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-K977-FU-08

Registry No. H11804, H11805, H11806, H11807

LOCALITY

State LOUISANIA

General Locality GULF OF MEXICO

Sublocality VICINITY OF CAMINADA PASS TO VICINITY OF GRAND BAYOU PASS

2009

CHIEF OF PARTY

ANDREW ORTHMANN

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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. H11804, H11805, H11806, H11807
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 LOUISANIA

General Locality GULF OF MEXICO

Locality VICINITY OF CAMINADA PASS TO VICINITY OF GRAND BAYOU PASS

Scale 1:10000 Date of Survey 08/16/2008 to 04/05/2009

Instructions dated MAY 28, 2008 Project No. OPR-K977-FU-08U

Vessel R/V LOCATOR (CF-4540-NB) and R/V CHINOOK (AK-1437-K)

Chief of party ANDREW ORTHMANN

Surveyed by BRIGGS, POECKERT, ORTHMANN, GILL, FARLEY, MOUNT, ROYKTA, GOSS, HOLLY, ET AL

Soundings taken by echo sounder, hand lead, pole ODOM DF3200 SBES (HULL MOUNTED BOTH VESSELS), RESON SEABAT 8101 MBES (LOCATOR - POLE 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 a modern hydrographic and debris mapping survey in the Gulf of Mexico in the vicinity of Caminada Pass to vicinity of Grand Bayou Pass

ALL TIMES ARE RECORDED IN UTC.

FUGRO PELAGOS INC.
3738 RUFFIN ROAD
SAN DIEGO, CA 92123

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A – Equipment

The R/V Locator and the R/V Chinook were utilized to collect echo-sounder and side scan sonar (SSS) data in a shallow water environment during the course of this project. The equipment list and vessel descriptions are included in Appendices I and II.

SOUNDING EQUIPMENT

The R/V Chinook was equipped with a hull mounted ODOM DF3200 single beam system during the OPR-K977-FU-08U project. The ODOM DF3200 consists of a 200 kHz transducer and the Echotrac DF3200 MkII transceiver and processor. The ODOM transmits and receives a single sonar pulse to measure the relative water depth over a footprint which is depth dependent. The range scale, power level, ping rates and pulse width were a function of water depth and data quality and were generally set to auto-scale by the ODOM. Parameters were noted on the survey line logs (see Separate 1).

The R/V Locator was also equipped with a hull mounted ODOM DF3200 single beam system. The ODOM transducer was mounted in a sea chest above an acoustically transparent window located within the hull of the vessel. In addition, the Locator was equipped with a pole-mounted Reson Seabat 8101 multibeam echo-sounder (MBES) system for target verification.

The line orientation for both vessels was generally parallel to the coastline and bathymetric contours in the area. The line spacing depended on the SSS range and data quality.

SIDE SCAN SONAR

Both the R/V Locator and the R/V C.B. #3 were equipped with rigid fixed pole mounted Klein System 3000 Digital SSS during the OPR-K977-FU-08U project. The Klein System 3000 Digital SSS operates with dual frequencies of 132 and 455 kHz. Though both frequencies were logged, for the purposes of this survey, only the high frequency, 455 kHz, was utilized in processing. The system transmits and receives an acoustic signal to measure the relative range and intensity of acoustic return from the surrounding seafloor. The range scale, fixed SSS depth, and pulse width were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1). Line orientation for both vessels was generally parallel to the coastline and bathymetric contours in the area. The line spacing was dependent on SSS range and data quality, with line spacing not exceeding half the range scale in use.

POSITIONING EQUIPMENT

Each vessel was equipped with an Applanix Position and Orientation System for Marine Vessels (POSMV) V4 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 POSMV. The POSMV was configured to accept differential corrections, which were output from a CSI MBX-3S Coast Guard beacon receiver. The POSMV unit provided the position and velocity values relative to the POSMV's Inertial Measurement Unit (IMU). The inertial navigation system, implemented by the POSMV, computes a position by way of a complex form of dead reckoning using the GPS position, heading, and motion of the IMU.

Positioning system confidence checks were conducted on a daily basis using the POSMV controller software. The controller software had numerous real time displays that were monitored throughout the survey to ensure the positional accuracies specified in the NOS Hydrographic Surveys Specifications and Deliverables (version May 2008) were achieved. These include, but are not limited to the following: GPS Status, Position Accuracy, Receiver Status (which included HDOP) and Satellite Status.

