Cover Sheet (NOAA Form 76-35A)

NOAA FORM 76-35A

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

Data Acquisition and Processing Report

Type of Survey HYDROGRAPHIC

Field No OPR-Q191-KR-07

Registry No. H11712, H11713, H11714, H11715, H11716, H11717, H11718, H11719, & H11720

LOCALITY

State ALASKA

General Locality KRENITZIN ISLANDS

Sublocality North of Unalga Island to NE of Sedanka Island

2007

CHIEF OF PARTY

DEAN MOYLES

LIBRARY & ARCHIVES

DATE ....

U.S. GOV. PRINTING OFFICE: 1985—566-054

Title Sheet (NOAA Form 77-28)

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION **HYDROGRAPHIC TITLE SHEET**	REGISTER NO. H11712, H11713, H11714, H11715, H11716, H11717, H11718, H11719, & H11720
INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office	FIELD NO.

State Alaska

General Locality Krenitzin Islands

Locality North of Unalga Island to NE of Sedanka Island

Scale 1:10,000 Date of Survey 06/15/07 – 07/28/07

Instructions dated June 15, 2006 Project No. OPR-Q191-KR-07

Vessel R/V Davidson (1066485) , R/V R2 (623241), R/V D2 (647782)

Chief of party DEAN MOYLES

Surveyed by ORTHMANN, REYNOLDS, GILL, MOUNT, STOCK, FARLEY, BRIGGS, POECKERT, ET AL

Soundings taken by echo sounder, hand lead, pole RESON 8101 (R2 & D2 - HULL MOUNT), RESON 8111 (DAVIDSON - HULL MOUNT)

Graphic record scaled by FUGRO PELAGOS, INC. PERSONNEL

Graphic record checked by FUGRO PELAGOS, INC. PERSONNEL

Protracted by N/A Automated plot by N/A

Verification by

Soundings in METERS at MLLW

REMARKS: The purpose of this work is to provide NOAA with modern and accurate hydrographic survey data for the areas in Alaska's Krenitzin Islands north of Unalga Island extending to the northeast of Sedanka Island.

ALL TIMES ARE RECORDED IN UTC.

Fugro Pelagos, Inc.
3738 Ruffin Rd.
San Diego, CA 92123

John Oswald & Associates LLC
2000 E. Dowling Rd, Suite 10
Anchorage, AK 99503

Stabbert Maritime
4 Nickerson St., Suite 301
Seattle, WA 98109

NOAA FORM 77-28 SUPERSEDES FORM C & GS-537 U.S. GOVERNMENT PRINTING OFFICE: 1986 - 652-007/41215

A – Equipment

The R/Vs Davidson, R2, and D2 acquired all of the sounding data during the course of this survey. The R/V Davidson collected multibeam data and sound velocity profiles in medium to deep water depths. The R/Vs R2 & D2 collected multibeam data and sound velocity profiles in shallow to medium water. The equipment list and vessel descriptions are included in Appendices I and II.

SOUNDING EQUIPMENT

The R/V Davidson was equipped with a hull mounted Reason 8111 multibeam system during the OPR-Q191-KR-07 project. The Reson 8111 system operates at a frequency of 100 kHz, with 101 horizontal beams centered 1.5º apart (150º across-track beam width) and 1.5º along-track beam width. It transmits and receives a sonar signal to measure the relative water depth over the 150º swath. The range scale, gain, power level, ping rate, etc., were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1).

The line orientation for the Davidson was generally parallel to the coastline and bathymetric contours in the area. The line spacing was dependent on the water depth and data quality, but never exceeded three times the water depth.

The R/V R2 was equipped with a hull mounted Reson SeaBat 8101 multibeam system during the OPR-Q191-KR-07 project. The Reson 8101 system operates at a frequency of 240 kHz, with 101 horizontal beams centered 1.5º apart (150º across-track beam width) and 1.5º along-track beam width. It transmits and receives a sonar signal to measure the relative water depth over the 150º swath. The range scale, gain, power level, ping rate, etc., were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1).

The line orientation for R2 was generally parallel to the bathymetric contours in the area. The line spacing depended on the water depth and data quality, but never exceeded three times the water depth.

The R/V D2 was equipped with a hull mounted Reson SeaBat 8101 multibeam system during the OPR-Q191-KR-07 project. The Reson 8101 system operates at a frequency of 240 kHz, with 101 horizontal beams centered 1.5º apart (150º across-track beam width) and 1.5º along-track beam width. It transmits and receives a sonar signal to measure the relative water depth over the 150º swath. The range scale, gain, power level, ping rate, etc., were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1).

The line orientation for D2 was generally parallel to the bathymetric contours in the area. The line spacing depended on the water depth and data quality, but never exceeded three times the water depth.

R/Vs R2 and D2 were also used to perform shoreline verification. The vessels were equipped with a POS/MV system, WinFrog (v3.7.0) data acquisition system, Laser range finder binoculars (with built-in compass), and a Sony digital camera. NOAA nautical charts, Remote Sensing Division (RSD) features, and multibeam coverages were displayed as layers in WinFrog for reference. All soundings on submerged features were collected by one of the multibeam systems.

Heights were taken on features awash or above the water level by visual estimation, using simultaneous comparison to a known reference (the vessel's bow).

SIDE SCAN SONAR

Towed Side Scan Sonar (SSS) operations were not required by this contract. Backscatter data collected by the Reson 8111 and 8101 multibeam systems was logged, but used only to facilitate data cleaning.

POSITIONING EQUIPMENT

Each vessel was equipped with an Applanix Position and Orientation System for Marine Vessels (POS/MV) to measure and calculate each position. Position was determined in real time using a Trimble Zephyr L1/L2 GPS antenna, which was connected to a Trimble BD950 L1/L2 GPS card residing in the POS/MV. The POS/MV was configured to accept differential corrections, which were output from a CSI MBX-3S Coast Guard beacon receiver. This unit also provided the position and velocity values to the POS/MV's Inertial Measurement Unit (IMU). The inertial navigation system implemented by the POS/MV computes a position by way of complex dead reckoning using GPS position, heading, and motion of the IMU.

An MBX-S differential receiver that used the U.S. Coast Guard (USCG) network of differential beacons was the main source of RTCM (Radio Technical Commission for Maritime Services) corrections. It was also necessary to acquire dual frequency GPS data at known locations on the ground so that a post-processed kinematic (PPK) solution could be used for final positioning. Sub-contractor John Oswald & Associates LLC (JOA) established two local control points: station "Malga A" and station "Malga B" in Malga Bay on Unalga Island, AK. Refer to Appendix II of the OPR-Q191-KR-07 "Horizontal & Vertical Control Report" for procedures and results.

The numerous real time displays of the POS/MV controller software were monitored throughout the survey to ensure that the positional accuracies specified in the NOS Hydrographic Surveys Specifications and Deliverables (April 2007) were achieved. These include, but were not limited to the following: GPS Status, Position Accuracy, Receiver Status (which included HDOP), and Satellite Status. During periods of high HDOP and/or low number of available satellites, survey operations were suspended.

SOFTWARE

Acquisition

The primary data sets were collected with Isis Sonar (v 7.1428.53) from Triton Imagining, Inc. Isis Sonar operated on an Athlon 2800 Dual Processor PC running Windows XP Pro. Data were logged in the XTF file format. The XTF files contain all multibeam bathymetry, position, attitude, heading, and UTC time stamp data required by CARIS to process the soundings. Delph Map was utilized on the same computer to assist with real time QC of the acquired data.

The following display windows are available in Isis & Delph Map for operators to monitor data quality:

1. Parameter Display: The display window shows navigation, attitude, and heading information. It gives the user the ability to switch files during data acquisition and also displays important information on ping count and file size.
2. View 2-D and 3-D: The 2-D window displays the current multibeam profile. The 3-D window displays a 3-D mesh of the current line of profiles. The data in both windows have attitude data applied for quality control purposes.
3. Waterfall: The Waterfall displays backscatter data.
4. Graph Window: The user can display the sensor data in a graphical format, which aids in determining heave filter settings for the POS/MV.
5. Delph Map: Delph Map displays binned soundings in plan view or 3-D. The bin size is user defined and can be filtered by beam number and sounding quality.

The Davidson, R2, and D2 were all equipped with an additional computer running WinFrog (v3.7.0).

WinFrog offers the following display windows for operators to monitor data quality:

1. Devices: The Devices window shows the operator which hardware is attached to the PC. It also allows the operator to configure the devices, determine whether they are functioning properly, and to view received data.
2. Graphic: The Graphic window shows navigation information in plan view. This includes vessel position, survey lines, background vector plots, and raster charts.
3. Vehicle: The Vehicle window can be configured to show any tabular navigation information required. Typically, this window displays position, time, line name, heading, HDOP, speed over ground, distance to start of line, distance to end of line, and distance off line. Many other data items are selectable.
4. Calculation: The Calculation window is used to look at specific data items in tabular or graphical format. Operators look here to view the status of the GPS satellite constellation and position solutions.

