound speed sensor used in the system is a direct-read 'time of flight' sound speed sensor. The Modus models used aboard S222 use a 100mm measurement path and include temperature sensors. The sound speed sensor can measure sound in fresh water or marine environments with a measurement range of 1400-1600 m/s, at a resolution of 0.001 m/s, with an accuracy of ± 0.03 m/s. The thru-hull port where the sound speed sensor is deployed is located adjacent and aft of the transducer fairing. Note on calibration date for Modus SVS 33711: The unit was calibrated on 12/14/2016 but was stowed in a temperature controlled space and not used until installed for ship use in Janurary 2018.

Inventory	*S222*	*Component*	Probe	Probe
		Model Number	Modus SVS	Modus SVS
		Serial Number	33711	33747
		Calibration	2018-05-04	2018-05-04

A.6.4 TSG Sensors

No surface sound speed sensors were utilized for data acquisition.

A.6.5 Other Sound Speed Equipment

No surface sound speed sensors were utilized for data acquisition.

A.7 Computer Software

A.7.1 Caris HIPS

Manufacturer	Caris
Software Name	HIPS
Version	10.4
Installation Date	2018-05-04
Use	Processing

A.7.2 Caris BASE Editor

Manufacturer	Caris
Software Name	BASE Editor
Version	4.4
Installation Date	2018-05-04
Use	Processing

A.7.3 NOAA Pydro

Manufacturer	NOAA
Software Name	Pydro

Version	18
Installation Date	2018-05-04
Use	Acquisition and Processing

A.7.4 HYPACK - A Xylem Brand HYPACK

Manufacturer	HYPACK - A Xylem Brand
Software Name	HYPACK
Version	2018
Installation Date	2018-05-04
Use	Acquisition

A.7.5 Applanix Corporation POSPac MMS

Manufacturer	Applanix Corporation
Software Name	POSPac MMS
Version	8.2.1
Installation Date	2018-05-04
Use	Processing

A.7.6 Applanix Corporation POSView

Manufacturer	Applanix Corporation
Software Name	POSView
Version	8.32
Installation Date	2018-05-04
Use	Acquisition

A.7.7 QPS, Inc Fledermaus

Manufacturer	QPS, Inc
Software Name	Fledermaus
Version	7.4.0d
Installation Date	2018-05-04
Use	Processing

A.7.8 ESRI, Inc. ArcGIS

Manufacturer	ESRI, Inc.
Software Name	ArcGIS
Version	10.3
Installation Date	2018-05-04
Use	Acquisition and Processing

A.7.9 Kongsberg Maritime AS Seafloor Information System (SIS)

Manufacturer	Kongsberg Maritime AS
Software Name	Seafloor Information System (SIS)
Version	4.3.0 (EM710) and 4.3.2 (EM2040)
Installation Date	2018-05-04
Use	Acquisition

A.7.10 Klein Marine Systems, Inc SonarPro

Manufacturer	Klein Marine Systems, Inc
Software Name	SonarPro
Version	14.1
Installation Date	2018-05-04
Use	Acquisition

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

A.8.1.1 Kahlisco Mud Snapper 214WA100 (AKA 'The Nibbler')

Manufacturer	Kahlisco
Model	Mud Snapper 214WA100 (AKA 'The Nibbler')
Description	The Kahlisco Mud Snapper is a hand held bottom sampler used to take bottom samples from HSLs 2903 and 2904. The Mud Snapper is a foot-trip model clam shell style bottom sampler. This sampler is designed to collect unconsolidated

	sediments up to the size of small pebbles. The sampler is fabricated from sturdy bronze and stainless steel materials for trouble-free service in a marine environment. The unit consists of a long threaded post surrounded by a strong compression spring that presses against the jaws at one end and an adjustable screw cap at the upper end. By turning this threaded cap the spring-compression is adjusted, changing the strength at which the jaws close. A shackle is attached through a hole on the top of the post and a line attached. Due to the small of this sampler, it may be deployed either by using a heavy duty fishing pole or by using a handline.

