U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

Data Acquisition & Processing Report

Type of Survey Hydrographic

Project No. 2013 *Rainier* field season

Time frame April - October 2013

LOCALITY

State Alaska, Washington, and Oregon

General Locality Offshore Washington and Oregon
Behm Canal, Alaska
Chatham Strait, Alaska
Shumagin Islands, Alaska
South Alaska Peninsula, Alaska

2013

CHIEF OF PARTY

Commander Richard T. Brennan, NOAA

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Data Acquisition and Processing Report

NOAA Ship *Rainier*
Chief of Party: CDR Richard T. Brennan
Year: 2013
Version: 1.0
Publish Date: 2013-04-30

A Equipment

A.1 Survey Vessels

A.1.1 NOAA Ship RAINIER (WTEF)

<table>
<tr><td>Name</td><td colspan="2">NOAA Ship RAINIER (WTEF)</td></tr>
<tr><td>Hull Number</td><td colspan="2">S221</td></tr>
<tr><td>Description</td><td colspan="2">Steel hydrographic ship</td></tr>
<tr><td>Utilization</td><td colspan="2">Mid-water multibeam</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>70.4 meters</td></tr>
<tr><td>Beam</td><td>12.8 meters</td></tr>
<tr><td>Max Draft</td><td>4.7 meters</td></tr>
<tr><td rowspan="3">Most Recent Full Static Survey</td><td>Date</td><td>2010-10-12</td></tr>
<tr><td>Performed By</td><td>Westlake Consultants, Inc.</td></tr>
<tr><td>Discussion</td><td>During the RAINIER's 2010-2011 major repair period, in conjunction with the installation of the new Kongsberg EM 710 multibeam system, Westlake Consultants, Inc. was contracted to conduct a measurement and alignment report. The spatial relationship between the ship’s granite block, IMU mounting plate, transducer array, POS/MV antennae, and multiple ship reference points were all determined.</td></tr>
<tr><td>Most Recent Partial Static Survey</td><td colspan="2">Partial static survey was not performed.</td></tr>
<tr><td>Most Recent Full Offset Verification</td><td colspan="2">Full offset verification was not performed.</td></tr>
</table>

<table>
<tr><td>Most Recent Partial Offset Verification</td><td colspan="2">Partial offset verification was not performed.</td></tr>
<tr><td rowspan="3">Most Recent Static Draft Determination</td><td>Date</td><td>2013-04-20</td></tr>
<tr><td>Method Used</td><td>Survey personnel record direct measurements to waterline from port and starboard benchmarks.</td></tr>
<tr><td>Discussion</td><td>During her mid-life refit, RAINIER had a new multibeam sonar system installed. As part of this installation, Westlake Consultants, Inc. performed a survey of the new sonar system in relation to the ship’s granite block and several benchmarks located about the ship. Unfortunately no benchmarks were positioned port and starboard in-line athwartship with the IMU. In light of this fact, RAINIER personnel located and positioned two benchmarks in these locations to ease the waterline measurement. These two benchmarks are located on the gunwale lip, both port and starboard, close to in-line with the IMU. Prior to any data collection, an Impulse 200 LR laser rangefinder is held level to the gunwale lip directly on the benchmark and distance shots are taken directly to the surface of the water. Six measurements are taken from each benchmark. Both the port and starboard measurements are individually averaged together to derive a final value. A new waterline measurement is acquired prior to every day of survey operation and when a significant change to the draft occurs (ex; dropping the launches). See section C.2.1 of this report for information regarding the use of waterline measurements in data processing.</td></tr>
</table>

Most Recent Dynamic Draft Determination	*Date*	2013-05-01
	Method Used	The ellipsoidally referenced method
	Discussion	The Ellipsoidally Referenced Dynamic Draft Measurement (ERDDM) methodology as outlined in the FPM (1.4.2.1.2.1— Dynamic Draft Measurement Techniques) was used to determine the settlement and squat values of RAINIER. Continuously Operating Reference Stations (CORS) were used as reference stations, no GPS base stations were installed by RAINIER.

Figure 1: The NOAA Ship Rainier S221 (WTEF)

A.1.2 RA3 (WZ2573)

Name	RA3 (WZ2573)
Hull Number	2803
Description	Aluminum hull Jensen survey launch

<table>
<tr><td>Utilization</td><td colspan="2">Shallow water multibeam</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>8.8 meters</td></tr>
<tr><td>Beam</td><td>3.7 meters</td></tr>
<tr><td>Max Draft</td><td>0.3 meters</td></tr>
<tr><td rowspan="3">Most Recent Full Static Survey</td><td>Date</td><td>2009-03-17</td></tr>
<tr><td>Performed By</td><td>National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch</td></tr>
<tr><td>Discussion</td><td>During the 2008-2009 winter inport a brand new Jensen (2803) launch was constructed and delivered to RAINIER. Personnel from the National Geodetic Survey’s Geodetic Services Division determined the spatial relationship of various sensors and reference points in relation to the POS/MV IMU. In all, seven benchmarks in strategic places around the hull, two GPS antennae, and the IMU were positioned.</td></tr>
<tr><td rowspan="3">Most Recent Partial Static Survey</td><td>Date</td><td>2009-04-07</td></tr>
<tr><td>Performed By</td><td>RAINIER personnel</td></tr>
<tr><td>Discussion</td><td>At the time NGS personnel were present for the launch survey, the projector mounting plate was not yet installed in its final position. Two benchmarks were positioned by NGS personnel by placing punch-marks on the keel (one fore and one aft of the mounting plate). By using these two benchmarks, the position of the projector mounting plate was easily measured by RAINIER personnel once the plate was installed in its final position. Since the sonar mounting bracket was built to precise dimensional standards, the exact orientation of the Reson 7125 sonar projectors could easily be determined.</td></tr>
<tr><td>Most Recent Full Offset Verification</td><td colspan="2">Full offset verification was not performed.</td></tr>
</table>

Most Recent Partial Offset Verification	*Date*	2013-03-19
	Method Used	Verification done with steel tapes, laser range finders, levels, plum-bobs, and carpenter squares.
	Discussion	Using reference marks and benchmarks established by the 2009 NGS survey, RAINIER personnel were able to re-verify the position of the mounting plate to which the Reson projectors are attached, the IMU, as well as the GPS antennas. A rotational matrix and vessel orientation measurements from the POS/MV was also used to correct for any roll or pitch vector errors. The measured position of the 7125 transducers and IMU differed by 3mm or less compared to the 2012 surveyed position. For the 8125 transducer a difference of 12mm on the Y axis compared to the 2012 surveyed position was the largest difference. The measured distance between the Port GPS antennas and IMU differed by 35mm or less compared to the 2012 surveyed position.

<table>
<tr><td rowspan="3">Most Recent Static Draft Determination</td><td>Date</td><td>2013-03-06</td></tr>
<tr><td>Method Used</td><td>Static draft determined by direct measurement of the distance between launch benchmarks and the waterline.</td></tr>
<tr><td>Discussion</td><td>All RAINIER survey launches were constructed with integrated benchmarks that were later surveyed by the National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch. Two of these benchmarks are located on the deck, both port and starboard, close to in-line with the IMU. During the determination process, a carpenter level was held level to the deck while a steel tape was used to measure directly to the surface of the water. At the same time the launch was kept level by observing the POS/ MV output and shifting personnel in the launch. Three measurements were taken on each benchmark. Both the port and starboard measurements were taken and averaged together for a final value.</td></tr>
<tr><td rowspan="3">Most Recent Dynamic Draft Determination</td><td>Date</td><td>2013-03-28</td></tr>
<tr><td>Method Used</td><td>Multibeam echo sounder method</td></tr>
<tr><td>Discussion</td><td>The procedure used follows the "Echosounder" method outlined in the FPM (1.4.2.1.2.1— Dynamic Draft Measurement Techniques). One survey line planned in a relatively flat and featureless section of Yaquina Bay was used to acquire the data. After the initial runs of 600 and 900 RPM, the speeds thereafter increased at 200-RPM increments up to a maximum of 1900 RPM. Every speed increment was run in both directions to minimize the effect of current.</td></tr>
</table>

Figure 2: Rainier survey launch RA3 (2803).

A.1.3 RA4 (WZ2574)

Name	RA4 (WZ2574)	
Hull Number	2801	
Description	Aluminum hull Jensen survey launch	
Utilization	Shallow water multibeam	
Dimensions	*LOA*	8.8 meters
	Beam	3.7 meters
	Max Draft	0.3 meters

Most Recent Full Static Survey	*Date*	2008-03-31
	Performed By	National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch
	Discussion	During the 2007-2008 winter import, a brand new Jensen (2801) launch was constructed and delivered to RAINIER. Personnel from the National Geodetic Survey's Geodetic Services Division determined the spatial relationship of various sensors and reference points in relation to the POS/MV IMU. Two of the eleven benchmarks located by NGS personnel are positioned on the sonar mounting bracket which was built to precise dimensional standards. These two benchmarks and blueprints of the mounting bracket allowed for the determination of the exact orientation of the Reson 7125 sonar projectors once they were mounted.
Most Recent Partial Static Survey	Partial static survey was not performed.	
Most Recent Full Offset Verification	Full offset verification was not performed.	

Most Recent Partial Offset Verification	*Date*	2013-03-06
	Method Used	Verification done with steel tapes, laser range finders, levels, plum-bobs, and carpenter squares.
	Discussion	Using reference marks and benchmarks established by the 2008 NGS survey, RAINIER personnel were able to re-verify the position of the mounting plate to which the Reson projectors are attached, the IMU, as well as the GPS antennas. A rotational matrix and vessel orientation measurements from the POS/MV was also used to correct for any roll or pitch vector errors. The measured position of the 7125 transducers and IMU differed by 5mm or less compared to the 2012 surveyed position. The measured distance between the Port GPS antennas and IMU differed by 28mm or less compared to the 2012 surveyed position.
Most Recent Static Draft Determination	*Date*	2013-03-06
	Method Used	Static draft determined by direct measurement of the distance between launch benchmarks and the waterline.
	Discussion	All RAINIER survey launches were constructed with integrated benchmarks that were later surveyed by the National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch. Two of these benchmarks are located on the deck, both port and starboard, close to in-line with the IMU. During the determination process, a carpenter level was held level to the deck while a steel tape was used to measure directly to the surface of the water. At the same time the launch was kept level by observing the POS/MV output and shifting personnel in the launch. Three measurements were taken on each benchmark. Both the port and starboard measurements were taken and averaged together for a final value.

Most Recent Dynamic Draft Determination	*Date*	2013-03-14
	Method Used	Multibeam echo sounder method
	Discussion	The procedure used follows the "Echosounder" method outlined in the FPM (1.4.2.1.2.1— Dynamic Draft Measurement Techniques). One survey line planned in a relatively flat and featureless section of Yaquina Bay was used to acquire the data. After the initial runs of 600 and 900 RPM, the speeds thereafter increased at 200-RPM increments up to a maximum of 1900 RPM. Every speed increment was run in both directions to minimize the effect of current.

Figure 3: Rainier survey launch RA4 (2801).

A.1.4 RA5 (WZ2575)

<table>
<tr><td>Name</td><td colspan="2">RA5 (WZ2575)</td></tr>
<tr><td>Hull Number</td><td colspan="2">2802</td></tr>
<tr><td>Description</td><td colspan="2">Aluminum hull Jensen survey launch</td></tr>
<tr><td>Utilization</td><td colspan="2">Shallow water multibeam</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>8.8 meters</td></tr>
<tr><td>Beam</td><td>3.7 meters</td></tr>
<tr><td>Max Draft</td><td>0.3 meters</td></tr>
<tr><td rowspan="3">Most Recent Full Static Survey</td><td>Date</td><td>2008-03-31</td></tr>
<tr><td>Performed By</td><td>National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch</td></tr>
<tr><td>Discussion</td><td>During the 2007-2008 winter import, a brand new Jensen (2801) launch was constructed and delivered to RAINIER. Personnel from the National Geodetic Survey’s Geodetic Services Division determined the spatial relationship of various sensors and reference points in relation to the POS/MV IMU. Two of the eleven benchmarks located by NGS personnel are positioned on the sonar mounting bracket which was built to precise dimensional standards. These two benchmarks and blueprints of the mounting bracket allowed for the determination of the exact orientation of the Reson 7125 sonar projectors once they were mounted.</td></tr>
<tr><td>Most Recent Partial Static Survey</td><td colspan="2">Partial static survey was not performed.</td></tr>
<tr><td>Most Recent Full Offset Verification</td><td colspan="2">Full offset verification was not performed.</td></tr>
</table>

Most Recent Partial Offset Verification	*Date*	2013-03-13
	Method Used	Verification done with steel tapes, laser range finders, levels, plum-bobs, and carpenter squares.
	Discussion	Using reference marks and benchmarks established by the 2008 NGS survey, RAINIER personnel were able to re-verify the position of the mounting plate to which the Reson projectors are attached, the IMU, as well as the GPS antennas. A rotational matrix and vessel orientation measurements from the POS/MV was also used to correct for any roll or pitch vector errors. The measured position of the 7125 transducers and IMU differed by 4mm or less compared to the 2012 surveyed position. The measured distance between the Port GPS antennas and IMU differed by 33mm or less compared to the 2012 surveyed position.
Most Recent Static Draft Determination	*Date*	2013-03-06
	Method Used	Static draft determined by direct measurement of the distance between launch benchmarks and the waterline.
	Discussion	All RAINIER survey launches were constructed with integrated benchmarks that were later surveyed by the National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch. Two of these benchmarks are located on the deck, both port and starboard, close to in-line with the IMU. During the determination process, a carpenter level was held level to the deck while a steel tape was used to measure directly to the surface of the water. At the same time the launch was kept level by observing the POS/MV output and shifting personnel in the launch. Three measurements were taken on each benchmark. Both the port and starboard measurements were taken and averaged together for a final value.

Most Recent Dynamic Draft Determination	*Date*	2013-03-19
	Method Used	Multibeam echo sounder method
	Discussion	The procedure used follows the "Echosounder" method outlined in the FPM (1.4.2.1.2.1— Dynamic Draft Measurement Techniques). One survey line planned in a relatively flat and featureless section of Yaquina Bay was used to acquire the data. After the initial runs of 600 and 900 RPM, the speeds thereafter increased at 200-RPM increments up to a maximum of 1900 RPM. Every speed increment was run in both directions to minimize the effect of current.

Figure 4: Rainier survey launch RA5 (2802)

A.1.5 RA6 (WZ2576)

Name	RA6 (WZ2576)

<table>
<tr><td>Hull Number</td><td colspan="2">2804</td></tr>
<tr><td>Description</td><td colspan="2">Aluminum hull Jensen survey launch</td></tr>
<tr><td>Utilization</td><td colspan="2">Shallow water multibeam</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>8.8 meters</td></tr>
<tr><td>Beam</td><td>3.7 meters</td></tr>
<tr><td>Max Draft</td><td>0.3 meters</td></tr>
<tr><td rowspan="3">Most Recent Full Static Survey</td><td>Date</td><td>2009-03-17</td></tr>
<tr><td>Performed By</td><td>National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch</td></tr>
<tr><td>Discussion</td><td>During the 2008-2009 winter import a brand new Jensen (2804) launch was constructed and delivered to RAINIER. Personnel from the National Geodetic Survey’s Geodetic Services Division determined the spatial relationship of various sensors and reference points in relation to the POS/MV IMU. In all, seven benchmarks in strategic places around the hull, two GPS antennae, and the IMU were positioned.</td></tr>
<tr><td rowspan="3">Most Recent Partial Static Survey</td><td>Date</td><td>2009-04-07</td></tr>
<tr><td>Performed By</td><td>RAINIER personel</td></tr>
<tr><td>Discussion</td><td>At the time NGS personnel were present for the launch survey, the projector mounting plate was not yet installed in its final position. Two benchmarks were positioned by NGS personnel by placing punch-marks on the keel (one fore and one aft of the mounting plate). By using these two benchmarks, the position of the projector mounting plate was easily measured by RAINIER personnel once the plate was installed in its final position. Since the sonar mounting bracket was built to precise dimensional standards, the exact orientation of the Reson 7125 sonar projectors could easily be determined.</td></tr>
<tr><td>Most Recent Full Offset Verification</td><td colspan="2">Full offset verification was not performed.</td></tr>
</table>

Most Recent Partial Offset Verification	*Date*	2013-03-18
	Method Used	Verification done with steel tapes, laser range finders, levels, plum-bobs, and carpenter squares.
	Discussion	Using reference marks and benchmarks established by the 2009 NGS survey, RAINIER personnel were able to re-verify the position of the mounting plate to which the Reson projectors are attached, the IMU, as well as the GPS antennas. A rotational matrix and vessel orientation measurements from the POS/MV was also used to correct for any roll or pitch vector errors. The measured position of the 7125 transducers and IMU differed by 14mm or less compared to the 2012 surveyed position. The measured distance between the Port GPS antennas and IMU differed by 41mm or less compared to the 2012 surveyed position.
Most Recent Static Draft Determination	*Date*	2013-03-06
	Method Used	Static draft determined by direct measurement of the distance between launch benchmarks and the waterline.
	Discussion	All RAINIER survey launches were constructed with integrated benchmarks that were later surveyed by the National Geodetic Survey, Geodetic Services Division Instrumentation & Methodologies Branch. Two of these benchmarks are located on the deck, both port and starboard, close to in-line with the IMU. During the determination process, a carpenter level was held level to the deck while a steel tape was used to measure directly to the surface of the water. At the same time the launch was kept level by observing the POS/MV output and shifting personnel in the launch. Three measurements were taken on each benchmark. Both the port and starboard measurements were taken and averaged together for a final value.

Most Recent Dynamic Draft Determination	*Date*	2013-03-29
	Method Used	Multibeam echo sounder method
	Discussion	The procedure used follows the "Echosounder" method outlined in the FPM (1.4.2.1.2.1— Dynamic Draft Measurement Techniques). One survey line planned in a relatively flat and featureless section of Yaquina Bay was used to acquire the data. After the initial runs of 600 and 900 RPM, the speeds thereafter increased at 200-RPM increments up to a maximum of 1900 RPM. Every speed increment was run in both directions to minimize the effect of current.

Figure 5: Rainier survey launch RA6 (2804).

A.1.6 RA7

Name	RA7
Hull Number	1906
Description	Aluminum hull SAFE boat survey skiff
Utilization	Shoreline Verification
Dimensions	*LOA*: 5.8 meters *Beam*: 2.6 meters *Max Draft*: 0.33 meters
Most Recent Full Static Survey	Full static survey was not performed.
Most Recent Partial Static Survey	Partial static survey was not performed.
Most Recent Full Offset Verification	Full offset verification was not performed.
Most Recent Partial Offset Verification	Partial offset verification was not performed.
Most Recent Static Draft Determination	Static draft determination was not performed.
Most Recent Dynamic Draft Determination	Dynamic draft determination was not performed.

Figure 6: Rainier survey skiff RA7

A.1.7 RA8

<table>
<tr><td>Name</td><td colspan="2">RA8</td></tr>
<tr><td>Hull Number</td><td colspan="2">1905</td></tr>
<tr><td>Description</td><td colspan="2">Aluminum hull SeaArk survey skiff</td></tr>
<tr><td>Utilization</td><td colspan="2">Shoreline Verification</td></tr>
<tr><td rowspan="3">Dimensions</td><td>LOA</td><td>5.7 meters</td></tr>
<tr><td>Beam</td><td>2.8 meters</td></tr>
<tr><td>Max Draft</td><td>0.35 meters</td></tr>
<tr><td>Most Recent Full Static Survey</td><td colspan="2">Full static survey was not performed.</td></tr>
<tr><td>Most Recent Partial Static Survey</td><td colspan="2">Partial static survey was not performed.</td></tr>
</table>

Most Recent Full Offset Verification	Full offset verification was not performed.
Most Recent Partial Offset Verification	Partial offset verification was not performed.
Most Recent Static Draft Determination	Static draft determination was not performed.
Most Recent Dynamic Draft Determination	Dynamic draft determination was not performed.

Figure 7: Rainier survey skiff RA8

A.2 Echo Sounding Equipment

A.2.1 Side Scan Sonars

No side scan sonars were utilized for data acquisition.

A.2.2 Multibeam Echosounders

A.2.2.1 Kongsberg EM710

Manufacturer	Kongsberg
Model	EM710
Description	S221 (RAINIER) is equipped with a hull-mounted Kongsberg EM 710, which operates at sonar frequencies in the 70 to 100 kHz range. The across-track swath width is up to 5.5 times water depth with a published maximum depth of more than 2000 m. The alongtrack beamwidth of RAINIER's configuration is ½° with a receive beamwidth of 1°. The number of beams is 256 or 128 respectively, with dynamic focusing employed in the near field. A high density beam processing mode provides up to 400 or 200 soundings per swath by using a limited range window for the detections. The beamspacing may be set to be either equiangular or equidistant. RAINIER typically collects 400 beams per ping in equidistant mode. The transmit fan is divided into three sectors to maximize range capability but also to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping, and use distinct frequencies or waveforms. By default, the transmit fan is electronically stabilized for roll, pitch and yaw but RAINIER experience has shown that yaw stabilization often caused a noticeable "step" between the three sectors of the transmit fan. Due to this problem, RAINIER typically disables yaw stabilization.
Serial Numbers	*Vessel Installed On*: S221 *Processor s/n*: 0356 *Transceiver s/n*: unknown *Transducer s/n*: unknown *Receiver s/n*: 218 *Projector 1 s/n*: unknown *Projector 2 s/n*: None

Specifications	*Frequency*	100 kilohertz	
	Beamwidth	*Along Track*	0.5 degrees
		Across Track	1.0 degrees
	Max Ping Rate	25 hertz	
	Beam Spacing	*Beam Spacing Mode*	Equidistant
		Number of Beams	400
	Max Swath Width	140.0 degrees	
	Depth Resolution	1 centimeters	
	Depth Rating	*Manufacturer Specified*	2000 meters
		Ship Usage	400 meters
Manufacturer Calibrations	Manufacturer calibration was not performed.		
System Accuracy Tests	System accuracy test was not performed.		
Snippets	Sonar does not have snippets logging capability.		

Figure 8: Kongsberg EM710 sonar transducer housing on Rainier (S221).

A.2.2.2 Reson 8125

Manufacturer	Reson
Model	8125
Description	The SeaBat 8125, with Option 033, Angle-Independent Imagery, is a 455 kHz multibeam system that uses high frequency focused near-field beam forming to measure relative water depths across a 120° swath. Each swath consists of 240 individual 0.5° x 1.0° beams. This system is capable of operating in depths from 4 meters to 60 meters, with varying range scale values dependent upon the depth of water and across-track slope. Surface sound velocity was measured using a Reson SVP 71 velocimeter and digitally input into the Seabat 8125 during acquisition. In order to simplify SWMB surveying in the near-shore areas, the SeaBat 8125 is mounted with a 34° angle looking towards starboard. The transducer is attached with a custom made aluminum bracket bolted to the forward hull hardpoint on the starboard side. Unfortunately this exposed position subjects the 8125 transducer to both high drag during transit and potential rock strikes during shoreline verification. To reduce this risk, a maximum transit speed of 12-kts was established for launch 2803 while the SeaBat 8125 was mounted. Under optimal conditions, 2803 can be run along the 30-foot contour parallel to shore during periods of high tide and produce near complete SWMB coverage between the 8 and 4 meter depth curves.
Serial Numbers	*Vessel Installed On*: 2803 *Processor s/n*: 29979 *Transceiver s/n*: n/a *Transducer s/n*: 0704003 *Receiver s/n*: n/a *Projector 1 s/n*: unknown *Projector 2 s/n*: None

<table>
<tr><td rowspan="11">Specifications</td><td>Frequency</td><td colspan="2">455 kilohertz</td></tr>
<tr><td rowspan="2">Beamwidth</td><td>Along Track</td><td>1.0 degrees</td></tr>
<tr><td>Across Track</td><td>0.5 degrees</td></tr>
<tr><td>Max Ping Rate</td><td colspan="2">40 hertz</td></tr>
<tr><td rowspan="2">Beam Spacing</td><td>Beam Spacing Mode</td><td>Equiangular</td></tr>
<tr><td>Number of Beams</td><td>240</td></tr>
<tr><td>Max Swath Width</td><td colspan="2">120.0 degrees</td></tr>
<tr><td>Depth Resolution</td><td colspan="2">6 millimeters</td></tr>
<tr><td rowspan="2">Depth Rating</td><td>Manufacturer Specified</td><td>150 meters</td></tr>
<tr><td>Ship Usage</td><td>60 meters</td></tr>
<tr></tr>
<tr><td>Manufacturer Calibrations</td><td colspan="3">Manufacturer calibration was not performed.</td></tr>
<tr><td rowspan="3">System Accuracy Tests</td><td>Vessel Installed On</td><td colspan="2">2803</td></tr>
<tr><td>Methods</td><td colspan="2">The Newport reference surface is a grid of 11 lines by 11 lines with each line being roughly 13m apart. This close spacing provides for a generous overlap of soundings. All RAINIER launches collected reference surface data, one dataset for each sonar system and/or frequency aboard each vessel. Reference surfaces of 1-meter CUBE surfaces were created for each system and frequency. All surfaces were initially referenced to MLLW but were later referenced to the ellipse to eliminate any potential tidal error. Because there is no known true value for the Newport reference surface, the 2801 Reson 7125 high frequency reference surface was used as the “zero” datum for comparison to the Reson 8125 surface.</td></tr>
<tr><td>Results</td><td colspan="2">see attached "Reference Surface Compare 2013" report</td></tr>
<tr><td>Snippets</td><td colspan="3">Sonar has snippets logging capability.</td></tr>
</table>

Figure 9: Reson Seabat 8125 mounted on survey launch 2803.

A.2.2.3 Reson 7125

Manufacturer	Reson
Model	7125
Description	The Reson SeaBat 7125-B is a dual frequency (200/400 kHz), high-resolution multibeam echo sounder system for shallow-water depths. The recommended maximum range at 200kHz is 500m resulting in a 220 m depth limit for full swath coverage on a flat bottom. The 400kHz setting maximum range is 200m resulting in a 87m depth limit for full swath coverage on a flat bottom. The transducer assembly consists of single flat-faced receiver array and two projectors, one for each frequency. These systems included the optional Reson SVP 71 surface sound velocity probe. The SeaBat 7125 measures water depths across a 128° swath in both high and low frequency. Beamforming is conducted in either equi-angle or equidistant mode. Equidistant mode is useful to produce soundings at a uniform distance apart across the entire swath-width of a ping at the cost of less sounding density near nadir. Equi-angle mode is good for maximum ensonification of the bottom directly under the launch at the cost of sparse sounding density in the outer beams. RAINIER launches typically acquire data in equidistant mode unless running development lines directly over a feature of interest.

In the 200kHz mode the system has a beamwidth of 1° x 2° and in the 400kHz mode has a beamwidth of 0.5° x 1°. At 200kHz, the SeaBat 7125 generates 256 beams per ping. At 400kHz, the system generates 256 or 512 beams per ping. Typical settings used aboard RAINIER are 256 beams, equidistant in low frequency mode and 512 beams, equidistant in high frequency mode.

Serial Numbers

Vessel Installed On	2801	2802	2803	2804	spare
Processor s/n	4707073	2708007	2708010	2708006	61203
Transceiver s/n	1515007	1515033	1515003	1515002	61206
Transducer s/n	200 kHz 4605049 / 400kHz 0908167	200 kHz 5006388 / 400kHz 5006393	200 kHz 608560 / 400kHz 1908193	200 kHz 0608558 / 400kHz 0908045	200 kHz 2808016 / 400kHz 1908188
Receiver s/n	500315	4107011	808037	2208058	2405277
Projector 1 s/n	4605049	5006388	608560	0608558	2808016
Projector 2 s/n	0908167	5006393	1908193	0908045	1908188

Specifications

<table>
<tr><td>Frequency</td><td colspan="2">200 kilohertz</td><td colspan="2">400 kilohertz</td></tr>
<tr><td rowspan="2">Beamwidth</td><td>Along Track</td><td>2.0 degrees</td><td>Along Track</td><td>1.0 degrees</td></tr>
<tr><td>Across Track</td><td>1.0 degrees</td><td>Across Track</td><td>0.5 degrees</td></tr>
<tr><td>Max Ping Rate</td><td colspan="2">50 hertz</td><td colspan="2">50 hertz</td></tr>
<tr><td rowspan="2">Beam Spacing</td><td>Beam Spacing Mode</td><td>Equidistant</td><td>Beam Spacing Mode</td><td>Equidistant</td></tr>
<tr><td>Number of Beams</td><td>256</td><td>Number of Beams</td><td>512</td></tr>
<tr><td>Max Swath Width</td><td colspan="2">128 degrees</td><td colspan="2">128 degrees</td></tr>
<tr><td>Depth Resolution</td><td colspan="2">5 millimeters</td><td colspan="2">5 millimeters</td></tr>
<tr><td rowspan="2">Depth Rating</td><td>Manufacturer Specified</td><td>220 meters</td><td>Manufacturer Specified</td><td>87 meters</td></tr>
<tr><td>Ship Usage</td><td>200 meters</td><td>Ship Usage</td><td>50 meters</td></tr>
</table>

Manufacturer Calibrations

Manufacturer calibration was not performed.

System Accuracy Tests

Vessel Installed On	2801, 2802, 2803, and 2804 (high and low frequency)
Methods	The Newport reference surface is a grid of 11 lines by 11 lines with each line being roughly 13m apart. This close spacing provides for a generous overlap of soundings. Reference surfaces were run for 7125 systems in both high (400 kHz) and low (200 kHz) frequency in equi-angle mode with each vessel. Reference surfaces of 1-meter CUBE surfaces were created for each system and frequency. All surfaces were initially referenced to MLLW but were later referenced to the ellipse to eliminate any potential tidal error. Because there is no known true value for the Newport reference surface, the 2801 Reson 7125 high frequency reference surface was used as the “zero” datum for all comparisons.
Results	see attached "Reference Surface Compare 2013" report

Snippets	Sonar has snippets logging capability.

Figure 10: Reson 7125 mounted on survey launch 2801.

A.2.3 Single Beam Echosounders

No single beam echosounders 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

Manufacturer	n/a
Model	n/a
Description	Despite the tremendous advances in hydrographic sonar technology, the hydrographer may occasionally require a direct measurement of water depth. To this end, a calibrated lead line is still essential for field parties. The Field Procedures Manual (FPM) states: “All field units engaged in hydrographic surveys where general depths are less than 40 meters shall have one or more lead lines marked and calibrated.” During shoreline verification, lead lines were used to acquire depths over rocks and other features too shallow to acquire soundings using echo sounders. Of RAINIER’s leadlines, currently six are marked well-enough to meet specifications while three failed.
Serial Numbers	LL_01 PASS LL_02 PASS LL_03 PASS LL_04 PASS LL_06 PASS RA-107 FAIL RA-201 FAIL RA-203 PASS RA-6S FAIL

Calibrations	*Serial Number*	ALL Lead Lines
	Date	2013-03-26
	Procedures	Lead Lines were soaked in fresh water for at least 60 minutes. Each lead line was laid out on the concrete pier at PMC and ends were secured to a steel survey measuring tape. Offsets were recorded by applying tension equal to the attached weight at the end of each line and recording the measurement.
Accuracy Checks	No accuracy checks were performed.	
Correctors	Correctors were not determined.	
Non-Standard Procedures	Non-standard procedures were not utilized.	

A.3.3 Sounding Poles

No sounding poles were utilized for data acquisition.

A.3.4 Other Manual Sounding Equipment

No additional manual sounding equipment was utilized for data acquisition.

A.4 Positioning and Attitude Equipment

A.4.1 Applanix POS/MV

Manufacturer	Applanix
Model	POS/MV 320 (version 4)
Description	RAINIER, and all of her launches, are equipped with Applanix POS/MV 320 (version 4) Position and Orientation Sensors to measure and calculate position. The POS/MV is a GPS-aided inertial navigation system, which provides a blended position solution derived from both an Inertial Motion Unit (IMU) and an integrated GPS receiver. The IMU and GPS receiver are complementary sensors, and data from one are used to filter and constrain errors from the other. This inter-dependence results in higher position accuracy and fewer errors. Position accuracy is displayed in real time by the POS/MV software and was monitored to ensure that positioning accuracy requirements as outlined in the NOS Hydrographic Surveys Specifications and Deliverables (HSSD) were not exceeded. In addition, the POS/MV software displays HDOP and the number of satellites used in position computation. Data acquisition was generally halted when an HDOP of 2.5 was exceeded or the number of satellites available dropped below four.