In addition to monitoring position, attitude, and heading accuracies, the Applanix POS/MV controller software was used to log raw POS/MV data—the standard POSPac logging groups, along with groups 3 (Primary GPS Data), and 102 (Sensor 1 Data). These data were collected via the Ethernet to the WinFrog computer at an update rate of 50 Hz and later post-processed and applied in CARIS HIPS.

MBSurvey Tools was used to aid in file administration and reporting during data acquisition. This program created a daily file that contained survey line, SVP, and static draft logs. These files were stored digitally, thus eliminating the constant printing and manual input of items such as line start and end times, Reson settings, etc., on each log sheet.

Processing

All Soundings were processed using CARIS (Computer Aided Resource Information System) HIPS (Hydrographic Information Processing System) (v6.1).

AutoDesk Map R 5.0 and ESRI ArcMap (v9.2) were utilized for general survey planning, reviewing coverage plots, creating fill-in lines, tielines, etc.

ESRI ArcMap (v9.2) with the Shoreline Correlator add-on was utilized for processing the additional item investigations, such as Detached Positions (DPs).

Applanix POSPac (v4.3) was utilized for post-processing the dual frequency GPS data sets acquired by the survey vessels and the base stations. For every survey day and vessel, a new project was set up in POSPac. The software then extracted the POS data collected on the survey vessel into the POSPac project; separating it into component data sets such as (IMU), primary GPS, and secondary GPS.

Using POSGPS—part of the POSPac suite—dual frequency GPS data from the vessels and ground control base stations were converted from their native format (Trimble), to the POS GPS .gpb format. The PPK data sets were then post-processed using the John Oswald & Associates LLC (JOA) antenna phase center positions given in Appendix II of the Horizontal and Vertical Control Report.

The POSPac module POSProc then used the post-processed PPK positions to post-process the POS/MV attitude data and refine the inertial solution. The final solution was exported to an sbet.out file, which was then used by an in-house converter program that extracted the PPK positions used in the CARIS Generic Data Parser (GDP) program.

MBSurvey Tools was used to extract True Heave data from the raw POS data collected on the survey vessels. This text file was parsed to a format acceptable by the CARIS Generic Data Parser using MBSurvey Tools. This was utilized only on days when the GPS rollover week became problematic. Otherwise the True Heave was applied via CARIS HIPS & SIPS (v6.1).

A complete summary of the GPS post processing accuracy estimates can be found in Appendix III of the Horizontal and Vertical Control Report.

Sound Velocity Profiles

Sound velocity profile (SVP) data from the Applied Microsystems Ltd. (AML) Smart Probes were acquired using Windows' Hyper Terminal. MBSurvey Tools was used to split the profile into up and down components, decimate the data, and write a CARIS format that contained time and position. A complete list of software and versions used on this project is included in Appendix I. Refer to the "2007-NOAAProcessing Procedures" document for a detailed processing routine with procedures used.

B –Quality Control

With the implementation of the Combined Uncertainty and Bathymetry Estimator (CUBE) in CARIS, a different approach is taken in the analysis of data sets. In the HIPS vessel configuration file (HVF) we now input or create an error model of our survey sensors that is used to calculate the Total Propagated Error (at the 95% Confidence Interval for the horizontal and vertical components) for each individual sounding collected during data acquisition. The values that were input into the CARIS HVF for the survey sensors are the specified manufacturer accuracy values and can be downloaded from the CARIS website @ http://www.caris.com/tpe/ . The following is a breakdown on the manufacturer and Fugro Pelagos derived values used in the error model (which are entered into the CARIS HVF and Fugro_CUBEParams.xml files):

- Navigation – In the CARIS HVF a value of 0.25m was entered for the Positional accuracy. Vessels were equipped with an Applanix POS/MV 320 and all raw positions were post-processed and the PPK solution parsed back into the data set. The accuracies yielded from the PPK routine were usually less than ten centimeters.
- Gyro/Heading – As mentioned above, the vessels were equipped with a POS/MV 320 and had a baseline of about 3m, so therefore a value of 0.020 degrees was entered in the HVF.
- Heave – The heave percentage of amplitude was set to 5%, and the Heave was set to 0.05m, as per the manufacturer accuracy values.
- Pitch and Roll - As per the manufacturer accuracy values, both were set to 0.020 degrees.
- Precise Timing – All data were time stamped when created, not when logged, using a single clock/epoch. Position, attitude, (including True Heave) and heading, are all time stamped in the POS/MV on the UTC epoch. This UTC string was also sent to the Reson processors and ISIS software via a serial string, yielding timing accuracies better than one millisecond.
- All vessel and sensor offsets were derived via conventional surveying techniques while the vessels were in dry dock. The results yielded a standard deviation of 0.025m.

- Tide values and Zoning were both set to 0.05m during TPE computing.
- Sound Speed Values were set to 1 m/s and 2.5 m/s for the Surface.
- IMU Align StdDev for the Gyro and Roll/Pitch were set to zero.

The calculated horizontal and vertical uncertainty or Total Propagated Error (TPE) values were then used to:

- filter the data to IHO Order 1 specifications
- create a CUBE surface used during subset cleaning stages
- create the final combined Bathymetric with Associated Statistical Error (BASE) surfaces.

The discussion that follows is an overview of our processing flow:

In order for the XTF files collected by ISIS to be used in CARIS, they must be converted to HDCS format using an XTF converter routine. Prior to the XTF files being converted using the XTF to HDCS function, vessel offsets, patch test calibration values, TPE values, and static draft were entered into the vessel configuration file.

Once converted, the SVP, Dynamic Draft, True Heave, and PPK data were loaded into each line and SVP corrected in CARIS HIPS. Once SVP corrected, the TPE was computed for each sounding in CARIS HIPS. The attitude, navigation, and bathymetry data for individual lines were examined for noise, as well as to ensure the completeness and correctness of the data set. Filter setting files used during processing of the Reson 8111 and 8101 lines were: TPE-60-012.hft and TPE-65-012.hft, which rejected beams outside IHO Order 1, beams greater than 60 and 65 degrees past nadir, and all soundings with a quality flag other than 3 (a quality flag is assigned to each sounding by the multibeam system). Data quality determined which filter setting file was applied. Note: “Rejected” does not mean the sounding data point was deleted, but that it was flagged as being bad. Data flagged as rejected due to the angle from nadir parameters, did contain valid data, but the routine was conducted to flag noise and speed the processing flow. Valid data could be reinserted into the data set during the line and subset editing phase to fill data gaps. The filter settings used were noted on each corresponding line log (refer to Separate 1).

In high noise areas additional filters may have been applied to specific sections or entire lines. In these instances, the additional filters were noted on the line logs (refer to Separate 1).

After each individual line was examined and cleaned in CARIS HIPS the tide zone file was loaded and the lines merged. Combined Uncertainty and Bathymetry Estimator (CUBE) surfaces were then created at varying resolutions depending on the depth range. For example:

- Depth Threshold: 0 to 20 meters, resolution = 1m
- Depth Threshold: 10 to 60 meters, resolution = 2m
- Depth Threshold: 40 to 70 meters, resolution = 4m
- Depth Threshold: 50 to 150 meters, resolution = 5m
- Depth Threshold: 130 to Max depth, resolution = 10m

Subsets Tiles were then created in CARIS HIPS and adjacent lines of data were examined to identify tidal busts, sound velocity and roll errors, as well as to reject any remaining noise in the data set that adversely affected the CUBE surface.

While examining the data in subset mode, soundings were designated wherever the CUBE surface did not adequately depict the shoalest point of a feature. Soundings were designated when they met or exceeded the criteria for designation set forth in the NOS Hydrographic Surveys Specifications and Deliverables (April 2007). Designation ensured that soundings were carried through to the finalized BASE surfaces.

A statistical analysis of the sounding data was conducted via the CARIS Quality Control Report (QCR) routine. Cross lines were run in each sheet and were compared with main-scheme lines wherever applicable. The Quality Control Reports are located in Separate 4.