A.8.1.2 Ponar Wildco Model #1728

Manufacturer	Ponar Wildco
Model	Model #1728
Description	The Ponar Wildco is a winch-deployed bottom sampler used aboard S222. The sampler is a Ponar type grab sampler of a design commonly used to sample a wide variety of sediment types. The sampler design uses self-tripping center hinged jaws and a spring loaded trigger pin that releases when the sampler makes impact with the bottom. The sampler's jaws are closed by the scissor action of the lever arms when the sampler is retrieved. The sampling area is 6" x 6".

A.8.1.3 NOAA-UNH NOAA-UNH Image Grab Sampler (IGS) v1.0

Manufacturer	NOAA-UNH
Model	NOAA-UNH Image Grab Sampler (IGS) v1.0
Description	The IGS is used to collect imagery of the seabed at a bottom sample location. The system utilizes a GoPro (tm) camera and several dive-rated flashlights positioned on a shaft with a stabilizing float. The frame set up connects between the deployment line and bottom sampler or optional sample frame. The Ponar Wildco grab sampler is used to obtain the physical samples. Sample imagery is downloaded from the GoPro camera following each deployment.

B System Alignment and Accuracy

B.1 Vessel Offsets and Layback

B.1.1 Vessel Offsets

All offsets for S222 are derived from full surveys performed by Kongsberg USA-contracted personnel and have been verified by Hydrographic Systems and Technology Branch (HSTB) personnel. All offsets are tracked and updated as needed. Offsets values are known in the vessel reference frame, the IMU reference frame, and Kongsberg EM710 reference frame. Offset values for the Kongsberg MBES systems are entered into SIS and the ship's Caris HIPS Hydrographic Vessel File (HVF), with the exception of the orthogonal offsets between the primary Applanix GNSS sensor antenna and the Applanix IMU. The offset between the primary GNSS antenna and the IMU is applied to the POS MV. The POS MV provides navigation and attitude data in the IMU reference frame at the IMU reference point. All other offsets are applied to data during the SVP or Merge processing steps in CARIS HIPS.

Offsets are applied to side scan sonar data in Caris HIPS during the Compute Towfish Navigation step.

All offsets for HSL 2903 and HSL 2904 are derived from full vessel surveys performed by NGS personnel. The reference point for the launches is the IMU.

All offsets, correctors, and values used in TPU calculation that are stored in the HVF file can be found in the Appendices to this report. HVF Reports are output from the Caris HVF Editor in a plain text document readable anywhere and include all of the requested values for the DAPR necessary to reproduce an HVF.

B.1.1.1 Vessel Offset Correctors

See included HVFs for information on applied correctors.

B.1.2 Layback

Towfish positioning is provided to Caris HIPS using cable-out values registered by the Totco cable counter and recorded in the SonarPro 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.

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 (approximately 15% of range scale in use), mid-field (approximately 50 % of range scale in use), and far-field (approximately 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.

B.2 Static and Dynamic Draft

B.2.1 Static Draft

Static draft is measured on the S222 using a Sutron Bubbler system. The waterline for the ship when fully loaded with fuel and ballasted normally is approximately 35cm below the reference point of the ship; the waterline may change by as much as +/- 30cm over the course of a field season.

The waterline for S222 is measured as needed. Waterline measurements are always taken at the beginning and end of 2-3 week survey legs. When feasible, waterline measurements are taken at weekly intervals and when the ship is fueled or ballasted. 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.

The waterline for HSL platforms is measured using physical measurements from the waterline of the vessel to physical known benchmarks.

All offsets, correctors, and values used in TPU calculation that are stored in the HVF file can be found in the included Appendix Folder, HVF Reports. These HVF Reports are output from the Caris HVF Editor in a plain text document readable anywhere, and include all of the requested values for the DAPR necessary to reproduce an HVF.

B.2.1.1 Static Draft Correctors

B.2.2 Dynamic Draft

Dynamic draft for all platforms was measured using the Post Processed Kinematic GPS method outlined in section 1.4.2.1.2.1 of NOAA's FPM. To reduce the effect of any potential current, reciprocal lines were run at each RPM step in order to get an average speed over ground for each RPM. This average speed was used to estimate the vessel’s speed through the water. Dynamic draft and vessel offsets corrector values are stored in the HIPS Vessel Files (HVF).

