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-FH-18

Time Frame:                January - November 2018

# LOCALITY

State(s):                  North Carolina
                           Virginia

General Locality:          Virginia/North Carolina

# 2018

CHIEF OF PARTY
LCDR Mark Blankenship, NOAA

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## Data Acquisition and Processing Report

**NOAA Ship *Ferdinand R. Hassler***
Chief of Party: LCDR Mark Blankenship, NOAA
Year: 2018
Version: 1.2
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# A. System Equipment and Software

## A.1 Survey Vessels

### A.1.1 NOAA Ship FERDINAND R. HASSLER

| | | |
|---|---|---|
| *Vessel Name* | NOAA Ship FERDINAND R. HASSLER | |
| *Hull Number* | S250 | |
| *Description* | FERDINAND R. HASSLER is a Small Waterplane Area, Twin-Hull (SWATH) coastal mapping vessel. | |
| *Dimensions* | *LOA* | 37.7 meters |
| | *Beam* | 18.5 meters |
| | *Max Draft* | 3.85 meters |
| *Most Recent Full Static Survey* | *Date* | 2011-09-04 |
| | *Performed By* | Raymond C. Impastato, Professional Land Surveyor |
| *Most Recent Partial Static Survey* | *Date* | 2012-06-12 |
| | *Performed By* | Kevin Jordan, NGS |
| *Most Recent Partial Offset Verification* | *Date* | 2013-04-07 |
| | *Method* | Optical level run while ship was out of drydock. A level loop was run from the POS antenna to each sensor mounted on the ship's hull. In addition, measurements were made to both IMU base plates through the 7125 cable passage. The resulting offsets from this survey were used to verify and update Z offsets between all sensors. |

*Figure 1: NOAA Ship FERDINAND R. HASSLER*

*Figure 2: NOAA Ship FERDINAND R. HASSLER, starboard view*

*Figure 3: NOAA Ship FERDINAND R. HASSLER, bow and stern view*

## A.2 Echo Sounding Equipment

### A.2.1 Multibeam Echosounders

### A.2.1.1 RESON 7125

The RESON 7125 is a dual head, dual frequency system configured to work as one unit. While the particulars of the port system are specified in this section and the starboard head in the following section, this description and following quality control addresses the two heads as an integrated system.

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

Patch Tests -
A patch test was conducted for each sonar head on the ship in both 200kHz and 400kHz modes on August 25-26, 2018 in the vicinity west of Cape Charles, VA in the Chesapeake Bay.

Reference Surfaces -
In conjunction with the patch test noted above, a reference surface for both sonar heads in both 400kHz and 200kHz modes  was conducted on August 25-26, 2018 in the vicinity west of Cape Charles, VA in the Chesapeake Bay.

| *Manufacturer* | RESON | | | | | |
|---|---|---|---|---|---|---|
| *Model* | 7125 | | | | | |
| *Inventory* | *S250* | *Component* | Processor | Transceiver | LCU | Receiver | Projector |
| | | *Model Number* | N/A | N/A | N/A | N/A | N/A |
| | | *Serial Number* | 18210412051 | 212036 | 0212036 | 0214074 | 2611093 |
| | | *Frequency* | N/A | N/A | N/A | 200/400 kHz | 200/400 kHz |
| | | *Calibration* | N/A | N/A | N/A | 2018-08-26 | 2018-08-26 |
| | | *Accuracy Check* | N/A | N/A | N/A | 2018-08-26 | 2018-08-26 |

*Figure 4: 7125 Housing flush-mounted on hull*

### A.2.1.2 Reson 7125

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

| Manufacturer | Reson | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | 7125 | | | | | | |
| Inventory | S250 | Component | Processor | Transceiver | LCU | Receiver | Projector |
| | | Model Number | N/A | N/A | N/A | N/A | N/A |
| | | Serial Number | 18215011048 | 212035 | 212035 | 1215068 | 1111236 |
| | | Frequency | N/A | N/A | N/A | 200/400 kHz | 200/400 kHz |
| | | Calibration | N/A | N/A | N/A | 2018-08-26 | 2018-08-26 |
| | | Accuracy Check | N/A | N/A | N/A | 2018-08-26 | 2018-08-26 |

### A.2.2 Single Beam Echosounders

No single beam echosounders were utilized for data acquisition.

### A.2.3 Side Scan Sonars

No side scan sonars were utilized for data acquisition.