Sounding data that passed the required quality assurance checks were used in the final BASE surfaces via CARIS HIPS. Due to the high volume of data, some of the near shore sheets were sub-divided into smaller overlapping FieldSheets. For each of these FieldSheets a series of BASE surfaces were created. On each BASE surface, CUBE surfaces were generated at different resolutions (1m, 2m, 5m & 10m). These surfaces were then finalized in CARIS with the specified parameters outlined in Sections 5.1.1.3 and 5.1.4.4 of the NOS Hydrographic Surveys Specifications and Deliverables (April 2007) to produce the final surfaces. To ensure sufficient overlap between these surfaces the following parameters were used:

- Depth Threshold: 0 to 15 meters, resolution = 1m
- Depth Threshold: 10 to 45 meters, resolution = 2m
- Depth Threshold: 40 to 60 meters, resolution = 4m
- Depth Threshold: 50 to 150 meters, resolution = 5m
- Depth Threshold: 130 to Max depth, resolution = 10m

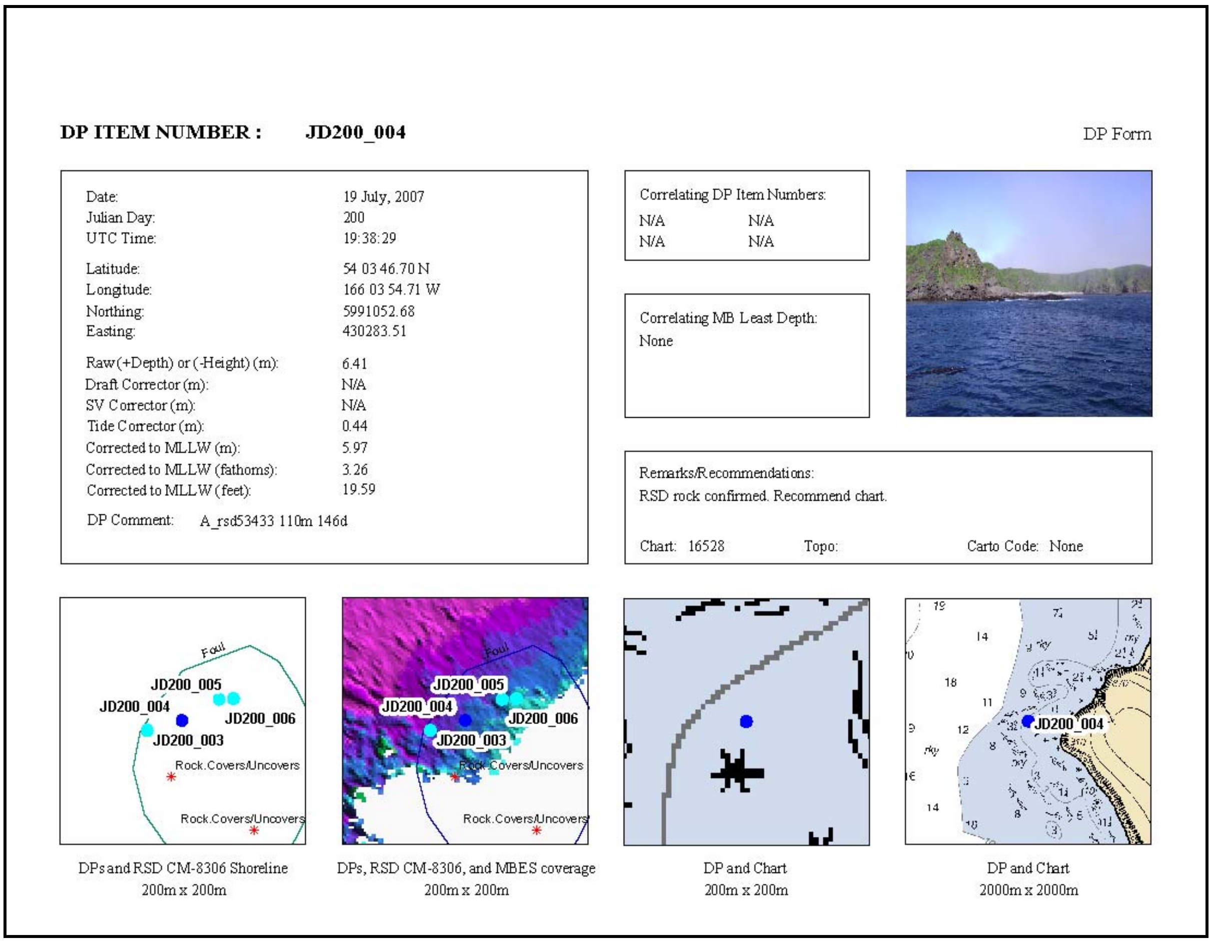
Note: It should be stated that these resolutions may vary on a sheet by sheet basis due to extreme slopes, but variations are documented in the Descriptive Reports.

For the final product a single FieldSheet that covered the entire sheet was created and the finalized surfaces for each resolution were combined. Refer to Fugro Pelagos Inc. Document titled “2007-NOAAProcessingProcedures”.

Features that were awash or above the waterline were manually tide corrected in Excel and imported into CARIS Notebook, edited where necessary, and exported as S57 Feature Files.

R2 and D2 were used to perform shoreline verification and could generally safely navigate in any area where they could maintain 4 meters of keel clearance. Exceptions were made for areas with heavy swells or thick kelp patches near shore. The vessels were equipped with a POS/MV system, WinFrog (v3.7.0) data acquisition system, Laser range finder binoculars (with built-in compass), and a Sony digital camera. NOAA nautical charts, Remote Sensing Division (RSD) features, and multibeam coverages were displayed as layers in WinFrog for reference. All soundings on submerged features were collected by one of the multibeam systems. Detached Positions (DPs) and their corresponding hydrographer's remarks were digitally recorded in WinFrog and digital photographs were taken of features when feasible.

ArcMap (v9.2), with the Shoreline Correlator add-on, written by the Fugro Pelagos Inc. GIS department, aided in the processing of the investigation results. The Correlator utilized the WinFrog log files to create an individual DP form for all acquired DPs. The Correlator was mapped to the WinFrog log file, tide file, corresponding photo, NOAA Chart (largest scale available), and multibeam coverage file to calculate and display the desired information for each DP. Figure 1 shows an example of a DP form produced from the Correlator.



DP ITEM NUMBER : JD200_004

DP Form

Date:	19 July, 2007
Julian Day:	200
UTC Time:	19:38:29
Latitude:	54 03 46.70 N
Longitude:	166 03 54.71 W
Northing:	5991052.68
Easting:	430283.51
Raw(+Depth) or (-Height) (m):	6.41
Draft Corrector (m):	N/A
SV Corrector (m):	N/A
Tide Corrector (m):	0.44
Corrected to MLLW (m):	5.97
Corrected to MLLW (fathoms):	3.26
Corrected to MLLW (feet):	19.59

DP Comment: A_rsd53433 110m 146d

Correlating DP Item Numbers:
N/A N/A
N/A N/A

Correlating MB Least Depth:
None

Remarks/Recommendations:
RSD rock confirmed. Recommend chart.

Chart: 16528 Topo: Carto Code: None

DPs and RSD CM-8306 Shoreline 200m x 200m

DPs, RSD CM-8306, and MBES coverage 200m x 200m

DP and Chart 200m x 200m

DP and Chart 2000m x 2000m

Figure 1 - DP Correlator Sheet

Correlator also utilized the final tide zones and verified tidal data to tide-correct all DP features. The tide-corrected feature information was exported to text file and then imported as a marker layer into CARIS Notebook.

In Notebook, the marker layer was reviewed in context of all available data, including multibeam coverages, raster / ENC charts, and RSD source shoreline. New features and features that differed from the chart(s) or RSD source were assigned appropriate S57 object acronyms and attributes and saved in the feature file.

Features above MLLW found by multibeam instead of DP were also reviewed in CARIS HIPS and their multibeam depth and position used to place the feature in the feature file.

Changes to a sheet's source (RSD) Data were noted in the Descriptive Report for that sheet, as well as significant deviations or disapprovals of previously charted features. When complete, an S57 Feature File was exported.

C - Corrections to Soundings

SOUND VELOCITY PROFILES

Sound velocity casts were normally performed every two to three hours. The AML Smart Probes used to determine sound velocities for the survey sampled at a rate of eight velocity and pressure observation pairs a second. For each cast, the probes were held at the surface for two minutes to achieve temperature equilibrium. The probes were then lowered and raised slowly (no greater then 1 meter per second) to maintain equilibrium. Between casts, the sound velocity sensors were stored in a barrel of fresh water to minimize salt-water corrosion and to hold them at ambient water temperatures. Refer to Appendix III for Calibration Reports.

SETTLEMENT CURVE

The squat settlement tests for the R/V R2 were conducted in Southeast Alaska on June 8, 2007 (Julian Day 159).

To perform the squat settlement test, the R/V R2 needed to log dual frequency (L1/L2) data on the POS/MV. The squat settlement test began by first establishing a 500 meter line in the direction of the current. The survey vessel then occupied the south end of the line for two minutes logging 'static' L1/L2 GPS data. Next, the line was run north at a constant engine speed of 300 RPM, then south at the same 300 RPMs. Stopping at the south end of the line, the survey vessel obtained an additional two minutes of 'static' L1/L2 GPS data, then repeated the scenario at incrementing engine RPMs.

All measurements were corrected for heave, pitch, and roll and then reduced to the vessel's Common Reference Point (CRP) and subsequently to the multibeam transducer. Static measurements observed at the end of lines were used to establish tidal correctors to apply to the squat settlement test data. A settlement curve for R2, with the Reson 8101 installed, was calculated from the corrected PPK derived altitude data.