	However, because positional accuracy can be maintained by the POS/MV through short GPS outages with the help of the IMU, data acquisition was not halted during short periods of time when the HDOP and number of satellites used exceeded stated parameters. In addition to position, the Applanix POS/MV also provides accurate navigation and attitude data to correct for the effects of heave, pitch, roll and heading. The POS/MV generates attitude data in three axes (roll, pitch and heading) to an accuracy of 0.02° or better. Heave measurements supplied by the POS/MV maintain an accuracy of 5% of the measured vertical displacement for movements that have a period of up to 20 seconds. The Heave Bandwidth filter was configured with a damping coefficient of 0.707. The cutoff period of the high pass filter was determined by estimating the swell period encountered on the survey grounds. These values ranged from 8 seconds (flat water) to 20 seconds (long period ocean swell), with values of 8 or 12 seconds typically. Currently the ship system is set to 20 seconds and the launches are set to 8 seconds. Intermittent problems with the heading accuracy climbing above the ideal cutoff of 0.05° are observed. Heading accuracy is monitored by the launch crew and survey operations are temporarily suspended in the event that the error exceeds 0.08°. Applanix "TrueHeave" values are also recorded. The TrueHeave algorithm uses a delayed filtering technique to eliminate many of the artifacts present in real time heave data. The TrueHeave data were applied to Reson bathymetry in CARIS HIPS post processing. Full POSPac data are also recorded on RAINIER and all of her survey launches. These data are used to post process POS/MV data to produce superior position and attitude data and can be used to produce a Post-Processed Kinematic (PPK) GPS solution. The POS Computer System (PCS) installed aboard RAINIER has been upgraded to allow internal logging. Previously internal logging was not used with the ship's system due to IMU data gaps experienced by other field units attempting to use this feature. Although this problem has reportedly been fixed, RAINIER continues to log RAW POS files directly to the acquisition computer since no issues have been noted using this method.

<table>
<tr><td rowspan="6">PCS</td><td>Manufacturer</td><td colspan="6">Applanix</td></tr>
<tr><td>Model</td><td colspan="6">POS/MV 320 V4</td></tr>
<tr><td>Description</td><td colspan="6"></td></tr>
<tr><td>Firmware Version</td><td colspan="6">unknown</td></tr>
<tr><td>Software Version</td><td colspan="6">4.3.4.0 (launches) 5.1.0.2 (S221)</td></tr>
<tr><td>Serial Numbers</td><td colspan="6"><table><tr><td>Vessel Installed On</td><td>S221</td><td>2801</td><td>2802</td><td>2803</td><td>2804</td></tr><tr><td>PCS s/n</td><td>3643</td><td>2206</td><td>2896</td><td>2893</td><td>2563</td></tr></table></td></tr>
<tr><td rowspan="5">IMU</td><td>Manufacturer</td><td colspan="6">Applanix</td></tr>
<tr><td>Model</td><td colspan="6">POS/MV 320 V4</td></tr>
<tr><td>Description</td><td colspan="6">On July 12, 2013 (DN193), RA3 (2803) experienced a failure of her TSS POS/MV system. The problem was eventually traced to a bad inertial measurement unit (IMU) which was replaced with a spare IMU from inventory. As a result, a new patch test for RA3 was completed on July 26, 2013 (DN207).</td></tr>
<tr><td>Serial Numbers</td><td colspan="6"><table><tr><td>Vessel Installed On</td><td>S221</td><td>2801</td><td>2802</td><td>2803</td><td>2803</td><td>2804</td></tr><tr><td>IMU s/n</td><td>353</td><td>693</td><td>694</td><td>343 [up to 7/12/201 (DN193</td><td>334 [after 7/12/201 (DN193</td><td>355</td></tr></table></td></tr>
<tr><td>Certification</td><td colspan="6">IMU certification report was not produced.</td></tr>
</table>

Antennas

Manufacturer	Trimble
Model	Zephyr Model 2 GNSS Antenna (P/N 57970-00)
Description	Used by S221

Serial Numbers

Vessel Installed On	S221	S221
Antenna s/n	1440925468	1440925253
Port or Starboard	Starboard	Port
Primary or Secondary	Secondary	Primary

Manufacturer	Trimble
Model	Zephyr L1/L2 (P/N 39105-00)
Description	Used by 2801 & 2802

Serial Numbers

Vessel Installed On	2801	2801	2802	2802
Antenna s/n	60216723	60216913	60201133	60205688
Port or Starboard	Starboard	Port	Starboard	Port
Primary or Secondary	Secondary	Primary	Secondary	Primary

Manufacturer	Trimble
Model	Zephyr L1/L2 (P/N 39105-00)
Description	Used by 2803 & 2804

Serial Numbers

Vessel Installed On	2803	2803	2804	2804
Antenna s/n	60073843	60145259	60073826	60078830
Port or Starboard	Starboard	Port	Starboard	Port
Primary or Secondary	Secondary	Primary	Secondary	Primary

GAMS Calibration

Vessel	S221	2801	2802	2803	2804
Calibration Date	2013-05-03	2013-03-14	2013-03-19	2013-03-28	2013-03-20

Configuration Reports

Vessel	S221	2801	2802	2803	2804
Report Date	2013-05-03	2013-03-14	2013-03-19	2013-03-28	2013-03-20

Figure 11: The aluminum extension bracket used to increase antenna separation of launches 2801 and 2802.

A.4.2 DGPS

Description	RAINIER, and all of her launches, are equipped with beacon receivers. These receivers are tuned to the closest available US Coast Guard maintained beacon transmitter with a reliable signal. The USCG beacon selected may change throughout the survey day depending on the received signal strength and position of the survey platform. GPS correctors are fed to the Applanix POS/MVs to produce real time differentially corrected positions.

<table>
<tr><td rowspan="8">Antennas</td><td>Manufacturer</td><td>Furuno</td></tr>
<tr><td>Model</td><td>GR-8 antenna coupler with preamp, FAW-1.2 whip antenna</td></tr>
<tr><td>Description</td><td>This unit consists of a preamp unit with a screw-in 1.2 meter whip antenna.</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Vessel Installed On</td><td>2801</td><td>2802</td><td>2804</td><td>S221</td></tr><tr><td>Antenna s/n</td><td>1-0785</td><td>1-1486</td><td>1-1449</td><td>1-1109</td></tr></table></td></tr>
<tr><td>Manufacturer</td><td>Trimble</td></tr>
<tr><td>Model</td><td>Trimble Pro Beacon</td></tr>
<tr><td>Description</td><td></td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Vessel Installed On</td><td>2803</td></tr><tr><td>Antenna s/n</td><td>unknown</td></tr></table></td></tr>
<tr><td rowspan="5">Receivers</td><td>Manufacturer</td><td>Furuno</td></tr>
<tr><td>Model</td><td>GR-80</td></tr>
<tr><td>Description</td><td>The Furuno GR-80 DGPS Beacon Receiver acquires differential error correction messages (RTCM SC104 format) broadcast by US Coast Guard radio beacons operating in the 283.5 to 325 kHz frequency range. The differential error correction messages are output via a serial port in NMEA 0183 protocol for use with an associated GPS receiver This results in differentially corrected position data with better than 2 meter accuracy.</td></tr>
<tr><td>Firmware Version</td><td>unknown</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Vessel Installed On</td><td>S221</td><td>2801</td><td>2802</td><td>2803</td><td>2804</td></tr><tr><td>Antenna s/n</td><td>3506-8414</td><td>3306-8043</td><td>3506-8385</td><td>3506-6743</td><td>3506-8032</td></tr></table></td></tr>
</table>

A.4.3 Trimble Backpacks

Manufacturer	Trimble
Model	Pathfinder Pro XRS
Description	RAINIER personnel use the Trimble “backpack” GPS system to obtain positions of selected shoreline features. They are also useful in positioning linear features on the

	shore such as finger piers or roads where the user can simply go ashore and walk the boundary of the object in question while wearing the backpack. The system consists of a Pathfinder Pro XRS, a 12-channel GPS receiver that provides real-time 1-2 meter accuracy with built-in Coast Guard differential beacon reception capability. This GPS receiver is connected to a Toughbook all-weather laptop computer running Caris Notebook. Due to both the portable and weather resistant attributes of this setup, it can be used in an open skiff to augment traditional shoreline verification in a survey launch.	
Serial Numbers	While the Trimble backpacks themselves have no serial numbers, the individual components they contain do.	
Antennas	*Manufacturer*	Trimble
	Model	GPS Pathfinder Pro XRS Antenna (part number 33580-50)
	Description	Integrated L1 GPS/Beacon/Satellite differential antenna.
	Serial Numbers	0220309434 0220309470
Receivers	*Manufacturer*	Trimble
	Model	Pathfinder Pro XRS
	Description	GPS receiver with built-in USCG beacon capabilities.
	Firmware Version	unknown
	Serial Numbers	0224070094 0224070154
Field Computers	*Manufacturer*	Panasonic
	Model	Toughbook 30
	Description	The Panasonic Toughbook CF-30 comes standard with a 1.66 GHz Intel Core Duo processor in a sealed all-weather design magnesium alloy case. The screen consists of a 13.3" sunlight-viewable display. Other design elements include a shock-mounted 160GB hard drive, a moisture and dust-resistant LCD, keyboard and touchpad. This laptop also has no cooling fan and instead dissipates heat "evenly" through the chassis. Having no fan ensures a better seal against dust and moisture. All external connection ports are also protected with waterproof flaps and covers.
	Operating System	Windows XP
	Serial Numbers	8HKSb80717 8HKSb80775 6LKSA03677 8HKSb80724

DQA Tests	*Date*	2013-03-12
	Serial Number	n/a
	Methods	During March 2013, horizontal control hardware was tested on benchmark BBCN88 off the Newport NOAA Pier. Base Station Data was collected for 3 hours. Trimble Backpack data, both differential and non-differential, was collected over the benchmark. Survey cameras capable of recording GPS positions and handheld GPS units were also tested.
	Results	The largest error seen with differential corrected Trimble Backpack data was 0.881m. The largest error seen with non-differential corrected Trimble Backpack data was 1.645m.

Figure 12: Trimble backpack GPS system deployed to survey the limits of an uncharted runway.

A.4.4 Laser Rangefinders

Manufacturer	Laser Technology Inc
Model	Impulse 200 LR
Description	The Impulse 200 LR (long range) is a hand-held, light weight laser ranging instrument which includes onboard calculation ability for height, horizontal, and vertical distance. The typical max range to a non-reflective target is 500m (1,640ft) with range accuracy of 3-5 centimeters. Two AA batteries supply up to 20 hours of use. Aiming is simplified with a 1X red-dot scope. In addition to measuring the distance to shoreline features, this instrument is also used to measure the waterline of RAINIER.
Serial Numbers	108786
DQA Tests	DQA test was not performed.

Manufacturer	Leica
Model	DISTO lite5
Description	The Leica DISTO lite5 is a splash and dust proof handheld laser rangefinder that emits a Class II 0.95mW laser on a wavelength of 620-690nm. Ranges measurable vary from 0.2m up to 200m with the smallest unit displayed 1mm. Measuring accuracy (at 2x standard deviation) is typically ± 3mm, ± 5mm at the instrument's extreme range.
Serial Numbers	40300556
DQA Tests	DQA test was not performed.

A.4.5 Other Positioning and Attitude Equipment

Manufacturer	Garmin		
Model	etrex Summit		
Description	The Garmin eTrex Summit is a small, waterproof, handheld GPS with a 64 x 128 pixel, 4 level gray LCD display. It is primarily used for benchmark descriptions and as a navigational aid in open skiffs.		
Serial Numbers	*Vessel*	n/a	n/a
	Serial Number	unknown	unknown
DQA Tests	*Date*	2013-03-12	
	Serial Number	n/a	
	Methods	During March 2013, horizontal control hardware was tested on benchmark BBCN88 off the Newport NOAA Pier. Base Station Data was collected for 3 hours. Trimble Backpack data, both differential and non-differential, was collected over the benchmark. Survey cameras capable of recording GPS positions and handheld GPS units were also tested.	
	Results	The largest error seen with handheld Garmin GPS was 2.96m.	

Manufacturer	Garmin		
Model	etrex Vista HCx		
Description	The Garmin eTrex Vista HCx is a small, waterproof, handheld GPS with a 176 x 220 pixel, 256 level color TFT display. It is primarily used for benchmark descriptions and as a navigational aid in open skiffs.		
Serial Numbers	*Vessel*	n/a	n/a
	Serial Number	16D179077	16D179076
DQA Tests	*Date*	2013-03-12	
	Serial Number	n/a	
	Methods	During March 2013, horizontal control hardware was tested on benchmark BBCN88 off the Newport NOAA Pier. Base Station Data was collected for 3 hours. Trimble Backpack data, both differential and non-differential, was collected over the benchmark. Survey cameras capable of recording GPS positions and handheld GPS units were also tested.	
	Results	The largest error seen with handheld Garmin GPS was 2.96m.	

A.5 Sound Speed Equipment

A.5.1 Sound Speed Profiles

A.5.1.1 CTD Profilers

A.5.1.1.1 SEA-BIRD ELECTRONICS, INC. SBE 19 SEACAT

Manufacturer	SEA-BIRD ELECTRONICS, INC.
Model	SBE 19 SEACAT
Description	The SEACAT SBE 19 profiler measures the electrical conductivity and temperature of seawater versus pressure. The aluminum housing allows for use in depths up to 3400 meters The sampling rate is set by command to the instrument with a maximum rate of 2 scans per second. Data are temporarily saved on an internal 64 Kbytes of solid-state memory which allows 1.5 hours of recording while sampling at two scans per second. The profiler is self -powered with 6 alkaline batteries which provide up to 48 hours of continuous operation. The SEACAT embodies sensor elements (Pyrex cell and pressure-protected thermistor) and a Wein-bridge oscillator interface technique using multiplexing. This technique allows a single oscillator to service both temperature and conductivity measurements. The pressure sensor is a Senso-Metrics Series SP-91 strain-gauge sensor. Set-up, check-out, and data extraction are performed without opening the housing via an external computer connected to a bulkhead connector at the base of the profiler with a serial cable. To ease quick identification of individual SEACAT profilers, RAINIER affixed a uniquely colored band of electrical tape around the housing at the top of each profiler. When assigned to a field unit in the plan of the day, the SEACAT profiler is simply referred to by color such as “green” or “black”. All RAINIER launches (2801, 2802, 2803, and 2804) are equipped with 24-volt electric winches attached to small swing-arm davits to deploy and recover SV profilers while the vessel is at rest.

Serial Numbers

Vessel Installed On	n/a	n/a
CTD s/n	192290-0219 (white)	192472-0281 (green)

Calibrations

CTD s/n	192290-0219	192472-0281
Date	2013-01-23	2013-01-23
Procedures	Sent to Sea-Bird electronics Inc. in Bellevue Washington for yearly post cruise calibration.	Sent to Sea-Bird electronics Inc. in Bellevue Washington for yearly post cruise calibration.

Figure 13: The SEACAT SBE 19 profiler. Note the band of electrical tape around the housing at the top of profiler marking this as the "green" CTD.

A.5.1.1.2 SEA-BIRD ELECTRONICS, INC. SBE 19plus SEACAT

Manufacturer	SEA-BIRD ELECTRONICS, INC.
Model	SBE 19plus SEACAT
Description	The SBE 19plus SEACAT profiler is designed to measure conductivity, temperature, and pressure in marine or fresh-water environments. The plastic housing of the profiler is rated for depths up to 600 meters (1950 feet). The 19plus runs

continuously, sampling at four scans per second (4 Hz). Nine D-size alkaline batteries provide 60 hours operation in profiling mode. Eight Mbytes of FLASH RAM records 50 hours of conductivity, temperature, and pressure data while sampling at four scans per second.

Logging is started by sliding the On/Off switch. In an improvement over the SEACAT SBE 19, the standard SBE 19plus includes an externally mounted SBE 5M pump, which provides a constant flow rate through the conductivity cell regardless of descent rate. As with the SBE 19, set-up, check-out, and data extraction are performed without opening the housing by connecting a serial cable between an external computer to a glass-reinforced epoxy bulkhead 4-pin I/O connector at the base of the profiler.

To ease quick identification of individual SEACAT profilers, RAINIER affixed a uniquely colored band of electrical tape around the housing at the top of each profiler. When assigned to a field unit in the plan of the day, the SEACAT profiler is simply referred to by color such as “green” or “black”.

All RAINIER launches (2801, 2802, 2803, and 2804) are equipped with 24-volt electric winches attached to small swing-arm davits to deploy and recover SV profilers while the vessel is at rest.

On July 14, 2013 (DN195) the SBE 19plus (s/n 19P26069-4039) experienced an unknown failure and refused to communicate with Velocipy. The problem profiler was removed from the active inventory and underwent extensive troubleshooting by the ship's ET. Eventually this SBE 19plus was returned to Sea-Bird Electronics for repair.

On August 18, 2013 (DN 230) during a Kodiak AK inport, RAINIER received a loaner SBE 19plus (s/n 19P26836-4087) from Sea-Bird Electronics while SBE 19plus (s/n 19P26069-4039) is off the ship and under repair.

On September 5, 2013 (DN 248) during a Kodiak AK inport, RAINIER received a brand new SBE 19plus (s/n 19P75469-7371) for permanent use in RAINIER's active inventor.

Serial Numbers

Vessel Installed On	n/a	n/a	n/a	n/a	n/a
CTD s/n	19P26069-403 (black)	19P27151-411 (yellow)	19P31464-434 (purple)	19P26836-408 (blue) loner	19P75469-737 (red)

Calibrations	*CTD s/n*	19P26069-403	19P27151-411	19P31464-434	19P26836-408	19P75469-737
	Date	2013-06-14	2013-06-14	2013-06-14	2013-08-16	2013-08-19
	Procedures	Sent to Sea-Bird electronics Inc. in Bellevue Washington for yearly post cruise calibration.	Sent to Sea-Bird electronics Inc. in Bellevue Washington for yearly post cruise calibration.	Sent to Sea-Bird electronics Inc. in Bellevue Washington for yearly post cruise calibration.	Unit was received from Sea-Bird electronics Inc. in Bellevue Washington with calibration documentatioi	Unit was received from Sea-Bird electronics Inc. in Bellevue Washington with calibration documentatioi

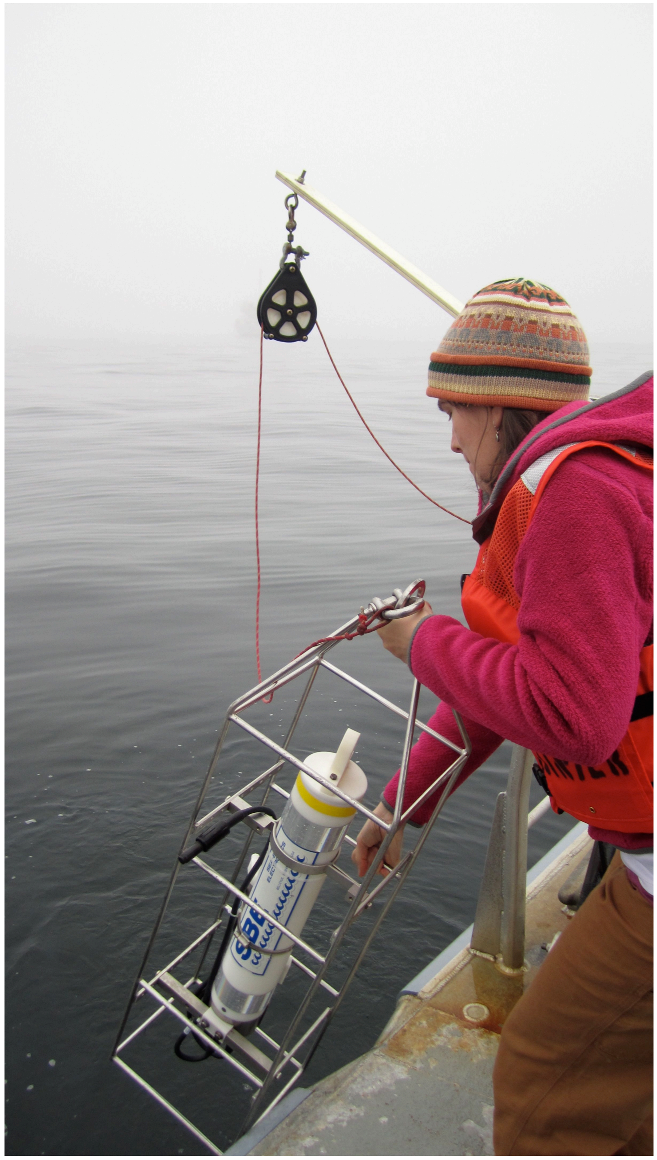

Figure 14: The SBE 19plus SEACAT profiler about to be deployed. Note the band of electrical tape around the housing at the top of profiler marking this as the "yellow" CTD.

A.5.1.2 Sound Speed Profilers

A.5.1.2.1 Rolls-Royce Group ODIM Brooke Ocean MVP200 Moving Vessel Profiler (MVP)

Manufacturer	Rolls-Royce Group ODIM Brooke Ocean

Model	MVP200 Moving Vessel Profiler (MVP)
Description	RAINIER is equipped with a Rolls-Royce Group ODIM Brooke Ocean MVP200 Moving Vessel Profiler (MVP). This system consists of a sensor fish, a conductor cable, a computer controlled high speed hydraulic winch, and a cable metering system. In the underway mode, the sensor fish is towed behind the ship and periodically is allowed to free-fall near vertical through the water column recording sound velocity profiles. This enables RAINIER to take SV casts without stopping the ship. To take deeper SV casts and take full advantage of all the cable on the drum, the ship must come to a stop. While stationary, 600 meter deep SV casts may be collected as opposed to a maximum of 235 meters deep when the ship is in typical survey mode and underway at 10 knots. The actual sensor package contained within the towfish is an Applied Microsystems Micro CTD. The unit consists of a 4-electrode conductivity sensor accurate to +/-0.01 mS/cm with a resolution of 0.001 mS/cm, a temperature (precision aged thermistor) sensor accurate to +/-0.005° C with a resolution of 0.001° C, and a pressure (temperature compensated strain gauge) sensor accurate to +/-0.05% FS (full scale) with a resolution of 0.005% FS. The Micro CTD supplied with the MVP200 is rated at 1000-dbar. On September 29, 2012 (DN273) during survey operations near Shumagin Islands, Alaska, the MVP200 towfish abruptly stopped sending data. After retrieving the fish, it was discovered that the conductivity sensor unit protruding from the side of the towfish had been sheared off by an unknown means. During the 2012-2013 winter repair period, the Applied Microsystems Micro CTD was returned to the manufacturer for repair and calibration. On July 30, 2013 (DN211) during survey operations near Shumagin Islands, Alaska, the repaired MVP200 towfish started sending suspect depths (-8 meters while it was underwater). The decision was made to change out the entire Applied Microsystems Micro CTD sensor unit with a spare (s/n 7511) from the MVP30 which is identical save a 200-dbar rating vs. the 1000-dbar rating of the damaged unit. The malfunctioning Micro CTD sensor was returned to Applied Microsystems for repairs. Applied Microsystems has since come back and said they could find nothing wrong with the sensor. On August 19, 2013 (DN231) during a Kodiak AK inport, the temporary 200-dbar rated Micro CTD (s/n 7511) was changed out with the fleet spare 1000-dbar Micro CTD (s/n 8565). The fleet spare Micro CTD was sent to the RAINIER while her 1000-dbar Micro CTD was under repair. On August 28, 2012 (DN240) during survey operations near Shumagin Islands, Alaska, the MVP200 towfish abruptly stopped sending conductivity data. After retrieving the fish, it was discovered that the conductivity sensor unit protruding from the side of the towfish had once again been sheared off. The decision was made to change out the entire Applied Microsystems Micro CTD sensor unit and replace it with the spare (s/n 7511) from the MVP30 which is identical save a 200-dbar rating vs. the 1000-dbar rating of the damaged unit.

	On September 20, 2013 (DN263) during operations in Cold Bay, the temporary 200-dbar rated Micro CTD (s/n 7511) was changed out with the original 1000-dbar Micro CTD (s/n 7761) after it was returned to RAINIER with a clean bill of health.
Serial Numbers	*Vessel Installed On*: S221 RAINIER / S221 RAINIER (200-dbar temporary) / S221 RAINIER (fleet spare); *Sound Speed Profiler s/n*: 7761 / 7511 / 8565
Calibrations	*Sound Speed Profiler s/n*: 7761 / 8565; *Date*: 2013-02-08 / 2013-08-27; *Procedures*: Sent to AML Oceanographic in Sidney B.C. Canada for repair and yearly post cruise calibration. / Calibration reports came with fleet spare 1000-dbar Micro CTD.

Serial Numbers

Vessel Installed On	S221 RAINIER	S221 RAINIER (200-dbar temporary)	S221 RAINIER (fleet spare)
Sound Speed Profiler s/n	7761	7511	8565

Calibrations

Sound Speed Profiler s/n	7761	8565
Date	2013-02-08	2013-08-27
Procedures	Sent to AML Oceanographic in Sidney B.C. Canada for repair and yearly post cruise calibration.	Calibration reports came with fleet spare 1000-dbar Micro CTD.

Figure 15: The ODIM Brooke Ocean MVP200 Moving Vessel Profiler as mounted aboard Rainier.

A.5.1.2.2 Rolls-Royce Group ODIM Brooke Ocean MVP30 Moving Vessel Profiler (MVP)

Manufacturer	Rolls-Royce Group ODIM Brooke Ocean
Model	MVP30 Moving Vessel Profiler (MVP)
Description	Vessel 2804 is equipped with a Rolls-Royce Group ODIM Brooke Ocean MVP30 MVP. This system consists of a sensor fish, a conductor cable, a computer controlled high speed hydraulic winch, and a cable metering system. In the underway mode the sensor fish is towed behind the launch and periodically is allowed to freefall near

	vertical through the water column recording sound velocity profiles. This enables the launch to take SV casts without stopping the vessel at the cost of not being able to collect casts with depths equal to the available cable length. To take deeper SV casts and take full advantage of all the cable on the drum, the launch must stop. While stationary, 125 meter deep SV casts may be collected as opposed to a maximum of 50 meters deep when the launch is in typical survey mode and underway at 7 knots. The actual sensor package contained within the towfish is an Applied Microsystems Micro CTD. The unit consists of a 4-electrode conductivity sensor accurate to +/-0.01 mS/cm with a resolution of 0.001 mS/cm, a temperature (precision aged thermistor) sensor accurate to +/-0.005° C with a resolution of 0.001° C, and a pressure (temperature compensated strain gauge) sensor accurate to +/-0.05% FS (full scale) with a resolution of 0.005% FS. The Micro CTD supplied with the MVP30 is rated at 200-dbar.

Serial Numbers

Vessel Installed On	2806	spare
Sound Speed Profiler s/n	7510	7511

Calibrations

Sound Speed Profiler s/n	7510	7511
Date	2013-02-19	2013-02-08
Procedures	Sent to AML Oceanographic in Sidney B.C. Canada for yearly post cruise calibration.	Sent to AML Oceanographic in Sidney B.C. Canada for yearly post cruise calibration.

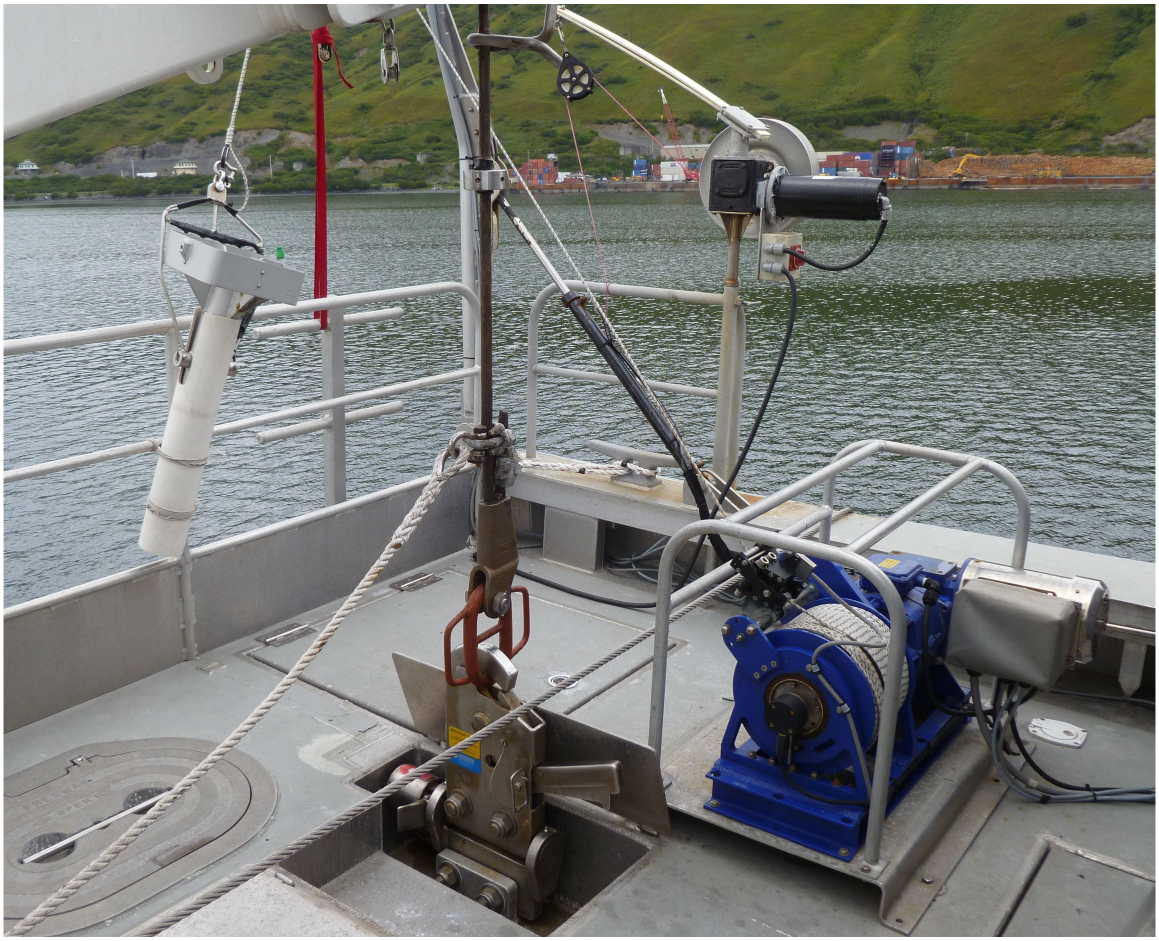

Figure 16: The ODIM Brooke Ocean MVP30 Moving Vessel Profiler as mounted aboard 2804.

A.5.2 Surface Sound Speed

A.5.2.1 Reson Inc. SVP 70

Manufacturer	Reson Inc.
Model	SVP 70
Description	The SVP 70 is a direct reading sound velocity probe with a sound transmission path of 125mm. The unit’s housing is constructed of a robust titanium that eases cleaning in environments with high levels of marine growth and is recommended for permanent installations. This sensor is mounted in close proximity to each ship’s multibeam transducers and provides real time surface sound speed values for

	refraction corrections. Yearly calibrations on the SVP 71 are not performed since the instrument can only be removed from the ship during dry dock.
Serial Numbers	*Vessel Installed On*: S221 *Sound Speed Sensor s/n*: unknown
Calibrations	No CTD profiler calibrations were performed.

A.5.2.2 Reson Inc. SVP 71

Manufacturer	Reson Inc.
Model	SVP 71
Description	The SVP 71 is a direct reading sound velocity probe with a sound transmission path of 125mm. The unit's housing is constructed of a hard anodized sea water resistant aluminum and is recommended for a semi-permanent mounting where regular maintenance is possible. This sensor is mounted in close proximity to each launches' multibeam transducers and provides real time surface sound speed values for refraction corrections.
Serial Numbers	(see below)
Calibrations	No CTD profiler calibrations were performed.