An average of dynamic draft values from years prior to 2018 is used for S222 for the 2018 field season. Dynamic draft values for HSL 2903 and 2904 were determined using the ERDDM method during HSRR activities in 2018.

In ERS surveys (those that use recorded GPS heights corrected via a VDatum SEP model to achieve tidal datum) the dynamic draft correction is not applied to the soundings.

All offsets, correctors, and values used in TPU calculation that are stored in the HVF file can be found in the included Appendix Folder, HVF Reports. These HVF Reports are output from the Caris HVF Editor in a plain text document readable anywhere, and include all of the requested values for the DAPR necessary to reproduce an HVF.

B.2.2.1 Dynamic Draft Correctors

See included HVFs for information on applied correctors.

B.3 System Alignment

B.3.1 System Alignment Methods and Procedures

THOMAS JEFFERSON conducts MBES calibration tests during annual HSRR activities for each individual multibeam system on the ship and her launches.

The procedure used to calibrate launch MBES systems is derived from the procedure outlined in section 1.5.5.1 of the Field Procedures Manual dated April 2014.

Offset values for all platforms were determined using the Caris HIPS MBES calibration tool.

All calibration reports can be found in the Appendix Folder.

B.3.1.1 System Alignment Correctors

See included HVFs and calibration reports for information on applied correctors.

C Data Acquisition and Processing

C.1 Bathymetry

C.1.1 Multibeam Echosounder

Data Acquisition Methods and Procedures

All multibeam data on THOMAS JEFFERSON platforms is logged using Kongsberg Seafloor Information System (SIS) in the Kongsberg ALL (.all) file format.

During acquisition aboard THOMAS JEFFERSON, the hydrographer:

- Monitors the SIS interface for errors and data quality

- Monitors the SIS interface for indication of sound speed changes requiring a cast, and conducts casts as necessary

- Monitors the Hysweep interface in HYPACK

- Monitors the vessel speed and requests the bridge to adjust as necessary to ensure density and coverage specifications are met

Data Processing Methods and Procedures

MBES is processed using Caris HIPS and the Pydro Charlene.

S222 Workflow:

Caris HIPS is used to conduct the following basic processing steps for S222:

1. Conversion: Kongsberg ALL (.all) MBES data is converted into the Caris project structure.

2. Load Delayed Heave: TrueHeave data from Applanix POS MV raw logged data is applied to all MBES sounding.

3. Sound Velocity Correct: MBES data is sound velocity corrected using the the Caris method.

4. Compute GPS Tide: GPS tides are computed using real-time ellipsoid height logged in the Kongsberg ALL files and a VDatum separation model.

5. Merge: MBES data is merged to apply appropriate correctors.

6. Compute Total Propagated Uncertainty (TPU): Uncertainty is computed based on parameters discussed elsewhere in this report.

7. Create Surface: Combined Uncertainty and Bathymetric Estimator (CUBE) bathymetric surfaces are created in accordance with relevant project and OCS survey specifications.

S222 workflow notes:

The procedure outlined above reflects the general workflow use on the ship to process MBES data. An additional step may be added to the workflow for the application of Smooth Best Estimate Trajectory (SBET) files. SBETs are loaded as Auxiliary data in cases where SBET files are used to provide improved ellipsoid height positioning; this processing step occurs after loading Delayed Heave and before Sound Velocity Correcting the data.

The unique integration setup for S222 requires that the Load Delayed Heave and Sound Velocity Correction steps be executed in HIPS in order to accurately Compute GPS Tides. This counter-intuitive requirement is the result of the equipment settings used on S222 to integrate multiple MBES systems (EM2040 and EM710) with one Attitude and Navigation sensor (POS MV v5). See the TJ EM710 and EM2040 Acceptance Report included in the Appendices to this report for further information about this requirement.