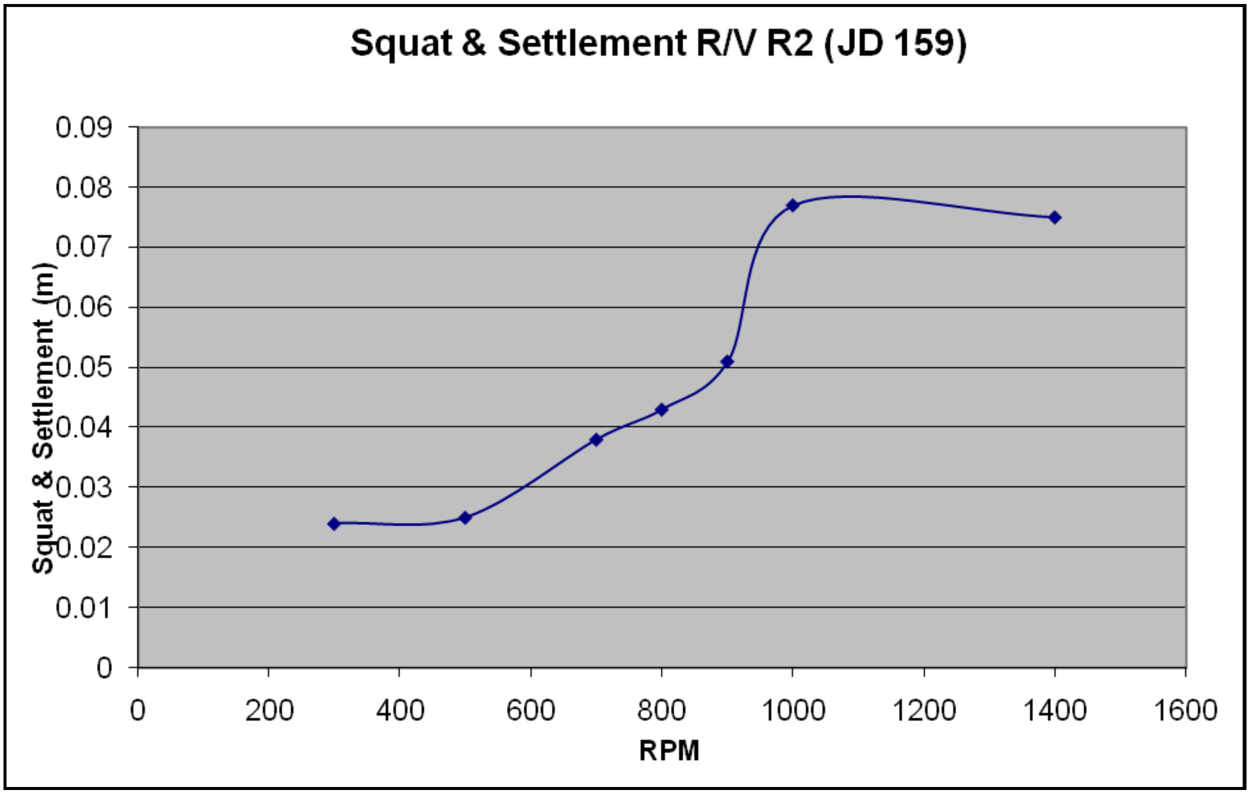


Figure 2 - R/V R2 Settlement Curve

The results of the squat settlement test for the Reson 8101 on R/V R2 are shown below.

Table 1 - R/V R2 Squat Settlement Results

R2-8101 CALCULATED SETTLEMENT	
RPM	Squat Value (m)
300	0.024
400	0.025
500	0.025
600	0.032
700	0.038
800	0.043
900	0.051
1000	0.077
1100	0.077
1200	0.076
1300	0.076
1400	0.075

Note: Vessel speed was recorded on the survey line logs (refer to Separate 1).

The squat settlement test for the R/V D2was conducted in Southeast Alaska on June 8, 2007 (Julian Day 159).

To perform the squat settlement test, the R/V D2 needed to log dual frequency (L1/L2) data on the POS/MV. The squat settlement test began by first establishing a 500 meter line in the direction of the current. The survey vessel then occupied the south end of the line for two minutes logging 'static' L1/L2 GPS data. Next, the line was run north at a constant engine speed of 700 RPMs, then south at the same 700 RPMs. Stopping at the south end of the line, the survey vessel obtained an additional two minutes of 'static' L1/L2 GPS data, and then repeated the scenario at incrementing engine RPMs.

All measurements were corrected for heave, pitch, and roll and then reduced to the vessel's Common Reference Point (CRP) and subsequently to the multibeam transducer. Static measurements observed at the end of lines were used to establish tidal correctors to apply to the squat settlement test data. A settlement curve for D2, with the Reson 8101 installed, was calculated from the corrected PPK derived altitude data.

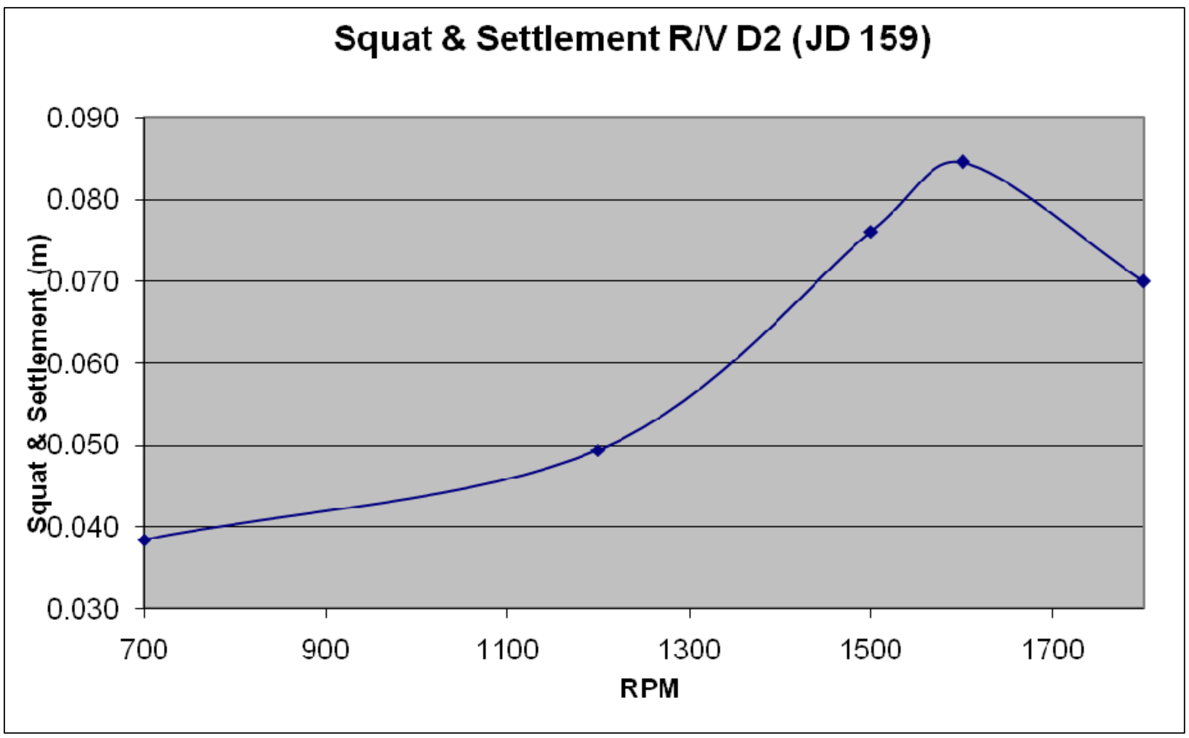


Figure 3 - R/V D2 Settlement Curve

The results of the squat settlement test for the Reson 8101 on R/V D2 are shown below.

Table 2 - R/V D2 Squat Settlement Results

D2-8101 CALCULATED SETTLEMENT	
RPM	Squat Value (m)
700	0.038
800	0.041
900	0.043
1000	0.045
1100	0.047
1200	0.049
1300	0.058
1400	0.067
1500	0.076
1600	0.085
1800	0.070

Note: Vessel speed was recorded on the survey line logs (refer to Separate 1).

The squat settlement test for the R/V Davidson was conducted in Puget Sound, WA. on June 7, 2007 (Julian Day 158).

To perform the squat settlement test, the R/V Davidson logged dual frequency data on the POS/MV. The squat settlement tests were performed by first establishing a 500 meter line in the direction of the current. The survey vessel occupied the south end of the line for two minutes logging 'static' L1/L2 GPS data. The line was then run north with a propeller pitch of 4, then south with a pitch of 4. Stopping at the south end of the line, the survey vessel obtained an additional two minutes of 'static' L1/L2 GPS data, and then repeated the scenario at incrementing propeller pitch.

All measurements were corrected for heave, pitch, and roll and then reduced to the vessel's Common Reference Point (CRP) and subsequently to the multibeam transducer. Static measurements observed at the end of lines were used to establish tidal correctors to apply to the squat settlement test data. A settlement curve for the Davidson with the Reson 8111 installed, was calculated from the corrected PPK derived altitude data.