### 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 POS MV 320 V5

Tightly coupled GPS and inertial positioning and attitude sensing system for both hulls.  The Inertial Measurement Units (IMU) on the ship are located below water line close to both 7125 wet ends. The GPS antennae are located on the O-2 level of S250. The two V5 ship system were installed on July 29, 2013.

| *Manufacturer* | Applanix | | | | |
|---|---|---|---|---|---|
| *Model* | POS MV 320 V5 | | | | |
| *Inventory* | *S250 Port* | *Component* | IMU | PCS | Antenna | Antenna |
| | | *Model Number* | Type 36 | POS/MV 320 V5 | GA830 GNSS/MSS | GA830 GNSS/MSS |
| | | *Serial Number* | 2423 | 5806 | 6997 | 5401 |
| | | *Calibration* | N/A | N/A | N/A | N/A |
| | *S250 Starboard* | *Component* | PCS | IMU | Antenna | Antenna |
| | | *Model Number* | POS/MV 320 V5 | Type 36 | GA830 GNSS/MSS | GA830 GNSS/MSS |
| | | *Serial Number* | 5807 | 2672 | 7000 | 5415 |
| | | *Calibration* | N/A | N/A | N/A | N/A |

## 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 Brooke-Ocean MVP200

Moving Vessel Profiler equipped with an AML micro-CTD in a single sensor free fall fish. Due to a malfunctioning relay board within the interface box, manual MVP casts were taken up to September 10th. A replacement was acquired after this date which allowed the ship to resume taking dynamic MVP casts.

| Manufacturer | Rolls-Royce Brooke-Ocean | | | |
|---|---|---|---|---|
| Model | MVP200 | | | |
| Inventory | S250 | Component | Winch | Towfish |
| | | Model Number | N/A | N/A |
| | | Serial Number | 10794 | 11406 |
| | | Calibration | N/A | N/A |

### A.6.2 CTD Profilers

#### A.6.2.1 Sea-Bird Electronics SeaCat 19plus 350 meter

Internal logging conductivity, temperature, and depth measuring devices.

| Manufacturer | Sea-Bird Electronics | |
|---|---|---|
| Model | SeaCat 19plus 350 meter | |
| Inventory | Component | CTD |
| | Model Number | SBE 19plus |
| | Serial Number | 6918 |
| | Calibration | 2018-05-30 |

#### A.6.2.2 Sea-Bird Electronics SeaCat 19plus 350 meter

Internal logging conductivity, temperature, and depth measuring devices.

| Manufacturer | Sea-Bird Electronics | |
|---|---|---|
| Model | SeaCat 19plus 350 meter | |
| Inventory | Component | CTD |
| | Model Number | SBE 19plus |
| | Serial Number | 4642 |
| | Calibration | 2018-05-30 |

### A.6.3 Sound Speed Sensors

### A.6.3.1 AML Oceanographic micro-CTD

AML micro-CTD SN 8660 was installed on the towfish on 30 March, 2018

| Manufacturer | AML Oceanographic | | |
|---|---|---|---|
| Model | micro-CTD | | |
| Inventory | S250 | Component | MVP Sound Speed Sensor |
| | | Model Number | Micro CTD |
| | | Serial Number | 8660 |
| | | Calibration | 2017-09-18 |

### A.6.3.2 RESON SVP-70

Sound velocity probe developed for fixed-mount installation near RESON 7125 transducer heads which uses a direct path echosounding technique that instantly compensates for temperature and pressure with internal sensors, providing accurate surface sound velocity measurements for beam steering.

The starboard cable run from the RESON TPU to the wet end is inoperable. SVP-70 1317122 is installed on the port hull and being fed into the starboard RESON TPU which is then repeated via network broadcast to the port RESON TPU. SVP-70 0217026 is being held has spare in ship's storage. The unit installed on the port hull was not calibrated within the past year due to the decision to leave the wet end connection undisturbed.

| *Manufacturer* | RESON | | | |
|---|---|---|---|---|
| *Model* | SVP-70 | | | |
| *Inventory* | *S250* | *Component* | Surface Sound Speed Sensor | Surface Sound Speed Sensor |
| | | *Model Number* | SVP 70 | SVP 70 |
| | | *Serial Number* | 1317122 | 0217026 |
| | | *Calibration* | 2017-07-17 | 2017-07-17 |