Vessel Installed On	2801	2802	2803	2804
Sound Speed Sensor s/n	1511089	1511086	1511076	1511077

A.5.2.3 Odom Hydrographic Systems Digibar Pro, model DB1200

Manufacturer	Odom Hydrographic Systems
Model	Digibar Pro, model DB1200
Description	The Odom Digibar Pro consists of a handheld display/logger with a RS232 computer interface. This logger is connected to a waterproof stainless steel probe by a detachable, four conductor, Kevlar reinforced, and polyethylene jacket cable. Mounted near the end of the sampling probe is the high frequency "sing -around" transducer and its associated reflector. Sound velocity is directly measured at a 10 Hz sampling rate by transmitting a ping with a frequency of 11 kHz. The precisely spaced transducer and reflector is used to measure the velocity of sound in water by transmitting and receiving a signal across their known separation distance. This sensor is mounted in close proximity to a multibeam transducer to provide real time surface sound speed values for refraction corrections.
Serial Numbers	(see below)
Calibrations	No CTD profiler calibrations were performed.

Vessel Installed On	spare	spare
Sound Speed Sensor s/n	98015	98016

A.6 Horizontal and Vertical Control Equipment

A.6.1 Horizontal Control Equipment

A.6.1.1 Base Station Equipment

<table>
<tr><td>Description</td><td colspan="2">During hydrographic operations, RAINIER maintains at least one GPS base station near the project area. Base station sites are chosen for both clear lines of site to either survey launches or the ship for easy data downloads in addition to a clear horizon to maximize the number of GPS satellites observed. At the recommendation of Applanix, base station sites are selected to fall within 20 kilometers of all data within the project area.

Each station consists of either a Trimble NetR5 or Trimble NetR9 GNSS reference receiver interfaced with a Freewave HTP-900RE 900 MHz Ethernet radio all sealed in a watertight Pelican plastic case. A Zephyr Goedetic 2 GPS antenna is secured atop a Seco fixed-height GPS antenna tripod and connected to the Trimble receiver through a watertight connection fitted in the side of the Pelican case. A UHF antenna on top of an extending pole supported by a standard survey tripod is connected to the Freewave Ethernet radio and provides for remote daily download of the Trimble data. Batteries and solar panels provide power.</td></tr>
<tr><td rowspan="4">GPS Antennas</td><td>Manufacturer</td><td>Trimble Navigation Ltd.</td></tr>
<tr><td>Model</td><td>Zephyr Goedetic 2</td></tr>
<tr><td>Description</td><td>The Trimble Zephyr Geodetic 2 antenna is an ideal design for horizontal control work. This antenna incorporates a large proprietary ground plane to “burn up” multipath energy. The Zephyr Geodetic 2 antenna is extremely rugged with a low profile design constructed of weather-resistant materials. This antenna is compatible with GNSS signals, including GPS L2C and L5, GLONASS, and even Galileo is supported.</td></tr>
<tr><td>Serial Numbers</td><td>unknown</td></tr>
</table>

GPS Receivers	*Manufacturer*	Trimble Navigation Limited
	Model	NetR5
	Description	The Trimble NetR5 reference station is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution. With 76 channels it can track all GPS signals (L1/L2/L5) as well as GLONASS (L1/L2). This receiver contains 56 MB of internal storage and has Ethernet ports compatible with HTTP and FTP protocols. Power is provided through a 9.5 V to 28 V DC input on 26 pin D sub connector while an internal 15 hour battery operates as a UPS in the event of power source outage.
	Firmware Version	n/a
	Serial Numbers	4910K61066
	Manufacturer	Trimble Navigation Limited
	Model	NetR9
	Description	The Trimble NetR9 reference station is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution. With 440 channels is capable of tracking signals from GPS, GLONASS, Galileo, Compass, and QZSS constellations. This receiver contains 8 GB of internal storage and an integrated RJ45 port with full-duplex, auto-negotiate 100Base-T compatible with HTTP and FTP protocols. Power is provided through Power over Ethernet (PoE) or a 9.5 V to 28 V DC input on a Lemo port while an internal 15 hour battery operates as a UPS in the event of power source outage.
	Firmware Version	n/a
	Serial Numbers	5034K69715
UHF Antennas	*Manufacturer*	L-com Global Connectivity
	Model	HGV-906U 800/900 MHz 6 dBi Omnidirectional Antenna
	Description	The HyperGain HGV-906U is a high performance omni directional antenna designed for the 800 MHz / 900 MHz ISM band. It is ideally suited for multipoint, non line of sight and mobile applications where high gain and wide coverage is desired. This antenna’s construction features a rugged 1.3" diameter white high intensity fiberglass radome for durability. It is designed for all weather operation.
	Serial Numbers	n/a

UHF Radios	*Manufacturer*	Freewave
	Model	HTP-900RE
	Description	The FreeWave Technologies HTplus Industrial 900 MHz Radio is an industrial grade high speed Ethernet radio that operates in harsh environments and noisy RF conditions. It features high speed (867 Kbps) over-the-air throughput with strong signal performance, maintaining high sensitivity even in marginal conditions. This radio has a point-to-point range of 15 miles with clear line of sight.
	Firmware Version	n/a
	Serial Numbers	885-5935 in NetR9 base station 885-8781 in NetR5 base station 886-0741 on S221 [RAINIER] 886-3478 on 2803 [RA3] 886-0701 on 2801 [RA4] 886-3434 on 2802 [RA5] 886-0778 on 2804 [RA6] 884-8978 (spare)
Solar Panels	*Manufacturer*	Uni-Solar (United Solar Systems Corp)
	Model	MBC-525
	Description	The Uni-Solar MBC-525 is a flexible 51" X 16" solar panel rated at 22 watts.
	Serial Numbers	n/a
Solar Chargers	*Manufacturer*	Morning Star
	Model	Sun Saver 10 SS-10L-12V
	Description	The Morningstar SunSaver SS-10L-12V is a small solar controller that regulates how much power goes into the storage batteries connected to a solar panel. The amount of power passed to the battery is dependent on the current level of the battery. This power regulation helps to increase long-term battery life. The Sunsaver also includes Low Voltage Disconnect (LVD) which automatically shuts off the load when batteries get to low, also saving on long-term battery life.
	Serial Numbers	unknown
DQA Tests	No DQA tests were performed.	

A.6.1.2 Rover Equipment

No rover equipment was utilized for data acquisition.

A.6.2 Vertical Control Equipment

A.6.2.1 Water Level Gauges

Manufacturer	CO-OPS Seattle Instrument Lab
Model	Portable Tide Gauge (PTG) system, 9210B data collection platform
Description	The Portable Tide Gauge (PTG) is used for temporary installations in locations without the infrastructure to support a typical full installation. The PTG is a stand-alone water level station housed in a ruggedized weatherproof housing and includes all components necessary to measure, record, and transmit near real-time water levels from anywhere within the GOES footprint. The PTG utilizes a pump as opposed to compressed nitrogen for its bubbler system thus reducing the overall weight and complexity of the system. The gauge components are housed within a Pelican weatherproof hard plastic housing. Inside the Pelican case is mounted a Sutron 9210B Data Collection Platform (DCP), a WaterLog H-355 Pump, and a Paroscientific 6000-30G pressure sensor. There are five external connections on the outside of the waterproof housing; the orifice quick connect, the GOES antenna connection (Type-N), a GPS antenna connection (SMA), a solar panel connection (2 pins), and finally the battery connection (4 pins).

	A complete PTG kit includes the gauge itself, GOES and GPS antennae, 40W solar panel, 40Ah battery, tripod, orifice, bubbler tubing and necessary cables. Additionally, a computer with an available serial port and a DB-9 serial cable are required to configure the DCP and/or manually download data. RAINIER personnel do not typically perform any calibrations of CO-OPS supplied portable tide gauges. Rather all gauges and their associated equipment are returned to CO-OPS Seattle where annual maintenance and calibrations are conducted during the ship's winter inport period.
Serial Numbers	PTG 03 PTG 04 PTG 05
Calibrations	No calibrations were performed.

Figure 17: The Portable Tide Gauge (PTG) system, 9210B data collection platform.

A.6.2.2 Leveling Equipment

Manufacturer	Carl Zeiss	
Model	Zeiss Ni2	
Description	The Zeiss Ni2 is the first automatic level based on suspended prisms that levels the light path. When set close to level, the internal compensator mechanism (a swinging prism) automatically removes any remaining variation from level. This reduces the need to set the instrument truly level since small inclination deviations are automatically corrected for. The telescope has a magnification power of 32 times and an objective diameter of 40 millimeters. It is 270 millimeters in length and produces an erect image. The cross-hairs form a straight cross with stadia hairs on the vertical hair. In contrast to most other geodetic instruments the cross-hairs only occupy the central 50% of the field of view.	
Serial Numbers	87102	
	100518	
	67312	
Calibrations	*Level s/n*	87102, 100518, and 67312
	Date	2013-02-27
	Procedures	The level was taken in to Kuker-Ranken Inc. for annual cleaning, inspection, adjustment, and calibration.
Kukkamaki	*Level s/n*	87102, 100518, and 67312
	Date	2013-03-07
	Procedures	The Kukkamaki procedure used follows that outlined in the User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987.

Figure 18: A Zeiss Ni2 optical level being used in the field.

Figure 19: The Kukkamak test performed on a Zeiss Ni2 optical level.

A.7 Computer Hardware and Software

A.7.1 Computer Hardware

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: CST OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: Microsoft Product ID: 00371-OEM-8992671-00524 Original Install Date: 10/20/2010, 8:50:07 AM System Boot Time: 4/30/2013, 3:35:39 PM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500 System Type: x64-based PC Processor(s): 1 Processor(s) Installed.

	[01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz BIOS Version: Dell Inc. A07, 4/12/2010 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume2 System Locale: en-us;English (United States) Input Locale: N/A Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 8,761 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 21,079 MB Virtual Memory: In Use: 3,490 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 180 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme Gigabit Ethernet Connection Name: Local Area Connection 2 DHCP Enabled: Yes DHCP Server: 10.48.12.5 IP address(es) [01]: 10.48.12.176 [02]: fe80::6c66:ec5:55ce:4b70
Serial Numbers	*Computer s/n*: 5 N 5 4 K N 1 *Operating System*: 00371-OEM-8992671-00524 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: PLOT2 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: Microsoft Product ID: 00371-OEM-8992671-00524 Original Install Date: 10/21/2010, 11:06:41 AM System Boot Time: 4/30/2013, 3:16:33 AM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500 System Type: x64-based PC

	Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz BIOS Version: Dell Inc. A15, 3/28/2012 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume2 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 5,175 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 17,783 MB Virtual Memory: In Use: 6,786 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 172 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.5 IP address(es) [01]: 10.48.12.188
Serial Numbers	*Computer s/n*: 5 N 7 5 K N 1 *Operating System*: 00371-OEM-8992671-00524 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: RA-PLOT3 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: ChiefET Registered Organization: Product ID: 00371-OEM-8992671-00524 Original Install Date: 12/19/2012, 7:26:54 AM System Boot Time: 4/27/2013, 1:46:42 PM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500 System Type: x64-based PC

	Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3325 Mhz BIOS Version: Dell Inc. A15, 3/28/2012 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 8,421 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 20,880 MB Virtual Memory: In Use: 3,689 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 123 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.5 IP address(es) [01]: 10.48.12.175 [02]: fe80::f04d:9247:4edf:ee7c	
Serial Numbers	*Computer s/n*	5 N 7 3 K N 1
	Operating System	00371-OEM-8992671-00524
	Use	Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: PLOT4 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: let Registered Organization: Microsoft Product ID: 00371-OEM-8992671-00524 Original Install Date: 10/15/2010, 1:37:25 PM System Boot Time: 4/27/2013, 3:33:32 PM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500

<table>
<tr><td></td><td>System Type: x64-based PC
Processor(s): 1 Processor(s) Installed.
[01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz
BIOS Version: Dell Inc. A07, 4/12/2010
Windows Directory: C:\Windows
System Directory: C:\Windows\system32
Boot Device: \Device\HarddiskVolume2
System Locale: en-us;English (United States)
Input Locale: en-us;English (United States)
Time Zone: (UTC-08:00) Pacific Time (US & Canada)
Total Physical Memory: 12,286 MB
Available Physical Memory: 6,535 MB
Virtual Memory: Max Size: 24,569 MB
Virtual Memory: Available: 19,671 MB
Virtual Memory: In Use: 4,898 MB
Page File Location(s): C:\pagefile.sys
Domain: noaas.rainier.omao.noaa.ship
Logon Server: \\RADC2
Hotfix(s): 163 Hotfix(s) Installed.

Network Card(s): 1 NIC(s) Installed.
[01]: Broadcom NetXtreme 57xx Gigabit Controller
Connection Name: Local Area Connection
DHCP Enabled: Yes
DHCP Server: 10.48.12.3
IP address(es)
[01]: 10.48.12.145</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Computer s/n</td><td>5 N 7 4 K N 1</td></tr><tr><td>Operating System</td><td>00371-OEM-8992671-00524</td></tr><tr><td>Use</td><td>Processing</td></tr></table></td></tr>
</table>

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: PLOT5 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: Microsoft Product ID: 00371-OEM-8992671-00524 Original Install Date: 10/21/2010, 9:42:54 AM System Boot Time: 4/30/2013, 9:25:55 AM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500

	System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz BIOS Version: Dell Inc. A07, 4/12/2010 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume2 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 9,857 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 21,525 MB Virtual Memory: In Use: 3,044 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 163 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.5 IP address(es) [01]: 10.48.12.172
Serial Numbers	*Computer s/n*: 5 N 6 4 K N 1 *Operating System*: 00371-OEM-8992671-00524 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: RA-PLOT6 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: Product ID: 00371-OEM-8992671-00524 Original Install Date: 4/4/2013, 4:10:42 PM System Boot Time: 5/1/2013, 9:56:15 AM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500

	System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz BIOS Version: Dell Inc. A16, 7/6/2012 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume2 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 9,204 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 21,452 MB Virtual Memory: In Use: 3,117 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 116 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.142 [02]: fe80::3d87:5e9b:3eeb:ed12
Serial Numbers	*Computer s/n*: 5 N 6 3 K N 1 *Operating System*: 00371-OEM-8992671-00524 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: PLOT7 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: Microsoft Product ID: 00371-OEM-8992671-00524 Original Install Date: 10/22/2010, 9:50:33 AM System Boot Time: 4/30/2013, 4:58:24 PM System Manufacturer: Dell Inc.

<table>
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System Type: x64-based PC
Processor(s): 1 Processor(s) Installed.
[01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3333 Mhz
BIOS Version: Dell Inc. A07, 4/12/2010
Windows Directory: C:\Windows
System Directory: C:\Windows\system32
Boot Device: \Device\HarddiskVolume2
System Locale: en-us;English (United States)
Input Locale: en-us;English (United States)
Time Zone: (UTC-08:00) Pacific Time (US & Canada)
Total Physical Memory: 12,286 MB
Available Physical Memory: 8,733 MB
Virtual Memory: Max Size: 24,569 MB
Virtual Memory: Available: 21,219 MB
Virtual Memory: In Use: 3,350 MB
Page File Location(s): C:\pagefile.sys
Domain: noaas.rainier.omao.noaa.ship
Logon Server: \\RADC2
Hotfix(s): 172 Hotfix(s) Installed.

Network Card(s): 1 NIC(s) Installed.
[01]: Broadcom NetXtreme 57xx Gigabit Controller
Connection Name: Local Area Connection
DHCP Enabled: Yes
DHCP Server: 10.48.12.3
IP address(es)
[01]: 10.48.12.163</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Computer s/n</td><td>5 N 6 5 K N 1</td></tr><tr><td>Operating System</td><td>00371-OEM-8992671-00524</td></tr><tr><td>Use</td><td>Processing</td></tr></table></td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td>DELL</td></tr>
<tr><td>Model</td><td>Precision WorkStation T3500</td></tr>
<tr><td>Description</td><td>Host Name: RA-HOLODECK1
OS Name: Microsoft Windows 7 Enterprise
OS Version: 6.1.7601 Service Pack 1 Build 7601
OS Manufacturer: Microsoft Corporation
OS Configuration: Member Workstation
OS Build Type: Multiprocessor Free
Registered Owner: NOS
Registered Organization: NOS
Product ID: 55041-007-1338661-86199
Original Install Date: 1/4/2012, 7:41:25 AM
System Boot Time: 4/30/2013, 5:33:03 AM
System Manufacturer: Dell Inc.</td></tr>
</table>

	System Model: Precision WorkStation T3500 System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3466 Mhz BIOS Version: Dell Inc. A11, 4/20/2011 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 8,428 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 20,636 MB Virtual Memory: In Use: 3,933 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC1 Hotfix(s): 158 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.143 [02]: fe80::44c5:a5d9:65db:8e6f
Serial Numbers	*Computer s/n*: C H D Q V R 1 *Operating System*: 55041-007-1338661-86199 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: RA-HOLODECK2 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: CET Registered Organization: Product ID: 00371-OEM-8992671-00524 Original Install Date: 4/15/2013, 9:15:19 AM System Boot Time: 5/1/2013, 10:57:21 PM

	System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500 System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3466 Mhz BIOS Version: Dell Inc. A12, 7/22/2011 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 10,991 MB Virtual Memory: Max Size: 24,569 MB Virtual Memory: Available: 22,329 MB Virtual Memory: In Use: 2,240 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 100 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.126 [02]: fe80::3dca:411c:b470:6bbe
Serial Numbers	*Computer s/n*: G V 1 W S R 1 *Operating System*: 00371-OEM-8992671-00524 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: RA-HOLODECK3 OS Name: Microsoft Windows 7 Enterprise OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: NOS Registered Organization: NOS Product ID: 55041-007-1338661-86365 Original Install Date: 1/4/2012, 3:21:49 PM

	System Boot Time: 4/30/2013, 6:42:49 PM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3500 System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3466 Mhz BIOS Version: Dell Inc. A12, 7/22/2011 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 12,286 MB Available Physical Memory: 10,416 MB Virtual Memory: Max Size: 30,711 MB Virtual Memory: Available: 28,807 MB Virtual Memory: In Use: 1,904 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC2 Hotfix(s): 154 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.134 [02]: fe80::79d2:2fc4:d9a9:8a7e
Serial Numbers	*Computer s/n*: G V 1 X S R 1 *Operating System*: 55041-007-1338661-86365 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3400
Description	Host Name: RA-HOL04 OS Name: Microsoft Windows 7 Professional OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: shawn.gendron Registered Organization: Product ID: 00371-OEM-9044641-20485

	Original Install Date: 4/13/2011, 3:29:29 PM System Boot Time: 4/27/2013, 4:08:20 PM System Manufacturer: Dell Inc. System Model: Precision WorkStation T3400 System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 15 Stepping 11 GenuineIntel ~2992 Mhz BIOS Version: Dell Inc. A08, 8/14/2008 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume2 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC-08:00) Pacific Time (US & Canada) Total Physical Memory: 4,030 MB Available Physical Memory: 2,708 MB Virtual Memory: Max Size: 8,057 MB Virtual Memory: Available: 6,421 MB Virtual Memory: In Use: 1,636 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RADC1 Hotfix(s): 163 Hotfix(s) Installed. Network Card(s): 1 NIC(s) Installed. [01]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.155 [02]: fe80::a17b:478b:efed:d675
Serial Numbers	*Computer s/n*: F D V F Z F 1 *Operating System*: 00371-OEM-9044641-20485 *Use*: Processing

Manufacturer	DELL
Model	Precision WorkStation T3500
Description	Host Name: RA-HOLODECK5 OS Name: Microsoft Windows 7 Enterprise OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: NOS Registered Organization: NOS

<table>
<tr><td></td><td>Product ID: 55041-007-1338661-86336
Original Install Date: 1/5/2012, 9:32:55 AM
System Boot Time: 4/30/2013, 7:27:43 PM
System Manufacturer: Dell Inc.
System Model: Precision WorkStation T3500
System Type: x64-based PC
Processor(s): 1 Processor(s) Installed.
[01]: Intel64 Family 6 Model 44 Stepping 2 GenuineIntel ~3466 Mhz
BIOS Version: Dell Inc. A12, 7/22/2011
Windows Directory: C:\WINDOWS
System Directory: C:\WINDOWS\system32
Boot Device: \Device\HarddiskVolume1
System Locale: en-us;English (United States)
Input Locale: en-us;English (United States)
Time Zone: (UTC-08:00) Pacific Time (US & Canada)
Total Physical Memory: 12,286 MB
Available Physical Memory: 10,352 MB
Virtual Memory: Max Size: 30,711 MB
Virtual Memory: Available: 28,790 MB
Virtual Memory: In Use: 1,921 MB
Page File Location(s): C:\pagefile.sys
Domain: noaas.rainier.omao.noaa.ship
Logon Server: \\RADC2
Hotfix(s): 155 Hotfix(s) Installed.

Network Card(s): 1 NIC(s) Installed.
[01]: Broadcom NetXtreme 57xx Gigabit Controller
Connection Name: Local Area Connection
DHCP Enabled: Yes
DHCP Server: 10.48.12.3
IP address(es)
[01]: 10.48.12.127
[02]: fe80::e1ae:4a3:f8d5:48d7</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Computer s/n</td><td>G V 1 3 T R 1</td></tr><tr><td>Operating System</td><td>55041-007-1338661-86336</td></tr><tr><td>Use</td><td>Processing</td></tr></table></td></tr>
</table>

Manufacturer	DELL
Model	Precision WorkStation T3400
Description	Host Name: RA-HYPACK OS Name: Microsoft Windows 7 Enterprise OS Version: 6.1.7601 Service Pack 1 Build 7601 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: Survey

	Registered Organization: Product ID: 55041-007-1338661-86481 Original Install Date: 8/21/2012, 02:07:16 System Boot Time: 4/30/2013, 22:22:19 System Manufacturer: Dell Inc. System Model: Precision WorkStation T3400 System Type: x64-based PC Processor(s): 1 Processor(s) Installed. [01]: Intel64 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz BIOS Version: Dell Inc. A13, 11/1/2011 Windows Directory: C:\Windows System Directory: C:\Windows\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 4,030 MB Available Physical Memory: 2,401 MB Virtual Memory: Max Size: 10,073 MB Virtual Memory: Available: 8,401 MB Virtual Memory: In Use: 1,672 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship Logon Server: \\RA-HYPACK Hotfix(s): 151 Hotfix(s) Installed. Network Card(s): 3 NIC(s) Installed. [01]: Realtek RTL8169/8110 Family PCI Gigabit Ethernet NIC (NDIS 6.20) Connection Name: PosMV Connection DHCP Enabled: No IP address(es) [01]: 129.100.1.230 [02]: fe80::d0c9:681a:3b48:a764 [02]: Broadcom NetXtreme 57xx Gigabit Controller Connection Name: Local Area Connection 2 DHCP Enabled: Yes DHCP Server: 10.48.12.3 IP address(es) [01]: 10.48.12.148 [02]: fe80::f877:994f:f309:6807 [03]: Realtek RTL8169/8110 Family PCI Gigabit Ethernet NIC (NDIS 6.20) Connection Name: Kongsberg Connection 3 DHCP Enabled: No IP address(es) [01]: 192.168.0.5 [02]: fe80::e506:d8cc:5344:110f

Serial Numbers	*Computer s/n*	G D V F Z F 1
	Operating System	55041-007-1338661-86481
	Use	Acquisition

Manufacturer	Rolls-Royce Group ODIM Brooke Ocean
Model	MVP200 controller (RAINIER)
Description	Host Name: MVP-CONTROLLER OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: MVP200 Registered Organization: Product ID: 76487-OEM-0028202-24565 Original Install Date: 10/29/2009, 7:29:23 PM System Up Time: 0 Days, 0 Hours, 5 Minutes, 40 Seconds System Manufacturer: System manufacturer System Model: System Product Name System type: X86-based PC Processor(s): 1 Processor(s) Installed. [01]: x86 Family 6 Model 23 Stepping 10 GenuineIntel ~2932 Mhz BIOS Version: A_M_I_ - 7000920 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 2,047 MB Available Physical Memory: 1,696 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: ODIM Logon Server: \\MVP-CONTROLLER Hotfix(s): 132 Hotfix(s) Installed. NetWork Card(s): 1 NIC(s) Installed. [01]: Realtek RTL8168C(P)/8111C(P) PCI-E Gigabit Ethernet NIC Connection Name: Local Area Connection DHCP Enabled: No IP address(es) [01]: 192.168.0.3

Serial Numbers	*Computer s/n*	system 134351
	Operating System	76487-OEM-0028202-24565
	Use	Acquisition

Manufacturer	Kongsberg
Model	EM HWS-122752
Description	Host Name: EM710HWS OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: User Registered Organization: Product ID: 76487-OEM-0056532-90519 Original Install Date: 7/7/2010, 3:10:23 AM System Up Time: 0 Days, 6 Hours, 54 Minutes, 35 Seconds System Manufacturer: System manufacturer System Model: System Product Name System type: X86-based PC Processor(s): 1 Processor(s) Installed. [01]: x86 Family 6 Model 26 Stepping 5 GenuineIntel ~2806 Mhz BIOS Version: 022410 - 20100224 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 3,063 MB Available Physical Memory: 2,389 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: WORKGROUP Logon Server: \\EM710HWS Hotfix(s): 156 Hotfix(s) Installed. NetWork Card(s): 5 NIC(s) Installed. [01]: Marvell Yukon 88E8056 PCI-E Gigabit Ethernet Controller Connection Name: E1_EM710PU_157.237.2.30 Status: Media disconnected [02]: Marvell Yukon 88E8056 PCI-E Gigabit Ethernet Controller Connection Name: Hypack_MVP_Network DHCP Enabled: No IP address(es)

	[01]: 192.168.0.1 [03]: Intel(R) Gigabit ET Dual Port Server Adapter Connection Name: Local Area Connection E3 Status: Media disconnected [04]: Intel(R) Gigabit ET Dual Port Server Adapter Connection Name: Local Area Connection E4 Status: Media disconnected [05]: 1394 Net Adapter Connection Name: Ignore
Serial Numbers	*Computer s/n*: 0356 *Operating System*: 76487-OEM-0056532-90519 *Use*: Acquisition

Manufacturer	ICI (Industrial Computer Inc.)
Model	3U Short Depth (15") Rack Mount Chassis - Black X7DAL
Description	Host Name: RA-3 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: EEB Registered Organization: NOAA Product ID: 76487-OEM-0040064-15355 Original Install Date: 12/12/2011, 10:25:08 System Up Time: 0 Days, 0 Hours, 41 Minutes, 22 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz [02]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 3,071 MB Available Physical Memory: 2,529 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: noaas.rainier.omao.noaa.ship

	Logon Server: \\RA-3 Hotfix(s): 255 Hotfix(s) Installed. NetWork Card(s): 3 NIC(s) Installed. [01]: Intel(R) PRO/1000 T Desktop Adapter Connection Name: POS MV Network Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson 7125 Network (for real) Status: Media disconnected [03]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson 8125 or FreeWave Status: Media disconnected
Serial Numbers	*Computer s/n*: OM77S31231 *Operating System*: 76487-OEM-0040064-15355 *Use*: Acquisition

Manufacturer	RESON
Model	7-P ROV Sonar Processor
Description	Host Name: RXP072409090012 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: RESON Registered Organization: RESON Product ID: 55274-OEM-0067564-54279 Original Install Date: 9/24/2007, 9:01:19 AM System Up Time: 0 Days, 0 Hours, 39 Minutes, 0 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz [02]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 2,047 MB Available Physical Memory: 1,708 MB

	Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: WORKGROUP Logon Server: \\RXP072409090012 Hotfix(s): 182 Hotfix(s) Installed. NetWork Card(s): 2 NIC(s) Installed. [01]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson DHCP Enabled: No IP address(es) [01]: 192.168.0.101 [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Local Area Connection 4
Serial Numbers	*Computer s/n*: 2708010 *Operating System*: 55274-OEM-0067564-54279 *Use*: Acquisition

Manufacturer	ICI (Industrial Computer Inc.)
Model	3U Short Depth (15") Rack Mount Chassis - Black
Description	Host Name: RA-4 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: Administator Registered Organization: NOAA Product ID: 76487-OEM-0040064-15356 Original Install Date: 12/12/2011, 18:06:36 System Up Time: 0 Days, 0 Hours, 4 Minutes, 44 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz [02]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States)

	Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 2,047 MB Available Physical Memory: 1,511 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: KLEIN Logon Server: \\RA-4 Hotfix(s): 281 Hotfix(s) Installed. NetWork Card(s): 3 NIC(s) Installed. [01]: 3Com 3C996B 10/100/1000 Server NIC Connection Name: POSMV Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: klein Status: Media disconnected [03]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Network DHCP Enabled: No IP address(es) [01]: 192.168.0.100
Serial Numbers	*Computer s/n*: OM77S31236 *Operating System*: 76487-OEM-0040064-15356 *Use*: Acquisition

Manufacturer	RESON
Model	7-P Sonar Processor
Description	Host Name: RXP072409090012 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: RESON Registered Organization: RESON Product ID: 55274-OEM-0041045-59299 Original Install Date: 9/24/2007, 9:01:19 AM System Up Time: 0 Days, 0 Hours, 1 Minutes, 29 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~3000 Mhz

	[02]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~3000 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 2,047 MB Available Physical Memory: 1,718 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,005 MB Virtual Memory: In Use: 43 MB Page File Location(s): C:\pagefile.sys Domain: WORKGROUP Logon Server: \\RXP072409090012 Hotfix(s): 184 Hotfix(s) Installed. NetWork Card(s): 2 NIC(s) Installed. [01]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Top Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Bottom DHCP Enabled: No IP address(es) [01]: 192.168.0.101
Serial Numbers	*Computer s/n*: 4707073 *Operating System*: 55274-OEM-0041045-59299 *Use*: Acquisition

Manufacturer	ICI (Industrial Computer Inc.)
Model	3U Short Depth (15") Rack Mount Chassis - Black
Description	Host Name: RA-5 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Member Workstation OS Build Type: Multiprocessor Free Registered Owner: EEB Registered Organization: NOAA Product ID: 76487-OEM-0040064-15357 Original Install Date: 12/21/2011, 21:29:03 System Up Time: 0 Days, 0 Hours, 5 Minutes, 37 Seconds System Manufacturer: Supermicro

<table>
<tr><td></td><td>System Model: X7DAL
System type: X86-based PC
Processor(s): 2 Processor(s) Installed.
[01]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz
[02]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz
BIOS Version: PTLTD - 6040000
Windows Directory: C:\WINDOWS
System Directory: C:\WINDOWS\system32
Boot Device: \Device\HarddiskVolume1
System Locale: en-us;English (United States)
Input Locale: en-us;English (United States)
Time Zone: (UTC) Coordinated Universal Time
Total Physical Memory: 3,071 MB
Available Physical Memory: 2,607 MB
Virtual Memory: Max Size: 2,048 MB
Virtual Memory: Available: 2,007 MB
Virtual Memory: In Use: 41 MB
Page File Location(s): C:\pagefile.sys
Domain: noaas.rainier.omao.noaa.ship
Logon Server: \\RA-5
Hotfix(s): 260 Hotfix(s) Installed.