Real-time positions were replaced in processing with a post-processed kinematic (PPK) solution of higher accuracy (also on NAD83). For this purpose Fugro Pelagos, Inc. established two GPS base stations (each consisting of a Novatel DL4 L1/L2 GPS receiver coupled to a L1/L2 antenna) and logged dual-frequency GPS data continuously during survey operations with them. This control data was then used in conjunction with the raw GPS data logged aboard each vessel to create the PPK solution. Refer to the Horizontal and Vertical Control Report for station and control information.

SOFTWARE

Acquisition

The primary data sets were collected with Triton ISIS v7.1.500.111 and Fugro Pelagos' WinFrog v3.08.23 operated on an PCs equipped with Intel 2.83 GHz Core2 quad-core processors PC running Microsoft Windows XP Professional. Data was logged in the XTF and the RAW file formats. The ISIS XTF files contain all SSS intensity, range, position, attitude, heading, and UTC time stamp data required by CARIS to process the side scan data. The WinFrog RAW files contain all single beam sonar soundings, position, attitude, heading, and UTC time stamp data required by CARIS to process the bathymetric data. WinFrog also logged XTF format files when recording multibeam bathymetery.

The Chinook and Locator were both equipped with a PC running ISIS v7.1.500.111. ISIS was used to log the sidescan sonar data. The following display windows were used in for operators to monitor data quality:

1. Signal Voltage: The signal window displays real time signal intensities returned.

2. Waterfall: The Waterfall plots the returned intensities in a range vs. time series. This window can be adjusted for color scale, gain, and become slant range corrected to ensure image quality. The Waterfall display was the primary quality assurance tool used in the side scan acquisition.
3. Parameter Display: The Parameter window shows attitude and sonar information in a tabular format. This includes position, pitch, roll, heading, speed, depth, range scale setting, and status of data logging. This display was checked frequently to ensure input from the POSMV was continuous as well as data logging status while online.

The Chinook and Locator were also equipped with an additional computer running Winfrog v3.08.23. Winfrog was used for general navigation, line tracking, and recording of SBES and MBES data as well as creation manual waypoint events during bottom sampling and feature verification.

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 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 ODOM produced depth, 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.

An additional Winfrog module was used to log raw POSMV data—consisting of the POSPac groups and 111 (True Heave). These data groups were logged to POS file at an update rate of 50 Hz and used for squat settlement calculations and for post-processed kinematic (PPK) processing.

Fugro Pelagos' MBSurvey Tools v2.00.17.00 was used to aid in file administration and reporting during data acquisition as well as calculation of the harmonic mean from sound velocity profiles for input into the acquisition systems. This program created a daily file that contained survey line, SVP and static draft logs. The daily file was later appended by processing to a master file and used to track tasks as they were completed. During project reporting MBSurvey Tools was also utilized to create the PDF log files available in Separate 1.

Sound velocity profile (SVP) data from the Applied Microsystems Ltd. (AML) Smart Probes were acquired using Microsoft Windows' Hyper Terminal.

Processing

All soundings and side scan data were processed using CARIS (Computer Aided Resource Information System) HIPS and SIPS (Hydrographic Information Processing System/Sonar Image Processing System) v6.1.

CARIS Notebook 3.0 was used to import log and shapefiles to create the S-57 feature file for each survey sheet.

ESRI ArcMap 9.3 was utilized for general survey planning, reviewing coverage plots, creating in-fill lines, crosslines, progress sketches, and for creating the chartlets presented in the DtoNs and final reports.

Fugro Pelagos' Target Analyst v3.0.1.0 add-on for ArcMap was utilized to correlate and report on sidescan contacts. The targets picked using CARIS SIPS were imported into Target Analyst, plotted in relation to other contacts and charted features, merged when contacts were deemed to be from the same target, and used to output the weekly contact reports.

Applanix POSPac v4.31 was utilized for post-processing the dual frequency GPS data sets acquired by the survey vessels and creation of the PPK solution applied to the data. The POSPac module POSGPS was used to post-process the dual frequency GPS data in conjunction with base station data using a kinematic GPS processing routine (KGPS). The POSPac module POSProc was then run to integrate the KGPS positions with the POSMV inertial solution. For SSS data, this final solution was exported to an SBET (Smoothed Best-Estimate of Trajectory) format file, which was then converted to text using an in-house converter program (MBSurvey Tools). The text files were then imported and applied to the CARIS HDCS data using the CARIS Generic Data Parser routine. For sounding data, the SBET was applied directly to the CARIS HIPS data using the Load Attitude/Navigation function in CARIS.