HSL workflow:

Caris HIPS is used to conduct the following basic processing steps for HSL 2903 and HSL 2904:

1. Conversion: Kongsberg ALL (.all) MBES data is converted into the Caris project structure.

2. Compute GPS Tide: GPS tides are computed using real-time ellipsoid height logged in the Kongsberg ALL files and a VDatum separation model.

3. Merge: MBES data is merged to apply appropriate correctors.

4. Compute Total Propagated Uncertainty (TPU): Uncertainty is computed based on parameters discussed elsewhere in this report.

5. Create Surface: CUBE bathymetric surfaces are created in accordance with relevant project and OCS survey specifications.

HSL workflow notes:

The Load Delayed Heave and Sound Velocity Correction processing steps are not required for HSL processing workflows. SBETs are loaded as Auxiliary data in cases where SBET files are used to provide improved ellipsoid height positioning; this processing step occurs after initial data Conversion and before the Compute GPS Tides step.

Charlene:

Charlene is a Pydro utility that automates the processing workflows described above. The utility is essentially a ‘software wrapper’ that provides a single user interface that can be used to initiate standardized processing workflows. Charlene utilizes Caris and Applanix software Application Programing Interface utilities to initiate a given processing workflow.

Charlene is used for all standard processing workflows aboard THOMAS JEFFERSON.

Other notes:

Workflows utilizing traditional tides are no longer used aboard THOMAS JEFFERSON.

C.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not acquired.

C.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

C.1.4 Gridding and Surface Generation

C.1.4.1 Surface Generation Overview

CUBE gridded surfaces are generated in Caris HIPS following initial bathymetric data processing.

Single resolution CUBE surfaces are used for daily quality control and directed editing purposes.

Gridded bathymetric surfaces which comply with Project Instruction and HSSD requirements are generated following the completion of on-site acquisition operations and are used for post-acquisition survey processing.

C.1.4.2 Depth Derivation

CUBE and Variable Resolution (VR) parameter files provided by HSD Operations are used to ensure that gridding parameters and surface computation algorithms comply with the HSSD requirements.

Filters are used on a case-by-case basis as determined by the hydrographer. Refer to the Descriptive Report for more information.

C.1.4.3 Surface Computation Algorithm

MBES data is gridded using Single Resolution or Variable Resolution CUBE algorithms; these algorithms are implemented in the Caris HIPS surface creation tools used to create gridded bathymetric surfaces.

Resolution is dictated by the Project Instructions and section 5.2.2 of the HSSD.

HSD gridding parameter files are used to ensure that gridding parameters and surface computation algorithms comply with the HSSD requirements.

THOMAS JEFFERSON submits Single Resolution surfaces in lieu of Variable Resolution surfaces when HSSD requirements allow.

C.2 Imagery

C.2.1 Multibeam Backscatter Data

Data Acquisition Methods and Procedures

Backscatter data on THOMAS JEFFERSON are logged in the Kongsberg ALL (.all) file format using Kongsberg SIS software.

Data Processing Methods and Procedures

Backscatter data are processed using the FMGT module of the QPS Fledermaus software package in accordance with OCS standard data processing methods.

C.2.2 Side Scan Sonar

Data Acquisition Methods and Procedures

Side scan sonar data are logged in the SDF (.sdf) file format using SonarPro.

During acquisition the hydrographer:

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

- Adjusts towfish height (for operations aboard THOMAS JEFFERSON)

Data Processing Methods and Procedures

Side scan sonar data are manually processed as follows:

1. Raw SDF data are converted into the Caris processed data format using the Caris HIPS data conversion utility.

2. The processor scans all navigation and attitude data; erroneous data are either flagged for further inspection or rejected with interpolation.

3. Towfish navigation and contact positions are recomputed using the ‘Re-compute Towfish’ process in Caris HIPS.

4. Each SSS line is visually scanned and significant contacts are marked by at least two independent processors.

5. Mosaic surfaces are created using the Caris HIPS ‘Create Mosaic’ process

Side scan data are automatically processed using Charlene in substantially the same way as described above for manual processing. The only exception is that towfish navigation is often re-computed twice: in this case, the ‘Re-compute Towfish’ towfish step is run once during the initial Charlene batch process and again after towfish attitude and/or navigation data have been edited by a processor.