### 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

| *Manufacturer* | *Software Name* | *Version* | *Use* |
|---|---|---|---|
| CARIS | HIPS/SIPS | 11.3 | Processing |
| CARIS | HIPS/SIPS | 10.3.2 | Processing |
| CARIS | Bathy BASE Editor | 4.2.13 | Processing |
| CARIS | Plot Composer | 5.3 | Processing |
| Applanix | POSPac MMS | 8.3 | Acquisition and Processing |
| NOAA | Pydro Explorer | 18.4 | Processing |
| IVS 3D | Fledermaus | 7.7.6 | Processing |
| Hypack | Hypack/Hysweep | 2017 | Acquisition and Processing |
| Applanix | POS View | 8.46 | Acquisition |

## A.8 Bottom Sampling Equipment

### A.8.1 Bottom Samplers

### A.8.1.1 Ponar Wildco 1728

Grab sampler triggered by contact with sea floor. A custom mount equipped with camera and light was designed for the acquisition of video of the seafloor.

A Go Pro Hero 3 camera is rigged as a drop camera to function along with grab sampler. The camera contains a 12 MP sensor capable of 1440p at 48fps. This camera supplements the data gathered with the grab sampler, and allows the field unit to provide data from null samples from the sediment sampler.

*Figure 5: Ponar grab sampler*

*Figure 6: Camera with custom mount allowing for high quality video of the seafloor*

*Figure 7: GoPro video camera*

# B. System Alignment and Accuracy

## B.1 Vessel Offsets and Layback

### B.1.1 Vessel Offsets

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

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

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

During patch test and reference surface acquisition a 10 cm offset was discovered between port and starboard MBES data.  The data was processed to the ellipsoid and transformed to MLLW via NOAA SEP model. Therefore, the offset was not a result of static or dynamic draft, tides or other offsets that do not affect to

ellipsoidally referenced data. All tidally referenced data was tightly aligned and did not have discrepancies between vessels. The vertical ERS offset was most likely tied to a residual offset between the transducer, IMU, and/or primary antenna. Offsets between the antenna and IMU were reprocessed to empirically derive a new x,y,z via PosPac. This process involved processing the SBET with original offsets and 10cm lever arm tolerance, reprocessing the SBET with final values from reported graphs of previous alignment two more times at 10cm tolerance, and reprocessing the final run with a 3cm tolerance. The final x,y,z offsets bring data to within approximately 5cm at 400kHz.

## B.1.1.1 Vessel Offset Correctors

| Vessel | FH_S250S_7125_512bms_400kHz | | | |
|---|---|---|---|---|
| Echosounder | Teledyne Reson SeaBat 7125 (400kHz 512 Beams) | | | |
| Date | 2018-08-24 | | | |
| Offsets | | | Measurement | Uncertainty |
| | MRU to Transducer | x | 1.424 meters | 0.050 meters |
| | | y | 0.380 meters | 0.050 meters |
| | | z | 1.358 meters | 0.050 meters |
| | Nav to Transducer | x | 4.528 meters | 0.050 meters |
| | | y | -2.320 meters | 0.050 meters |
| | | z | 14.278 meters | 0.050 meters |
| | Transducer Roll | Roll | -4.50 degrees | |

| Vessel | FH_S250S_7125_512bms_200kHz | | | |
|---|---|---|---|---|
| Echosounder | Teledyne Reson SeaBat 7125 (200kHz 256 Beams) | | | |
| Date | 2018-08-24 | | | |
| Offsets | | | Measurement | Uncertainty |
| | MRU to Transducer | x | 1.424 meters | 0.050 meters |
| | | y | 0.380 meters | 0.050 meters |
| | | z | 1.358 meters | 0.050 meters |
| | Nav to Transducer | x | 4.528 meters | 0.050 meters |
| | | y | -2.320 meters | 0.050 meters |
| | | z | 14.278 meters | 0.050 meters |
| | Transducer Roll | Roll | -4.50 degrees | |

| *Vessel* | FH_S250P_7125_512bms_400kHz | | | |
|---|---|---|---|---|
| *Echosounder* | Teledyne Reson SeaBat 7125 (400kHz 512 Beams) | | | |
| *Date* | 2018-08-24 | | | |
| *Offsets* | *MRU to Transducer* | | *Measurement* | *Uncertainty* |
| | | *x* | -1.244 meters | 0.050 meters |
| | | *y* | 0.362 meters | 0.050 meters |
| | | *z* | 1.349 meters | 0.050 meters |
| | *Nav to Transducer* | *x* | -2.246 meters | 0.050 meters |
| | | *y* | -2.351 meters | 0.050 meters |
| | | *z* | 14.269 meters | 0.050 meters |
| | *Transducer Roll* | *Roll* | 4.50 degrees | |