NetWork Card(s): 4 NIC(s) Installed.
[01]: Intel(R) PRO/1000 MT Dual Port Network Connection
Connection Name: Card Bottom
Status: Media disconnected
[02]: Intel(R) PRO/1000 MT Dual Port Network Connection
Connection Name: Card Top
Status: Media disconnected
[03]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration
Connection Name: RESON (mainboard top)
Status: Media disconnected
[04]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration
Connection Name: POS_MV (mainboard bottom)
DHCP Enabled: No
IP address(es)
[01]: 192.168.0.200</td></tr>
<tr><td>Serial Numbers</td><td><table><tr><td>Computer s/n</td><td>OM77S31569</td></tr><tr><td>Operating System</td><td>76487-OEM-0040064-15357</td></tr><tr><td>Use</td><td>Acquisition</td></tr></table></td></tr>
</table>

<table>
<tr><td>Manufacturer</td><td>RESON</td></tr>
<tr><td>Model</td><td>7-P Sonar Processor</td></tr>
<tr><td>Description</td><td>Host Name: RXP072409090012
OS Name: Microsoft Windows XP Professional</td></tr>
</table>

	OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: RESON Registered Organization: RESON Product ID: 55274-OEM-0067564-96684 Original Install Date: 9/24/2007, 9:01:19 AM System Up Time: 0 Days, 0 Hours, 1 Minutes, 46 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz [02]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 2,047 MB Available Physical Memory: 1,716 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,006 MB Virtual Memory: In Use: 42 MB Page File Location(s): C:\pagefile.sys Domain: WORKGROUP Logon Server: \\RXP072409090012 Hotfix(s): 260 Hotfix(s) Installed. NetWork Card(s): 2 NIC(s) Installed. [01]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Top Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Bottom DHCP Enabled: No IP address(es) [01]: 192.168.0.101
Serial Numbers	*Computer s/n*: 2708007 *Operating System*: 55274-OEM-0067564-96684 *Use*: Acquisition

Manufacturer	ICI (Industrial Computer Inc.)
Model	3U Short Depth (15") Rack Mount Chassis - Black
Description	Host Name: RA-6 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 3 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: LET Registered Organization: NOAAS RAINIER Product ID: 76487-OEM-0027912-35769 Original Install Date: 1/25/2012, 6:20:28 PM System Up Time: 0 Days, 3 Hours, 54 Minutes, 50 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 2 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz [02]: x86 Family 6 Model 15 Stepping 6 GenuineIntel ~2666 Mhz BIOS Version: SMCI - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\system32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (UTC) Coordinated Universal Time Total Physical Memory: 3,071 MB Available Physical Memory: 2,323 MB Virtual Memory: Max Size: 2,048 MB Virtual Memory: Available: 2,008 MB Virtual Memory: In Use: 40 MB Page File Location(s): C:\pagefile.sys Domain: FREEWAVE Logon Server: \\RA-6 Hotfix(s): 216 Hotfix(s) Installed. NetWork Card(s): 3 NIC(s) Installed. [01]: Linksys LNE100TX Fast Ethernet Adapter(LNE100TX v4) Connection Name: klein Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: POS Status: Media disconnected [03]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Network DHCP Enabled: No

	IP address(es) [01]: 192.168.0.100
Serial Numbers	*Computer s/n*: OM87S39144 *Operating System*: 76487-OEM-0027912-35769 *Use*: Acquisition

Manufacturer	RESON
Model	7-P Sonar Processor
Description	Host Name: RXP072409090012 OS Name: Microsoft Windows XP Professional OS Version: 5.1.2600 Service Pack 1 Build 2600 OS Manufacturer: Microsoft Corporation OS Configuration: Standalone Workstation OS Build Type: Multiprocessor Free Registered Owner: RESON Registered Organization: RESON Product ID: 55274-OEM-0067564-54278 Original Install Date: 9/24/2007, 9:01:19 AM System Up Time: 0 Days, 0 Hours, 3 Minutes, 12 Seconds System Manufacturer: Supermicro System Model: X7DAL System type: X86-based PC Processor(s): 4 Processor(s) Installed. [01]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz [02]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz [03]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz [04]: x86 Family 6 Model 15 Stepping 11 GenuineIntel ~3000 Mhz BIOS Version: PTLTD - 6040000 Windows Directory: C:\WINDOWS System Directory: C:\WINDOWS\System32 Boot Device: \Device\HarddiskVolume1 System Locale: en-us;English (United States) Input Locale: en-us;English (United States) Time Zone: (GMT) Casablanca, Monrovia Total Physical Memory: 2,047 MB Available Physical Memory: 1,755 MB Virtual Memory: Max Size: 5,991 MB Virtual Memory: Available: 5,558 MB Virtual Memory: In Use: 433 MB Page File Location(s): C:\pagefile.sys Domain: WORKGROUP Logon Server: \\RXP072409090012 Hotfix(s): 5 Hotfix(s) Installed. NetWork Card(s): 2 NIC(s) Installed. [01]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration

	Connection Name: REson_Top Status: Media disconnected [02]: Intel(R) PRO/1000 EB Network Connection with I/O Acceleration Connection Name: Reson_Bottom DHCP Enabled: No IP address(es) [01]: 192.168.0.101
Serial Numbers	*Computer s/n*: 2708006 *Operating System*: 55274-OEM-0067564-54278 *Use*: Acquisition

A.7.2 Computer Software

Manufacturer	CARIS
Software Name	HIPS and SIPS
Version	7.1
Service Pack	2
Hotfix	6
Installation Date	2013-04-18
Use	Processing
Description	CARIS HIPS and SIPS is a comprehensive bathymetric, seafloor imagery and water column data processing software. HIPS & SIPS allows the user to convert raw hydrographic data into a usable format and then compute and apply all correctors. Data may then be visualized and manipulated by the user for analysis and cleaning. Automated data cleaning filters and algorithms assist the user in this process.

Manufacturer	CARIS
Software Name	HIPS and SIPS
Version	8.0 (x64)
Service Pack	n/a
Hotfix	n/a
Installation Date	2013-04-09
Use	Processing
Description	CARIS HIPS and SIPS is a comprehensive bathymetric, seafloor imagery and water column data processing software. HIPS & SIPS allows the user to convert raw hydrographic data into a usable format and then compute and apply all correctors.

	Data may then be visualized and manipulated by the user for analysis and cleaning. Automated data cleaning filters and algorithms assist the user in this process.

Manufacturer	CARIS
Software Name	HIPS and SIPS
Version	8.0 (x64)
Service Pack	n/a
Hotfix	4
Installation Date	2013-07-20
Use	Processing
Description	The latest hotfix.

Manufacturer	CARIS
Software Name	HIPS and SIPS
Version	8.1 (x64)
Service Pack	n/a
Hotfix	n/a
Installation Date	2013-08-12
Use	Processing
Description	CARIS HIPS and SIPS is a comprehensive bathymetric, seafloor imagery and water column data processing software. HIPS & SIPS allows the user to convert raw hydrographic data into a usable format and then compute and apply all correctors. Data may then be visualized and manipulated by the user for analysis and cleaning. Automated data cleaning filters and algorithms assist the user in this process.

Manufacturer	CARIS
Software Name	HIPS and SIPS
Version	8.1 (x64)
Service Pack	n/a
Hotfix	1
Installation Date	2013-09-27
Use	Processing
Description	The latest hotfix.

Manufacturer	CARIS
Software Name	Notebook
Version	3.1.1

Service Pack	1
Hotfix	1
Installation Date	2012-01-23
Use	Acquisition and Processing
Description	Notebook allows for the quick collection of geo-referenced hydrographic object data and notes in the field. Both NMEA and Trimble formats are supported in CARIS Notebook which allows the user to obtain data directly from a GPS receiver. New S-57 objects can be added and proper S-57 attributes attached during collection. Field note descriptions can be attached to new marker objects as attributes. The newly digitized S-57 hydrographic objects can easily be brought directly into ENC production software.

Manufacturer	CARIS
Software Name	BASE Editor (x64)
Version	4.0.3
Service Pack	n/a
Hotfix	3
Installation Date	2013-02-08
Use	Processing
Description	CARIS Bathy DataBASE BASE editor allows the user to open all sources of data from historical BASE surfaces, S-57 shoreline files, raster charts to the latest high density multibeam survey in a single space. Once opened, these data can easily be simultaneously examined for consistency. Analysis tools to compare BASE surfaces in their common area ease junction and crossline comparisons. In addition the 3D fly-through offers an easy way to catch data fliers.

Manufacturer	Applanix
Software Name	POSPac MMS
Version	6.1.4553.15282
Service Pack	
Hotfix	
Installation Date	2013-05-02
Use	Processing
Description	The Applanix POSPac Mobile Mapping Suite (MMS) is post-processing software designed to maximize the accuracy potential of the POS/MV (Position and Orientation System – Marine Vessels) system. Highly accurate position and orientation solutions from the GNSS and Inertial data logged to a POS MV system may be obtained despite periods of GNSS outages. Logged POS/MV files are imported into POSPac MMS for automatic analysis and quality checks. When

	available, data from RAINIER installed base stations is also loaded once it receives an OPUS solution. If there is no user installed base stations to reference the acquired POS data to, reference station and precise ephemeris data may be imported from the internet. This produces a SBET (Smoothed Best Estimated Trajectories) file that may be applied in CARIS to produce superior position and attitude data.

Manufacturer	NOAA (HSTP)
Software Name	Pydro
Version	13.2 r4224
Service Pack	
Hotfix	
Installation Date	2013-06-11
Use	Processing
Description	Pydro is a special—purpose hydrographic GIS written by HSTP that provides important functionality for the quality control of NOAA hydrographic survey data. Pydro assists the hydrographer and cartographer in managing feature/object data in the context of other supporting/correlating data ("other" vector data, bathymetry, and raster data).

Manufacturer	Pitney Bowes Software Inc.
Software Name	MapInfo
Version	11.5.1 r109
Service Pack	
Hotfix	
Installation Date	2013-01-15
Use	Processing
Description	MapInfo Professional is an easy-to-use desktop mapping application which enables the user to view and arrange a variety of charts and other GIS products. This software is primarily used for project planning and overview in addition to attribution for the submission of survey outlines.

Manufacturer	HYPACK, Inc.
Software Name	Hypack 2013
Version	13.0.6.9
Service Pack	
Hotfix	
Installation Date	2013-02-28
Use	Acquisition

Description	Hypack and the associated Hysweep software is the primary multibeam and singlebeam data acquisition software used aboard RAINIER. Data from sonar, GPS and attitude sensors are logged to the hard drive while real time displays of launch position and sonar coverage are displayed on a digital chart.

Manufacturer	Applanix Corporation
Software Name	MV-POSView
Version	5.1.0.2
Service Pack	
Hotfix	
Installation Date	2013-02-28
Use	Acquisition
Description	The MV-POSView controller program is used to configure and operate the POS MV attitude and positioning system. This program is also used to record the POS/MV .000 files used to produce the SBET files post-applied in CARIS to improve attitude and navigation.

Manufacturer	NOAA (HSTP)
Software Name	Velocipy
Version	13.2 r4224
Service Pack	
Hotfix	
Installation Date	2013-06-15
Use	Acquisition
Description	Velocipy is a special purpose program written by HSTP to communicate with Sea-Bird sound velocity profiling equipment. With this software, CTD profilers can be initialized and after deployment have the raw conductivity, temperature and pressure data downloaded. These data are then processed into a form usable by CARIS in addition to an archival NODC format.

Additional Discussion

Although CARIS HIPS and SIPS 8.0 was made available in early April of 2013, in time for the beginning of the 2013 field season, significant performance and stability issues prevent the program’s immediate adoption. In particular was the excessive processing time of HIPS 8 surfaces. While a 1m surface might take 9 minutes to complete with HIPS 7, in HIPS 8 one could find the same surface 24% complete after 4 hours of work. More issues arose with HIPS 8 when more than one person tried to access the same sheet as seen in incredible slowdowns when applying and SV correcting, merging, TPU calculation, adding data to surfaces, re-computing surfaces, and navigating in subset editor. Users were also often “locked out” of even opening data due to the new database style management.

During the third leg of the field season visiting CARIS programmer Burns Foster managed to iron out the most egregious of HIPS 8.0's problems in beta hotfix 3 that made the program usable enough for general adoption by RAINIER. Thus, project OPR-O193-RA-13, Behm Canal was process entirely using CARIS HIPS 7.1 while OPR-O322-RA-13, Chatham Strait was also processed using CARIS HIPS 7.1 up until roughly May 28th when CARIS HIPS 8.3beta took over. OPR-P183-RA-12, Shumagin Islands and all later projects were processed using CARIS HIPS 8.0.3beta or later versions.

While CARIS HIPS and SIPS 8.1 became available in early August of 2013, it soon became apparent that this new version was even less stable than the 8.0.4 version. Surface creation proved to be especially problematic, taking 12 to 16 times longer in 8.1 than in 8.0.4. In response to a Help Desk ticket submitted by visiting PS Martha Herzog, Janice Eisenberg suggested that the RAINIER hold off on upgrading to version 8.1. This problem was eventually resolved in late September with hotfix 1. After much field testing and watching the CARIS Help Desk for potential problems, CARIS HIPS 8.1.1 was approved for use aboard RAINIER on 10/22/2013.

A.8 Bottom Sampling Equipment

A.8.1 Bottom Samplers

A.8.1.1 Kahl Scientific Instrument Corporation/Kahlsico International Corp. No. 214WA110 KAHLSICO MUD SNAPPER

Manufacturer	Kahl Scientific Instrument Corporation/Kahlsico International Corp.
Model	No. 214WA110 KAHLSICO MUD SNAPPER
Description	The No. 214WA110 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 medium pebbles. The sampler is fabricated from sturdy bronze and stainless steel materials for trouble-free service in a marine environment. The Snapper 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. RAINIER personnel added an approximately 7-lb lead weight to the threaded post of the sampler to enable use in areas with stronger currents. A shackle is attached through a hole on the top of the post and a line attached, allowing sediment sampling by either hand lowering the line or by free-fall to the ocean bed.

	Prior to deployment, the jaws are cocked open by manipulation of the attached foot-trip assembly. Upon impact with the bottom, the foot-trip is pushed up, disengaging the pivoted locking arm and allowing the spring-tensioned, hinged jaws to snap shut.

Figure 20: The KAHLSICO No. 214WA110 Mud Snapper, a clam shell style bottom sampler.

A.8.1.2 Unknown Unknown, but referred to as the "Nibbler"

Manufacturer	Unknown
Model	Unknown, but referred to as the "Nibbler"
Description	The "Nibbler" 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 "Nibbler" 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 is deployed by hand using a heavy duty fishing pole.

	Prior to deployment, the jaws are cocked open by manipulation of an internal triggering mechanism, internal to the jaws. Upon impact with the bottom, the tension is momentarily released on the clam shell jaws, disengaging the internal trigger, and allowing the spring-tensioned, hinged jaws to snap shut.

Figure 21: The "Nibbler" clam shell style bottom sampler.

A.8.1.3 AMS, Inc. 15 lb SST Dredge #445.10

Manufacturer	AMS, Inc.
Model	15 lb SST Dredge #445.10
Description	The AMS 15 lb SST Dredge is a Ponar type grab sampler, a commonly used sampler that is very versatile for all types of bottom sediments such as sand, gravel and clay. This modified Van Veen type self-tripping sampler features 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". The sampler is constructed with stainless steel jaws and powder-coated carbon steel lever arms for corrosion resistance. It also includes an underlip attachment that cleans gravel from the jaws that would normally allow lateral loss of sample during retrieval. The top of the stainless steel sampling chamber has been cut with slits

	and covered with neoprene rubber flaps which allow water to flow through for a controlled descent and to reduce the frontal shock wave that may displace sediment as the dredge contacts the sample surface. This relatively lightweight model (1/8" stainless plate) is easily used from a small boat with nylon cable.

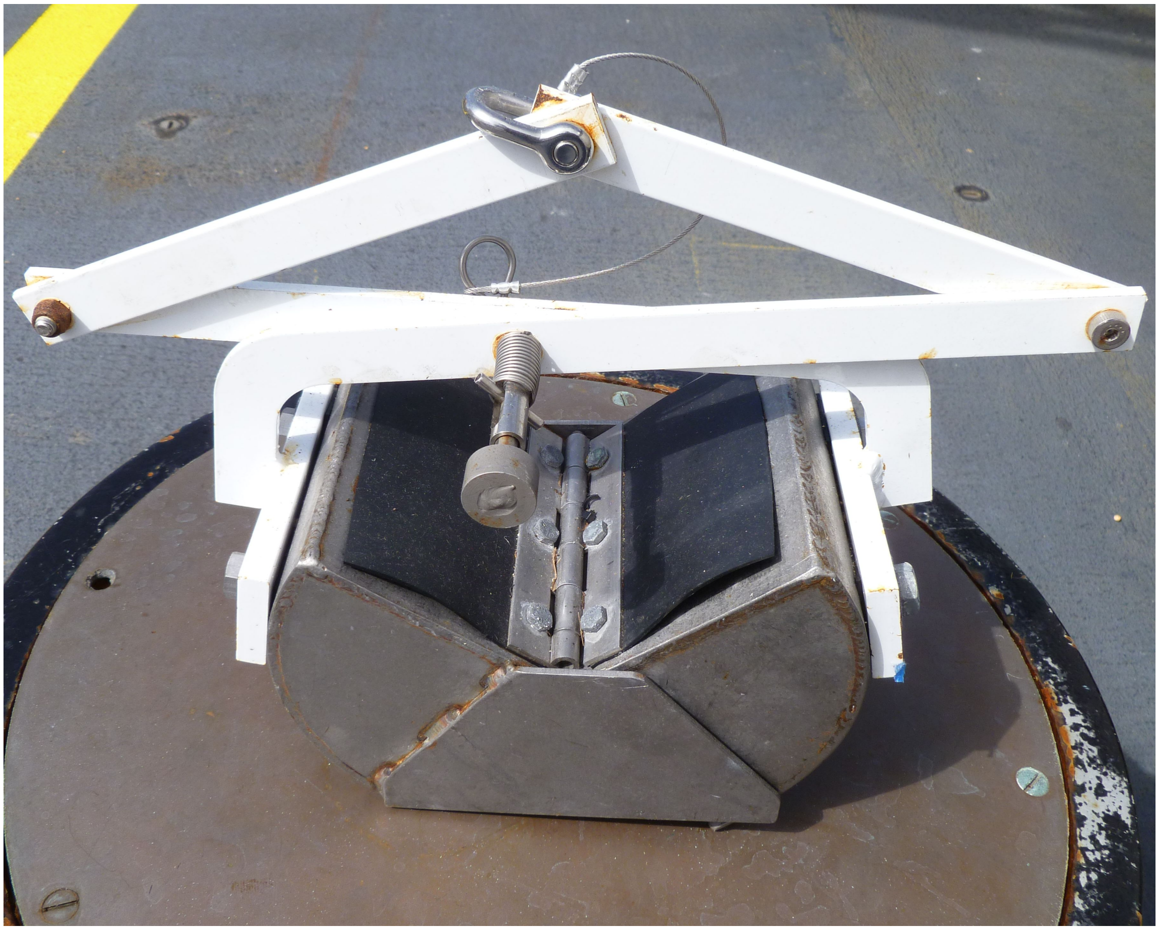


Figure 22: The AMS 15 lb SST Dredge #445.10, a Ponar type grab sampler.

B Quality Control

B.1 Data Acquisition

B.1.1 Bathymetry

B.1.1.1 Multibeam Echosounder

Acquired shallow water multibeam data are monitored in real-time using the 2-D and 3-D data display windows in the on-screen display for the Reson SeaBat 8125. Reson SeaBat 7125-B shallow water multibeam data are monitored in real-time using the Reson 7K Control Center online bathymetry data display. Adjustable user parameters common for Reson systems are range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure the best bathymetric data quality. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Draft Standing Project Instructions, to ensure the required along-track coverage for object detection. Power, absorption and spreading settings may be adjusted to minimize over-saturation of backscatter data while maintaining bathymetric data quality by using the program Saturation Monitor as detailed in section B.1.7 of this report.

For the RAINIER's Kongsberg EM 710 system, shallow water multibeam data were monitored in real-time with the acquisition software, SIS (Seafloor Information System). Data were displayed using 2-D and 3-D data display windows in the real-time screen display.

For launch acquisition, real-time coverage tools are now exclusively used to assess SWMB coverage in lieu of traditional pre-planned line files. During the planning stage, "bite sized" polygons were arranged to cover the entire survey area of each assigned sheet. These polygons were devised to fall within a single depth range (see figure #39) so that they could be acquired at the proper resolution to find holidays as they occurred in the field. Polygons were also shaped to optimize running with the contours and not against them. Polygons covering deeper areas were planned to be larger than those covering shoaler areas. In general, polygons were sized such that a launch could expect to complete 3 to 5 polygons per day.

Once the polygons were drawn using MapInfo or Caris Notebook, they were exported as S-57 (.000) files or shape files since Hysweep can handle either format. Hysweep displays these polygons over the chart in addition to plotting the SWMB swath coverage as it is collected. This display of the real-time swath coverage is based upon the matrix file, a polygon with user defined geographic bounds and resolution set up prior to data collection. The resolution of the matrix is selected to match depth range (see Figure 39) of the polygon currently being used. The launch coxswain uses this display to adjust the line as it is driven so that the swath currently being collected overlaps the grid of previously collected data. Any holidays are immediately evident in the field and can easily be filled in. This method of data acquisition saves time in both the pre-planning stage as well as greatly reducing the need for filling holidays during the subsequent rounds of data acquisition. In the event of any holidays found in post-processing, either traditional holiday lines, small polygons, or exported CARIS BASE surface GeoTIFFs may be used to fill them in.

For ship acquisition, a blended solution of line planning and real-time coverage is adopted. At the start of acquisition, a single line is drawn, which the ship navigates via Hypack. Throughout the line, the survey team notes the swath width and, based on these values, renders the subsequent survey line in such a way to provide ~10% overlap with the previous line. In this way, lines are used to minimize the number of turns and course adjustments required for the relatively un-maneuverable RAINIER; while the real-time coverage is used to prevent excessive overlap or holidays based on an (ill-informed) a priori line plan.

Kongsberg EM710 Data Artifact:

Dates Affected - 2012 Field Season

During the 2012 Hydrographic Survey Readiness Review, an artifact was identified in bathymetric data acquired with the RAINIER's Kongsberg EM710. This heave-like artifact amplifies with vessel dynamics; in particular, as the magnitude of the ship's pitch and heave increases (e.g. in heavy weather), so too does the magnitude of the depth errors. Figure 23 shows an overhead view of two survey lines acquired in similar depths (~90 meters) on different days. On the left, data was acquired in a more dynamic regime (8 foot seas), while the right was acquired on a calmer day (4 foot seas) -- both lines are gridded at a 4-meter resolution with equivalent vertical exaggerations.

The survey lines of Figure 23 are shown in CARIS Subset view in Figure 24. Figure 24 (top) demonstrates the characteristic undulation of the nadir pings of the ship's system, when in heavy seas. By way of contrast, Figure 24 (bottom), acquired in a less dynamic environment, is nearly free of the artifact. While not an absolute rule, every 1-degree of vessel pitch leads to about 0.1 meters of vertical bias. To mitigate problems associated with this artifact, ship's acquisition was only conducted in a sea state that was commensurate with minimizing vessel dynamics. Additionally, it was discovered that application of the True Heave file resulted in a worse artifact.

For the 2012 field season, processing of Kongsberg data was standardized to not apply True Heave and rely upon less optimal real time heave values to minimize the effects of this artifact.. It was in this state the bulk of the 2012 RAINIER surveys containing Kongsberg data were delivered to PHB.

Dates Affected - 2013 Field Season – 28 April (DN118) to 25 May (DN145)

Projects Affected - Offshore WA and OR (S-M921-FARA-13), Behm Canal, AK (OPR-O193-RA-13) and Chatham Strait, AK (OPR-O322-RA-13).

During the 2012-2013 winter import, datasets were sent off the ship to various interested parties in an effort to resolve the Kongsberg EM710 artifact. In April of 2013, Bill Lamey and Burns Foster of CARIS identified a problem with the Kongsberg supplied Simrad sound velocity correction (SVC) module used in CARIS HIPS. Although the Simrad SVC appears to work properly in the application of SVP, problems occurred during the application of True Heave which also uses the Simrad SVC module. This problem was later confirmed (not in writing) by Kongsberg acknowledging the Simrad SVC module was not designed for a reverse-mounted array.

As a temporary solution, CARIS supplied RAINIER with a license file that relied upon the University of New Brunswick's Ocean Mapping Group (OMG) SVC algorithm instead of the Simrad SVC module. The OMG SVC algorithm is the default Caris HIPS SVC module that appropriately accounts for the reverse-mounted arrays and produces much better results (Figure 25).

Although this workaround produced good results when True Heave is applied, there are times when a corrupt or missing file prevents True Heave application. Inspection revealed the presence or absence of a True Heave file necessitated that the data be processed in a different manner. In the event that True Heave is unavailable, the heave offset values (from the ship's reference point to the sonar's transmit array) must be populated in the HVF; while if True Heave is applied, the offset should be zeroed. As a long-term workflow, adjusting these settings is cumbersome, since every series of lines lacking True Heave requires two custom entries in the HVF: one in which the non-zero heave offset vector is added (lines lacking True Heave); with a subsequent entry re-zeroing the offset (True Heave files resume) (Figure 26).

All data acquired during the 2013 field season, up to 25 May (DN145) was processed using the aforementioned methodology, using the HIPS vessel file (S221_Simrad-EM710.hvf). For the purposes of testing, two 2012 surveys (H12452 and D00165) were processed in this manner, and both showed marked improvements in data quality.

Under this processing paradigm, both the application of SBETs (particularly the importing of attitude data) and referencing the ship's data to the ellipse led to questionable results. As such, all data acquired by the Kongsberg EM710 during this time period had the gyro, pitch and roll records excluded during the application of SBETs (Figure 27).

Dates Affected - 2013 Field Season – 26 May (DN146) to present (10 Aug – DN222)

Projects Affected - Behm Canal, AK (OPR-O193-RA-13), Chatham Strait, AK (OPR-O322-RA-13), Shumagin Islands, AK (OPR-P183-RA-13).

During the 20 – 31 May 2013 leg, Jonathan Beaudoin and Glen Rice (University of New Hampshire – Center for Coastal and Ocean Mapping), along with Burns Foster and Karen Hart (CARIS) joined the ship's company to reconfigure the system integration on board RAINIER, as well as develop a robust processing workflow in CARIS HIPS. In short, the majority of the Kongsberg EM710 artifact boiled down to a combination of two problems. First, under the previous configuration, the CARIS HIPS architecture forces sound velocity correction to apply True Heave at the ship's reference point, the granite block, while the Kongsberg reports heave at the EM710 transmitter. Secondly (as mentioned earlier), the Kongsberg supplied .DLL that computes sound velocity correction has an error that does not correctly handle reverse-mounted arrays (such as that on RAINIER). The solution to both problems was to change the sensor configurations to avoid these problems in the first place.

The resulting configuration, shown in Figure 28, moved the reference point for the POSMV, the EM710 and the CARIS HVF from the granite block to the center of the EM710 transmit array. The associated HVF (S221_Simrad-EM710_TxRef.hvf) has the Swath/Gyro/Heave/Pitch/Roll offsets and alignment angles zeroed; SVP1 has the EM710 TX offsets and alignments; and SVP2 has the EM710 RX offsets and alignments. This configuration is used for all 2013 EM710 data acquired after 26 May (DN146).

As part of this reconfiguration, a new patch test was conducted, and a 0.014 second delay was identified between the attitude data broadcast by the POSMV and the depth data recorded by the EM710. This delay was entered into the SIS serial feed, enabling the EM710 TRU to correct for the delay in real-time. Providing SIS with the corrected attitude enables improved beam steering, and better real-time gridding.

The above configuration also allows for the application of True Heave (without the need for modifying the heave offset vector in the HVF), the application of SBETs (including attitude records), and the ability to reference the data to the ellipse. While it was thought that the application of True Heave or SBETs would require the inclusion of the 0.014 second delay during the loading of these correctors in CARIS, testing by ship's personnel suggests the data artifact is minimized when no delay is applied. This apparent removal of the delay seen in real-time, suggests the origin of the delay may lie in the transmission between the POSMV and SIS. When the correctors are applied in post-processing, the True Heave and SBET files are derived directly from the POSMV, thus the transmission between the POSMV and SIS is eliminated – and so, too, is the timing delay.

It should be noted that data acquired using the TxRef vessel file degrades in data quality when True Heave is not available (Figure 29) – an artifact on the order of 10-20 centimeters. While the improvement in data quality with the application of True Heave could simply be a manifestation of the gains garnered from post-processing heave; it is thought there may still be some latent configuration issues. Preliminary experiments by ship's personnel suggest the artifact associated with a lack of True Heave may be related back to time latency (Figure 30). Changing the time offset of the heave records does appear to diminish (but not fix) the artifact at nadir. These results may be happenstance, and, at this time, RAINIER is not recommending applying a time delay in CARIS.

Finally, even with the apparent resolution of the major heave-related artifact seen at nadir in the 2012 data sets, there may still be some gains to be made in the outer beams (Figure 31). Large oscillations within the outer beams are routinely seen with magnitudes of up to 0.20 meters. Whether these oscillations are indicative of a further problem with the sonar, or merely a manifestation of outer beam attenuation is unclear at this time. Until these outer beam oscillations are better understood, RAINIER will limit the swath angle from the maximum possible angle of ±75° to ±65° during acquisition (Figure 32).

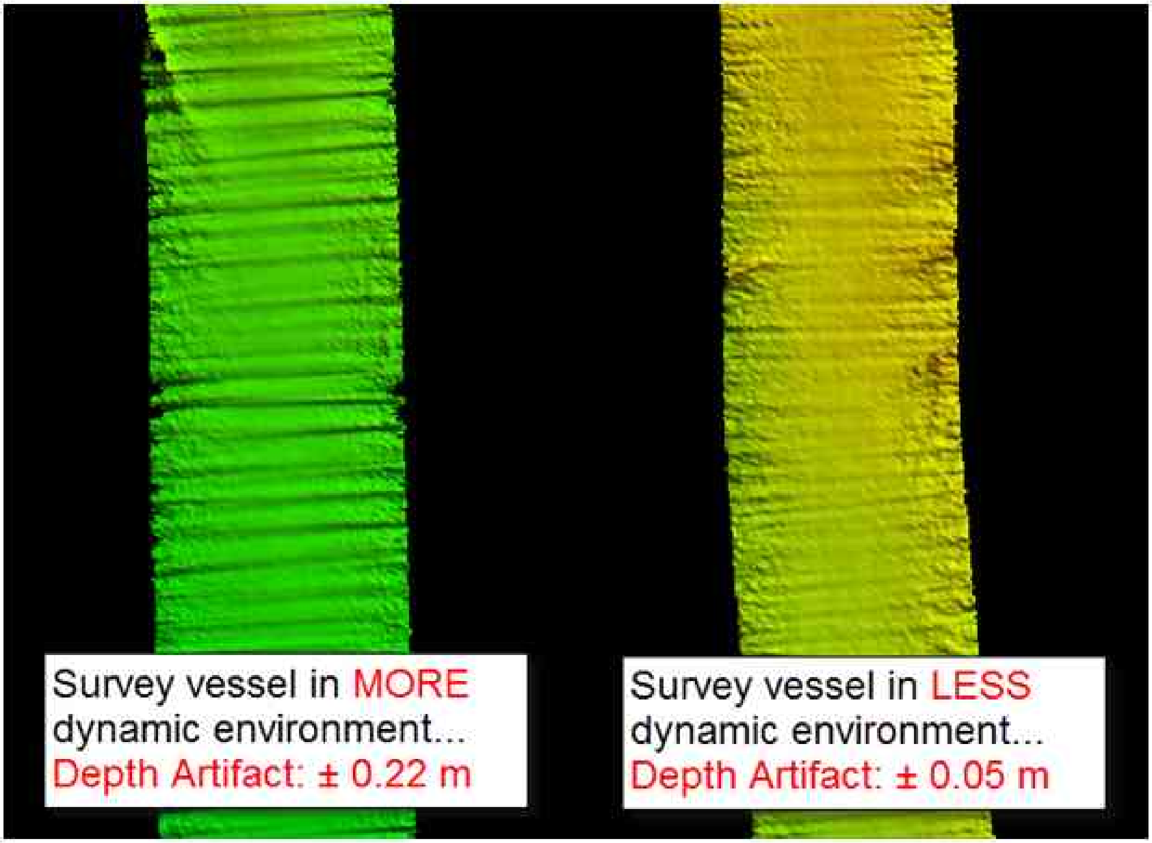


Figure 23: Overhead view of two survey lines, acquired on different days, using the Rainier's Kongsberg EM710. Data acquired in heavier seas (left) displayed a characteristic undulation in the gridded sea floor, while calmer days (right) yielded a smoother representation of the bottom.