C.2.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not acquired.

C.3 Horizontal and Vertical Control C.3.1

Horizontal Control

C.3.1.1 GNSS Base Station Data

GNSS base station data were not acquired.

C.3.1.2 DGPS Data

Differential GPS (DGPS) data were not acquired.

C.3.2 Vertical Control

C.3.2.1 Water Level Data

Data Acquisition Methods and Procedures

THOMAS JEFFERSON uses the Fugro Marinestar satellite based corrector service to provide realtime correction to the horizontal position and ellipsoid height for all data acquisition and initial processing. The corrector signal is received on the L1 channel of the POS MV primary GPS antenna and logged directly into the POS MV.

In the event of issues with the real-time solution, the raw POS files produced during acquisition can be post-processed using POSPac MMS software to produce a trajectory solution in the WGS84 reference frame and an associated uncertainty file containing the realtime uncertainty estimates of the position and attitude data.

THOMAS JEFFERSON does not normally install GNSS reference stations or temporary tide stations for operations on the East Coast. Data from permanently installed GNSS reference stations and/or tide stations (typically maintained by NGS and CO-OPS, respectively) may be used in certain workflows (described below).

Data Processing Methods and Procedures

THOMAS JEFFERSON reduces all data to chart datum via Ellipsoidally Referenced Survey (ERS) workflows for all surveys.

GPS Tides:

The ‘Compute GPS Tides’ process in Caris HIPS is the primary means by which bathymetric data is reduced to chart datum. The Compute GPS Tides step references all MBES data to an ellipsoid and then applies a separation model to the ellipsoidally referenced data to achieve reduction to chart datum. The separation model is an XYZ surface that represents the difference between the ellipsoid and chart datum for the a given geographic area. The XYZ separation model used for typical NOAA workflows is delivered as a Caris CSAR file and represents the difference between the WGS84 ellipsoid and MLLW at a given location.

All separation models for waters in which THOMAS JEFFERSON operates are derived from the NGS Vertical Datum (VDatum) program. Separation models are usually generated, approved and disseminated by HSD Ops.

GNSS positioning methods employed to meet ERS specifications include the methods described below:

Vertical control requirements are satisfied through the use of one or more of the following methods.

Real-time Precise Point Positioning (RTPPP):

THOMAS JEFFERSON uses the Fugro Marinestar satellite based corrector service to provide real-time correction to the horizontal position and ellipsoid height for all data acquisition and initial processing. The corrector signal is received on the L1 channel of the POS MV primary GPS antenna. Marinestar correctors are used in the real-time POS MV trajectory solution and are logged in POS MV raw data files.

Ellipsoid height values derived from the Marinestar corrected POS MV real-time trajectory solution are logged in all Kongsberg MBES data. The ellipsoid height data present in the Kongsberg MBES files are normally used for all ‘GPS Tides’ computations in Caris HIPS.

In the event of issues with the real-time solution, the POS files produced during acquisition can be processed through the POSPac MMS software to produce an SBET in the WGS84 reference frame and an RMS file containing the realtime uncertainty estimates of the position and attitude data.

Real-time corrected ellipsoid height is recorded directly in Kongsberg MBES data logged through the Kongsberg SIS program on THOMAS JEFFERSON and is used when processing ship MBES data in CARIS HIPS.

Post-processed Precise Point Positioning (5P):

Raw GNSS-INS observables and Marinestar corrector data logged through POSView can be post-processed in POSPac MMS to provide a trajectory solution that can be applied to MBES data in CARIS HIPS. The post-processed PPP processing workflow is normally only used for crosslines and when problems arise in the real-time solution data.

Inertially Aided Post-Processed Kinematic (IAPPK):

Inertially Aided Post-Processed Kinematic (IAPPK) may be used in some situations. An IAPPK solution is created by combining GPS/GNSS satellite ephemeris and clock data with position information downloaded from a network of Continually Operating Reference Stations (CORS). The resulting position data are 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 an SBET. The resulting position can be used to apply higher quality navigation information to the processed data.