| *Vessel* | FH_S250P_7125_512bms_200kHz | | | |
|---|---|---|---|---|
| *Echosounder* | Teledyne Reson SeaBat 7125 (200kHz 256 Beams) | | | |
| *Date* | 2018-08-24 | | | |
| *Offsets* | *MRU to Transducer* | | *Measurement* | *Uncertainty* |
| | | *x* | -1.244 meters | 0.050 meters |
| | | *y* | 0.362 meters | 0.050 meters |
| | | *z* | 1.349 meters | 0.050 meters |
| | *Nav to Transducer* | *x* | -2.246 meters | 0.050 meters |
| | | *y* | -2.351 meters | 0.050 meters |
| | | *z* | 14.269 meters | 0.050 meters |
| | *Transducer Roll* | *Roll* | 4.50 degrees | |

## B.1.2 Layback

Side Scan Sonar was not used for this project.

Layback correctors were not applied.

## B.2 Static and Dynamic Draft

### B.2.1 Static Draft

Because of her SWATH design, FERDINAND R. HASSLER is particularly susceptible to loading and trim. While underway, the ballast is actively managed to maintain the draft at the design draft of 3.77 meters. During typical survey operations, HASSLER burns approximately 4,000 liters of diesel per day. At a density of 0.83 kilograms/liter this is approximately 3.3 metric tons of fuel per day. At design draft of 3.77 meters, 1.3 metric tons is required to submerge an additional 0.01 meters of the hull in salt water. The daily fuel burn would thus account for 0.03 meters of variation in the draft. Ballast is adjusted daily to account for fuel burn and the levels in other tanks. Uncertainty is estimated at 0.05 meters. The assumed design waterline of 3.8 meters and measured offsets to IMU were used to determine the static draft of the reference point.

### B.2.1.1 Static Draft Correctors

| *Vessel* | | FH_S250S_7125_512bms_400kHz | FH_S250S_7125_512bms_200kHz | FH_S250P_7125_512bms_400kHz | FH_S250P_7125_512bms_200kHz |
|---|---|---|---|---|---|
| *Date* | | 2017-08-28 | 2017-08-28 | 2017-08-28 | 2017-08-28 |
| *Loading* | | 0.05 meters | 0.05 meters | 0.05 meters | 0.05 meters |
| *Static Draft* | *Measurement* | -2.383 meters | -2.383 meters | -2.383 meters | -2.383 meters |
| | *Uncertainty* | 0.05 meters | 0.05 meters | 0.05 meters | 0.05 meters |

### B.2.2 Dynamic Draft

Dynamic draft is calculated as the dynamic height of the vessel reference point as a function of vessel speed compared to the height at rest. This correction is applied during CARIS processing. An ellipsoidally referenced dynamic draft measurement (ERDDM) was performed on following guidelines in the 2014 FPM on September 3rd, 2018 (DN246) for vessel S250. An area was selected about 5NM off the Virginia coast near the Chesapeake Bay entrancewhere the slope of the geoid was minimal. Data were acquired with canards at zero trim angle. During all survey operations, the canards are set to zero trim angle. Speeds from 6 to 10 knots were run in one direction. The ship was then turned to the reciprocal heading, brought to a complete stop, and then the speeds from 6 to 10 knots were run in the opposite direction. The fourth order polynomial results for the dynamic draft curves from the port and starboard side were averaged. Averages are being calculated from all ERDDM tests since the installation of the buoyancy appendages in 2013. The 2017 results and comparisons between 2011 - 2017 can be found included in the attached appendices. Results from the last five years were averaged for use as the dynamic draft corrector values for 2017. An ERDDM was performed for the ship on a transit with temporal and spatial limitations (ie: on a transit well offshore).The results indicated a bad test that was likely the result of sea state miles offshore. The distribution at dead in water, at speed, and between runs is spread out. A decision was made that the averages from 2017 would be used for 2018 since S250 dynamic draft did not likely change and the ship submits ERS surfaces.