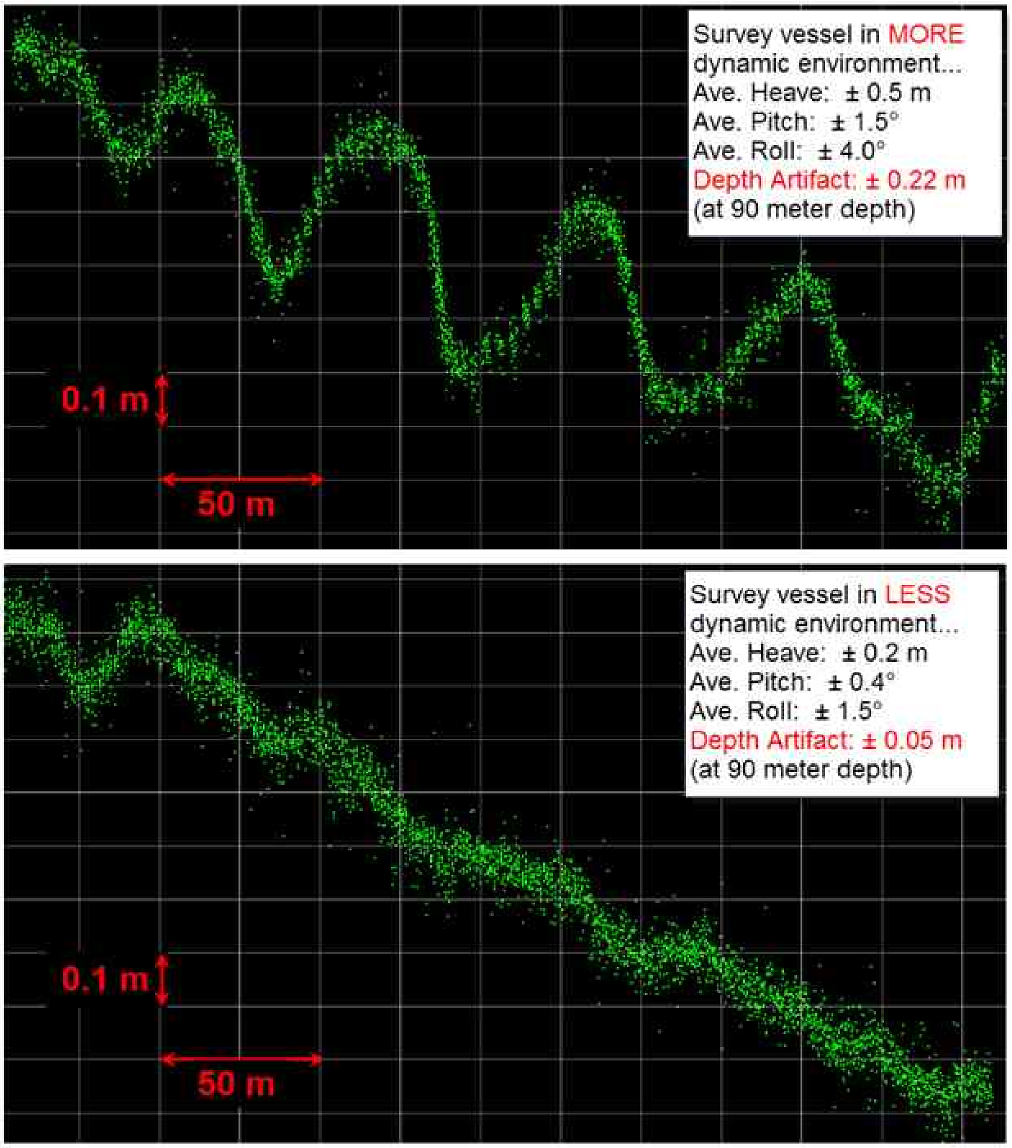


Figure 24: Cross section view of data acquired using the Rainier's Kongsberg EM710, over a smooth sea floor, on both dynamic (top) and calm (bottom) sea states. Notice that with increased vessel dynamics, there is an increased artifact in the processed depths.

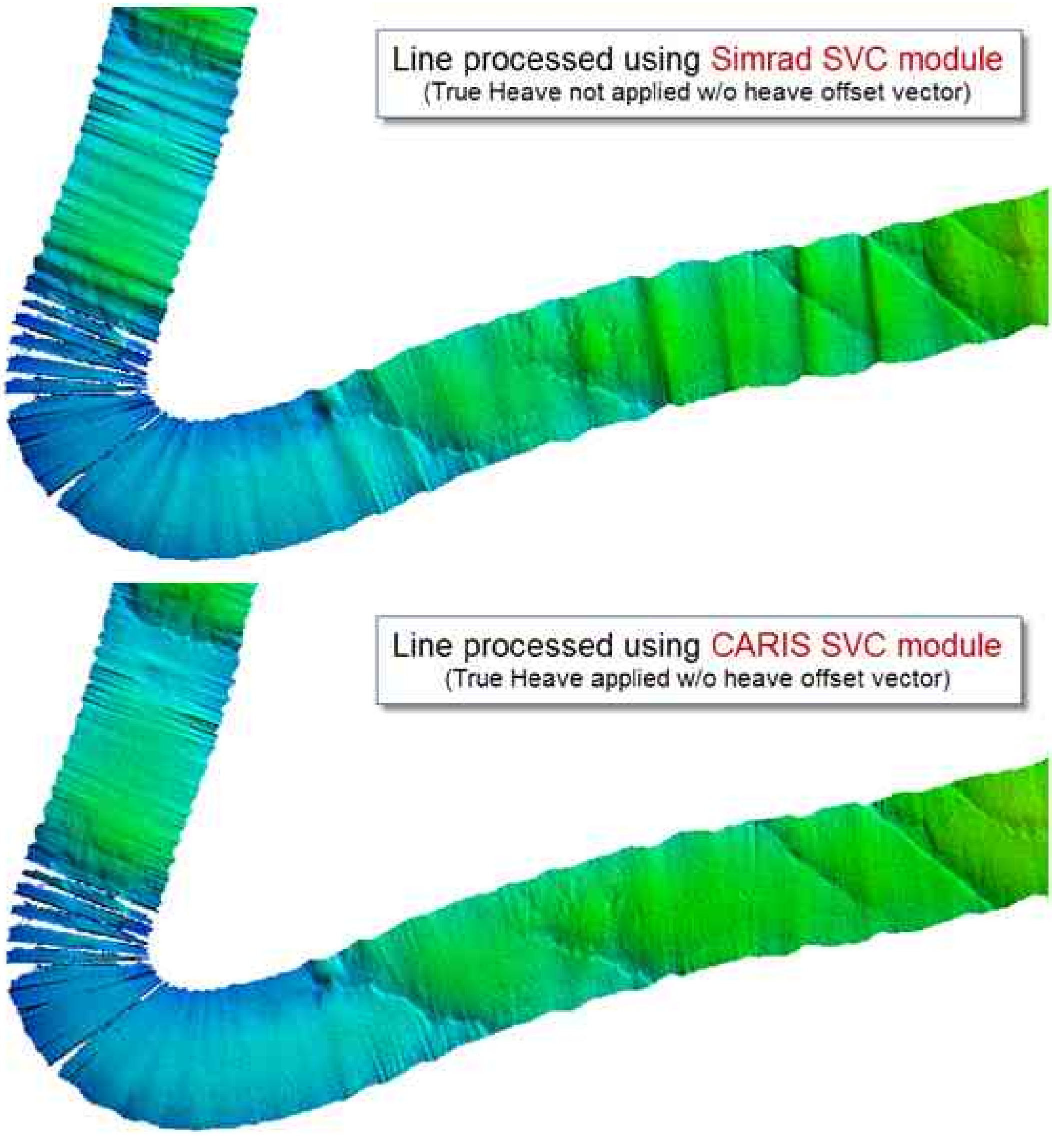
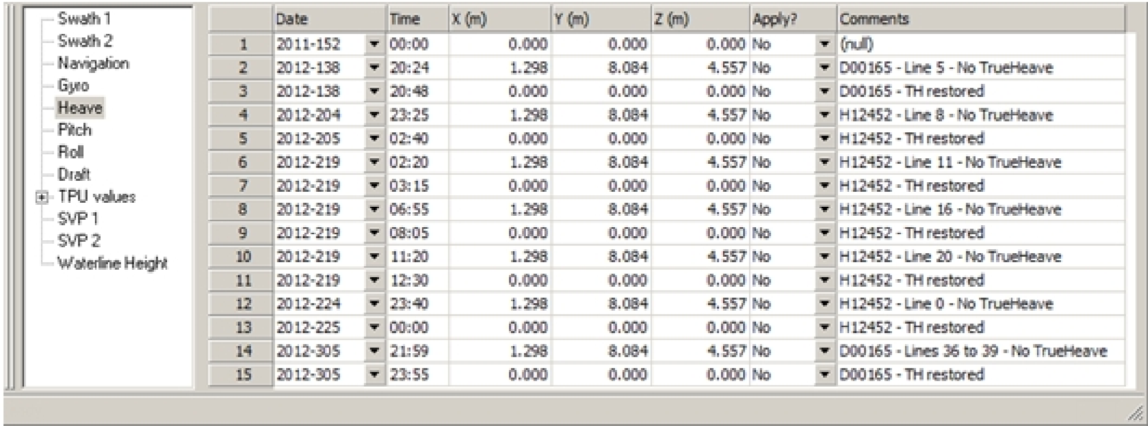


Figure 25: Survey line processed using 2012 configuration – Simrad SVC module used, with True Heave not applied; (bottom) updated configuration using CARIS SVC module with True Heave applied.



	Date	Time	X (m)	Y (m)	Z (m)	Apply?	Comments
1	2011-152	00:00	0.000	0.000	0.000	No	(null)
2	2012-138	20:24	1.298	8.084	4.557	No	D00165 - Line 5 - No TrueHeave
3	2012-138	20:48	0.000	0.000	0.000	No	D00165 - TH restored
4	2012-204	23:25	1.298	8.084	4.557	No	H12452 - Line 8 - No TrueHeave
5	2012-205	02:40	0.000	0.000	0.000	No	H12452 - TH restored
6	2012-219	02:20	1.298	8.084	4.557	No	H12452 - Line 11 - No TrueHeave
7	2012-219	03:15	0.000	0.000	0.000	No	H12452 - TH restored
8	2012-219	06:55	1.298	8.084	4.557	No	H12452 - Line 16 - No TrueHeave
9	2012-219	08:05	0.000	0.000	0.000	No	H12452 - TH restored
10	2012-219	11:20	1.298	8.084	4.557	No	H12452 - Line 20 - No TrueHeave
11	2012-219	12:30	0.000	0.000	0.000	No	H12452 - TH restored
12	2012-224	23:40	1.298	8.084	4.557	No	H12452 - Line 0 - No TrueHeave
13	2012-225	00:00	0.000	0.000	0.000	No	H12452 - TH restored
14	2012-305	21:59	1.298	8.084	4.557	No	D00165 - Lines 36 to 39 - No TrueHeave
15	2012-305	23:55	0.000	0.000	0.000	No	D00165 - TH restored

Figure 26: Sample entries in the CARIS HIPS vessel file showing the constant adding and removing of the heave offset vector depending on whether True Heave was applied to the respective survey lines.

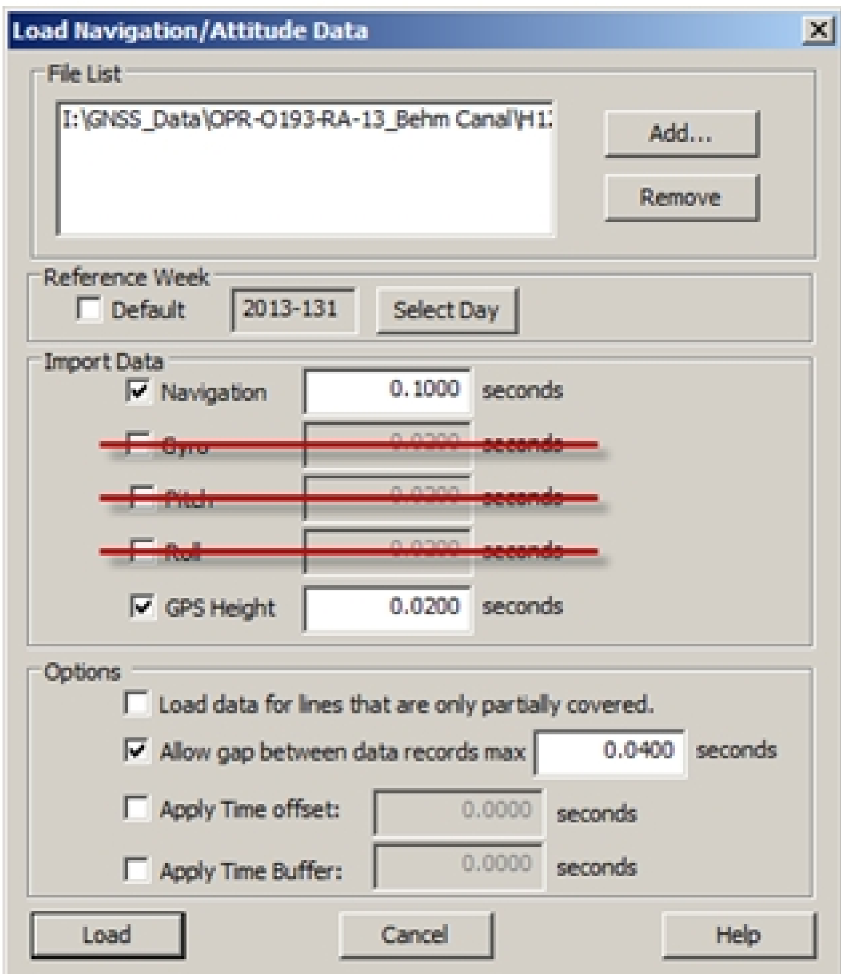


Figure 27: Application of SBETs to Kongsberg EM710 data on RAINIER was limited to navigation and GPS height records for the early portion (up to 25 May) of the 2013 field season.

	+ve fwd	+ve stbd	+ve down	+ve port up	+ve bow up	+ve to stbd
	X (m)	Y (m)	Z (m)	Roll (°)	Pitch (°)	Heading (°)
POSMV primary antenna (port)	-20.110	-1.186	-17.877	-	-	-
IMU	-8.064	-1.860	-4.607	-0.165°	0.020°	0.160°
Center of rotation	-18.284	-0.106	-4.557	-	-	-
EM710 TX	0.000	0.000	0.000	-0.0515° *	0.012° *	179.978°
EM710 RX	-1.5405	-0.1045	0.000	-0.030° *	0.000° *	180.019°
Waterline	-	-	-4.831	-	-	-

** Roll/Pitch sign convention is opposite of usual Kongsberg convention due to reverse mounting of TX and RX arrays*

Figure 28: Summary of sensor linear and angular offsets. Fields in dark gray are input into the POSMV configuration, while fields in light gray are entered into the SIS configuration and CARIS HVF (reproduced from Beaudoin, June 2013).

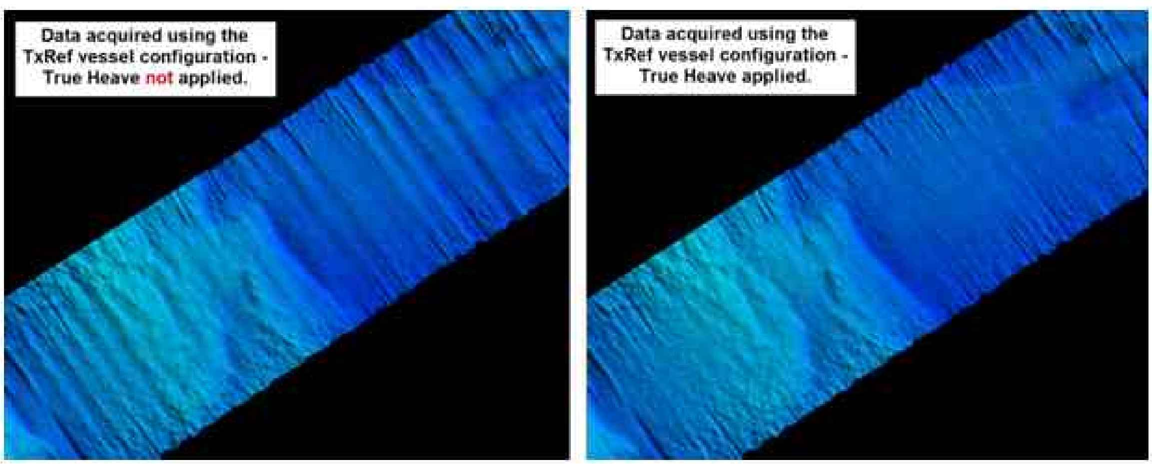


Figure 29: Two survey lines acquired and processed using the TxRef vessel file without True Heave applied (left) and with True heave applied (right).

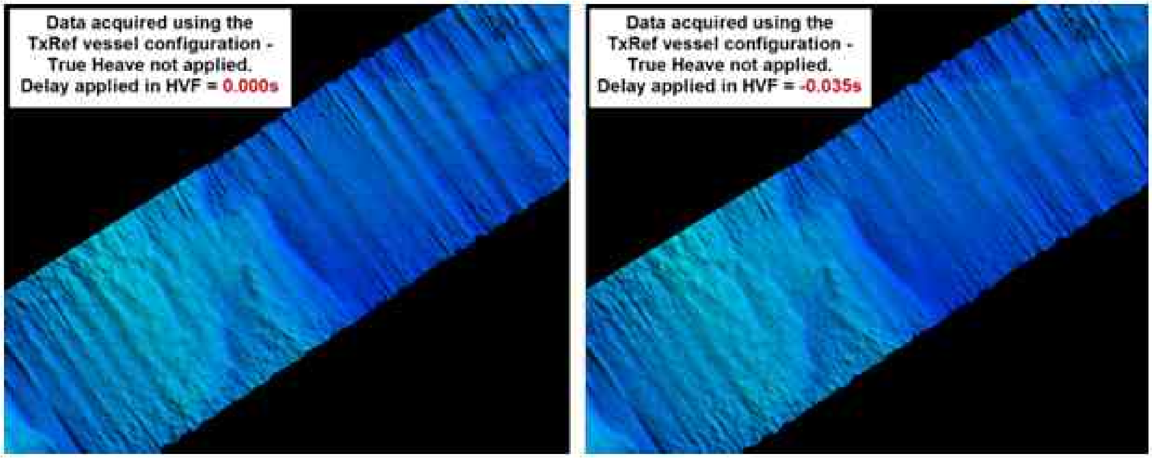


Figure 30: Two survey lines acquired and processed using the TxRef vessel file without True Heave applied and no time delay applied in CARIS (left), and a -0.035 second time delay in CARIS (right). At present, RAINIER is not recommending applying a time delay in CARIS.

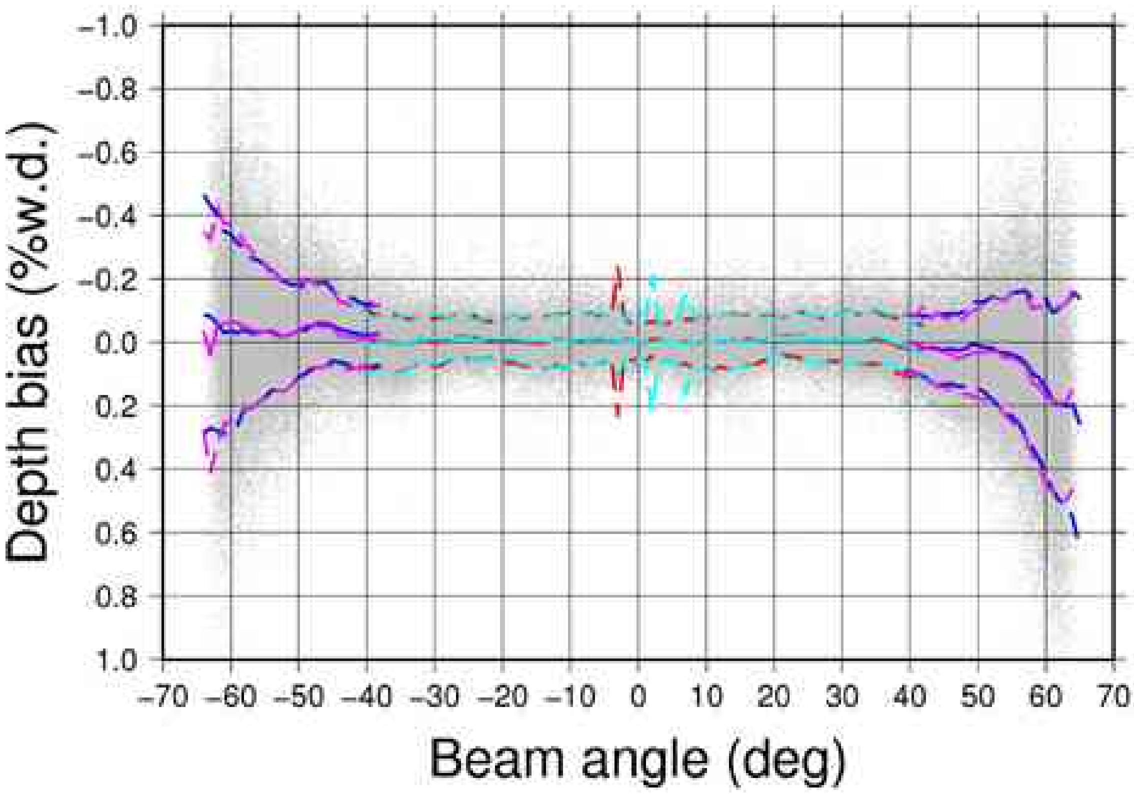


Figure 31: Scatter plot of beam depth biases with respect to a relative reference surface for the EM710 in DEEP CW mode. The mean and standard deviation is computed in 1° bins across the swath with the mean plotted as a solid line and the standard deviation (1#) plotted as dashed lines. Color coding corresponds to the transmission sectors, alternating in red-blue or magenta-cyan across the swath. Red-blue indicates data from the first swath of the dual-swath geometry and magenta-cyan is for the second swath of the dual-swath geometry (reproduced from Beaudoin, June 2013).

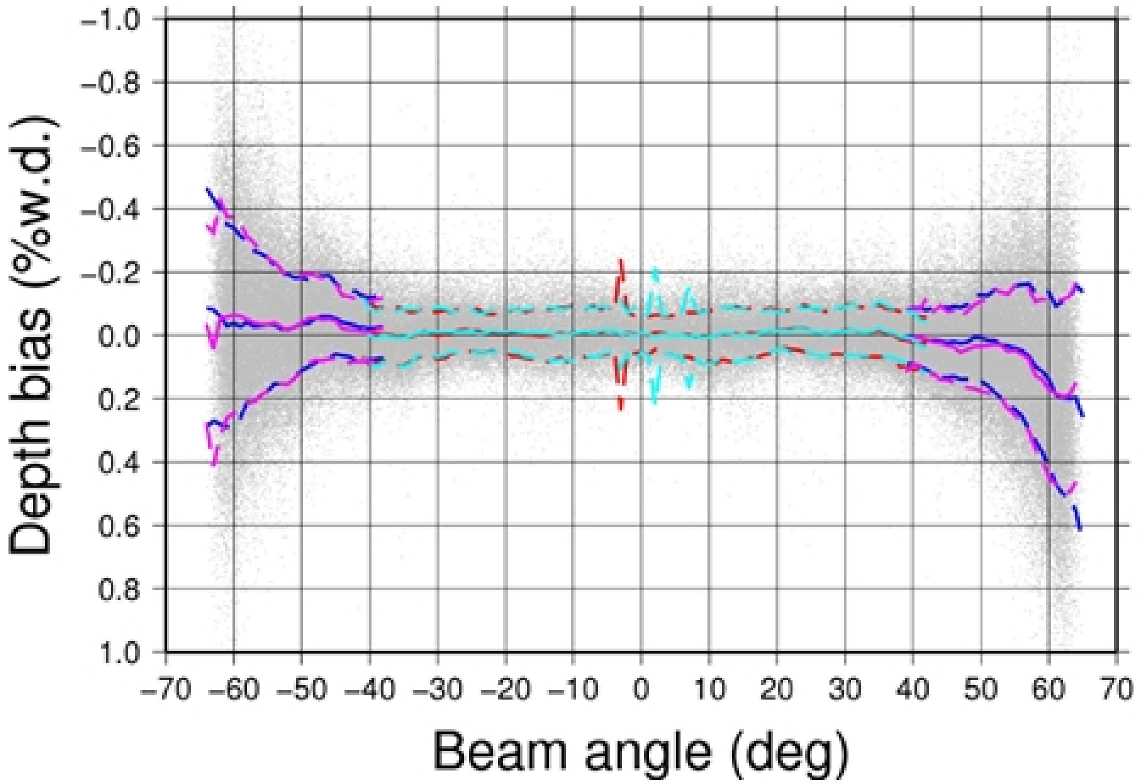


Figure 32: Within the outer beams, an oscillation is sometimes evident in the full swath of data (left); until the problem is better understood, Rainier will limit the swath angle to ±65° during acquisition (reproduced from Beaudoin, June 2013).

B.1.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not acquired.

B.1.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not acquired.

B.1.2 Imagery

B.1.2.1 Side Scan Sonar

Side scan sonar imagery was not acquired.

B.1.2.2 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not acquired.

B.1.3 Sound Speed

B.1.3.1 Sound Speed Profiles

RAINIER and her launches use the Sea-Bird SEACAT conductivity, temperature, and depth profiler (CTD) or the Rolls-Royce Moving Vessel Profiler (MVP) to acquire sound speed data.

All RAINIER launches (2801, 2802, 2803, and 2804) are equipped with 24-volt electric winches attached to small swing-arm davits to deploy and recover Sea-Bird SEACAT profilers while the vessel is at rest. The rate at which the spool deploys line may be adjusted with a knob on the side of the winch which controls friction washers.

The NOS Hydrographic Surveys Specifications and Deliverables require a minimum of one cast every four hours. Casts were also conducted when changing survey areas, or when a change of conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles. The launch crew also monitored the real-time display of the Reson SVP 71for drastic changes in the surface sound velocity indicative of the need for a new cast.

Velocipy software is used for both data processing and setting up Sea-Bird SEACAT instruments. Prior to deployment the SEACAT voltage is checked. The SBE 19plus should have a minimum of 9.5 volts and the SBE 19 should have a minimum of 7 volts. In the event of lower voltage readings, the instrument batteries were changed.

The site selected should be in the deepest portion of the project area expected to be surveyed. Before the instrument is placed in the water, the Hydrographer must ensure that the plastic tube covering the sensors has been removed.

When conducting SEACAT casts with the SBE 19, the 3-2-1 rule of thumb is followed. The instrument should be turned on and allowed to sit on deck for 3 minutes while the sensors settle and form baseline. The instrument is then set to soak just below the surface for 2 minutes. Finally the instrument is lowered at a rate of 1 meter/second.

When conducting SEACAT casts with the SBE 19plus, the instrument should be lowered and held just below the water's surface for about 1 minute to allow air to escape the salinity cell. After soaking the instrument, it should be lowered at a rate of 1 meter/second through the water column. In areas with lenses of fresh water or other complex sound speed variation near the surface, the instrument should be lowered slowly (in some cases, much less than 1 meter/second) through the first 5-10 meters of water in order to accurately sample the sound speed. After this initial decent, the instrument should proceed to drop at a rate of 1 meter/second.

The Moving Vessel Profiler (MVP) is an automated winch system that deploys a fish containing a sound speed sensor by free fall. The fish is towed behind the survey vessel in a ready position that is marked by messengers attached to the tow cable. Ideally at survey speeds the fish “flying” just above the depth of the sonar transducers. The specified depth deployed is selected by specifying a distance off the bottom (typically 10 meters). Once at the depth limit, the winch freefall is automatically stopped 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 towing position.

The fish can either be user-deployed or deployed automatically by the computer at a user defined time interval. The RAINIER uses the user-deployed method due to the danger of an automatic deployment taking place during a turn. Casts with the MVP are taken as often as every 15 minutes. This high frequency is due to the ease of collecting casts while losing no survey time stopping for a SEACAT cast. In addition there is also a need to better define the SV profile over larger horizontal distances covered since it is preferable to minimize turns while the MVP is deployed.

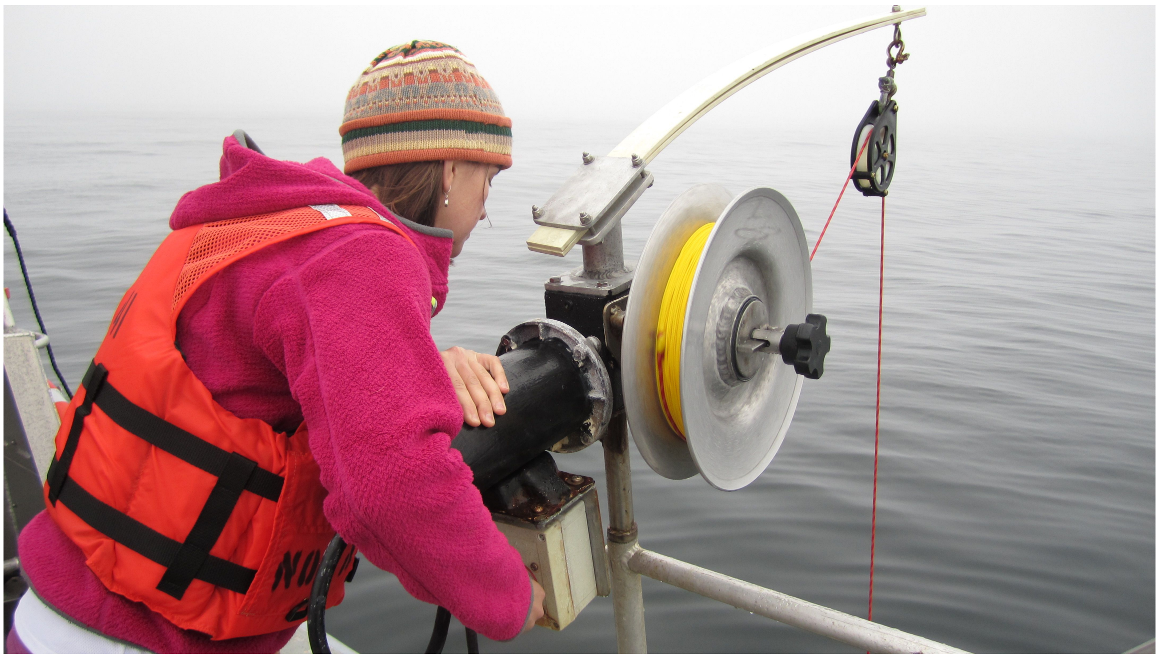


Figure 33: The 24v electric SV winch mounted on all Rainier survey launches. Note the knob at the side of the spool which controls deployment speed.

B.1.3.2 Surface Sound Speed

Surface sound speed values are measured by a SVP 70 on RAINIER and SVP 71 probes on all survey launches. These sound speed values are applied in real-time to all MBES systems to provide refraction corrections to flat-faced transducers.

B.1.4 Horizontal and Vertical Control

B.1.4.1 Horizontal Control

A Single Base solution using a base station or a Precise Point Positioning (PPP) solution utilizing precise ephemeris data are the preferred methods of post processing the horizontal positioning of bathymetric data. This is due to the dearth of permanent GPS stations installed in the remote regions of Alaska that would make a Smart Base solution utilizing multiple base stations practicable. The Single Base solution of processing SBETs requires the input of attitude data acquired by the POS/MV in addition to simultaneously collected base station data. For single baseline processing, the shore side base station used should be within 20km of the survey area. Consult the HVCR of each individual project for more information on base stations installed or utilized in addition to processing methodology.

The Trimble NetR5 and NetR9 Global Navigation Satellite System (GNSS) reference station receivers used by RAINIER collect data in raw .T01 or .T02 format. Data collection parameters are configured as per the “TRIMBLE NetR9 SETUP” document in Appendix IV of the FPM.

The POS/MV .000 files are collected individually by each launch daily, beginning at least five minutes before the collection of bathymetric data and ending at least five minutes after the conclusion of bathymetric data collection. Logging is started by opening the MV-POSView window and selecting “Ethernet Realtime…” from the Logging menu. In the Ethernet Realtime Output Control window only the following message groups are selected: 3, 7, 20, 102, 111 and 113. The Output Control rate is also set to ‘50 Hz’. It is also important not log through UTC Midnight on Saturdays, the end of the GPS week. In the event that a line would cross over UTC Midnight, Hypack/Hysweep logging and POS file logging is stopped and a new POS file with a new day number is started after UTC midnight.