Fugro Pelagos' MBSurvey Tools v2.00.17.00 was used by processing to log observations, comments, and track the specific tasks completed to each survey line. MBSurvey tools also assisted in processing tasks such as processing sound velocity profiles and converting them into CARIS format, and creation of CARIS format draft files using logged vessel RPMs. During project reporting MBSurvey Tools was also utilized to create the PDF log files available in Separate 1. Utilities built in to MBSurvey Tools consisting of various text exporters and converters were also used as required

A complete list of software and versions used on this project is included in Appendix I. Refer to the "2008-NOAAProcessing Procedures" document for more details concerning processing procedures used.

B –Quality Control

Single Beam Echosounder

To ensure correct data were output by the single beam echosounder, lead line checks were performed generally once per week. Lead line checks were performed by measuring the depth of the water using a weight attached to a line with minimal stretch coefficient and comparing this result with the ODOM output. Random lead line comparisons were also imported into CARIS HIPS to further verify all corrections and offsets were being correctly applied in processing.

Single beam sounding data were acquired in the RAW format using WinFrog. In order to be used by the CARIS HIPS processing package, the data was converted to HDCS format using the CARIS HIPS Conversion utility (Winfrog to HDCS version 6.1.2.0). Updated static draft information for each survey shift was added to the HIPS Vessel File (HVF) after conversion.

Once converted, the TrueHeave (delayed heave), dynamic draft (derived from squat-settlement tests), PPK positions, tide, and HVF data were loaded into each line and then SVP corrected in CARIS HIPS. Once SVP corrected, the lines were merged; the attitude, navigation and bathymetry data for individual lines were all examined for noise, as well as to ensure the completeness and correctness of the data set. Sounding data were then reviewed using the CARIS HIPS Single Beam Editor. This allowed the processor to visually check every sounding acquired and reject any erroneous data. Note: “Rejected” does not mean the sounding data point was deleted, but that it was flagged as bad and therefore not to be applied to final surfaces.

A statistical analysis of the sounding data was conducted via the CARIS Quality Control Report (QCR) routine. Crosslines run in each sheet were compared with lines acquired from the mainscheme lines where applicable. The Quality Control Reports are located in Separate 4 for each survey.

Prior to creation of the finalized data, shoal-biased contours and soundings were generated. These were manually examined for spikes or aberrations and offending soundings investigated and rejected when necessary.

Final soundings were delivered via a BASE Surface (5m resolution) in CARIS HIPS format, as well as a XYZ format (5m bin, shoal-biased).

Multibeam Echosounder

Multibeam was used on this project to verify and obtain least depths on significant contacts identified from the side scan sonar records.

Multibeam sounding data were acquired in the XTF format using WinFrog. In order to be used by the CARIS HIPS processing package, the data was converted to HDCS format using the CARIS HIPS Conversion utility (Winfrog to HDCS version 6.1.2.1). Updated static draft information for each survey shift was added to the HIPS Vessel File (HVF) after conversion.

Once converted, the TrueHeave (delayed heave), dynamic draft (squat-settlement), PPK positions, tide, and HVF data were loaded into each line and then SVP corrected in CARIS HIPS. Once SVP corrected, the lines were merged; the attitude, navigation and bathymetry data for individual lines were all examined for noise, as well as to ensure the completeness and correctness of the data set. Sounding data were then reviewed using the CARIS HIPS Swath Editor as well as the Subset Editor. This allowed the processor to visually check every sounding acquired and reject any erroneous data.

A statistical analysis of the sounding data was conducted via the CARIS Quality Control Report (QCR) routine. Intersecting multibeam lines were used as crosslines and compared to each other where applicable. The Quality Control Reports are located in Separate 4 for each survey.

Side Scan Sonar

Sidescan Sonar (SSS) data was acquired for each survey line using Triton ISIS v7.1.500.111 in XTF format. In order to be processed by CARIS SIPS processing package, the XTF data was converted into SIPS using the XTF to HDCS routine (v6.1.2.1) in CARIS HIPS. The vessel offsets and calibration values were entered in a HVF for each survey vessel.