RTX:

Trimble RTX is a Precise Point Positioning technology similar to the G2 Fugro Marinestar service. The positioning algorithms used by Trimble RTX result in positioning solutions that generally achieve vertical positioning accuracies better than 6 cm (95% real-time and post-processed accuracy). RTX solutions are only available through post-processing in POSPac MMS software as utilized by NOAA and for marine applications. THOMAS JEFFERSON does not currently have regular access to an RTX subscription. The information presented above is noted for reference purposes only.

Non-ERS vertical control approaches:

Two ‘legacy’ workflows could potentially be used to reduce data to chart datums in the event that ERS specifications cannot be achieved. The following workflows are briefly described for reference purposes only.

Discrete Zoned Tides:

This method utilizes one or more National Water Level Observation Network (NWLON) water level gauges and a discrete zoned tidal modal to determine vertical control correctors to be applied to soundings at a given location and time. 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 with 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. THOMAS JEFFERSON does not install tertiary gauges in support of tidal modeling. After completion of a survey area, CO-OPS verifies all zoning and water level data.

TCARI Tides:

Tidal Constituent and Residual Interpretor (TCARI) 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 are 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.

C.3.2.2 Optical Level Data

Optical level data was not acquired.

C.4 Vessel Positioning

Data Acquisition Methods and Procedures

As described in Section A.5 of this document.

Data Processing Methods and Procedures

As described in Section C.3 of this document.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

Data Acquisition Methods and Procedures

S222 uses an AML Micro CTD Probe installed inside an MVP free-fall fish to acquire sound speed profiles. Profiles aboard the ship are generally acquired at 30 to 90 minute intervals. Casts are taken at least once every four hours. Cast frequency is increased when the comparisons show significant variability. Casts are generally taken no more frequently than once every 15 minutes. Sampling intervals are adjusted to ensure spatial variability or if there is suspicion of sudden changes in the water-column.

The Moving Vessel Profiler (MVP) is an automated winch system that deploys a towfish containing a sound speed sensor. The fish is towed behind the survey vessel in a ready position that is marked by messengers attached to the tow cable. The towfish is typically deployed at a ready depth that is approximately the same depth of the ship MBES transducers. Deployment depth is a function of water depth. The towfish descends at the rate of freefall when deployed. Towfish freefall is automatically stopped once a specified depth limit is met and the drag forces on the fish cause it to rise toward the surface due to the ship's forward motion. The cable slack is then pulled in by the winch to the ready towing position.

HSL 2903 and HSL 2904 both use Sea-Bird SBE 19plus CTDs to collect sound speed profiles. Casts are generally taken at 2-4 hour intervals. Casts are also conducted when changing survey areas or when a change of weather, tide, or current warrant. The launch crew also monitors the real time display of the Reson SVP-70/71 sound velocity probe for significant changes in the surface sound velocity. Casts are typically taken in the deepest portions of the project area.

The following procedure is followed when conducting manual CTD casts with the SBE 19plus: The instrument is lowered into the water and submerged just below the water's surface for about two minutes to allow air to escape the salinity cell. The instrument is lowered at the rate of free fall. The instrument is lowered slowly through the first 5-10 meters of water in order to accurately sample the sound speed for areas with lenses of fresh water or other complex sound speed variation near the surface.

Pydro Sound Speed Manager software is used to process all CTD data. Each cast is processed immediately after the cast is taken. The cast is checked for obviously erroneous data and then distributed to MBES systems for use in real-time ray-tracing processes.

Data Processing Methods and Procedures

Sound Speed Manager (distributed with Pydro) is used to download and process all sound speed data on THOMAS JEFFERSON. Sound speed profiles are visually checked for obviously erroneous data and compared against available historical data. Sound speed cast data is provided to the Kongsberg SIS acquisition program using a data distribution function built into the Sound Speed Manager software.

Processed sound speed data data is applied to the MBES data in Caris HIPS.

C.5.2 Surface Sound Speed

Data Acquisition Methods and Procedures

A Valeport Modus SVS probe is used to measure the speed of sound at the approximate depth of the S222 transducers.