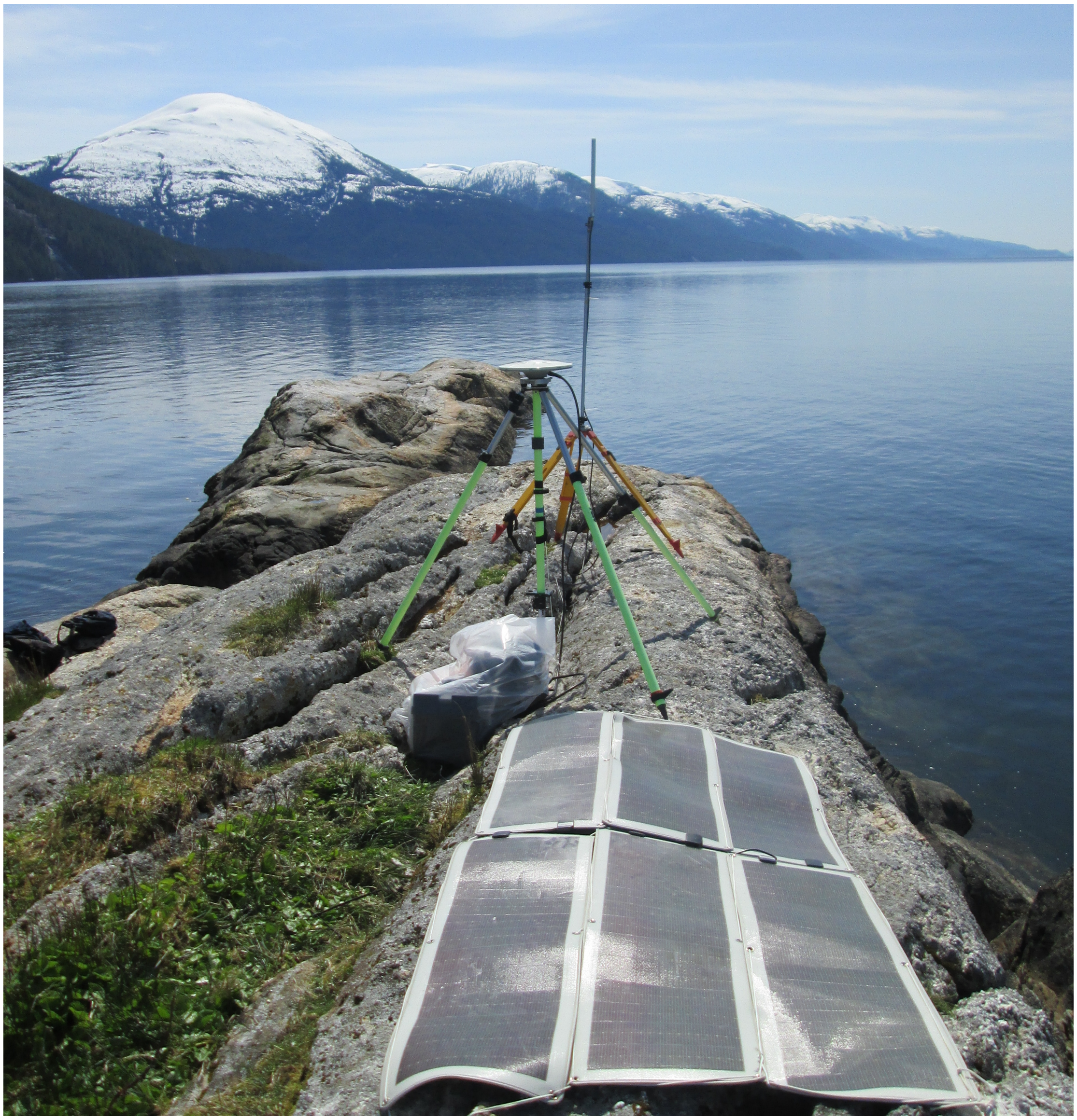


Figure 34: A horizontal control base station consisting of a fixed height GPS tripod, a UHF transmission antenna and solar panels. The NetR9 receiver with associated batteries are in the plastic bag.

B.1.4.2 Vertical Control

All RAINIER installed tide gauges conform to the data collection and transmission requirements as stated in section 4.2 of the Hydrographic Surveys Specifications and Deliverables (HSSD). Installation and documentation of the tide staff, benchmarks, bubbler orifice in addition to leveling requirements also conform to the HSSD as well as the User's Guide for GPS Observations At Tide and Water Level Station Bench Marks, Updated December 2009.

Requirements for the acquisition of water level data from subordinate tide gauge(s) is spelled out in the Hydrographic Survey Project Instructions. Most tide gauges assigned are subordinate “30-day” stations. As the name implies, data acquisition must be continuous for a 30-day minimum. Tidal data collection must begin at least 4 hours before the start of the hydrographic survey operations and continue 4 hours after the end of survey operations.

Each gauge installation at its most basic includes the tide gauge that is attached to a GOES antenna and a bubble orifice, a tide staff, and five benchmarks. For tide gauges, RAINIER employs the CO-OPS supplied Portable Tide Gauge (PTG) system 9210B water level gauge as described in section A.6 of this report. Tide staffs consist of 2.5 meter long 2 x 4s with attached vitrified plastic scale and stainless steel staff stops. Benchmarks are standard sized NOS benchmarks made of red brass for superior weathering resistance.

Tide gauge sites assigned are either historic or new. If a historic gauge site is assigned, the Project Instructions package will include a written report of the gauge site and benchmark descriptions. Although there is no requirement to install the tide gauge and staff at their exact historic locations, every effort should be made to recover as many benchmarks as possible. All historic benchmarks must be reused for the tide station installation although replacement benchmarks may need to be installed to replace those missing. Some historic gauges have only three benchmarks installed, so two new marks need to be installed to bring the total up to the required five.

Instructions for new gauges include a proposed installation site, but this is not set in stone. Prior to actual installation, it is standard procedure to recon the immediate area and select the best potential site. After consultation with CO-OPS and if the new location is approved, the gauge is assigned a new seven-digit station identifier number.

Figure 35: A Portable Tide Gauge (PTG) system with GOES and GPS antennae mounted on an aluminum tripod and a solar panel secured to a rock.

Figure 36: An example of a typical Rainier tide staff.

B.1.5 Feature Verification

Feature Data

Source shoreline data is typically supplied by N/CS31 in a single Composite Source file (CSF) in both S-57 .000 and .hob formats. Additionally, a Project Reference file (PRF) is supplied containing sheet limits, AWOIS items, and recommended bottom sample sites. The project-wide CSF file was trimmed to each sheet's individual survey limits and saved as both HOB and S-57 .000 files by the survey managers. The .000 format is used for the real time acquisition display in Hypack on the survey launches. The HOB file was used in CARIS Notebook and printed to create paper boat sheets for reference and note-taking during shoreline verification operations. This process is described in detail in the "CARIS Notebook" section below.

Shoreline verification was conducted during daylight periods near MLLW. A line was run along the shore approximating the position of the Navigational Area Limit Line (NALL). Thick near-shore kelp often dictated the position of the NALL. In the absence of direction to the contrary, the NALL was the furthest offshore of the following:

- The 4m depth contour at MLLW.

- A line seaward of the MHW line by the ground distance equivalent to 0.8mm at the scale of the largest scale raster chart of the area.

This definition of the NALL is subject to modification by the Project Instructions, Chief of Party (Commanding Officer), or (in rare instances) Hydrographer-In-Charge of the survey launch.

Some likely additional reasons for modifying the position of the NALL included:

- Sea conditions such as kelp or breakers in which it was unsafe to approach shore to the specified distance or depth.
- Regular use of waters inshore of this limit by vessels navigating with NOAA nautical chart products. (This does not include skiffs or other very small craft navigating with local knowledge.)

As the approximate NALL line was run along the shore, the hydrographer both annotated the shoreline reference document and scanned the area for features to be addressed. All features with CARIS Notebook custom attribute “asgnmt” populated with 'Assigned' offshore of the NALL were fully investigated. 'Assigned' features inshore of the NALL were verified or DP’d for height if exposed but launches did not navigate inshore of the NALL to either disprove or investigate potential submerged 'Assigned' features. Features were addressed in the following manner:

- Seaward of the NALL:
  - A feature found within 2mm at survey scale of the composite source position had its height/depth determined.
  - A feature outside 2mm at survey scale of the composite source position had its field position revised in addition to a heights/depth determination.
  - Features with any linear dimension greater than 1mm at survey scale were treated as an area and delineated.
  - New features not in the Composite Source file.
  - AWOIS items and other features specifically identified for investigation.

- Inshore of the NALL:
  - Navigationally significant features only, as defined below.

Navigationally Significant features were defined as the following:

- All features within the limits of safe navigation (i.e., offshore of the NALL).
- Features inshore of the NALL which:
  - are sufficiently prominent to provide a visual aid to navigation (landmarks). Note that rocks awash are almost never landmarks, but distinctive islets or other features visible at MHW can be useful for visual navigation.
  - significantly (a ground unit distance equivalent to 0.8mm at the scale of the largest scale chart of the area) deflect this limit. Common examples of these features include foul areas and large reef/ledge structures.
  - are man-made permanent features connected to the natural shoreline (such as piers and other mooring facilities) larger than the resolution specified for the survey. Seasonal features will be evaluated by the Command.

- are man-made permanent features disconnected from the shoreline, such as stakes, pilings, and platforms, regardless of size.

Small, private mooring facilities (piers and buoys) suitable for pleasure craft were not generally considered navigationally significant. Areas with a high density of mooring buoys for these vessels were delineated, but the features themselves not individually positioned.

Terminology used for field annotation of the shoreline reference document during shoreline verification was as follows:

“Noted”
- The existence of a feature and its characteristics were confirmed from a distance, and its position appeared to be correct within the scale of the chart or source.
- Appropriate for features inshore of the limit of hydrography and not navigationally significant, significant features that require no further investigation, or features unsafe to approach to verify position within survey scale.
- Noted features were annotated on the shoreline reference document but carried no further forward in the processing pipeline. A "noted" annotation on a feature is not included in the H-Cell and adds little to PHB’s current evaluation and verification process.

“ Verified "
- The feature’s position and characteristics were acquired and recorded either by directly occupying the site, or by applying a range and bearing offset to a known position. Positioning was generally by DGPS methods.
- Appropriate for navigationally significant features inshore of the limits of hydrography. Also appropriate for existing features that do not require a height (VALSOU or HEIGHT attribute).

“DP for Height”
- The feature’s source position is correct, but height (VALSOU or HEIGHT attribute) was either unknown or incorrect. This position does not supersede that of the source data, so it is only necessary to approach the feature as closely as required to accurately estimate the height.
- Appropriate for source features found within 20m of their source positions, but with incorrect or missing height or depth data.

“New"
- The feature’s position and attributes (including height) were acquired and recorded either by directly occupying the site, or by applying a range and bearing offset to a known position. Positioning was generally by DGPS methods.
- Appropriate for items seaward of the NALL that are not present in the Composite Source.
- Items inshore of the NALL which are navigationally significant and are not present in source data.

“Not Seen”
- The feature was present in source data (chart, DCFF, etc.) but was not visually observed in the field. Full disproval search (see below) was not conducted.
- Appropriate for:
  - Features above MHW, the absence of which can be proven visually from a distance.

- Source features inshore of the limit of hydrography which are not observed, but whose presence on or absence from the survey will not affect safe navigation.
- Any feature from source which was not seen, but for which full disproval search (see below) is impractical or unsafe.

"Disproved"

- The feature was present in source data, but was not located after a full search. "Full Search" means SWMB, VBES, SSS, and/or Detached Position coverage of the area which conclusively shows that the item is not located at the position given to the accuracy and scale of the source document.

The primary purpose of detached positions (DPs) is to verify and define shoreline features (ex: rocks, reefs ledges, piles), disprove charted features, position navigational aids and landmarks (ex: buoys, beacons, lights), and mark positions of bottom samples. Point features were captured in the field as attributed S-57 objects in CARIS Notebook. Any line objects, such as small piers or foul areas were digitized directly into CARIS Notebook while in the field. Concurrent with the acquisition of these features, digital photographs were taken of most objects which were exposed above the waterline.

The survey vessel's track may also be used to delineate area features, such as reefs, ledges, or foul areas. Where it is safe to approach these features to within the specified horizontal accuracy requirement, this method can produce a more accurate and efficient representation of large features than would be provided by multiple DPs on the extents.

In addition to the traditional shoreline techniques, RA3 (2803) may also be used to delineate the NALL with her ~34-degree tilted Reson 8125. During periods of high tide, 2803 acquired data while running parallel to shore. While running along the 30-foot curve was found to nicely fill in between the 4 and 8 meter curves with complete coverage, it also produced coverage far inside the NALL line (typically the 4-meter curve). Areas of kelp often prevented 2803 from reaching the 30-foot curve. Any additional soundings collected inshore of the NALL line were processed as follows:

- "Good" seafloor is not rejected anywhere. Any bad soundings are cleaned out to make the surface represent the seafloor, but there is no cut-off of soundings shoaler than the 4-meter or 0-meter curves. Negative soundings are fine so long as they accurately represent the bottom.

- No launch is to go inside the NALL line trying for the 0-meter curve, or developing items that are found outside the survey limits (i.e. NALL line)

- For cultural features (pilings, piers, buoy's and buoy chains, etc.) that are above MLLW (i.e. negative sounding) AND on the CSF HOB layer, all soundings on the cultural item are deleted. This technique will prevent the BASE surface from being pulled up on features already charted above MLLW in the HOB file.

- For cultural features that are below MLLW, the shoalest sounding is designated (which the BASE surface will honor) AND the feature is included on the field verified HOB file.

- For cultural features that are above MLLW and are not on the field verified HOB file, the least depth is flagged as "outstanding," but not included in the BASE surface and all other data on the object is rejected. In this case, the "outstanding" sounding is used as a basis for creating a new feature in the field verified HOB, but it will not affect the BASE surface. This is accomplished by using the option in BASE surface creation to not include outstanding soundings. Alternatively, in the case of area-type cultural features, all depths may be temporarily retained and the resultant DTM used to digitize the feature. Once digitization is complete, all soundings on the cultural item are deleted.

- Rocks and reefs are treated as "seafloor." No data is rejected on rocks, reefs or ledges, even above MLLW. The primary method of getting heights on rocks will remain "leveling" (aka eyeballing) during traditional shoreline, but if a least depth of a rock is obtained with SWMB, it will be designated and the height/depth will be used as the VALSOU in the CSF HOB. As previously stated, launches will not go inshore of the NALL line trying to get these data, but it will not be discarded if they are obtained. In cases where the echosounder data does not get the least depth, the soundings obtained will be left in the surface and a DP (or previously acquired comp source data) will be used for the feature.

Following acquisition, digital photos were renamed with an unique ID and moved into a single folder. Any required application of tide and SV corrections are performed in CARIS Notebook.

S-57 Attribution

With the advent of custom CARIS support files supplied by HSTP, Caris Notebook, Bathy DataBASE, and Plot Composer now supports feature flags previously available only in Pydro. All feature flagging can now be accomplished in CARIS Notebook while Pydro is relegated to generating reports.

Features are selected for investigation by HSD OPS based on distance from MHW. Project Instructions require that “All features with attribute asgnmt populated with 'Assigned' shall be verified even if they are inshore of NALL.”

No RAINIER launches ventured inshore of the NALL, even for assigned investigation items, when there was a question of safety or potential equipment damage. If the feature in question was exposed, time and height attributes were assigned while driving past. If the feature was not evident while driving the NALL during shoreline verification, a remark of “inshore of NALL not investigated” was made with a recommendation of retain as charted.

Feature attribution was completed for all 'Assigned' and any newly discovered items. Unassigned features were left untouched.

Submerged features, such as wrecks and submerged piles designated in CARIS may also be brought into Notebook for attribution.

All features marked as “primary” were edited to have their object/attribute instances describe each feature as completely as possible. Object attributes assigned to each feature conform to direction located within both the Field & Processing Branch Features Encoding Guide v1.3 and the CARIS “IHO S-57/ENC Object and Attribute Catalogue”. S-57 attribution is not required for those features flagged as "secondary" nor for unassigned features.

NOAA specific attribution in Notebook includes “descrp” with a drop-down menu which is edited to reflect the hydrographer recommendations as follows:

- descrp - new -- A new feature was identified during survey operations. The hydrographer recommends adding the feature to the chart. Also, in cases in which the geographic extents/position of an existing object were modified; the newly proposed feature was characterized as "new", while the original feature was flagged as "delete".
- descrp - update -- The feature was found to be portrayed incorrectly on the chart. Update is also used in the case where the feature was found to be attributed incorrectly or insufficiently and is modified to reflect the additional or corrected attribution.
- descrp - delete -- The feature was disproved using approved search methods and guidelines. The hydrographer recommends removing it from the chart. Also, in cases in which the geographic extents and/or position of an existing object were modified; the newly proposed feature was characterized as "new", while the original feature was flagged as "delete".
- descrp - retain -- The feature was found during survey operations to be positioned correctly and no additional attribution was required. The hydrographer recommends retaining the feature as charted.
- descrp – not addressed -- The feature was not investigated during shoreline acquisition, typically because it was either inshore of the NALL or unsafe to approach. The hydrographer recommends retaining the feature as charted.

Features described as "new" and "update" are updated with the SORIND/SORDAT attribution of the current survey.

Features described as "delete", "retain", and "not addressed" have their SORIND/SORDAT attribution remain unchanged.

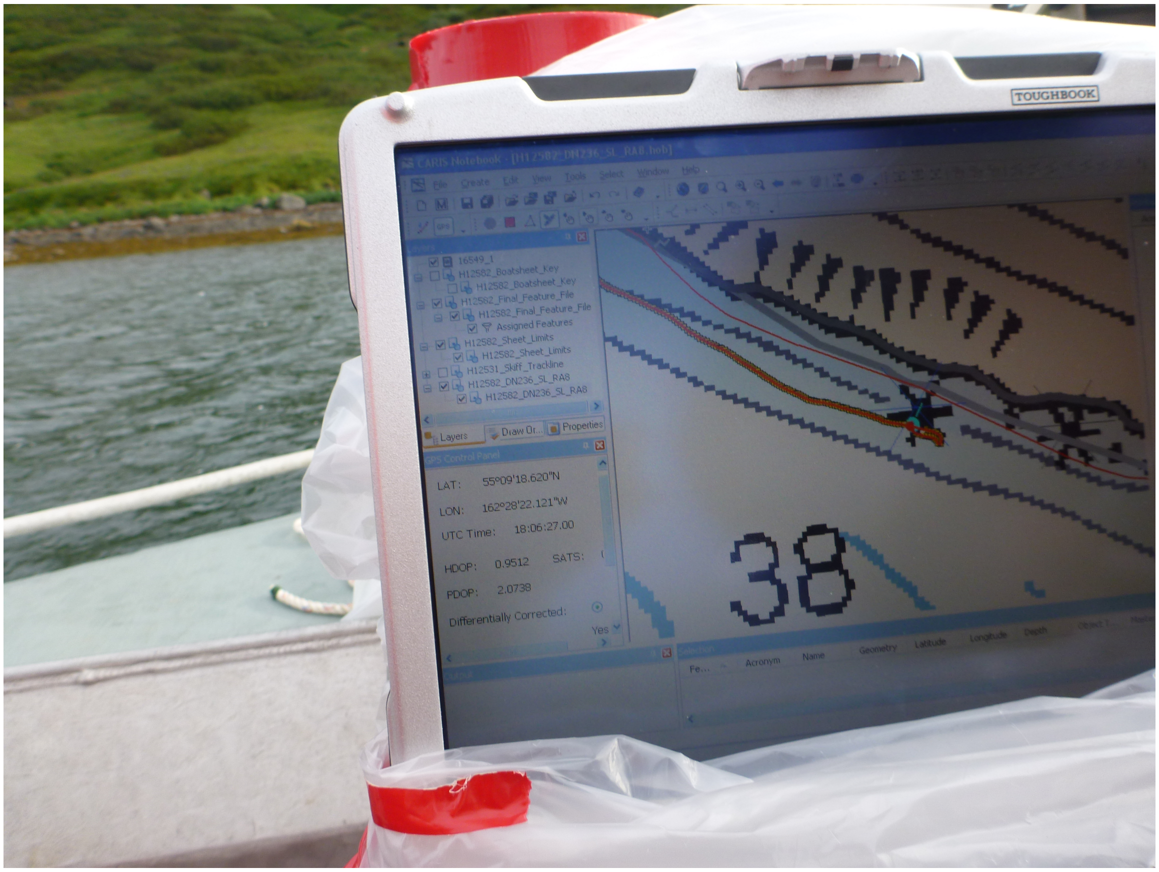


Figure 37: CARIS Notebook running on a waterproof Toughbook computer

Figure 38: A Trimble backpack set up for shoreline verification on RA7.

B.1.6 Bottom Sampling

Typically headquarters provides the field unit with a number of recommended bottom sample sites included as part of the shoreline project reference file (PRF). These proposed sample sites, which are encoded as S57 springs, are examined by the command and potentially culled based on the actual depths found during survey operations or added to based on good anchorage positions located by the ship.

Samples are collected by launch using one of the two bottom samplers described in the equipment section of this report. Once obtained, samples are analyzed for sediment type and classified with S57 attribution using

CARIS Notebook, with the most prevalent sediment type listed first. In the event that no sample is obtained after three attempts, the sample site NATSUR is characterized as “unknown”. Samples are then discarded after field analysis is complete.

B.1.7 Backscatter

Current guidance from the Field Procedures Manual calls for field units to acquire and submit multibeam backscatter data in snippet mode whenever feasible. Reson “snippets” imagery are recorded at acquisition and are present in the raw data, but not processed or analyzed. Snippet data contains the amplitude data of each individual sonar beam in a swath, but there are problems, well-documented in the hydrographic literature, that reduces the efficacy of processing these data.

When tuned to collect the optimal bathymetric data, Reson sonar systems tend to over-saturate the return signal and thus limit its value in terms of backscatter. In an attempt to alleviate this problem Saturation Monitor (SatMon) was developed by Glen Rice based on thesis work by Sam Greenaway with the goal of producing consistent and high quality backscatter data without adversely affecting the collection of bathymetric data. SatMon is a bundle of python code developed in-house as part of the Pydro software suite and is intended to aid the sonar operator in estimating the saturation state of the receiver of a Reson 7k series multibeam sonar.

SatMon is run simultaneously with the Reson data acquisition software during survey operations and displays “Beam vs Percent Nonlinear.” This plot displays by beam the received magnitude relative to the maximum allowable magnitude for the applied gain. While monitoring bottom detection quality with Reson, the sonar operator also makes every attempt to keep the saturation monitor histogram below the red line and also below the yellow line when possible. By adjusting Reson power the whole histogram can be raised and lowered. Adjusting absorption and spreading settings in Reson will help push up or down the outer beams.

Backscatter data are collected by default with the RAINIER's EM710.

B.1.8 Other

No additional data were acquired.

B.2 Data Processing

B.2.1 Bathymetry

B.2.1.1 Multibeam Echosounder

Following acquisition, multibeam sonar data were processed using the CARIS HIPS and SIPS Batch Processor. The batch processor runs a user defined script which accomplishes the following standard tasks without user intervention:

1. Convert the “raw” Reson or SIS data to the HDCS data format.
2. Load True Heave
3. Load predicted tides.
4. Load and apply sound velocity files.
5. “Merge” data to apply position, attitude, vessel offsets, and dynamic draft correctors to bathymetry and compute the corrected depth and position of each sounding.
6. Compute Total Propagated Uncertainty (TPU).
7. Filters may be applied to the data after checking with the sheet manager if specific data issues exist. If used, data is filtered according to the following criteria:

   - Reject soundings with poor quality flags, (0 for Reson).
   - Reject soundings with TPU greater than the horizontal and vertical error limits specified in the NOS Hydrographic Surveys Specifications and Deliverables:

     Horizontal Error > ±(5m + 5% of depth)
     Vertical Error > ±SQRT(a^2+(b*d)^2) , where “a” and “b” are defined as

     - in depth ranges 0-100m, a=0.500 b=0.013
     - in depth ranges > 100m, a=1.000 b=0.023

8. Add data to the master “QC” field sheet encompassing the entire survey.

   - “QC” Field Sheet naming convention: Hxxxxx_QC (e.g., H12345_QC)
   - Base surfaces are created in accordance with the depth ranges set forth in table below.

It has been the experience aboard RAINIER that CUBE surfaces of differing resolutions that cover the same dataset may produce widely different results. In an effort to eliminate this problem, cube surface resolution values of 1, 2, 4, 8,16 and 32 meters were chosen. On occasion a 0.5m CUBE surface is utilized in areas of rocky or uneven bottom when the default surface does not well represent all of the shoal points. Since these resolution values are even multiples, all of the surfaces produced for a given field sheet will have the nodes of all surfaces co-located.

The following options are selected when CUBE surfaces were created:

- Surface Type – CUBE
- IHO S-44 Order – Order 1a
- Include status – check Accepted, Examined and Outstanding
- Disambiguation method - Density & Locale (this method selects the hypothesis that contains the greatest number of soundings and is also consistent with neighboring nodes).
- Advanced Configuration – As per the figure below and dependent upon the surface resolution.

After consultation with the sheet manager, preliminary data cleaning may be performed on “QC” field sheet. Each surface is masked to the appropriate depth range for its resolution using the attribute filter found in the “properties” of the depth layer. The Attribute Filter is enabled by selecting the check box. The filter is set by checking on the button and changing the expression to read “Depth >X AND Depth <Y” where X= min depth for the resolution and Y= max depth for the resolution. E.g. a 2 m resolution surface would get the expression: Depth >18 AND Depth <40.

Preliminary data cleaning is performed daily using “QC” field sheet CUBE surface as a guide for "directed editing". Typically the night processing crew only cleans out the most blatant of fliers and blow-outs, leaving the final cleaning to the sheet manager. Depth, Standard Deviation, Hypothesis Strength and Hypothesis Count models derived from the boat-day surface are viewed with appropriate vertical exaggeration and a variety of sun illumination angles to highlight potential problem areas. Based on this analysis the most appropriate cleaning method is selected as follows:

- Subset Mode is the default tool selected due to its ability to quickly compare large numbers of soundings with adjacent or overlapping data for confirmation or rejection. Subset mode also excels with the assessment of possible features, disagreement between overlapping lines, and crossline comparison. The image designer can be used to visually enhance patterns and anomalies in CUBE surfaces, especially the standard deviation CUBE surface.

- Swath Editor is useful for burst noise, multipath, and other "gross fliers" which are specific to a particular line or lines, and most easily removed in this mode. Additionally, when it was felt that the quality of the data was reduced due to environmental conditions such as rough seas or extreme variance in sound velocity, data were filtered on a line by line basis to a lesser swath width to ensure data quality. Swath editor is also useful when examining single lines of tilted 8125 data.

- Both modes (but particularly Swath Editor) are used as a training aid to help novices learn how the various sonars operate, and provide feedback to the acquisition process.

With the advent of CUBE-based processing, it has become possible to adjust the final bathymetric surface directly by selecting the correct hypothesis to use. Although this method is available, it is not “allowed” according to HSD and it is standard practice on RAINIER to clean soundings in the traditional method until the CUBE algorithm selects the correct hypothesis.

Once all the data from all launches is cleaned based on the depth range to which they will be finalized, the “QC” field sheet CUBE surfaces are examined to ensure bottom coverage and plan additional lines or polygons to fill “holidays”. In addition, the “QC” field sheet is used to compare adjacent lines and crosslines, for systematic errors such as tide or sound velocity errors, sensor error, sonar errors (consistent bad beams), vessel configuration problems, and noise. Any irregular patterns or problems are reported immediately to the FOO and the Survey Manager so that remedies can be found and applied before more data are acquired.

A coarse 4m resolution “Launch” BASE surface may also be maintained for use in the survey launches during data acquisition. The 4m resolution was selected to maintain smaller, easily transportable GeoTiff files.

- Naming convention is Hxxxxx_4m_DNxxx.
- The surface is created as a single resolution CUBE surface at 4m resolution.
- The CUBE surface is colored using a standardized custom RAINIER generated CARIS Colour Range table.
- The color pallet selected is intended to aid swift navigation over previously surveyed areas in addition to highlighting shallow areas.

Depth Range Filtering	CUBE Surface Resolution	BASE surface Advanced Options Configuration
0-20 m	1 m	NOAA_1m
18-40 m	2 m	NOAA_2m
36-80 m	4 m	NOAA_4m
72-160 m	8 m	NOAA_8m
144-320m	16 m	NOAA_16m
288-> m	32 m	NOAA_32m

Figure 39: Depth range vs. CUBE surface resolution.

B.2.1.2 Single Beam Echosounder

Single beam echosounder bathymetry was not processed.

B.2.1.3 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar bathymetry was not processed.

B.2.1.4 Specific Data Processing Methods

B.2.1.4.1 Methods Used to Maintain Data Integrity

see section B.2.1.1

B.2.1.4.2 Methods Used to Generate Bathymetric Grids

see section B.2.1.1

B.2.1.4.3 Methods Used to Derive Final Depths

Methods Used	Surface Computation Algorithms
Description	RAINIER uses the CARIS CUBE BASE surface algorithms for the generation of all surfaces generated for final submission. The exact behavior of CUBE is determined by the values set in the CUBE parameters file, a xml file which can be selected by the user in the CARIS Tools --> Options --> Environment tab. The Hydrographic Surveys Division (HSD) has created and provided a customized CUBE parameters file (CubeParams_NOAA.xml) with new CUBE parameters that are required for each grid resolution. During the creation of CUBE surfaces, the user is given the option to select parameter configurations based upon surface resolution which have been tuned to optimize the performance of the CUBE algorithm. Figure 39 illustrates how the advanced options configuration is manipulated based on the grid resolution of the CUBE surface being generated.

B.2.2 Imagery

B.2.2.1 Side Scan Sonar

Side scan sonar imagery was not processed.

B.2.2.2 Phase Measuring Bathymetric Sonar

Phase measuring bathymetric sonar imagery was not processed.

B.2.2.3 Specific Data Processing Methods

B.2.2.3.1 Methods Used to Maintain Data Integrity

Although RAINIER currently has no side scan sonar systems in her inventory, option 033 of the Reson 8125 SWMB system used aboard 2803 provides angle-independent imagery similar to fixed-mount side scan sonar (SSS). The Reson 7125 systems aboard 2801, 2802, 2803 and 2804 also acquired angle-independent pseudo SSS imagery. This SSS imagery is primarily used during processing of the multibeam sounding data to aid in determining whether anomalous soundings are true features or noise. It generally does not have sufficient resolution for small object detection, but the shape of objects and their strength of return can greatly increase the confidence in processing results.

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

n/a

B.2.2.3.3 Methods Used to Verify Swath Coverage

n/a

B.2.2.3.4 Criteria Used for Contact Selection

n/a

B.2.2.3.5 Compression Methods Used for Reviewing Imagery

No compression methods were used for reviewing imagery.

B.2.3 Sound Speed

B.2.3.1 Sound Speed Profiles

Downloading and processing of sound speed data is performed using Velocipy, a part of the HSTP supplied Pydro program suite. Raw SV files are retained and archived for later submission to NGDC. Processed SVP files are archived and submitted to the hydrographic branch as part of the sheet submission package.

For Seacats

- After a cast, the SBE Seacat is connected to the download computer with a serial cable.
- After starting Velocipy, “File/ Download from SBE” is selected from the dropdown menu. A window showing available casts is then displayed with checkboxes to select cast(s) for download.
- After download the user is then required to enter cast metadata. Empty slots for Project, Survey, NOAA Unit, Instrument, Username, Process Date, Draft, and Latitude and Longitude are given. While Velocipy still asks for metadata, this step can be skipped since the data isn't written to the output files.
- After entering metadata, the sound velocity graph is viewable by clicking on the SV tab in the Metadata window. The user can change the sound speed/depth units (X and Y buttons), zoom in (Magnifier tool), and take a look/edit cast points (+ button). Additional tabs display the Temperature and Table view.
- Casts are exported into CARIS SVP format files by selecting File/Export Selected Profiles. A File Export Settings window will pop up, allowing the user to point to the Caris/ SVP folder and if necessary append the current cast. After clicking OK, the Log Window should read ‘exported sound speed profile successfully’.
- To prepare for the next cast, SEACAT PreCast Setup is selected to clear all memory and initialize the profiler for the next cast.

For MVP

- For the MVP, casts are typically processed as a group at the end of the day or survey watch.
- After starting Velocipy, “File/ Load Profiles” is selected from the dropdown menu. Navigate to the s12 file

produced by the MVP and select file/s to process.

- After the files load, the user is then required to enter cast metadata. Empty slots for Project, Survey, NOAA Unit, Instrument, Username, Process Date, and Draft are given. Unlike the SBE Seacat, Latitude and Longitude are already populated.
- After entering metadata, the sound velocity graph is viewable by clicking on the SV tab in the Metadata window. The user can change the sound speed/depth units (X and Y buttons), zoom in (Magnifier tool), and take a look/edit cast points (+ button). Additional tabs display the Temperature, Salinity and Table view.
- Casts are exported into CARIS SVP format files by selecting "File/Export Selected Profiles". A File Export Settings window will pop up, allowing the user to point to the Caris/ SVP folder and if necessary append the current cast. After clicking OK, the Log Window should read 'exported sound speed profile successfully'.