Once converted, the SSS depth was applied using the CARIS Generic Data Parser (GDP) and the attitude and navigation data were examined to ensure correctness and completeness for the data set. The altitude data were then reviewed using the CARIS Side Scan Editor on a line by line basis to ensure that appropriate bottom tracking was used throughout the line and to correct inconsistencies when found. The lines were then slant range corrected and appropriate beam pattern, time varied gain, and angle varied gain applied. Following the corrections the line was reexamined to ensure proper data quality for analysis of targets.

SSS mosaics were created using the CARIS FieldSheet function as a resolution of 1 meter to ensure that 200% coverage was maintained throughout the survey. Mosaics were then reviewed to ensure accurate positioning data was maintained by comparing linear bottom formations passing through adjacent lines.

SSS confidence checks were performed daily by visual confirmation that a distinct change in bottom return could be seen passing in a cross track fashion through nadir. These are located in Appendix IV.

Fugro Pelagos' Target Analyst add-on for ArcMap aided in the quality control of contacts. Target Analyst compiled exported CARIS contact lists into a GIS database and examined the database for duplicate targets. Targets within 5 meters of each other were considered to be the same target and were automatically merged, placing the final position halfway between. The targets were then reviewed manually to ensure target information was accurate and edited where necessary. In general, targets greater than or equal to 0.30 meters off the seafloor were selected as contacts for reporting purposes. After review the utility was used to export the weekly contact reports. An inverted gold color pallet and distance reference scale was then applied to each contact image utilizing Irfanview 3.98.

C - Corrections to Soundings

SOUND VELOCITY PROFILES

For singlebeam data collection, sound velocity casts were performed normally once a shift or after significant vessel relocation. The harmonic mean of the sound velocity profile was applied in the ODOM Echotrac for real time sound velocity correction. For multibeam data collection they were performed usually every hour and/or near each set of multibeam lines. The AML Smart Probes used to determine sound velocities for the surveys sampled at a rate of ten 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 (at a rate of approximately 1 meter per second) to ensure enough profiles were collected to fully sample the water column. 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

A squat-settlement test for the R/V Locator was conducted near Grand Isle, LA, on October 6th, 2008 (Julian day 2008-280). However, this test did not cover all the RPM ranges eventually used on the Locator, necessitating an additional squat-settlement which was performed on March 25th, 2009 (Jualian day 2009-084).[1] The 2009-084 test results were applied to all data.

To perform the squat settlement test, the R/V Locator logged dual-frequency (L1/L2) GPS data from the POSMV. The squat settlement tests were performed by first establishing a 1000 meter line in the direction of the current. The survey vessel occupied the east end of the line for two minutes while logging L1/L2 GPS data. The line was then run heading west at an engine rate of 700 RPM and then east at 700 RPM, stopping at the east end of the line to obtain an additional two minutes of static L1/L2 GPS data. Again, the survey vessel occupied the east end of the line and the scenario repeated at incrementing engine RPMs to cover all possible survey RPMs.

[1] The squat-settlement results compared very well (within 0.02m) for RPM ranges common to the two tests

All measurements were corrected for heave, pitch, and roll and reduced to the vessel's common reference point (CRP). Static measurements observed at the end of lines were used to compute a tide curve for tidal corrections. A settlement curve for the Locator, with the ODOM DF3200 and Reson Seabat 8101, was then computed.