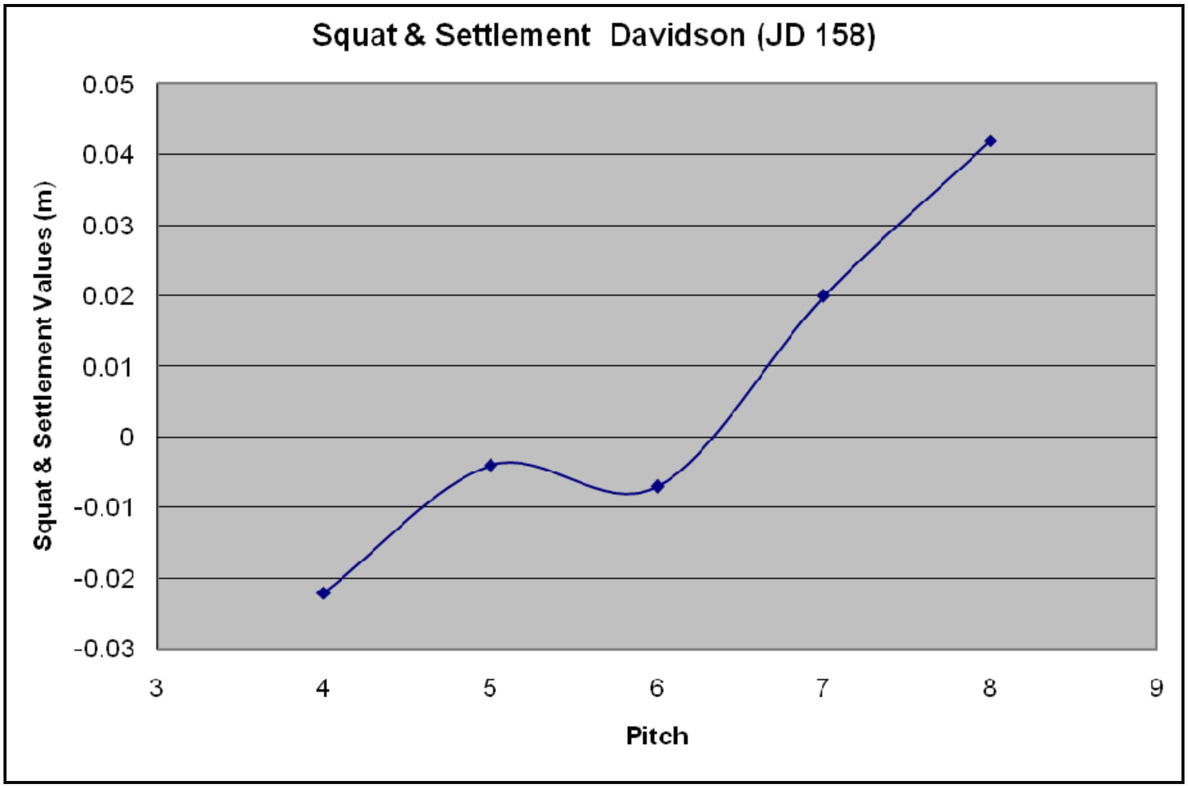


Figure 4 - R/V Davidson Settlement Curve

The results of the squat settlement test for the Reson 8111 on R/V Davidson are shown below.

Table 3 - R/V Davidson Squat Settlement Results

Davidson-8111 CALCULATED SETTLEMENT	
Pitch	Squat Value (m)
4	-0.022
5	-0.004
6	-0.007
7	0.02
8	0.042

Note: Vessel speed was recorded on the survey line logs (refer to Separate 1).

STATIC DRAFT

Static draft was measured from tabs on both sides of the vessels, the average was taken, and then the correction to the common reference point was applied. The table below shows the draft values for the R/V R2 used in data processing.

Table 4 - Draft Measurements for the R2 (Reson 8101)

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
1	166	6/15/2007	15:15	-0.27
2	167	6/16/2007	15:32	-0.27
3	168	6/17/2007	15:25	-0.28
4	169	6/18/2007	15:23	-0.28
5	170	6/19/2007	15:23	-0.26
6	171	6/20/2007	15:37	-0.26
7	172	6/21/2007	15:17	-0.27
8	173	6/22/2007	15:54	-0.29
9	174	6/23/2007	15:37	-0.29
10	175	6/24/2007	15:31	-0.29
11	176	6/25/2007	15:08	-0.29
12	177	6/26/2007	17:05	-0.29
13	179	6/28/2007	15:40	-0.28
14	180	6/29/2007	16:10	-0.28
15	181	6/30/2007	15:26	-0.28
16	182	7/1/2007	15:12	-0.28
17	183	7/2/2007	15:05	-0.28
18	184	7/3/2007	15:20	-0.28
19	184	7/3/2007	15:20	-0.28
20	185	7/4/2007	15:17	-0.28
21	186	7/5/2007	15:56	-0.32
22	187	7/6/2007	15:29	-0.31
23	188	7/7/2007	15:07	-0.28
24	189	7/8/2007	16:14	-0.27
25	190	7/9/2007	16:29	-0.25
26	191	7/10/2007	16:54	-0.25
27	192	7/11/2007	16:47	-0.25
28	193	7/12/2007	15:37	-0.27
29	194	7/13/2007	15:45	-0.30
30	195	7/14/2007	20:22	-0.27
31	196	7/15/2007	19:49	-0.28

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
32	197	7/16/2007	16:07	-0.26
33	198	7/17/2007	16:50	-0.27
34	199	7/18/2007	16:20	-0.29
35	200	7/19/2007	16:49	-0.29
36	201	7/20/2007	16:01	-0.27
37	202	7/21/2007	16:58	-0.27
38	203	7/22/2007	15:11	-0.28
39	204	7/23/2007	15:25	-0.26
40	206	7/25/2007	16:39	-0.27
41	208	7/27/2007	19:13	-0.28
42	209	7/28/2007	15:16	-0.28

The table below shows the draft values for the R/V D2 used in data processing.

Table 5 - Draft Measurements for the D2 (Reson 8101)

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
1	166	6/15/2007	15:10	-0.21
2	167	6/16/2007	15:44	-0.20
3	168	6/17/2007	16:15	-0.21
4	170	6/19/2007	2:44	-0.20
5	171	6/20/2007	2:38	-0.21
6	171	6/20/2007	15:49	-0.21
7	172	6/21/2007	15:43	-0.22
8	173	6/22/2007	15:46	-0.22
9	174	6/23/2007	15:41	-0.22
10	175	6/24/2007	15:15	-0.21
11	176	6/25/2007	15:11	-0.22
12	177	6/26/2007	15:40	-0.22
13	179	6/28/2007	15:00	-0.22
14	180	6/29/2007	16:20	-0.22
15	181	6/30/2007	15:35	-0.21
16	182	7/1/2007	15:04	-0.21
17	183	7/2/2007	15:02	-0.23
18	184	7/3/2007	15:10	-0.22
19	185	7/4/2007	15:03	-0.22
20	186	7/5/2007	14:52	-0.22
21	187	7/6/2007	15:57	-0.21

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
22	188	7/7/2007	14:55	-0.22
23	189	7/8/2007	15:42	-0.22
24	190	7/9/2007	15:45	-0.22
25	191	7/10/2007	15:35	-0.22
26	192	7/11/2007	16:00	-0.21
27	193	7/12/2007	15:10	-0.22
28	194	7/13/2007	15:00	-0.22
29	195	7/14/2007	19:36	-0.21
30	196	7/15/2007	19:01	-0.22
31	197	7/16/2007	16:50	-0.21
32	198	7/17/2007	17:00	-0.21
33	199	7/18/2007	15:14	-0.22
34	200	7/19/2007	15:53	-0.22
35	201	7/20/2007	15:18	-0.22
36	202	7/21/2007	15:22	-0.22
37	203	7/22/2007	15:13	-0.21
38	204	7/23/2007	15:09	-0.21
39	206	7/25/2007	15:40	-0.22
40	208	7/27/2007	18:12	-0.22

The table below shows the draft values for the R/V Davidson used in data processing.