*Figure 8: S250 dynamic draft derived from ERDDM methods comparison from 2011-2017*

*Figure 9: S250 dynamic draft derived from ERDDM methods.*

## B.2.2.1 Dynamic Draft Correctors

| Vessel | FH_S250S_7125_512bms_400... | | FH_S250S_7125_512bms_200... | | FH_S250P_7125_512bms_400... | | FH_S250P_7125_512bms_200k... | |
|---|---|---|---|---|---|---|---|---|
| Date | 2017-08-28 | | 2017-08-28 | | 2017-08-28 | | 2017-08-28 | |
| | Speed (m/s) | Draft (m) | Speed (m/s) | Draft (m) | Speed (m/s) | Draft (m) | Speed (m/s) | Draft (m) |
| Dynamic Draft | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0.50 | 0.00 | 0.50 | 0.00 | 0.50 | 0.00 | 0.50 | 0.00 |
| | 1.00 | -0.01 | 1.00 | -0.01 | 1.00 | -0.01 | 1.00 | -0.01 |
| | 1.50 | -0.02 | 1.50 | -0.02 | 1.50 | -0.02 | 1.50 | -0.02 |
| | 2.00 | -0.03 | 2.00 | -0.03 | 2.00 | -0.03 | 2.00 | -0.03 |
| | 2.50 | -0.03 | 2.50 | -0.03 | 2.50 | -0.03 | 2.50 | -0.03 |
| | 3.00 | -0.03 | 3.00 | -0.03 | 3.00 | -0.03 | 3.00 | -0.03 |
| | 3.50 | -0.02 | 3.50 | -0.02 | 3.50 | -0.02 | 3.50 | -0.02 |
| | 4.00 | 0.00 | 4.00 | 0.00 | 4.00 | 0.00 | 4.00 | 0.00 |
| | 4.50 | 0.02 | 4.50 | 0.02 | 4.50 | 0.02 | 4.50 | 0.02 |
| | 5.00 | 0.05 | 5.00 | 0.05 | 5.00 | 0.05 | 5.00 | 0.05 |
| | 5.50 | 0.08 | 5.50 | 0.08 | 5.50 | 0.08 | 5.50 | 0.08 |
| | 6.00 | 0.10 | 6.00 | 0.10 | 6.00 | 0.10 | 6.00 | 0.10 |
| | 6.50 | 0.12 | 6.50 | 0.12 | 6.50 | 0.12 | 6.50 | 0.12 |
| Uncertainty | Vessel Speed (m/s) | Delta Draft (m) | Vessel Speed (m/s) | Delta Draft (m) | Vessel Speed (m/s) | Delta Draft (m) | Vessel Speed (m/s) | Delta Draft (m) |
| | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

# B.3 System Alignment

## B.3.1 System Alignment Methods and Procedures

A multibeam patch test was performed in the vicinity of Cape Charles on August 25-26, 2018 (DN237-238). The values used for the ship's angular offsets were determined by way of a statistical mean using all the

available values from 2012 through 2018. Any values outside the standard deviation were removed and values were re-averaged. The re-averaged values were then input to the HVF.  Shallow water (<20 meters) reference surface data was acquired in the vicinity of Cape Charles on August 25-26, 2018 (DN237-238). For the 400kHz systems, the starboard head was on average 5cm deeper with a standard deviation of 6cm. For the 200kHz systems, the starboard head was on average 9cm deeper with a standard deviation of 6cm.

*Figure 10: Summary of Patch Test Values*

*Figure 11: Summary of Reference and Difference Surface Values*

*Figure 12: Difference Surface: Reson 7125 400kHz minus 200kHz*

*Figure 13: Difference Surface: Reson 7125 400kHz minus 200kHz*

*Figure 14: Reference surface general location near Cape Charles, VA*

## B.3.1.1 System Alignment Correctors

| *Vessel* | FH_S250S_7125_512bms_400kHz | | |
|---|---|---|---|
| *Echosounder* | Teledyne Reson SeaBat 7125 (400kHz 512 Beams) | | |
| *Date* | 2018-08-28 | | |
| *Patch Test Values* | | *Corrector* | *Uncertainty* |
| | *Transducer Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Navigation Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Pitch* | -0.017 degrees | 0.060 degrees |
| | *Roll* | 0.073 degrees | 0.060 degrees |
| | *Yaw* | 0.598 degrees | 0.090 degrees |
| | *Pitch Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Roll Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Yaw Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Heave Time Correction* | 0.000 seconds | 0.005 seconds |

| Vessel | FH_S250S_7125_512bms_200kHz | | |
|---|---|---|---|
| Echosounder | Teledyne Reson SeaBat 7125 (200kHz 256 Beams) | | |
| Date | 2018-08-28 | | |
| *Patch Test Values* | | *Corrector* | *Uncertainty* |
| | *Transducer Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Navigation Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Pitch* | 0.064 degrees | 0.020 degrees |
| | *Roll* | 0.076 degrees | 0.020 degrees |
| | *Yaw* | 0.474 degrees | 0.120 degrees |
| | *Pitch Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Roll Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Yaw Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Heave Time Correction* | 0.000 seconds | 0.005 seconds |