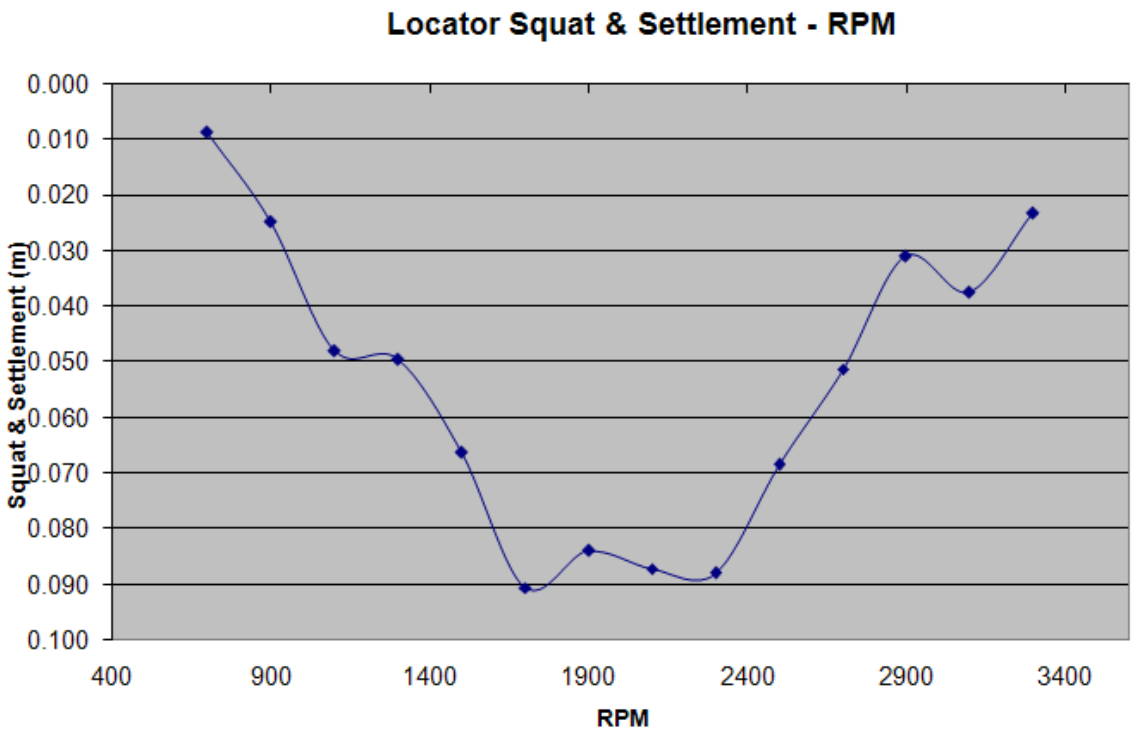


Figure 1 - R/V Locator Settlement Curve JD2009-084

The results of the squat settlement test for the Locator:

Table 1 - R/V Locator Squat Settlement Results

LOCATOR ODOM DF3200 AND RESON 8101 CALCULATED SETTLEMENT JD2009-084	
RPM	SETTLEMENT (m)
700	0.009
900	0.025
1100	0.048
1300	0.050
1500	0.066
1700	0.091
1900	0.084
2100	0.087

2300	0.088
2500	0.068
2700	0.051
2900	0.031
3100	0.038
3300	0.023

Note: Vessel RPM and speed was tracked by the acquisition crew on the survey line logs (refer to Separate 1 for all logs). MBSurveyTools was then used by processing to generate a Delta Draft file using the above corrections and then applied in CARIS HIPS.

Squat-settlement tests for the R/V Chinook were conducted near Grand Isle, LA, on October 9th, 2008 (Julian day 2008-283) and October 12th, 2008 (Julian day 2008-286). However, these initial tests did not cover all the RPM ranges eventually used on the Chinook, necessitating an additional squat-settlement which was performed on March 25th, 2009 (Jualian day 2009-084).[2] The 2009-084 test results were applied to all data.

To perform the squat settlement test, the R/V Chinook logged dual-frequency (L1/L2) GPS data from the POSMV. The squat settlement tests were performed by first establishing a 1000 meter line in the direction of the current. The survey vessel occupied the east end of the line for two minutes while logging L1/L2 GPS data. The line was then run heading west at an engine rate of 800 RPM and then east at 800 RPM, stopping at the east end of the line to obtain an additional two minutes of static L1/L2 GPS data. Again, the survey vessel occupied the east end of the line and the scenario repeated at incrementing engine RPMs to cover all possible survey RPMs.

All measurements were corrected for heave, pitch, and roll and reduced to the vessel's common reference point (CRP). Static measurements observed at the end of lines were used to compute a tide curve for tidal corrections. A settlement curve for the Chinook, with the ODOM DF3200 installed, was then computed.

[2] The squat-settlement results compared very well (within 0.04m) for RPM ranges common to the three tests