HSL 2903 and HSL 2904 use Reson SV-70/71 probes to acquire sound speed at their respective transducer faces.

Sound speed values are applied in real-time to all MBES systems to provide refraction corrections to flat-faced transducers.

The accuracy of each surface sound speed device is checked against the closest CTD data point after every CTD cast.

Data Processing Methods and Procedures

Surface sound speed data are logged directly into both Kongsberg raw data files and raw/processed sound speed files.

Surface sound speed data are not typically processed after the time of acquisition.

C.6 Uncertainty

C.6.1 Total Propagated Uncertainty Computation Methods

Total Propagated Uncertainty (TPU) is calculated in Caris HIPS using the 'Compute TPU' tool.

The uncertainty values for each input into the TPU model can come from one of three sources: Real-time, Static, or Vessel. Real-time values are provided from the sensor or processing package (e.g. POSPac RMS values). Static values are those entered manually into the Compute TPU dialog (e.g. tidal zoning uncertainty and sound speed measurement uncertainties). Static values are documented in each Descriptive Report. Vessel values are taken from the HVF if no realtime or static values are available.

Uncertainty values entered into the HVF for the multibeam and positioning systems are derived 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 2014 FPM.

Sound speed static values are derived from the guidance in the FPM, manufacturer specifications and annual calibration results.

Tide correction uncertainty values depend on the method of correction: real-time values are used for the TCARI workflow; static values specified in the Project Instructions are used for Zoned Tides or ERS workflows.

Ellipsoid height uncertainty values for ellipsoid measurements derived from the Marinstar service are derived from both manufacturer specifications and empirical observation. Static values are used to account for known discrepancies with the magnitude of the position uncertainty values reported by the POS MV system when utilizing Marinestar correctors.

Ellipsoid height uncertainty values for ellipsoid measurements derived from 5P or IAPPK workflows are applied as real-time values from Applanix RMS files.

Both the Kongsberg and Reson MBES systems provide uncertainty statistics that are recorded in raw MBES files.

All offsets, correctors, and values used in TPU calculation that are stored in the HVF file can be found in the included Appendix Folder, HVF Reports. These HVF Reports are output from the Caris HVF Editor in a plain text document readable anywhere, and include all of the requested values for the DAPR necessary to reproduce an HVF.

See included HVFs for information on vessel uncertainty values.

C.6.2 Uncertainty Components

As described in section C.6.1 above.

C.7 Shoreline and Feature Data

Data Acquisition Methods and Procedures

The following workflow is used to develop and verify features:

- Potentially significant features are initially identified and inspected in Caris HIPS (both MBES and SSS contacts).

- A development area polygon or point feature is exported from Caris HIPS; a line plan is created using HIPS or ArcMap if needed.

- Object Detection level MBES data are collected over all MBES and/or SSS contacts and all possible shoal areas.

Quality of data is controlled through:

- Real time monitoring during acquisition to ensure that all features are covered by near nadir beams.

- Inspection of the resultant CUBE surface's Density, Standard Deviation, and Uncertainty layers.

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

Data Processing Methods and Procedures

Feature verification begins during initial data processing. Both SSS and MBES data are processed following the conclusion of daily acquisition operations or at regular intervals (typically daily) for continuous ship operations. Significant contacts are identified and noted during initial processing. 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 or HIPS. 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) in .000 format.

C.8 Bottom Sample Data

Data Acquisition Methods and Procedures

HSD Operations typically provides the field unit with a number of recommended bottom sample sites. Proposed sample sites are encoded as S-57 SPRINGS and are provided in files distributed with the Project Instructions for the survey.

Bottom sample acquisition typically occurs after the majority of main-scheme MBES acquisition has completed. Bathymetric surfaces, backscatter surfaces and SSS intensity mosaics are examined to confirm the validity of the proposed sample sites. Sample sites may be moved or eliminated depending on field conditions.

Samples are collected by launch or ship using one of the bottom samplers described in the equipment section of this report.

Imagery of the bottom type is collected in accordance with HSSD 2018 requirements.