| Vessel | FH_S250P_7125_512bms_400kHz | | |
|---|---|---|---|
| Echosounder | Teledyne Reson SeaBat 7125 (400kHz 512 Beams) | | |
| Date | 2018-08-28 | | |
| *Patch Test Values* | | *Corrector* | *Uncertainty* |
| | *Transducer Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Navigation Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Pitch* | 0.300 degrees | 0.080 degrees |
| | *Roll* | -0.060 degrees | 0.080 degrees |
| | *Yaw* | -0.264 degrees | 0.070 degrees |
| | *Pitch Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Roll Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Yaw Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Heave Time Correction* | 0.000 seconds | 0.005 seconds |

| *Vessel* | FH_S250P_7125_512bms_200kHz | | |
|---|---|---|---|
| *Echosounder* | Teledyne Reson SeaBat 7125 (200kHz 256 Beams) | | |
| *Date* | 2018-08-28 | | |
| *Patch Test Values* | | *Corrector* | *Uncertainty* |
| | *Transducer Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Navigation Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Pitch* | -0.015 degrees | 0.060 degrees |
| | *Roll* | -0.116 degrees | 0.060 degrees |
| | *Yaw* | -0.229 degrees | 0.060 degrees |
| | *Pitch Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Roll Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Yaw Time Correction* | 0.000 seconds | 0.005 seconds |
| | *Heave Time Correction* | 0.000 seconds | 0.005 seconds |

# C. Data Acquisition and Processing

## C.1 Bathymetry

### C.1.1 Multibeam Echosounder

Data Acquisition Methods and Procedures

Multibeam data on S250 are logged locally on the RESON topside machines in s7k format. Multibeam data are also acquired through Hypack/Hysweep in HSX format for bathymetry, though these files are only used in the event of errors in the s7k file and are otherwise discarded. The HSX format includes sounding solutions, navigation, and attitude data. Ship navigation and survey line monitoring are performed with Hypack/Hysweep. The s7k format includes sounding solutions, navigation, attitude, and backscatter snippet data. This record is configured to include the following RESON datagrams: 1003: Position; 1012: Roll, Pitch, Heave; 1013: Heading; 7000: 7k Sonar Settings; 7004: 7k Beam Geometry; 7006: 7k Bathymetric Data; 7008: Bathymetry (For UI Display Only); 7017: Bathymetry (RAW for hydrography); 7027: 7k Generic Watercolumn Data (used for snippets backscatter) and 7503: Remote Control Sonar Settings.

All multibeam sonars are configured in equidistant ("Best Coverage" in newest RESON version) beam steering mode. The opening angle of the 7125 systems is configured based on analysis of coverage, speed, and expected sound speed refraction errors for each survey. This angle typically varies between 120 and 140 degrees. Power, gain, and TVG parameters are typically set for a particular project and changes during acquisition are minimal.

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

*Figure 15: Ship survey systems wiring diagram.*

*Figure 16: 2702 survey systems wiring diagram.*

Data Processing Methods and Procedures

Bathymetry processing followed section 4.2 of the FPM unless otherwise noted.  Raw .s7k (Reson 7125s) and .HSX (R2Sonic) multibeam data were converted to CARIS HIPS HDCS format using established and internally documented settings.  After TrueHeave, water level correctors, Smoothed Best Estimate of Trajectory (SBET), attitude/navigation, and SBET RMS data are applied, GPS Tides are calculated using the HSD Operations Branch provided VDatum separation model.  Sound speed correctors are then applied and finally the lines are merged.  Once lines are merged, Total Propagated Uncertainty (TPU) is computed using settings documented for each survey in the Descriptive Report.  Default CARIS device models (devicemodels.xml) are used during processing.  The standard option to accomplish this workflow in an automated fashion is to use Charlene, a tool available in the Pydro Explorer developed by NOAA's Office of Coast Survey.

*Figure 17: MBES flow diagram*

**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**

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

**C.1.4.2 Depth Derivation**

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

**C.1.4.3 Surface Computation Algorithm**

BASE surfaces were created using the CUBE algorithm and parameters contained in the NOAA CUBEParams_NOAA_2018.xml file as provided by HSTB. The CUBEParams_NOAA_2018.xml file is included with the HIPS Vessel Files with the individual survey data. The NOAA parameter configurations for variable resolution are used.