Table 6 - Draft Measurements for the Davidson (Reson 8111)

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
1	166	6/15/2007	15:00	-2.422
2	167	6/16/2007	15:15	-2.377
3	168	6/17/2007	15:12	-2.507
4	170	6/19/2007	15:13	-2.447
5	170	6/19/2007	3:07	-2.407
6	171	6/20/2007	15:37	-2.437
7	172	6/21/2007	15:17	-2.407
8	173	6/22/2007	15:43	-2.437
9	174	6/23/2007	15:40	-2.377
10	175	6/24/2007	15:22	-2.387
11	176	6/25/2007	14:59	-2.377
12	176	6/25/2007	1:05	-2.487
13	177	6/26/2007	15:46	-2.397

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
14	178	6/27/2007	14:49	-2.402
15	179	6/28/2007	15:02	-2.367
16	180	6/29/2007	16:24	-2.402
17	181	6/30/2007	15:30	-2.427
18	182	7/1/2007	15:34	-2.357
19	183	7/2/2007	14:54	-2.362
20	184	7/3/2007	15:25	-2.352
21	185	7/4/2007	15:18	-2.387
22	186	7/5/2007	15:54	-2.412
23	187	7/6/2007	15:24	-2.362
24	188	7/7/2007	14:50	-2.342
25	189	7/8/2007	4:29	-2.372
26	189	7/8/2007	15:46	-2.352
27	190	7/9/2007	16:01	-2.362
28	191	7/10/2007	10:45	-2.462
29	191	7/10/2007	16:23	-2.362
30	192	7/11/2007	16:03	-2.337
31	192	7/11/2007	13:10	-2.432
32	193	7/12/2007	15:17	-2.342
33	193	7/12/2007	8:10	-2.347
34	194	7/13/2007	15:27	-2.337
35	195	7/14/2007	19:47	-2.277
36	196	7/15/2007	19:40	-2.317
37	197	7/16/2007	16:35	-2.272
38	197	7/16/2007	3:59	-2.322
39	198	7/17/2007	17:09	-2.277
40	199	7/18/2007	16:04	-2.277
41	202	7/21/2007	8:10	-2.312
42	203	7/22/2007	15:21	-2.277
43	204	7/23/2007	22:32	-2.217

TIDES

All sounding data were reduced to MLLW initially using unverified tidal data from two tide stations located in Reef Bight and Biorka Village, AK. Tidal data for a twenty-four hour period UTC, (Alaska Daylight Time to UTC was +8 hours) was assembled by JOA and emailed to the Davidson at the end of every Julian Day. A cumulative file in a CARIS format was updated each day by appending the new data. Refer to the “OPR-Q191-KR-07 Horizontal & Vertical Control Report” for additional tidal information and station descriptions.

January 10, 2008, JOA issued verified tidal data and final zoning for OPR-Q191-KR-07. The tidal zoning was modified by JOA, providing a more elaborate zoning scheme from those zones issued in the Statement of Work. For additional information, refer to JOA’s Final Report. All sounding data were then re-merged using CARIS HIPS and SIPS tide routine. Verified tidal data were used for all final Navigation BASE surfaces and S57 Feature files.

VESSEL ATTITUDE, HEADING, HEAVE, PITCH, AND ROLL

Vessel heading and dynamic motion were measured by the POS/MV for the OPR-Q191-KR-07 project. The system calculated heading by inversing between two Trimble GPS generated antenna positions. An accelerometer block (the IMU), which measured vessel attitude, was mounted directly over the multibeam transducer on each vessel. The operational accuracy specifications for this system, as documented by the manufacturer, are as follows:

Table 7 - POS/MV Specifications

POS/MV Accuracy	
Pitch and Roll	0.035°
Heading	0.05°
Heave	5% or 5-cm over 20 seconds

CALIBRATIONS

Multibeam

A patch test was conducted to identify alignment errors (timing, pitch, heading, and roll) between the motion sensor and the multibeam transducer.

On July 1, 2007, during Survey operations in the Krenitzin Islands for project OPR-Q191-KR-07 the R/V R2 struck a submerged object. Review of the data on July 1, 2007 after the incident revealed a shift in sonar to IMU alignment parameters. An additional patch test was conducted the next day to obtain new parameters. It was apparent that the new alignment parameters were static and valid after 01:07 on July 1 (the time of the incident).

Additional patch tests were conducted during the course of the survey for quality control and testing purposes, but the derived values were not entered into the vessel configuration file, hence, not used in processing. Patch test calibration values used to correct all soundings for the survey were as follows:

Table 8 - Patch Test Results for R/V R2 Reson 8101

Patch Test Results for R/V R2 Reson 8101 May 5th, 2007 (2007-125)		
Test	CARIS Session	Mean Correction
Navigation Timing Error	Patch_125_Nav	0.00 seconds
Pitch Offset	Patch_125_Pitch	-2.200°
Azimuth Offset	Patch_125_Yaw	-2.400°
Roll Offset	Patch_125_Roll	0.040°

Table 9 - Patch Test Results for R/V R2 Reson 8101

Patch Test Results for R/V R2 Reson 8101 July 1st, 2007 (2007-182)		
Test	CARIS Session	Mean Correction
Navigation Timing Error	Patch_182_Nav	0.00 seconds
Pitch Offset	Patch_182_Pitch	-2.000°
Azimuth Offset	Patch_182_Yaw	-2.300°
Roll Offset	Patch_182_Roll	-0.380°

Table 10 - Patch Test Results for R/V D2 Reson 8101

Patch Test Results for R/V D2 Reson 8101 May 5th, 2007 (2005-125)		
Test	CARIS Session	Mean Correction
Navigation Timing Error	Patch_128_Nav	0.00 seconds
Pitch Offset	Patch_128_Pitch	-0.680°
Azimuth Offset	Patch_128_Yaw	0.750°
Roll Offset	Patch_128_Roll	1.670°

Table 11- Patch Test Results for the R/V Davidson Reson 8111

Patch Test Results for Davidson Reson 8111 May 5th, 2007 (2007-125)		
Test	CARIS Session	Mean Correction
Navigation Timing Error	Patch_142_Nav	0.00 seconds
Pitch Offset	Patch_142_Pitch	0.00°
Azimuth Offset	Patch_142_Yaw	-0.400°
Roll Offset	Patch_142_Roll	0.780°

<u>Additional Sounding Techniques</u>

No additional sounding techniques were used throughout the course of the survey.

D - Approval Sheet

Approval Sheet

For

H11712, H11713, H11714, H11715, H11716, H11717, H11718, H11719, & H11720

Standard field surveying and processing procedures were followed in producing this survey in accordance with the following documents:

> OPR-Q191-KR-07 Statement of Work and 2007 Specifications & Deliverables;
> Fugro Pelagos, Inc. Acquisition Procedures (2007- NOAA Acquisition Procedures);
> Fugro Pelagos, Inc. Processing Procedures (2007-NOAA Processing Procedures);

The data were reviewed daily during acquisition and processing.

This report has been reviewed and approved. All records are forwarded for final review and processing to the Chief, Pacific Hydrographic Branch.

Approved and forwarded,

Dean Moyles, Fugro Pelagos, Inc.
Lead Hydrographer
Fugro Pelagos, Inc. Survey Party

Dean Moyles
Digitally signed by Dean Moyles
DN: cn=Dean Moyles, email=dmoyles@fugro.com, o=Fugro Pelagos, Inc., l=San Diego, CA
Date: 2008.03.03 06:07:20 -08'00'

Appendix I – Equipment List and Software Versions

Equipment

Table 12 - Equipment List

System	Manufacturer	Model	Serial No.
Multibeam Sounder	Reson	SeaBat 8101 Processor	12945
		SeaBat 8101 Transducer	1600001
		8101 Firmware Dry: 8101-2-07-2D4D	
		Wet: 8101-1-06-2F6B	
Multibeam Sounder	Reson	SeaBat 8101 Processor	37127
		SeaBat 8101 Transducer	
		8101 Firmware Dry: 8101-2-09-E34D	
		Wet: 8101-1-08-C215	
Multibeam Sounder	Reson	SeaBat 8111 Processor	Multibeam Sounder
		SeaBat 8111 Transducer Array	Transmit/Receive
		8111 Firmware Dry: 8111-E2.09-6114 Wet:8111-E1.01-AFAA	
POS/MV	Applanix	Firmware Model 320: Ver 4	2161
POS/MV	Applanix	IMU	231
POS/MV	Applanix	Firmware Model 320: Ver 4	2640
POS/MV	Applanix	IMU	241
POS/MV	Applanix	Firmware Model 320: Ver 4	2354
POS/MV	Applanix	IMU	78
POS/MV	Applanix	Firmware Model 320: Ver 4	2355
POS/MV	Applanix	IMU	49
GPS Antenna	Trimble	L1/L2	4435A43274
GPS Antenna	Trimble	L1/L2	4435A43283
GPS Antenna	Trimble	L1/L2	4644A74185
GPS Antenna	Trimble	L1/L2	4644A74186
GPS Antenna	Trimble	L1/L2	4541A61043
GPS Antenna	Trimble	L1/L2	4541A61064
GPS Antenna	Trimble	L1/L2	4541A61044
GPS Antenna	Trimble	L1/L2	4533A9383
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4655
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	5282
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4820
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	5283
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4703 (not used)
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4966
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4932
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4431
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4656
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	5284
CTD Profiler	Sea-Bird Electronics	CTD- 12	727
RTCM	CSI Inc.	CSI MBX-3	9834-2211-0001
RTCM	CSI Inc.	CSI-MBX-3	9920-3754-0002
RTCM	CSI Inc.	CSI MBX-3	9833-2166-0001
RTCM	CSI Inc.	CSI-MBX-3	9913-3442-0001
RTCM	CSI Inc.	CSI MBX-3	9830-2023-0001
RTCM	CSI Inc.	CSI-MBX-3	9834-2211-0001
RTCM	CSI Inc.	CSI-MBX-3	9834-2211-0020
DGPS	CSI Inc.	GBX PRO	0124-8517-0001