B.2.3.1.1 Specific Data Processing Methods

B.2.3.1.1.1 Caris SVP File Concatenation Methods

CARIS SVP files are concatenated as follows:

PROJECT	LOCATION	CONCATENATION METHOD
S-M921-FARA-13	Offshore Washington and Oregon	Sheet and Vessel master file
OPR-O193-RA-13	Behm Canal, Alaska	Vessel master file
OPR-O322-RA-13	Chatham Strait, Alaska	Vessel master file
OPR-P183-RA-13	Shumagin Islands, Alaska	Sheet and Vessel master file
OPR-P377-RA-13	South Alaska Peninsula, Alaska	tbd
OPR-N305-RA-13	Strait of Juan De Fuca, Washington	tbd

Figure 40: CARIS SVP file concatenation method.

B.2.3.2 Surface Sound Speed

Although no formal post-processing of surface sound speed is required, plotting changes of surface sound speed over an area surveyed can be useful as a troubleshooting tool. To that end, ENS Damian Manda of the RAINIER created a python script (extractsv.py). This tool takes single or multiple HSX files and allows the surface sound speed to be plotted over time as a launch collects data. The output is a geotiff file that may then be overlaid with survey data or charts using another program.

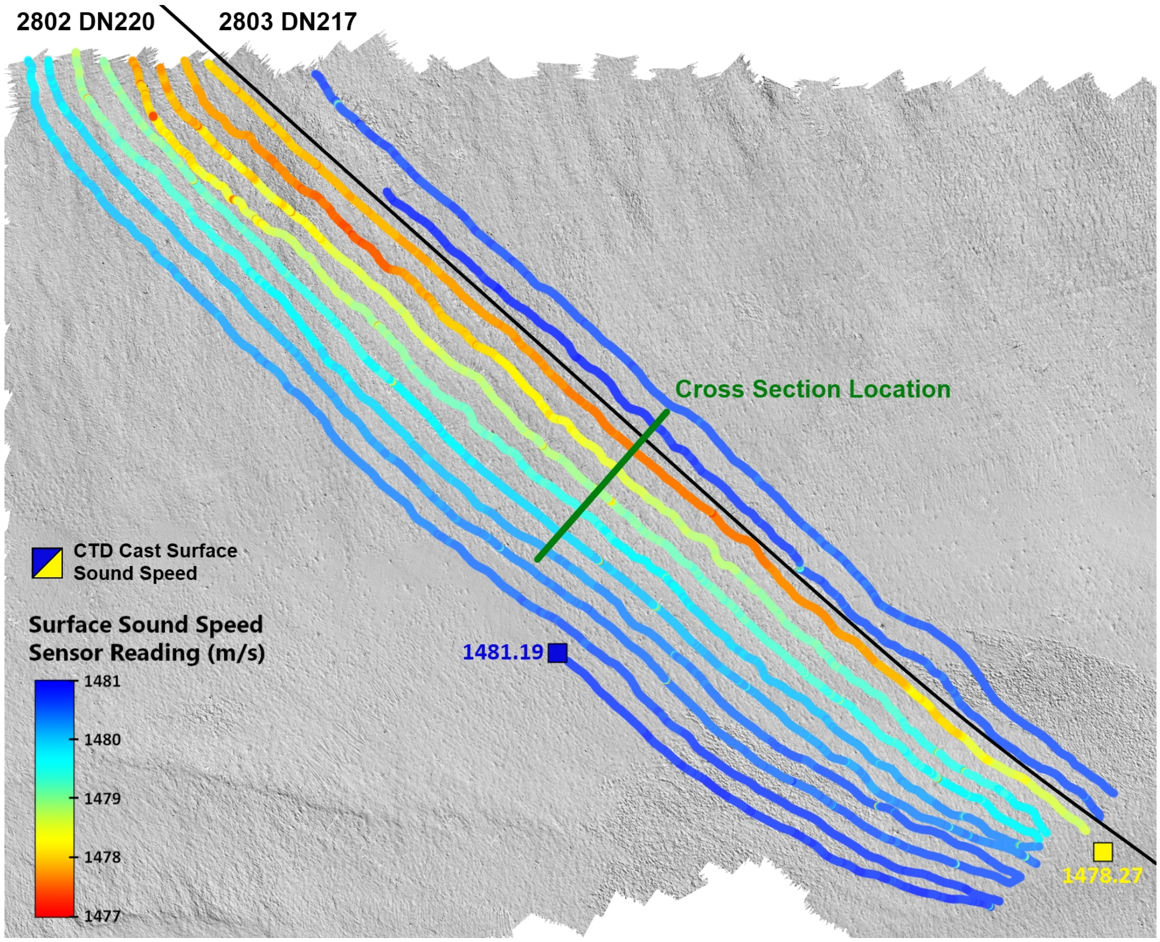


Figure 41: An example of a surface sound speed geotiff overlaid on a DTM.

B.2.4 Horizontal and Vertical Control

B.2.4.1 Horizontal Control

POSPac 000 and BASE station data processing conforms to the Ellipsoidally Referenced Surveys Standard Operating Procedure document in the Appendix IV of the FPM . By post processing the POSPac 000, GNSS and base station data, POSPac creates SBET (smoothed best estimate trajectory) files which are used by CARIS along with the corresponding POSPac 000 file to improve the data collected. Applying SBETs in CARIS HIPS increase the accuracies of attitude and navigation related data. Currently it is the responsibility of the HorCon project manager and the sheet manager to work together applying SBETs to the survey after post acquisition tasks are complete.

Initial processing requires:

• Processing RAW GPS BASE station data – When geographically possible, raw GPS data is downloaded daily from shore stations as (.T01/.T02) files. These files are converted into RINEX format using Trimble utility program “Convert to RINEX – TBC utility” v2.1.1.0. Three files are produced, files .YYg, .YYn, and .YYo.

• Obtaining Base Station OPUS Solution -- After creating RINEX files from the base station receiver raw file, the .YYo file is then submitted to OPUS in order to get a precise position solution. If bandwidth is an issue, as it usually is aboard the ship, the RINEX file may need to be decimated and zipped to get the file size smaller and achieve a reasonable upload time. A 3mb file usually takes about 3-5 minutes to upload on the ship’s Vsat.

• OPUS reference frame and format -- Once the RINEX file size is reasonable (under 7mb), go to the OPUS website at: http://www.ngs.noaa.gov/OPUS. At the OPUS site the user is given the option to choose the new IGS08 reference from or the old ITRF00 reference frame. Until further testing and verification is done, RAINIER continues to use the old ITRF00 reference frame. For Solution Formats, the extended solution + XML (DRAFT) is selected. Once processed, a NGS OPUS solution report is produced in .txt format. It is in this report that the NAD83 coordinates of the base station which are later entered into POSPac are found.

• Single Base Station Processing

1) Open Applanix POSPac™ Mobile Mapping Suite and set up the project
2) Load the Applanix 000 file (recorded on the launch)
3) Load the satellite data logged by the base station (the .YYo file that corresponds to the day number being processed).
4) Once the coordinate manager window opens, the true ITRF coordinates from the OPUS report is input. The same ITRF coordinates are used throughout the project and are checked against "new" OPUS solutions to maintain consistency.
5) Both the SBET (in ITRF format) and smrmsg error data files are created.

• Batch Processing -- Batch processing allows processing of multiple POS/MV .000 files from multiple vessels on a once per day per survey sheet basis.

• PosPac SBET Quality Control -- Once the POSPac project has completed processing successfully, quality control of the SBETs (Smoothed Best Estimated Trajectories) is performed.

• Exporting Custom SBET -- Once the QC is complete and the processing log updated, the next step is to export a custom SBET in NAD83. A custom SBET in NAD 83 is created since the DGPS beacons broadcast in NAD83 and the default SBET created by POSPac is in ITRF.

For a Single Base solution, SBETs are applied in CARIS by loading both the SBET files and error data files in smrmsg format. Every SBET file generated during single base station processing there is an associated smrmsg file.

1) Process --> Load Attitude/Navigation data… Load the custom SBET files (NAD83). Import data for Navigation, Gyro, Pitch, Roll, and GPS Height are all selected for survey launches. Only

Navigation and GPS Height are selected for the ship .

2) Process --> Load Error data… Load the smrmsg error data file. Import data for Position RMS, Roll RMS, Pitch RMS, and Gyro RMS are selected for survey launches. Vertical RMS is not selected since HIPS will default to using the trueheave RMS values. Only Position RMS is selected for the ship.

In the event that no base station falls within the 20km limit as is often the case with offshore sheets, and a Precise Point Positioning (PPP) solution utilizing precise ephemeris data is used, SBET and RMS are loaded a follows.

1) Process --> Load Attitude/Navigation data… Load the custom SBET files (NAD83). Import data for Navigation and GPS Height are selected for survey launches and the ship.

2) Process --> Load Error data… Load the smrmsg error data file. Import data for just the Position RMS, is selected for survey launches and the ship. Vertical RMS is not selected since HIPS will default to using the trueheave RMS values for the launches.

-

PROJECT	LOCATION	Ship Installed BASE Sation
S-M921-FARA-13	Offshore Washington and Oregon	none
OPR-O193-RA-13	Behm Canal, Alaska	Channel Island, AK
OPR-O322-RA-13	Chatham Strait, Alaska	Red Bluff Bay, AK
OPR-P183-RA-13	Shumagin Islands, Alaska	Bird Island, AK
OPR-P377-RA-13	South Alaska Peninsula, Alaska	none
OPR-N305-RA-13	Strait of Juan De Fuca, Washington	none

Figure 42: 2013 Project BASE stations installed

B.2.4.2 Vertical Control

All tide data is processed off of the ship by the Center for Operational Oceanographic Products and Services (CO-OPS). Although RAINIER does not process any of the tidal water level data that she collects, preliminary and final data packages are submitted to CO-OPS. All Tide & Water Level Data Packages submitted conform to the requirements of section 5.2.2.4 of the FPM and section 4 of the HSSD.

To receive final water level correctors to apply to an individual hydrographic sheet, a Request for Approved Tides/Water Levels must be submitted to the Chief of Products and Services Branch, N/OPS3. This package includes an Abstract of Times of Hydrography and digital MID MIF files of the track lines from Pydro. Once this request has been received, CO-OPS has agreed to provide final water level correctors relative to the appropriate chart datum and final tidal zoning, as soon as possible. Final approved water levels are applied to applicable data of all hydrographic surveys before data submission to PHB.

For the 2013 field season all surveys had their elevations referenced to the MLLW.

PROJECT	LOCATION	REFERENCE FRAME
S-M921-FARA-13	Offshore Washington and Oregon	MLLW
OPR-O193-RA-13	Behm Canal, Alaska	MLLW
OPR-O322-RA-13	Chatham Strait, Alaska	MLLW
OPR-P183-RA-13	Shumagin Islands, Alaska	MLLW
OPR-P377-RA-13	South Alaska Peninsula, Alaska	MLLW
OPR-N305-RA-13	Strait of Juan De Fuca, Washington	MLLW

Figure 43: 2013 Project water level reference frames

B.2.5 Feature Verification

The composite source shoreline feature file created at HSD and delivered with the Project Instructions is to be used as the only shoreline data for use in the field. The composite source file is compiled from all available source shoreline files (i.e. ENC, Geographic Cells, lidar, RNC, and Prior Surveys) into a single file in an S-57 .000 format.

In preparation for shoreline verification, the Survey Manager copied the project wide composite source file and cropped it to include only items contained on their assigned sheet. This cropped file is then saved as a HOB file named HXXXXX_Composite_Source.hob. At this point, no further edits are ever made to this HOB file and it is retained as the “starting point” to any subsequent changes discovered during shoreline verification. A copy of the original source HOB file is created and called HXXXXX_ Final_Features_File.hob. It is to this final features HOB file that any edits are performed.

The Survey Manager creates a composite shoreline reference document, the paper representation of the shoreline that will be used to write observations in the field. The HXXXXX_Composite_Source.hob file may be color coded to highlight any assigned features by using the asgnmt=Assigned field. The resultant color coded shoreline is then sent directly to the plotter from Notebook. The HXXXXX _Composite_Source.hob is also saved in an S-57 .000 format which can be directly opened in Hypack for field reference and verification where necessary.

In the field, CARIS Notebook was used to acquire DPs and/or modify S-57 attribution of existing features. Edits and DPs were collected on the most current version of the HXXXXX_ Final_Features_File.hob file. An archival copy of the final features file is saved for each day of feature verification. Daily copies are produced in order to aid feature tracking and the eventual compilation of all features in the submission HXXXXX_ Final_Features_File.hob.

De-confliction of the composite source shoreline was conducted only on items specifically addressed in the field while conducting shoreline verification. As a general rule, nearly all features inshore of the NALL line are not investigated. All conflicting composite source features that are not addressed in the field were left unedited in the final features file HOB.

Composite source features offshore of the NALL which were DPed for height were also de-conflicted if multiple shoreline features were present representing the same item. The source item most closely representing the actual feature was flagged “Primary” and “retain” or “update” if edited for height while the other extraneous features were flagged “Secondary” and “delete” with a comment “removed due to deconfliction". In the event that a DP was taken to reposition an incorrectly charted feature, all of the composite source features in the wrong position were “Secondary” and “delete”.

Primary and secondary flagged features are correlated using the NOAA custom attributes prkyid (Primary Key ID) and dbkyid (Database Key ID). The primary feature has its dbkyid populated with a unique number and any secondary features selected to be linked has its prkyid updated with the same number. The unique number assigned is typically the CARIS Feature Object ID (FOID).

For surveys where limited shoreline verification was performed, DPs and/or CARIS VBES/SWMB CUBE surfaces were used to help define kelp and foul areas. Any new line features were digitized in the HXXXXX_ Final_Features_File.hob file. If an area feature required modification, a copy of the feature was edited to reflect the current survey and characterized as "new" while the original feature was flagged as "delete". When objects were added or modified as “new”, the SORDAT and SORIND fields were updated. All features flagged as "delete" always maintain their original SORDAT and SORIND.

Investigation methods and results are described in CARIS Notebook under the S-57 attributes acronym “remrks”. In the event that charting confusion could result from just the “remrks” field, specific recommendations are described under the S-57 attributes acronym “recomd”. Any composite source features or shoreline not addressed during shoreline verification are left untouched.

All shoreline data is submitted as the edited final features file (HXXXXX_Final_Features_File) in S-57 format (.000). The SORDAT and SORIND fields are filled in for any objects added to or modified in the final features file.

Placeholder

Figure 9999: This figure can not be deleted

B.2.6 Backscatter

Although no formal processing of backscatter data were performed, backscatter data were periodically converted solely to spot check and ensure that it was being properly logged. No processed backscatter data is included with the data submission but all raw backscatter data are submitted directly to NGDC for archival purposes.

Placeholder

Figure 9999: This figure can not be deleted

B.2.7 Other

Initial data processing at the end of each survey day is the responsibility of the Night Processing Team, or Launch Crew if no Night Processing Team is assigned. The Night Processing Team is typically composed of two crewmembers, one with at least a year's experience, and one junior member in training. Daily processing produces a preliminary product in which all gross data problems have been identified and/or removed, and thus can be used by the Survey Team to plan the next day's operations. The Night Processors complete a data pass down log to inform the Survey Manager and FOO of any notable features or systematic problems in the day's data.

In addition, the Night Processing Team may be assigned to processing and QC checks of POSPac data. Final application of the POSPac data is the responsibility of the HorCon project manager and/or assistants. The HorCon Project Manager and the Sheet Manager work together to ensure SBETs were properly applying to the survey after post acquisition tasks are complete.

Final data processing and analysis is the responsibility of the Survey Team. While "ping-by-ping" data editing is not required, the Team will review the survey in its entirety to ensure that the final products reflect observed conditions to the standards set by the relevant OCS guidance. Bathymetric surfaces are reviewed with the best available correctors applied to ensure that all data quality problems are identified and resolved if possible, and all submerged features are accurately represented. Shoreline verification (if applicable) and feature data are reviewed in the context of this bathymetry. Survey documentation (including the Descriptive Report) is generated in conjunction with this review process.

Placeholder

Figure 9999: This figure can not be deleted

B.3 Quality Management

Final review of the “QC” field sheet CUBE Surface is left to the Mentor or experienced Survey Manager who inspects areas with questionable shaded depth models and/or high standard deviation to ensure that no actual features were cleaned out. The use of large subset tiles is encouraged to track coverage of problems areas.

On occasion, the resolution of the CUBE surface may not be sufficient to capture the high point of a feature. In less than 20m of water, any feature where the most probable accurate sounding was shoaler than the CUBE surface by greater than one half the allowable error under IHO S-44 Order 1 was considered inadequately captured by the CUBE surface. In greater than 20m of water, this allowable error was expanded to the full Order 1 error allowance at that depth. Although this may occur on irregular shoals or rock pinnacles, man-made features such as piles and wrecks are of particular concern. These features have very slender high points that extend far above the surrounding seafloor as well as the CUBE surface. To ensure that these features are properly represented, the shoalest point is flagged “designated” in CARIS. During the “finalization” process, the CUBE surface is forced to honor all soundings which have been flagged “designated”. In the case of a survey where the high points of many features are not being captured by the CUBE surface, (i.e. a boulder field), the hydrographer may decide to produce higher resolution CUBE surfaces to ensure that these features are being honored. Any such deviations from standard procedures will be noted in that survey’s Descriptive Report.

At the time of this report, Coast Survey has not approved multiple resolution BASE surfaces as a final deliverable. Although these surfaces are acceptable for field use, the algorithm produces artifacts at the resolution steps that are unsuitable for a final product. To circumvent this problem, single resolution CUBE surfaces were generated to be “cookie cut” and then reassembled to create the final CUBE surface from which depths are derived. Multiple CUBE surfaces are gridded using different resolutions for different depth ranges as defined in section 5.2.2.2 of the HSSD.

Under ideal circumstances, gridding should be done at the finest resolution that the data density will support. This theoretical maximum resolution was historically defined as three times the beam footprint size for a particular echosounder and depth combination. Current guidance (HSSD 5.2.2.2) states that 95% of the nodes in a cube surface shall contain at least 5 soundings per node. This minimum density of 5 soundings per node has experimentally been shown to be adequate to represent the depth of the seafloor while not being strongly influenced by a single erroneous sounding.

In order to extract data density statistics from a given sheet, the function “Compute Statistics…” was selected for each finalized surface. Statistics were calculated on the Density attribute layer with a bin size of 0.05 selected. The resulting graph and text file provide the total count of nodes and count of nodes within each bin. From these values, it is elementary to compute the percent of nodes having greater that five soundings and ensuring that the 95% benchmark was met. These results were documented within the Descriptive Report for each individual survey.

To meet the required sounding density, RAINIER adheres to the table of resolutions and depth ranges as defined in HSSD which are based on practical experience in “typical” survey areas, and a working knowledge of bottom coverage capabilities of each echo sounding system currently in use throughout the fleet. These resolutions are also based on assumed sonar system selections for each depth regime and practical data processing limitations. Deeper areas are gridded at a coarser resolution than shoaler areas where the data density is greater.

With the advent of the CARIS CSAR framework and multi-threaded CUBE processing implemented in CARIS HIPS and SIPS, it is now practical to create a single field sheet that covers an entire survey. All resolution-specific CUBE surfaces are now created in a single sheet wide field sheet. The field sheet layout and CUBE surface resolutions are described for each survey in the Descriptive Report.

Each resolution-specific CUBE surface is named according to the following convention:

H<registry #>_<resolution in meters>m

(EX: “H12345_2m” refers to the two-meter resolution surface of survey H12345)

Once the collection of CUBE surfaces accurately represent the surveyed bottom and it is certain that no further edits will be made, each CUBE surface is finalized using the resolution as defined in section 5.2.2.2 of the HSSD. All finalized CUBE surfaces are then combined at the coarsest resolution created for the data set to produce the final combined CUBE surface. The final combined CUBE surface is named by the following convention; Hxxxxx_Final_Combined.

The final CUBE surfaces are sun-illuminated from different angles and examined for coverage and as a final check for systematic errors such as tide, sound velocity, or attitude and/or timing errors. The final CUBE surface submitted in the field sheet serves to demonstrate that both SWMB coverage requirements are met and that systematic errors have been examined for quality-assurance purposes.

As a quality control (QC) measure, cross-lines with a linear nautical total of at least 4% of mainscheme multibeam lines were run on each survey. Then a CUBE surface was created using strictly the main scheme lines, while a second surface was created using only the crosslines. From these two surfaces, a surface difference was generated (at a 1 meter resolution). Statistics were then derived from the difference surface and documented within the Descriptive Report for each survey.

B.4 Uncertainty and Error Management

RAINIER’s primary bathymetric data review and quality control tool is the CARIS CUBE (Combined Uncertainty and Bathymetry Estimator) surface as implemented in CARIS HIPS. The CUBE algorithm generates a surface consisting of multiple hypotheses that represent the possible depths at any given position. The CUBE surface is a grid of estimation nodes where depth values are computed based on the horizontal and vertical uncertainty of each contributing sounding as follows:

- Soundings with a low vertical uncertainty are given more influence than soundings with high vertical uncertainty
- Soundings with a low horizontal uncertainty are given more influence than soundings with a high horizontal uncertainty.

- Soundings close to the node are given a greater weight than soundings further away from the node.

As soundings are propagated to a node, a hypothesis representing a possible depth value is developed for the node. If a sounding's value is not significantly different from the previous sounding then the same or modified hypothesis is used. If the value does change significantly, a new hypothesis is created. A node can contain more than one hypothesis. As node-to-node hypotheses are combined into multiple surfaces through methodical processing, a final surface that is the best representation of the bathymetry is created.

Any individual sounding's uncertainty, or Total Propagated Uncertainty (TPU), is derived from the assumed uncertainty in the echosounder measurement itself, as well as the contributing correctors from sound speed, water levels, position, and attitude. TPU values for tide and sound velocity must be entered for each vessel during TPU computation.

- Tide values measured uncertainty value error ranges from 0.01m to 0.05 m dependent upon the accuracy of the tide gauges used and the duration of their deployment. RAINIER is using a value of 0.0 since the Tide Component Error Estimation section of the Hydrographic Survey Project Instructions now includes the estimated gauge measurement error in addition to the tidal datum computation error and tidal zoning error.

- Tide values zoning is unique for each project area and typically provided in Appendix II of the Hydrographic Survey Project Instructions, Water Level Instructions. In section 1.3.1.1 of the Water Level Instructions, Tide Component Error Estimation, the tidal error contribution to the total survey error budget is provided at the 95% confidence level, and includes the estimated gauge measurement error, tidal datum computation error, and tidal zoning error. Since this tidal error value is given for two sigma, the value must be divided by 1.96 before it can be entered into CARIS (which expects a one sigma value). If TCARI grids are assigned to the project area, this value is set at 0.0 since TCARI automatically calculates the error associated with water level interpolation and incorporates it into the residual/harmonic solutions.

- Measured sound speed value error ranges from 0.5 to 4 m/s, dependent on temporal/spatial variability. Although the FPM recommends a value of 4 m/s when 1 cast is taken every 4-hours, RAINIER experience in the field suggests that a value of 3.0 m/s better models this error.

- Surface sound speed value is dependent on the manufacturer specifications of the unit utilized to measure surface SV values for refraction corrections to flat-faced transducers. The Reson SVP 71 fixed-mount sound velocity probe is affixed to vessels 2801 2802, 2803 and 2804 to provide correctors for the flat face Reson 7125 and in the case of 2803 the Reson 8125. A Reson SVP 70 is mounted on RAINIER to provide correctors for the EM710. The Reson SVP 71 velocity probe has a published accuracy of 0.15 m/s while the SVP 70 has a published accuracy of 0.05 m/s.

All other error estimates are read from the Hydrographic Vessel File (HVF) and Device Model file. The HVF contains all offsets and system biases for the survey vessel and its systems, as well as error estimates for latency, sensor offset measurements, attitude and navigation measurements, and draft measurements. In addition, the HVF specifies which type of sonar system the vessel is using, referencing the appropriate entry from the Device Model file.

B.4.1 Total Propagated Uncertainty (TPU)

B.4.1.1 TPU Calculation Methods

There are two places in CARIS where the user directly defines uncertainty values for use in CARIS to calculate TPU values, in the HVF and the direct input of SV and tide values during the TPU computation.

B.4.1.2 Source of TPU Values

TPU values for all motion, navigation position and timing values are taken directly from Appendix IV (Uncertainty values for use in CARIS with vessels equipped WITH an attitude sensor) of the Field Procedures Manual. All timing values were set to 0.005 seconds as outlined for setups with Ethernet connections and precise timing.

All offset values were chosen to be 0.010 meters based on the accuracy provided by professional surveys.

All MRU alignment values are derived from the patch test. The gyro value is taken directly from the standard deviation of the yaw values. The pitch/roll value is combined as one in the HVF and is computed as the square root of pitch standard deviation squared plus roll standard deviation squared.

The vessel speed uncertainty is defined as 0.03 m/s plus an average value (assumed to be 0.05 m/s) for currents for a total of 0.08 m/s . Vessel loading was determined by measuring the waterline of a single launch under a variety of fuel loading conditions (full, empty, and somewhere in between) and the standard deviation calculated. Vessel draft was determined by measuring the waterline 3 times from both the starboard and port side of each launch. The standard deviation was calculated individually for each side and the larger of these two values was selected for the HVF. Vessel delta draft was determined by measuring the standard deviation of the depth for each speed (RPM) in the dynamic draft determination. The largest of these values was selected for the HVF.

B.4.1.3 TPU Values

Vessel	2801_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees

	Navigation Position		1.000 meters
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.131 degrees
		Pitch	0.048 degrees
		Roll	0.048 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.003 meters
		Delta Draft	0.030 meters
Vessel	2801_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		1.000 meters
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters

	MRU Alignment	*Gyro*	0.073 degrees
		Pitch	0.088 degrees
		Roll	0.088 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.003 meters
		Delta Draft	0.030 meters
Vessel	2802_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 feet	
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.029 degrees
		Pitch	0.047 degrees
		Roll	0.047 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.005 meters
		Delta Draft	0.014 meters
Vessel	2802_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		

TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		1.000 meters
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.088 degrees
		Pitch	0.077 degrees
		Roll	0.077 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.005 meters
		Delta Draft	0.014 meters
Vessel	2803_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		1.000 meters

	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.118 degrees
		Pitch	0.111 degrees
		Roll	0.111 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.003 meters
		Delta Draft	0.019 meters
Vessel	2803_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude 0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 meters	
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters

	MRU Alignment	*Gyro*	0.042 degrees
		Pitch	0.064 degrees
		Roll	0.064 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.003 meters
		Delta Draft	0.019 meters
Vessel	2803_Reson8125		
Echosounder	Reson SeaBat 8125 455 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 meters	
	Timing	*Transducer*	0.008 seconds
		Navigation	0.008 seconds
		Gyro	0.008 seconds
		Heave	0.008 seconds
		Pitch	0.008 seconds
		Roll	0.008 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.012 degrees
		Pitch	0.121 degrees
		Roll	0.121 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.003 meters
		Delta Draft	0.019 meters
Vessel	2804_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		

TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		1.000 meters
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.091 degrees
		Pitch	0.050 degrees
		Roll	0.050 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.005 meters
		Delta Draft	0.028 meters
Vessel	2804_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position		1.000 meters

	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.059 degrees
		Pitch	0.075 degrees
		Roll	0.075 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.010 meters
		Draft	0.005 meters
		Delta Draft	0.028 meters
Vessel	S221_Simrad-EM710		
Echosounder	Simrad EM710 0.5x1 100 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 meters	
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters

	MRU Alignment	*Gyro*	0.047 degrees
		Pitch	0.032 degrees
		Roll	0.032 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.025 meters
		Draft	0.021 meters
		Delta Draft	0.010 meters
Vessel	S221_Simrad-EM710_TxRef		
Echosounder	Simrad EM710 0.5x1 100 kilohertz		
TPU Standard Deviation Values	*Motion*	*Gyro*	0.020 degrees
		Heave	5.000 % Amplitude
			0.050 meters
		Pitch	0.020 degrees
		Roll	0.020 degrees
	Navigation Position	1.000 meters	
	Timing	*Transducer*	0.005 seconds
		Navigation	0.005 seconds
		Gyro	0.005 seconds
		Heave	0.005 seconds
		Pitch	0.005 seconds
		Roll	0.005 seconds
	Offsets	*x*	0.010 meters
		y	0.010 meters
		z	0.010 meters
	MRU Alignment	*Gyro*	0.200 degrees
		Pitch	0.100 degrees
		Roll	0.100 degrees
	Vessel	*Speed*	0.080 meters/second
		Loading	0.025 meters
		Draft	0.020 meters
		Delta Draft	0.020 meters

B.4.2 Deviations

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

C Corrections To Echo Soundings

C.1 Vessel Offsets and Layback

C.1.1 Vessel Offsets

C.1.1.1 Description of Correctors

Vessel offset correctors are the values used to describe the location of all hydrographic sensors in relation to a defined reference point. These values are needed to compute sensor lever arms needed to correct for vessel orientation and ultimately produce the final geographic position for every sounding collected.

C.1.1.2 Methods and Procedures

For RAINIER survey launches, all vessel offset values are stored in the CARIS HVF. The POS/MVs IMU is defined as Reference Point (RP). Ideally the RP should be as close as possible to the center of rotation for the vessel as feasible and this fact was taken into account when positioning the IMU. Since the IMU is the source for all launch heave, pitch, roll, gyro, and navigation values, all of these sensors have X-Y-Z values of 0,0,0. Only Swath 1, the sonar unit, requires non-zero offset values entered.

For RAINIER, all vessel offset values are stored in the Kongsberg SIS ship file. The Reference Point (RP) has been defined as the ship’s granite block. Since the granite block was defined as the ships coordinate system origin for the Kongsberg installation survey, populating vessel offset values simply required pulling numbers directly out of this report. The IMU was not used, as is the case with the launches, since it had yet to be installed at the time of the survey. In an attempt to correct the Kongsberg data artifact discussed in section B.1.1 of this report, offset values to the approximate position of RAINIER's center of motion have been entered into the POS/MV. The values were intended to help with the pitch calculation but have thus far met with limited success.

A CARIS HVF is also maintained for RAINIER, required for application of SV and dynamic draft correctors. For this HVF, all vessel offset values have been set to 0,0,0 to avoid double-correction. The only exceptions to this are the SVP1 and SVP2 offset values (and waterline discussed in section C.2.1) that are required for SV application.

All actual offset values were surveyed and verified as described in section A.1 of this report.

Figure 44: A Zeiss Ni2 and level rod being used to confirm offsets aboard Rainier.

Figure 45: A steel measuring rod, plumb-bob, and level being used to confirm the offsets of a Rainier launch.