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

# C.2 Imagery

## C.2.1 Multibeam Backscatter Data

Data Acquisition Methods and Procedures

Backscatter is acquired in the 7008 record logged in the .s7k files directly from the RESON 7125 processors. For the 7125 400kHz systems, snippet size is set to 25 samples in water depths less than 50 meters and to 50 samples in depth greater than 50 meters. The 7125 200kHz system has snippets size set to 100 in depths less than 100 meters and 200 in all depths greater than 100 meters.

<u>Data Processing Methods and Procedures</u>

All processing of backscatter is done using the FM Geocoder Toolbox module of the QPS Fledermaus package. Backscatter processing complies with guidance provided in HTD 2018-3 Backscatter.

### C.2.2 Side Scan Sonar

Side scan sonar imagery was not acquired.

### 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 was not acquired.

### C.3.1.2 DGPS Data

DGPS data was not acquired.

### C.3.2 Vertical Control

### C.3.2.1 Water Level Data

Water level data was not acquired.

### C.3.2.2 Optical Level Data

Optical level data was not acquired.

## C.4 Vessel Positioning

<u>Data Acquisition Methods and Procedures</u>

Realtime vessel navigation and attitude is measured by the two POS/MVs by receiving DGPS correctors via WASS and recorded in the Hysweep .HSX file and the RESON .s7k file.

The heave lever arms for S250 are configured to a point on the centerline of the vessel between the two POS IMUs. This is done to prevent long-term static roll angles from causing a steady state heave offset.


Data Processing Methods and Procedures


The POS/MV TrueHeave data are logged within the POS/MV .000 files and are applied in CARIS HIPS during post processing using the "Import/Axillary Data/Applanix POS M/V" 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 V5 User Guide 2011.

The POS files produced during acquisition are processed through the POSPac MMS software to produce an SBET via PP-RTX in the NAD83 reference frame and an RMS file containing the realtime uncertainty estimates of the position and attitude data.  The resulting SBET and RMS files are then applied in CARIS HIPS during post processing using the "Import/Axillary Data/Applanix SBET" and "Import/Axillary Data/ Applanix RMS" functions, respectively.

Applanix's unique PP-RTX GNSS aided-inertial module provides centimeter-level post-processed positioning accuracies buy using a network of approximately 100 stations that track GPS, GLONASS, BDS, QZSS, and Galileo satellites.  These correctors are made available via the internet within minutes of real-time which prevents any delays in the data processing timeline.



# C.5 Sound Speed

## C.5.1 Sound Speed Profiles

Data Acquisition Methods and Procedures


Seabird SBE 19plus and MVP sound speed profilers are used regularly to collect sound speed data for ray tracing corrections for the multibeam sonar systems.  Due to the time saving potential, the MVP is the primary means of collecting sound speed data.  If necessary, the SBE 19plus is hand deployed from the stern.

Casts are taken at least every four hours, but typically far more frequently.  The interval between casts is typically between ten and forty minutes based on the observed variability between casts.  The Survey Data Monitoring tab within Sound Speed Manager is used to run CastTime which assists the hydrographer determine an appropriate frequency to conduct sound speed profiles.



Data Processing Methods and Procedures


Data are downloaded from the Seabird CTDs with a serial connection to a processing computer in the form of .HEX and .cnv files.  Data are instantly transmitted from the MVP towfish to a processing computer

once a dynamic cast is completed in the form of .s12, .calc, .eng, .raw, and .log files.  Data from both the Seabird and MVP are then processed through Sound Speed Manager to produce CARIS .svp formatted sound velocity profiles.  All .svp profiles for a survey sheet are then concatenated to one master file for a survey.

### C.5.2 Surface Sound Speed

Data Acquisition Methods and Procedures

Surface sound speed for both Reson 7125's is fed from individual SVP-70 sound velocity sensors mounted near each transducer.  While operating in dual-head mode and due to the starboard cable being inoperable, the port SVP-70 feeds both the master and slave.

Data Processing Methods and Procedures

The data collected by the SVP-70 and miniSVS sound velocity sensors are used for realtime beam steering. Sound speed DQAs are conducted by using Pydro's Sound Speed Manager to compare the measured sound speed from the SVP-70 or miniSVS to the measured sound speed from the MVP or CTD at the same depth.

## C.6 Uncertainty

### C.6.1 Total Propagated Uncertainty Computation Methods

TPU is calculated in CARIS HIPS using the Compute TPU tool.  Project specific values for tide and sound speed are entered and used over the duration of each project.  Error values for the multibeam and positioning systems were compiled from manufacturer specifications sheets for each sensor and from values set forth in section 4.2.3.8 of the 2014 FPM.