Physical sample bottom material is discarded after field analysis is complete.

Data Processing Methods and Procedures

Samples are analyzed for sediment type and classified with S57 attribution.

The NATSUR S-57 attribute for a sample site is characterized as “unknown” in the event that no sample is obtained after three collection attempts.

S-57 attribution is conducted in Caris HIPS or BASE Editor.

Imagery is included as a feature file media attachment.

All bottom samples are processed in accordance with HSD HTD 2018-4_Bottom Sample Drop Camera Imagery.

D Data Quality Management

D.1 Bathymetric Data Integrity and Quality Management

D.1.1 Directed Editing

All statistics layers generated by the Caris CUBE implementation are used (including uncertainty, hypothesis count, hypothesis strength, and standard deviation) to direct data cleaning.

The Flier Finder function in Pydro QC Tools is used to direct cleaning of potential 'fliers' in the bathymetric surface data.

D.1.2 Designated Sounding Selection

In accordance with HSSD.

D.1.3 Holiday Identification

Holidays are identified primarily through the use of two tools: the QC Tools program included with the Pydro software program and via standard tools included in ArcGIS (primarily to inspect SSS mosaics). All surfaces are also visually inspected.

D.1.4 Uncertainty Assessment

In accordance with HSSD using methods described above.

D.1.5 Surface Difference Review

D.1.5.1 Crossline to Mainscheme

Difference surfaces are conducted in accordance with HSSD and as outlined in the DR.

D.1.5.2 Junctions

Difference surfaces are conducted in accordance with HSSD and as outlined in the DR.

D.1.5.3 Platform to Platform

Difference surfaces are conducted in accordance with HSSD and as outlined in the DR.

D.2 Imagery data Integrity and Quality Management

D.2.1 Coverage Assessment

Coverage is assessed in accordance with HSSD.

Automated and visual methods are used to inspect surface coverage: ArcGIS tools are used to automatically identify coverage deficiencies; surfaces are inspected against brightly colored backgrounds for visible gaps in coverage.

CUBE statistical surfaces that show gridded node density are used to visually assess surfaces for compliance with bathymetric surface node density requirements.

Pydro QC Tools is used to statistically inspect CUBE surfaces for compliance with bathymetric surface node density requirements.

D.2.2 Contact Selection Methodology

Contacts are selected in accordance with HSSD.

Visual inspection of all SSS data is conducted in Caris HIPS by multiple scanners (initial processor, check scanner and/or sheet manager).

List of Appendices:

Mandatory Report	***File***
Vessel Wiring Diagram	OPR-D304-TJ-18_DAPR_Appendices.pdf
Sound Speed Sensor Calibration	OPR-D304-TJ-18_DAPR_Appendices.pdf
Vessel Offset	OPR-D304-TJ-18_DAPR_Appendices.pdf
Position and Attitude Sensor Calibration	OPR-D304-TJ-18_DAPR_Appendices.pdf
Echosounder Confidence Check	OPR-D304-TJ-18_DAPR_Appendices.pdf
Echosounder Acceptance Trial Results	OPR-D304-TJ-18_DAPR_Appendices.pdf

Additional Report	***File***
HVF Values	OPR-D304-TJ-18_DAPR_Appendices.pdf
Additional Report	***File***
HSRR Documentation	OPR-D304-TJ-18_DAPR_Appendices.pdf

E. Approval Sheet

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 (2018 ed).

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

Approver Name	Approver Title	Date	Signature
LT Charles Wisotzkey	Acting Field Operations Officer	07/17/2018	WISOTZKEY.CHARLES.JUSTIN.1300819660 c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=NOAA, cn=WISOTZKEY.CHARLES.JUSTIN.1300819660 2018.07.19 14:12:10 -05'00'
CDR Chris van Westendorp	Commanding Officer	07/17/2018	VAN WESTENDORP.CHRISTIAAN.HENRY.1012828175 c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=NOAA, cn=VAN WESTENDORP.CHRISTIAAN.HENRY.1012828175 2018.07.18 19:24:16 -05'00'