C.1.1.3 Vessel Offset Correctors

Vessel	2801_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 milliseconds		
Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	0.005 meters
		y	0.054 meters
		z	0.443 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.005 meters
		y	0.054 meters
		z	0.443 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2801_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	0.005 meters
		y	0.052 meters
		z	0.421 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.005 meters
		y	0.052 meters
		z	0.421 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2802_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		

Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	-0.008 meters
		y	0.047 meters
		z	0.437 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-0.008 meters
		y	0.047 meters
		z	0.437 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2802_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	-0.008 meters
		y	0.044 meters
		z	0.421 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-0.008 meters
		y	0.044 meters
		z	0.421 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2803_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		
Date	2013-03-02		

Offsets	*MRU to Transducer*	*x*	-0.006 meters
		y	0.033 meters
		z	0.451 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-0.006 meters
		y	0.033 meters
		z	0.451 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2803_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	-0.006 meters
		y	0.029 meters
		z	0.431 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	-0.006 meters
		y	0.029 meters
		z	0.431 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2803_Reson8125		
Echosounder	Reson SeaBat 8125 455 kilohertz		
Date	2013-03-02		

Offsets	*MRU to Transducer*	*x*	0.724 meters
		y	0.874 meters
		z	0.561 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.724 meters
		y	0.874 meters
		z	0.561 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	-34.000 degrees
		Roll2	
Vessel	2804_Reson7125_HF_512		
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz		
Date	2013-03-02		
Offsets	*MRU to Transducer*	*x*	0.011 meters
		y	0.028 meters
		z	0.443 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.011 meters
		y	0.028 meters
		z	0.443 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	2804_Reson7125_LF_256		
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz		
Date	2013-03-02		

Offsets	*MRU to Transducer*	*x*	0.011 meters
		y	0.024 meters
		z	0.423 meters
		x2	
		y2	
		z2	
	Nav to Transducer	*x*	0.011 meters
		y	0.024 meters
		z	0.423 meters
		x2	
		y2	
		z2	
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	
Vessel	S221_Simrad-EM710		
Echosounder	Simrad EM710 0.5x1 100 kilohertz		
Date	2013-05-08		
Offsets	*MRU to Transducer*	*x*	1.298 meters
		y	8.084 meters
		z	4.557 meters
		x2	1.193 meters
		y2	6.543 meters
		z2	4.557 meters
	Nav to Transducer	*x*	1.298 meters
		y	8.084 meters
		z	4.557 meters
		x2	1.193 meters
		y2	6.543 meters
		z2	4.557 meters
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	0.000 degrees
Vessel	S221_Simrad-EM710_TxRef		
Echosounder	Simrad EM710 0.5x1 100 kilohertz		
Date	2013-05-24		

Offsets	*MRU to Transducer*	*x*	0.000 meters
		y	0.000 meters
		z	0.000 meters
		x2	-0.105 meters
		y2	-1.541 meters
		z2	0.000 meters
	Nav to Transducer	*x*	0.000 meters
		y	0.000 meters
		z	0.000 meters
		x2	-0.105 meters
		y2	-1.541 meters
		z2	0.000 meters
	Transducer Roll	*Roll*	0.000 degrees
		Roll2	0.000 degrees

C.1.2 Layback

Layback correctors were not applied.

C.2 Static and Dynamic Draft

C.2.1 Static Draft

C.2.1.1 Description of Correctors

Static draft correctors are the z-values used to describe the difference between the measured waterline on the hull and the reference point while the vessel is at rest. Since the distance between the reference point and transducers is known, it is elementary to derive the difference between the water line and the transducer. This value is required to correct for the draft of the transducer when computing the corrected water depths.

C.2.1.2 Methods and Procedures

For RAINIER survey launches, all static draft corrector values are stored in the CARIS HVF as the waterline value. This value is measured during the HSRR, as described in section A.1. of this report, and used for the entire field season. It is assumed that this value remains relatively unchanged since little difference in draft has been seen under various fuel loading conditions.

For RAINIER, static draft corrector values are entered in the Kongsberg SIS Installation Parameters window. Unlike survey launches, loading conditions on the ship, particularly fuel and launches, does have a significant influence on static draft. To compensate, during the Kongsberg start up procedure static draft values are measured as described in section A.1 of this report. In addition to being entered into the SIS Installation Parameters window, waterline values are also entered in the CARIS HVF. This Waterline value in CARIS will only be used during Sound Velocity Correction. The Apply switch is also set to “No”. If it is set to “Yes”, the waterline value will be applied twice, once in SIS and again in Merge.

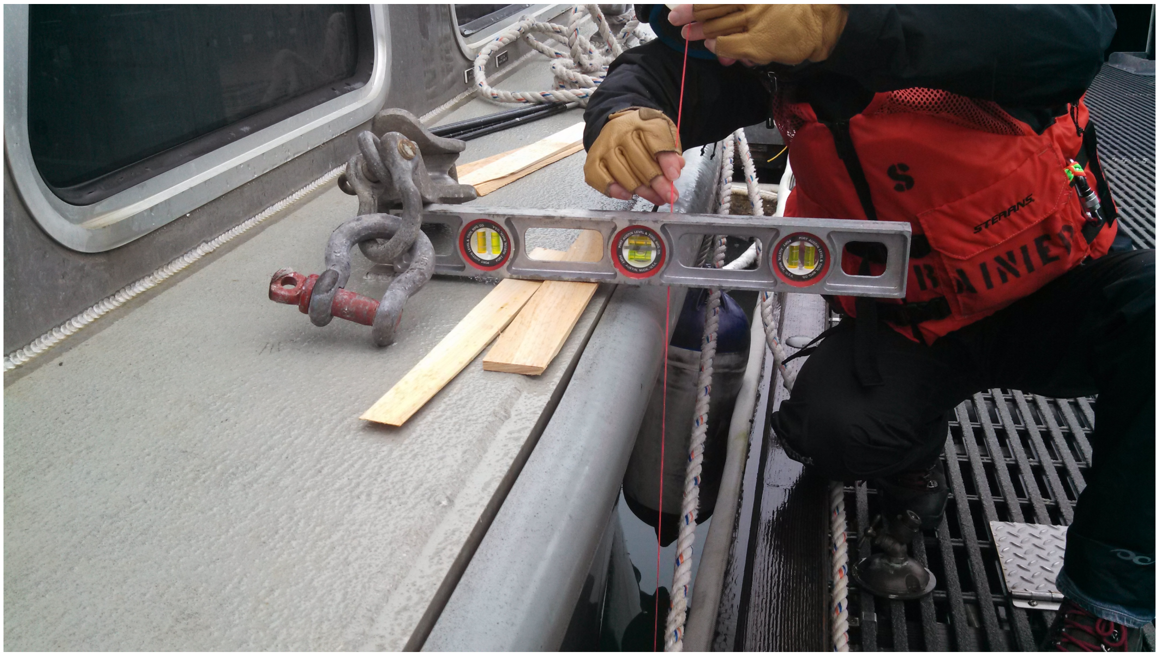


Figure 46: Measuring the waterline on a Rainier survey launch.

Figure 47: Measuring the waterline on Rainier with a Impulse 200 LR laser.

C.2.2 Dynamic Draft

C.2.2.1 Description of Correctors

The purpose of the dynamic draft and settlement & squat measurements (DDSSM) is to correlate a vessel's speed through the water with the vertical rise/fall of the vessel's Inertial Navigation System (INS) reference point (typically chosen to be coincident with Inertial Measurement Unit, IMU). Since RAINIER's launches lack a method of accurately logging speed through the water, the GPS-based speed over ground (SOG) is used as a proxy. Consequently, the presence of currents introduce errors into the DDSSM that must be mitigated by careful planning of data acquisition methods. Ideally, this test would be conducted in an area with no current, chop, or swell.

Historically, RAINIER has performed DDSSM using the ellipsoidally-referenced method in Lake Washington, which is free of tidal effects, currents, and significant wave action. After the move to Newport, Oregon, this was no longer an option. Experiments using the ellipsoidally-referenced method in both open waters of the Pacific Ocean and in the Yaquina River with daily currents up to 3 knots produced poor to unusable results. The best results were obtained by timing data acquisition to coincide with slack current but even these values were suspect. Further testing determined that the echosounder method using multibeam produced the best results in this environment.

C.2.2.2 Methods and Procedures

DDSSM for all four RAINIER launches were determined in March of 2013 on the Yaquina River in Newport, Oregon. The MBES system method as described in section 1.4.2.1.2.1 of the May 2013 version of the Field Procedures Manual was the technique used. The lines were run as close to high water slack tide as possible to minimize the amount of current due to both the Yaquina River and tidal influence. Reciprocal lines, with and against the anticipated current direction, were run at each RPM step in order to get an average speed over ground for each RMP. This average speed was used to estimate the vessel's speed through the water.

DDSSM for RAINIER was determined on May 1, 2013 using the ellipsoidally-referenced method just outside of Birch Bay, Puget Sound, Washington. 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 RMP. 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 (HVFs). Survey platforms which mount more than one acquisition system or use sonar systems with multiple frequencies have a separate HVF associated with each individual acquisition method. Each of these HVFs contains sensor offset and dynamic draft correctors that pertain to this single acquisition system. Sensor offset and dynamic draft correctors were applied to bathymetric data in CARIS during post-processing.

C.2.2.3 Dynamic Draft Correctors

Vessel	2801
Date	2013-03-02
Dynamic Draft Table	see below

Speed	0.000 me second	4.570 me second	6.540 me second	7.590 me second	8.360 me second	9.110 me second	11.260 m second	13.950 m second	13.951 m second
Draft	0.000 me	0.033 me	0.070 me	0.082 me	0.073 me	0.040 me	-0.063 m	-0.200 m	-0.200 m

Vessel	2802
Date	2013-03-02
Dynamic Draft Table	see below

Speed	0.000 mete second	4.879 mete second	6.844 mete second	7.786 mete second	8.753 mete second	10.311 me second	13.500 me second	16.570 me second
Draft	0.000 mete	0.018 mete	0.059 mete	0.074 mete	0.065 mete	0.012 mete	-0.075 met	-0.155 met

Vessel	2803								
Date	2013-03-02								
Dynamic Draft Table	*Speed*	0.000 meter second	4.870 meter second	6.560 meter second	7.530 meter second	8.350 meter second	9.270 meter second	10.970 mete second	
	Draft	0.000 meter	0.030 meter	0.060 meter	0.080 meter	0.070 meter	0.030 meter	-0.080 mete	
Vessel	2804								
Date	2013-03-02								
Dynamic Draft Table	*Speed*	0.000 meter second	4.760 meter second	6.570 meter second	7.530 meter second	8.310 meter second	9.360 meter second	12.040 mete second	
	Draft	0.000 meter	0.025 meter	0.059 meter	0.073 meter	0.070 meter	0.014 meter	-0.090 mete	
Vessel	S221 (part 1)								
Date	0013-05-24								
Dynamic Draft Table	*Speed*	0.000 mete second	0.972 mete second	1.944 mete second	2.916 mete second	3.888 mete second	4.860 mete second	5.832 mete second	6.803 mete second
	Draft	0.000 mete	0.20 meter	0.030 mete	0.040 mete	0.040 mete	0.050 mete	0.070 mete	0.080 mete
Vessel	S221 (part 2)								
Date	2013-05-24								
Dynamic Draft Table	*Speed*	7.775 meter second	8.747 meter second	9.719 meter second	10.691 mete second	11.663 mete second	12.635 mete second	13.607 mete second	
	Draft	0.110 meter	0.140 meter	0.170 meter	0.200 meter	0.230 meter	0.250 meter	0.260 meter	

C.3 System Alignment

C.3.1 Description of Correctors

For RAINIER (S221):

As part of the annual Hydrographic Systems Readiness Review (HSRR), RAINIER conducted MBES calibration tests for the Kongsberg EM710 installed on board. In spite of the Kongsberg multibeam system working on multiple frequencies (70-100 kHz), only one patch test is required since the system has only one transducer. The calibration procedure used follows that outlined in section 1.5.5.1 of the Field Procedures Manual dated April 2012. Timing, pitch and yaw bias was determined using a target on the seafloor. Roll bias was determined using the standard flat bottom method.

For all survey launches:

As part of the annual HSRR, RAINIER conducted MBES calibration tests for each individual multibeam system on all survey launches. Multibeam systems with two frequencies required an individual test for each frequency. The procedure used follows that outline in section 1.5.5.1 of the Field Procedures Manual dated April 2012. Timing bias was determined using the induced roll method. Pitch and yaw bias was determined using a target on the seafloor. And finally, roll bias was determined using the standard flat bottom method.

C.3.2 Methods and Procedures

For RAINIER (S221):

Data was converted in CARIS HIPS version using an HVF file with heave, pitch, roll and timing values set to zero. Water levels, the most recent dynamic draft, and sound velocity were applied and the data merged before cleaning via Swath Editor. Biases were determined using the CARIS HIPS Calibration tool by five individual testers. The multiple values determined for each bias by individual testers were examined by a reviewer, and obvious outliers rejected before an average was determined. This average value was then applied to the bias in question and applied to the data before moving on to the next bias determination. Bias values were determined in the following order; timing, pitch, roll, and finally yaw. These averaged values were established as the final correctors and were added to the CARIS HVF.

In addition to average values, standard deviation was also determined for each bias. These values were then used to adjust the Timing (s), MRU Roll/Pitch, and MRU Gyro uncertainties under TPU values in the HVF.

For all survey launches:

Data was converted in CARIS HIPS version using an HVF file with heave, pitch, roll and timing values set to zero. True heave, water levels, the most recent dynamic draft, and sound velocity were applied and the data merged before cleaning via Swath Editor. Biases were determined using the CARIS HIPS Calibration tool by at least 7 individual testers. The multiple values determined for each bias by individual testers were examined by a reviewer, and obvious outliers rejected before an average was determined. This average value was then applied to the bias in question and applied to the data before moving on to the next bias determination. Bias values were determined in the following order; timing, pitch, roll, and finally yaw. These averaged values were established as the final correctors and were added to the CARIS HVF.

In addition to average values, standard deviation was also determined for each bias. These values were then used to adjust the Timing (s), MRU Roll/Pitch, and MRU Gyro uncertainties under TPU values in the HVF.

C.3.3 System Alignment Correctors

Vessel	2801_Reson7125_HF_512
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz
Date	2013-04-30

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.533 degrees
	Roll	-0.212 degrees
	Yaw	0.446 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.4 System Alignment Correctors

Vessel	2801_Reson7125_LF_256	
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz	
Date	2013-03-02	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.498 degrees
	Roll	-0.244 degrees
	Yaw	0.423 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.5 System Alignment Correctors

Vessel	2802_Reson7125_HF_512	
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz	
Date	2013-03-02	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-1.089 degrees
	Roll	-0.234 degrees
	Yaw	0.633 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.6 System Alignment Correctors

Vessel	2802_Reson7125_LF_256
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz
Date	2013-03-02
Patch Test Values	
	Navigation Time Correction: 0.000 seconds
	Pitch: -1.295 degrees
	Roll: -0.215 degrees
	Yaw: 0.280 degrees
	Pitch Time Correction: 0.000 seconds
	Roll Time Correction: 0.000 seconds
	Yaw Time Correction: 0.000 seconds
	Heave Time Correction: 0.000 seconds

C.3.7 System Alignment Correctors

Vessel	2803_Reson7125_HF_512
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz
Date	2013-03-02
Patch Test Values	
	Navigation Time Correction: 0.000 seconds
	Pitch: -0.162 degrees
	Roll: -0.076 degrees
	Yaw: 0.030 degrees
	Pitch Time Correction: 0.000 seconds
	Roll Time Correction: 0.000 seconds
	Yaw Time Correction: 0.000 seconds
	Heave Time Correction: 0.000 seconds
Vessel	2803_Reson7125_HF_512
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz
Date	2013-07-14

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.328 degrees
	Roll	0.002 degrees
	Yaw	-0.274 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.8 System Alignment Correctors

Vessel	2803_Reson7125_LF_256	
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz	
Date	2013-03-02	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.243 degrees
	Roll	0.002 degrees
	Yaw	0.150 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.9 System Alignment Correctors

Vessel	2803_Reson8125	
Echosounder	Reson SeaBat 8125 455 kilohertz	
Date	2013-03-02	
Patch Test Values	*Navigation Time Correction*	-0.012 seconds
	Pitch	0.640 degrees
	Roll	0.456 degrees
	Yaw	0.430 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds
Vessel	2803_Reson8125	

Echosounder	Reson SeaBat 8125 455 kilohertz
Date	2013-07-14
Patch Test Values	*Navigation Time Correction*: 0.023 seconds *Pitch*: 1.440 degrees *Roll*: 0.480 degrees *Yaw*: 0.740 degrees *Pitch Time Correction*: 0.000 seconds *Roll Time Correction*: 0.000 seconds *Yaw Time Correction*: 0.000 seconds *Heave Time Correction*: 0.000 seconds

C.3.10 System Alignment Correctors

Vessel	2804_Reson7125_HF_512
Echosounder	Reson SeaBat 7125 (400kHz 512 Beams) 400 kilohertz
Date	2013-03-02
Patch Test Values	*Navigation Time Correction*: 0.000 seconds *Pitch*: -0.208 degrees *Roll*: 0.866 degrees *Yaw*: -0.100 degrees *Pitch Time Correction*: 0.000 seconds *Roll Time Correction*: 0.000 seconds *Yaw Time Correction*: 0.000 seconds *Heave Time Correction*: 0.000 seconds

C.3.11 System Alignment Correctors

Vessel	2804_Reson7125_LF_256
Echosounder	Reson SeaBat 7125 (200kHz 256 Beams) 200 kilohertz
Date	2013-03-02

Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.192 degrees
	Roll	0.848 degrees
	Yaw	-0.060 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.12 System Alignment Correctors

Vessel	Simrad	
Echosounder	Simrad EM710 0.5x1 100 megahertz	
Date	2013-04-30	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	0.000 degrees
	Roll	0.000 degrees
	Yaw	179.919 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.3.13 System Alignment Correctors

Vessel	S221_Simrad-EM710_TxRef	
Echosounder	Simrad EM710 0.5x1 100 kilohertz	
Date	2013-05-24	
Patch Test Values	*Navigation Time Correction*	0.000 seconds
	Pitch	-0.012 degrees
	Roll	0.051 degrees
	Yaw	179.978 degrees
	Pitch Time Correction	0.000 seconds
	Roll Time Correction	0.000 seconds
	Yaw Time Correction	0.000 seconds
	Heave Time Correction	0.000 seconds

C.4 Positioning and Attitude

C.4.1 Description of Correctors

Heave, pitch, roll and heading, including attitude biases and navigation timing errors.

C.4.2 Methods and Procedures

Attitude and Heave data were measured with the sensors described in Section A, and applied in post-processing during SVP Correct and Merge in CARIS HIPS.

RAINIER and all of her SWMB equipped survey launches utilize a heave filter integration method known as “TrueHeave” as described in Section 3 of the OCS Field Procedures Manual. This dramatically reduces the filter settling time as compared to the traditional heave filter, almost completely eliminating the need for steadying up on lines before logging can begin.

TrueHeave data application to Kongsberg EM 710 multibeam data collected by RAINIER prior to DN 151 can be problematic due to a bug in the Simrad SVC module used by CARIS. Please refer to section B.1.1.1 , Kongsberg EM710 Data Artifact, of this report for more information.

TrueHeave data were logged throughout the survey day, independent of line changes. A new POS file need be created only in the event that the acquisition computer crashes. Every “POS” file is named in such a manner to be easily identifiable with the applicable year, DN and VN (ex: 2011_285_2801.000). TrueHeave files are transferred to the “POSMV” folder of the CARIS preprocessed data drive (ex: H:\OPR-O190-A-11\H12289\POSMV\2801(RA-4)\DN265 contains TrueHeave data acquired by vessel 2801 on day number 265 for sheet H12289) for later submission to the PHB. In the event of computer crashes, multiple POS files have their names appended with “A”, “B”, and so on in the order they were collected. After regular CARIS data conversion, the TrueHeave file was separately loaded into HIPS, replacing the unfiltered heave values recorded in the raw data. TrueHeave is actually applied to the data, if the checkbox is marked, during the sound velocity correction process.

It is standard procedure to begin logging the POS/MV Applanix .000 file at least 5 minutes before starting bathymetric data acquisition and letting it run for at least 5 minutes afterward. Although the filter that produces the true heave values by looking at a long series of data to create a baseline needs only 3 minutes before and after the acquisition of bathymetric data, SBET processing which uses the same .000 file requires logging for 5 minutes before and after bathymetric acquisition.

Timing and attitude biases were determined in accordance with Section 1 of the Field Procedures Manual, and are described in section “C” of this report.

All RAINIER survey launch offsets, dynamic draft correctors, and system bias values are contained in CARIS HIPS Vessel Files (HVFs) and were created using the program Vessel Editor in CARIS. These offsets and biases are applied to the sounding data during processing in CARIS.

Due to both software bugs and the workaround procedures affecting the Kongsberg EM710 implementation aboard RAINIER as detailed section B.1.1.1 of this report, offsets, dynamic draft correctors, and system bias values are spread out between the ship's HVF, SIS configuration and POS/MV configuration.

C.5 Tides and Water Levels

C.5.1 Description of Correctors

Water level correctors are typically applied to RAINIER hydrographic data by one of two methods; 1) discrete zones by way of a CO-OPS supplied zone definition file (.zdf) or by 2) TCARI, the Tidal Constituent And Residual Interpolator by way of a CO-OPS supplied TCARI grid file (.tc).

Depending on vertical control requirements, CO-OPS may require the installation of subordinate tide gauge(s) in the project area. If subordinate tide gauge(s) are used, station packages are sent to CO-OPS following installation, performance of bracketing levels, and removal as required by Section 4.6.1 of NOAA HSSD.

Upon completion of sheet, Pydro is used to generate a request for final tides which includes a times of hydrography abstract and mid/mif tracklines. This request is submitted via email to Final.Tides@noaa.gov with the project number and sheet number in the subject line of the email. Once CO-OPS receives this request, a review of the times of hydrography, final tracklines, and six-minute water level data from all applicable water level gauges is conducted.

After this review if there are no issues, CO-OPS will send a notice indicating that the tidal zoning scheme (.zdf or .tc) sent with the project instructions has been approved for final zoning. If there are discrepancies, CO-OPS will make the appropriate adjustments and forward a revised tidal zoning scheme to the ship for final processing.

DISCRETE ZONES

For daily processing, soundings are reduced to Mean Lower-Low Water (MLLW) using predicted water levels files supplied with the project instructions. The predicted water level data are applied to the survey depths in CARIS using height ratio and time correctors from a preliminary CO-OPS provided zone definition file. No real-time tide or water level corrections of soundings took place in during data acquisition.

After the conclusion of data acquisition, CO-OPS will either accept preliminary zoning as the final zoning or supply a revised zoning file. Verified six-minute water level data is downloaded for the operating station(s) providing water level reducers for the project as listed in section 1.3.1 of the Water Level Instructions. Once all required water levels are downloaded, they are loaded from the main menu in CARIS HIPS, Process > Load Tide… and the zdf file is selected.

TCARI

To reduced soundings to Mean Lower-Low Water (MLLW), the TCARI grid file sent from CO-OPS is loaded into Pydro. Once in Pydro the TCARI grid may be examined along with the list of tide stations that affect it. TCARI utilizes all tide stations in the project area (historical and currently operating) for harmonic constants and datums. Only those stations selected in the residual column are used for residuals. Residuals are the difference between observed water levels and predicted water levels due to non-tidal components such as meteorological effects. The TCARI Project Instructions sent for each project list the stations required for residuals that must be downloaded from the CO-OPS website.

For initial daily processing, soundings were reduced to Mean Lower-Low Water (MLLW) using predicted water levels from the preliminary TCARI file supplied with the project instructions. Applying tides with the TCARI file by itself without loading any water level data simply applies predicted tides without any of the residual correctors that observed water levels would provide.

After the conclusion of data acquisition, verified six-minute water level data for operating stations supplying residuals as listed in section 1.3.6 of the Water Level Instructions are downloaded on the MLLW datum in meters and UTC. TCARI tides are loaded and applied directly to CARIS HDCS data using Pydro. Once all required water levels are downloaded, they are loaded from the main menu bar, Tides > Load WL Data. Tide reducers are generated for HDCS bathymetry from the main tool bar, Tides >CARIS TCARI Tide>Load TCARI Tide in HIPS PVDLs. At this time HDCS data is selected by project, vessel, and day with individual lines selected with the Descend/Confirm button. TCARI then creates new "Tide", "TideLineSegments", and "TideTmIDX" files for each line of bathymetry. Once TCARI created the new tide files, the lines were re-merged in CARIS to force the changes to take effect.

TCARI automatically calculates the error associated with water level interpolation. This error is incorporated into the residual/harmonic solutions and included in the Total Propagated Error (TPE) for the survey. Although the uncertainty values input into TCARI model are 2-sigma, Pydro automatically supplies 1-sigma values to CARIS when computing uncertainty.

C.5.2 Methods and Procedures

After the conclusion of data acquisition, water levels were applied to the soundings of each individual project as follows:

S-M921-FARA-13, Offshore Washington and Oregon, Washington and Oregon
There is no Vertical Control requirement for this project. In CARIS HIPS a zero tide file was applied to all survey lines.

OPR-O193-RA-13, Behm Canal, Alaska
Preliminary water levels are generated using height ratio and time correctors from the CO-OPS supplied zone definition file O193RA2013CORP.zdf and verified observed water levels from Ketchikan (945-0460). In addition, a 30-day subordinate station installed at Burroughs Bay (945-0917) is required to provide tidal datums, water level reducers, refinement to final zoning, and harmonic constituents.

OPR-O322-RA-13, Chatham Strait, Alaska
Preliminary water levels are generated using height ratio and time correctors from the CO-OPS supplied TCARI file O322RA2013.tc and verified observed water levels from Sitka (945-1600) and Port Alexander

(945-1054). Sheet #1 (H1231) is approximately 20 Nm south of the rest of the project and not covered by O322RA2013.tc and requires its own TCARI file, O322RA2013_v2_Sheet1_ONLY.tc In addition, a 30-day subordinate station installed at Red Bluff Bay (945-1467) is required to provide tidal datums, water level reducers, refinement to final zoning, and harmonic constituents.

OPR-P183-RA-13, Shumagin Islands, Alaska
Preliminary water levels are generated using height ratio and time correctors from the CO-OPS supplied zone definition file P183RA2013CORP.zdf and verified observed water levels from Sand Point (945-9450). In addition, a 30-day subordinate station installed at Bird Island (945-9251) is required to provide tidal datums, water level reducers, refinement to final zoning, and harmonic constituents.

OPR-P377-RA-13, South Alaska Peninsula, Alaska
Preliminary water levels are generated using height ratio and time correctors from the CO-OPS supplied zone definition file P377RA2013CORP.zdf and verified observed water levels from King Cove (945-9881). In addition, a 30-day subordinate station installed at Cold Bay (945-9949) is required to provide tidal datums, water level reducers, refinement to final zoning, and harmonic constituents.

OPR-N305-RA-13, Strait of Juan De Fuca, Washington
Preliminary water levels are generated using height ratio and time correctors from the CO-OPS supplied zone definition file P183RA2013CORP.zdf and verified observed water levels from Friday Harbor (9449880) and Port Townsend (9444900).

C.6 Sound Speed

C.6.1 Sound Speed Profiles

C.6.1.1 Description of Correctors

Sound velocity profiles for RAINIER survey launches were acquired with SeaBird Electronics SeaCat SBE19 and SBE 19Plus Conductivity, Temperature, and Depth (CTD) profilers or with the Brooke Ocean Moving Vessel Profiler MVP30. For ship acquisition, sound velocity profiles were acquired with the Brooke Ocean Moving Vessel Profiler MVP200. All RAINIER launches (2801, 2802, 2803, and 2804) are equipped with 24-volt electric winches attached to small swing-arm davits to deploy and recover SV profilers while the vessel is at rest.

C.6.1.2 Methods and Procedures

For both the individual SeaCat profilers, the launch mounted MVP-30, and RAINIER’s MVP-200, sound velocity profiles for CARIS were computed from raw pressure, temperature, and conductivity measurements using the program Velocipy. Velocipy was supplied to RAINIER by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP). Velocipy generated sound velocity profiles for CARIS in the .SVP format.

For survey launches, the speed of sound through the water was determined by a minimum of one cast for every four hours of SWMB acquisition, as strongly recommended in the NOS Hydrographic Surveys Specifications and Deliverables manual. Casts were conducted more frequently when changing survey areas, or when it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles. Additionally, drastic changes in the surface sound velocity indicative of the need for a new cast were determined by observation of the real-time display of the Reson SVP 71 mounted on all RAINIER SWMB launches.

While conducting survey operations on a launch with the MVP30 mounted, casts may be taken as often as every 15 minutes. This increased frequency is in part due to the ease of acquiring casts without losing time by stopping to take a static cast.

While conducting survey operations with the ship and the MVP200, the frequency of cast was determined with the aid of the program “CastTime” developed at the University of New Hampshire’s Center for Coastal and Ocean Mapping / Joint Hydrographic Center. This tool monitors oceanographic variability in real-time based on sound speed data acquired by the MVP200. From this information, CastTime provides recommendations for optimal water-column sampling intervals. As a result, ship personnel are no longer required to subjectivity take casts based on some arbitrary time interval. Rather an improvement in sounding accuracy is realized with a sampling interval based on constant monitoring of oceanographic variability. In addition CastTime also prevent needless overworking of the underway profiler, saving on wear and tear maintenance costs for the MVP200 system.

When CastTime determines the need for a cast, the user is notified. After the first two casts are acquired at the configured initial sampling interval, the time of next cast is based purely on the real-time oceanographic variability and comparison to the previous cast. Each time a cast is acquired by the MVP and sent to CastTime, the data is sent automatically to SVP Editor where the profile can be viewed and edited. After any edits the cast is extended using climatological data from the World Ocean Atlas. This edited, extended cast is then sent directly to the SIS acquisition computer.

SIS also monitors changes in the surface sound speed vs. the value obtained with the last cast in real-time. The user is then warned for the need of a new cast by highlighting both the “SV Profile” and “SV Used” numerical displays in yellow with a difference greater than 3 m/s and red for a difference greater than 5 m/s.

Processed MVP casts sent directly to the Kongsberg EM710 are applied to all subsequent SWMB data. This method has the drawback that the MVP cast taken prior to the collection of the SWMB data will always be applied rather than the SV cast that is geographically closest. This shortcoming may be circumvented by post applying SV data to all EM710 data in CARIS HIPS/SIPS.

All sound velocity profiles for CARIS, both CTD and MVP, are concatenated into a vessel-wide file in order of ascending time/date and saved in the appropriate vessel subdirectory of each sheet’s SVP folder. At the discretion of each individual sheet manager, a sheet-wide concatenated containing all sound velocity profiles may be generated and saved in the root of each sheet’s SVP folder. These concatenated file(s) are then applied to all HDCS data acquired, including that of the EM710, with the option “Nearest in distance within time (4 Hours)” selected under the “Profile Selection Method”. On occasion, SV issues seen in the sounding data as characteristic “smiles” and “frowns” may force the Hydrographer to deviate from this standard. Refer to individual Descriptive Reports for further information regarding the application of sound velocity correctors specific to each survey.

C.6.2 Surface Sound Speed

C.6.2.1 Description of Correctors

All multibeam systems utilized on aboard RAINIER require a sound velocity probe to be interfaced with the sonar acquisition unit for use in projector steering computations. During all survey operations, surface sound velocity probes are on at all times. In the event of a velocity probe failure, survey operations immediately cease until the failure is corrected.

C.6.2.2 Methods and Procedures

The Reson 7125 SWMB systems utilized on vessels 2801, 2802, 2803 and 2804 require a sound velocity probe to be interfaced with the sonar acquisition unit for use in projector beam steering computations. A Reson SVP 71 surface sound velocity probe is utilized to feed real time SV values directly into the 7-P Sonar Processing Unit.

The Reson 8125 SWMB system utilized on vessel 2803 also requires a sound velocity probe to be interfaced with the sonar acquisition unit for use in projector steering computations. The Reson SVP 71 surface sound velocity probe already in place for use by the Reson 7125 SWMB system is also used to feed real time SV values for the Reson 8125 SWMB system via the 81-P Sonar Processor unit.

The Kongsberg EM 710 multibeam systems utilized on aboard RAINIER requires a sound velocity probe to be interfaced with the sonar acquisition unit for use in projector steering computations. A Reson SVP 70 surface sound velocity probe is utilized to feed real time SV values directly into the acquisition computer for use in beam steering calculations. RAINIER’s MVP is also interfaced to send cast information directly to the SIS acquisition computer. SIS monitors changes in the surface sound speed vs. the value obtained with the last cast in real-time. The user is then warned for the need of a new cast by highlighting both the “SV Profile” and “SV Used” numerical displays in yellow with a difference greater than 3 m/s and red for a difference greater than 5 m/s.

D. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were followed during the 2013 field season. All operations were conducted in accordance with the Office of Coast Survey Field Procedures Manual (April 2013 edition), NOS Hydrographic Surveys Specifications and Deliverables (April 2013 edition), and all Hydrographic Technical Directives issued through the dates of data acquisition. All departures from these standard practices are described in this Data Acquisition and Processing Report and/or the relevant Descriptive Reports.

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

Richard T. Brennan
2013.11.13 10:26:36 -08'00'

Approved and Forwarded: ______________________________

Richard T. Brennan, CDR/NOAA
Commanding Officer
NOAA Ship *Rainier*

In addition, the following individual was also responsible for overseeing data acquisition and processing of this project:

James Jacobson
I am the author of this document
2013.11.07 11:32:19 -08'00'

Chief Survey Technician: ______________________________

James B. Jacobson
Chief Survey Technician
NOAA Ship *Rainier*

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