**C.6.2 Uncertainty Components**

**A Priori Uncertainty**

| Vessel | | FH_S250S_7125_512 bms_S250S_7125_512 | FH_S250S_7125_512 bms_S200MP_7125_512 | FH_S200MP_7125_512 bms_S200MP_7125_512 | FH_S200MP_7125_512 bms_200 |
|--------|-------|-----------|-----------|-----------|-----------|
| Motion Sensor | Gyro | 0.02 degrees | 0.02 degrees | 0.02 degrees | 0.02 degrees |
| | Heave | 5.00%<br>0.05 meters | 5.00%<br>0.05 meters | 5.00%<br>0.05 meters | 5.00%<br>0.05 meters |
| | Roll | 0.02 degrees | 0.02 degrees | 0.02 degrees | 0.02 degrees |
| | Pitch | 0.02 degrees | 0.02 degrees | 0.02 degrees | 0.02 degrees |
| Navigation Sensor | | 1.00 meters | 1.00 meters | 0.50 meters | 0.50 meters |

**Real-Time Uncertainty**
Real-time uncertainty was not applied.

## C.7 Shoreline and Feature Data

Shoreline and feature data was not acquired.

## C.8 Bottom Sample Data

Data Acquisition Methods and Procedures

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

Data Processing Methods and Procedures

Drop camera video files were processed using VLC Media Player to clip the video starting just before
the bottom sampler lands on the sea floor and ending just after recovery was initiated.  Bottom sample
attribution was conducted as prescribed in section 7.2.3 of the HSSD.

# D. Data Quality Management

## D.1 Bathymetric Data Integrity and Quality Management

### D.1.1 Directed Editing

Multibeam data were reviewed and edited in HIPS Subset Editor as necessary. The finalized BASE surfaces, CUBE hypotheses, and python based program, Flyer Finder, guided directed data editing at the appropriate depth range in subset editor.  The surfaces and subset editor views were also used to demonstrate coverage and to check for errors due to tides, sound speed, attitude and timing.

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

### D.1.2 Designated Sounding Selection

Designated soundings were selected as outlined in section 5.2.1.2.3 of the HSSD.

### D.1.3 Holiday Identification

The identification of holidays was accomplished by visual inspection of BASE surfaces in addition to using the python based program, Holiday Finder.  Holidays were identified as outlined in section 5.2.2.3  of the HSSD.

### D.1.4 Uncertainty Assessment

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

### D.1.5 Surface Difference Review

### D.1.5.1 Crossline to Mainscheme

A crossline to mainscheme comparison was conducted as outlined in section 5.2.4.3 of the HSSD.

**D.1.5.2 Junctions**

Junction comparisons were conducted as outlined in section 7.2.2 of the HSSD.

**D.1.5.3 Platform to Platform**

Due to multibeam sonar configuration geometry, the port and starboard sonars have a significant amount of overlap that exists between the inboard areas of each swath.  These areas of overlap are differenced to assess platform to platform parity.  If substantial discrepancies are observed, the results are notated in the Descriptive Report for the particular survey.

# D.2 Imagery data Integrity and Quality Management

Imagery data integrity and quality management were not conducted for this survey.

# E. Approval Sheet

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

The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual, Letter Instructions, and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

| Approver Name | Approver Title | Date | Signature |
|---|---|---|---|
| Megan Guberski, LCDR/NOAA | Chief of Party | 09/22/2020 | |
| Steven Wall, LT/NOAA | Operations Officer | 09/22/2020 | |

# List of Appendices:

| *Mandatory Report* | *File* |
|---|---|
| *Vessel Wiring Diagram* | 2702_2018_Wiring_Diagram.pdf |
| | FH_2018_Wiring_Diagram.pdf |
| *Sound Speed Sensor Calibration* | Micro_CTD_calibration.pdf |
| | MiniSVS-48002_calibration report.pdf |
| | SBE 19plus C4642 30May18.pdf |
| | SBE 19plus P4642 18May18.pdf |
| | SBE 19plus T4642 30May18.pdf |
| | SBE 19plus V2 C6918 30May18.pdf |
| | SBE 19plus V2 P6918 22May18.pdf |
| | SBE 19plus V2 T6918 30May18.pdf |
| | SVP70_calibration reports.pdf |
| *Vessel Offset* | S250_Offsets_2013_SFG.xlsx |
| *Position and Attitude Sensor Calibration* | N/A |
| *Echosounder Confidence Check* | N/A |
| *Echosounder Acceptance Trial Results* | N/A |