System	Manufacturer	Model	Serial No.
Digital Camera	Kodak	Kodak	KCKDP43503807
Digital Camera	Sony	Sony	0947524
Digital Camera	Sony	Sony	0947522
Control Station	Novatel	Novatel DL4 Receiver	0001
Control Station	Novatel	Novatel DL4 Receiver	0009
Control Station	Novatel	Novatel GPS 702 Rev 3 Ant.	NVH06140007
Control Station	Novatel	Novatel GPS 702 Rev 3 Ant.	NVH05230012
Automatic Level	Trimble	AL228	801241
Total Station	Topcon	GTS 211D	LG4090

Software

Triton Isis v 7.1428.53
Delph Map v2.9.0.21
WinFrog v 3.7.0
CARIS Hips/Sips v 6.1 (w/ Service Pack 1)
CARIS GIS v 4.4a (w/ Service Pack 5)
MapInfo Professional v 5.0
AutoDesk Map R 5.0
MBSurvey Tools v2.00.05.00
POS/MV v4 Controller v3.2.2.2 & 3.4.0.0 (firmware dependent)
ESRI Arc Map v9.2
Correlator v1.0
POSConv v1.4
POSPac 4.3 & 4.31

Appendix II – Vessel Descriptions

R/V R2

The R/V R2 (Figure 6) was modified to accommodate a survey crew and acquisition hardware. The keel was cut just aft of mid-ship and Reson 8101 multibeam sonar was installed. A conical cowling protected the sonar head forward and aft by a crescent shaped skid (Figure 8). The accelerometer package for a POS/MV was mounted in the hull of the vessel just over the 8101 multibeam transducer head.

Two Trimble L1/L2 antennas were mounted above the 8101 and accelerometer for positioning and heading (Figure 7). The two POS/MV antennas were offset 1.0m to the port and starboard. The port side antenna (L1/L2) functioned as the POS/MV master antenna; the starboard side antenna functioned as the POS/MV secondary.

The AML Smart Probe SV&P sensors and the CTD were deployed from an A-Frame on the stern using a small hydraulic winch.

Offset values were applied to the data in CARIS HIPS as specified in the HIPS vessel configuration file (HVF). Vessel offsets used are shown in the following table. Note that the HVF does not contain navigation offsets because the position provided by the POS/MV is already corrected to the CRP.

Table 13 - Vessel Offsets (R2)

R2 Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS/MV	0.000	0.00	0.00
CRP	Reson 8101 Transducer	0.009	-0.614	0.632
CRP	GPS1 – Master Antenna	-0.998	-0.005	-3.071
CRP	GPS2 – Slave Antenna	1.010	-0.020	-3.035
CRP	Draft Measuring Point, Port	-1.795	-3.527	-1.503
CRP	Draft Measuring Point, Starboard	1.771	-3.560	-1.460

Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 14 - Vessel Specifications (R2)

Survey Launch	R2
Official Number	623241/647782
Owner	Stabbert Maritime Yacht & Ship
Year Built	1980/1982
Length	28.9 ft.
Beam	12 ft.
Draft	5.7 ft.
Gross Ton	15
Net Ton	13
Mechanical Power	Caterpillar 3208
Electrical	Northern Lights

Figure 5 - R/V R2

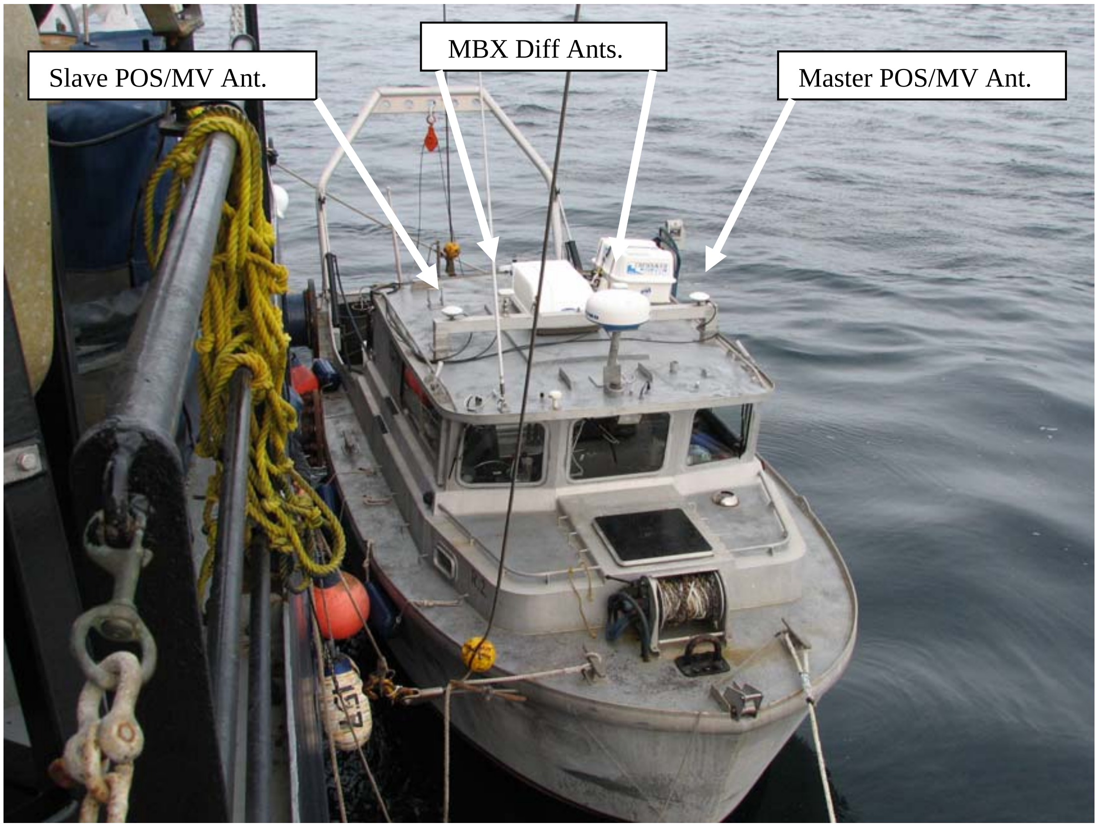


Figure 6 - Differential and POS/MV Antennas (R/V R2)

Figure 7 – Hull Mounted Reson 8101 (R/V R2)

The R/V D2 (Figure 9) was modified to accommodate a survey crew and acquisition hardware. The keel was cut just aft of mid-ship and Reson 8101 multibeam sonar was installed. A conical cowling protected the sonar head forward and aft by a crescent shaped skid. The accelerometer package for a POS/MV was mounted in the hull of the vessel just over the 8101 multibeam transducer head.

Two Trimble L1/L2 antennas were mounted above the 8101 and accelerometer for positioning and heading (Figure 10). The two POS/MV antennas were offset 1.06m to the port and starboard. The port side antenna (L1/L2) functioned as the POS/MV master antenna; the starboard side antenna functioned as the POS/MV secondary.

The AML Smart Probe SV&P sensors and the CTD were deployed from an A-Frame on the stern using a small hydraulic winch.

Offset values were applied to the data in CARIS HIPS as specified in the HIPS vessel configuration file (HVF). Vessel offsets used are shown in the following table. Note that the HVF does not contain navigation offsets because the position provided by the POS/MV is already corrected to the CRP.

Table 15 - Vessel Offsets (D2)

D2 Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS/MV	0.000	0.00	0.00
CRP	Reson 8101 Transducer	-0.016	-0.879	0.548
CRP	GPS1 – Master Antenna	-1.002	-0.064	-3.095
CRP	GPS2 – Slave Antenna	0.991	-0.048	-3.046
CRP	Draft Measuring Point, Port	-1.794	-2.535	-1.397
CRP	Draft Measuring Point, Starboard	1.846	-2.521	-1.331

Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 16 - Vessel Specifications (D2)

Survey Launch	D2
Official Number	623241/647782
Owner	Stabbert Maritime Yacht & Ship
Year Built	1980/1982
Length	28.9 ft.
Beam	12 ft.
Draft	5.7 ft.
Gross Ton	15
Net Ton	13
Mechanical Power	Caterpillar 3208
Electrical	Northern Lights

Figure 8 - R/V D2

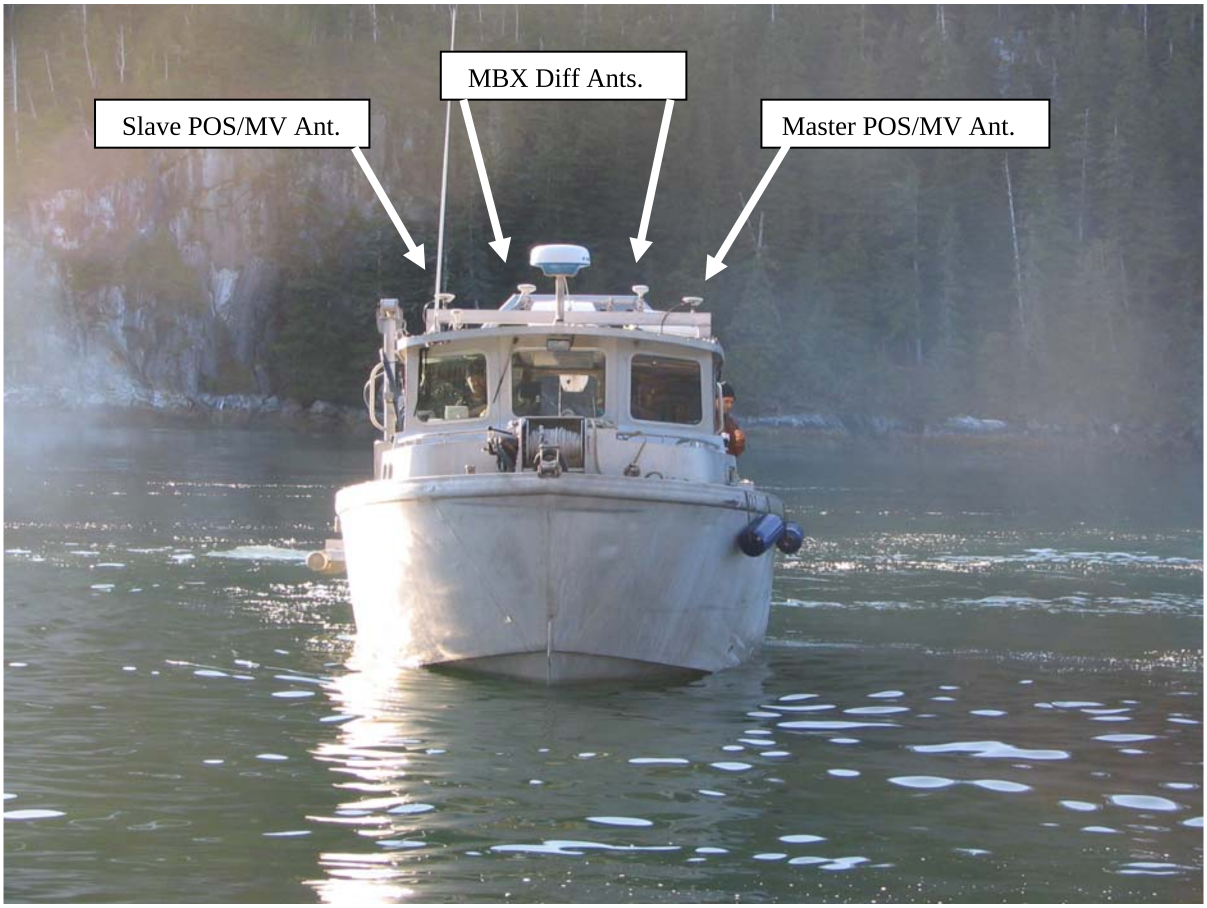


Figure 9 - Differential and POS/MV Antennas (R/V D2)

R/V Davidson

The R/V Davidson (Figure 14) accommodated a survey crew, acquisition hardware, and processing equipment. The keel was cut just aft of mid-ship and Reson 8111 multibeam sonar was installed. A conical cowling protected the sonar head forward and aft by a crescent shaped skid. The accelerometer package for a POS/MV was mounted on the lower deck of the vessel just over the 8111 multibeam transducer head.

Two Trimble L1/L2 GPS antennas were mounted on the ships top deck for positioning and heading (Figure 15). The two POS/MV antennas were offset 2.0m apart fore and aft. The forward antenna functioned as the POS/MV master antenna; the aft antenna functioned as the POS/MV secondary.

The AML Smart Probe SV&P sensors and the CTD were deployed from an A-Frame on the stern using a hydraulic winch.

Offset values were applied to the data in CARIS HIPS as specified in the HIPS vessel configuration file (HVF). Vessel offsets used are shown in the following table. Note that the VHF does not contain navigation offsets because the position provided by the POS/MV is already corrected to the CRP.

Table 17 - Vessel Offsets (Davidson)

Davidson Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS/MV	0.000	0.000	0.000
CRP	Reson - 8111 Transducer	0.046	-0.342	2.047
CRP	GPS 1 - Master Antenna	-0.248	4.982	-23.478
CRP	GPS 2 - Slave Antenna	-0.318	2.993	-23.419
CRP	Draft Measuring Point, Port	-5.778	-1.599	-4.282
CRP	Draft Measuring Point, Starboard	5.672	-10.211	-5.392

Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 18 - Vessel Specifications (Davidson)

Survey Launch	R/V Davidson
Official Number	1066485
Owner	Davidson, LLC/Ocean Services, LLC
Year Built	1967
Length	175 ft
Beam	38 ft
Draft	17.75 ft
Gross Ton	250
Net Ton	833
Mechanical Power	1800 hp

Figure 10 R/V Davidson

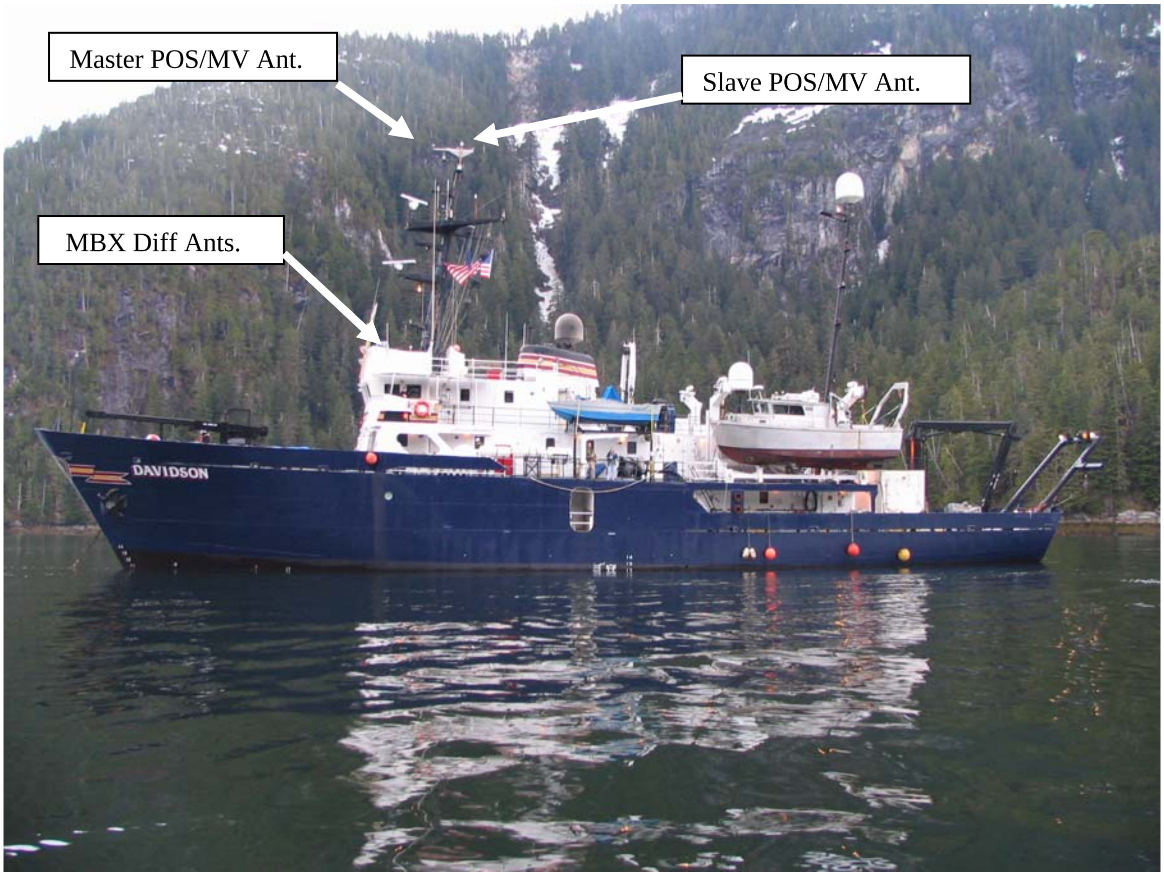


Figure 11 Differential and POS/MV Antennas (Davidson)

Figure 12 Hull Mounted Reson 8111

Appendix III – Calibration Reports

4431 Calibration Certificate.pdf
4655 Calibration Certificate.pdf
4656 Calibration Certificate.pdf
4820 Calibration Certificate.pdf
4932 Calibration Certificate.pdf
4966 Calibration Certificate.pdf
5282 Calibration Certificate.pdf
5283 Calibration Certificate.pdf
5284 Calibration Certificate.pdf
727 Calibration Certificate.pdf