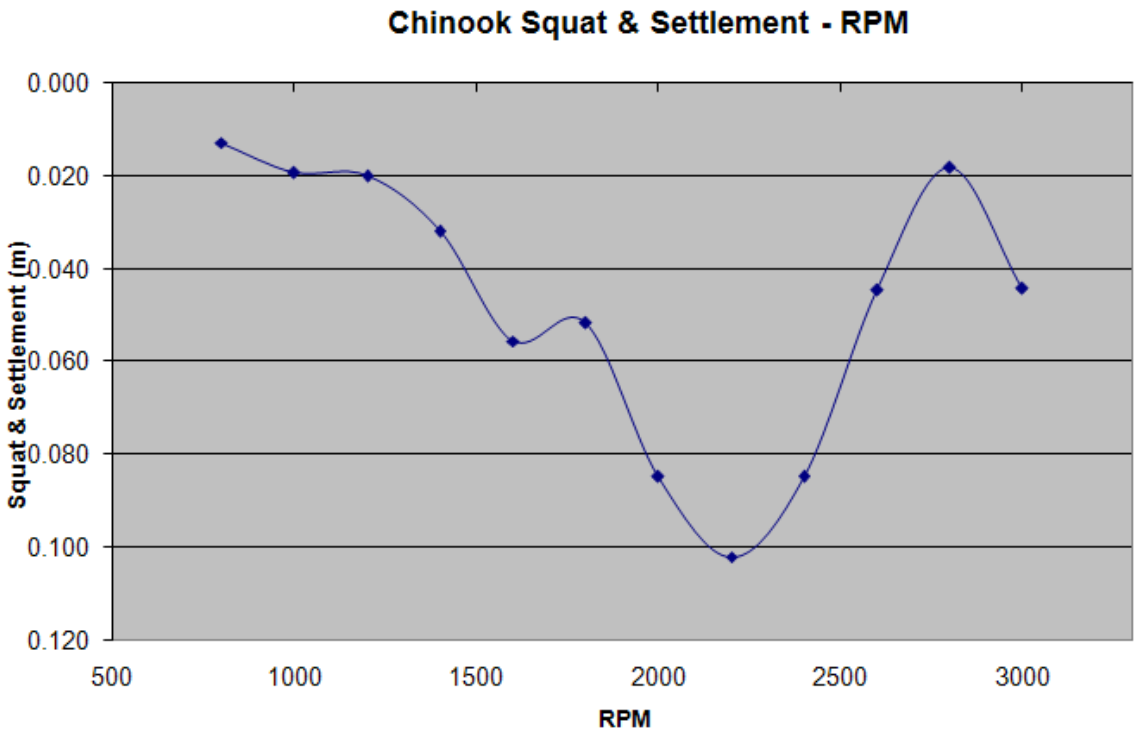


Figure 2 - R/V Chinook Settlement Curve JD2009-084

The results of the squat settlement test for the Chinook:

Table 2 - R/V Chinook Squat Settlement Results

CHINOOK ODOM DF3200 CALCULATED SETTLEMENT JD2009-084	
RPM	SETTLEMENT (m)
800	0.013
1000	0.019
1200	0.020
1400	0.032
1600	0.055
1800	0.052
2000	0.085
2200	0.102
2400	0.085
2600	0.045
2800	0.018
3000	0.044

Note: Vessel RPM and speed was tracked by the acquisition crew on the survey line logs (refer to Separate 1 for all logs). MBSurveyTools was then used by processing to

generate a Delta Draft file using the above corrections and then applied in CARIS HIPS.

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 Locator (for Odom SBES) used in data processing.

Table 3 - Draft Measurements for the R/V Locator for ODOM SBES

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
1	2008-229	22:16:00	-0.02
2	2008-230	11:09:00	-0.01
3	2008-232	11:23:00	-0.07
4	2008-233	11:45:00	-0.01
5	2008-234	11:25:00	0.00
6	2008-235	11:37:00	0.00
7	2008-236	13:38:00	0.02
8	2008-237	13:38:00	0.02
9	2008-239	11:40:00	0.00
10	2008-240	11:44:00	0.00
11	2008-241	11:44:00	0.01
12	2008-263	22:56:00	0.01
13	2008-265	11:10:00	0.01
14	2008-266	11:19:00	0.02
15	2008-267	11:32:00	0.02
16	2008-268	11:42:00	0.01
17	2008-269	11:11:00	0.01
18	2008-270	11:04:00	0.02
19	2008-271	11:10:00	0.01
20	2008-272	10:52:00	0.02
21	2008-273	11:20:00	0.00
22	2008-274	11:22:00	0.02
23	2008-275	11:27:00	0.00
24	2008-277	12:36:00	0.01
25	2008-278	11:05:00	0.01
26	2008-284	10:53:00	0.01
27	2008-285	11:00:00	0.02

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
28	2008-287	10:49:00	0.02
29	2008-287	12:47:00	0.01
30	2008-294	17:54:00	0.01
31	2008-295	11:11:00	0.01
32	2008-299	11:03:00	0.00
33	2008-300	10:59:00	0.01
34	2008-303	11:05:00	0.02
35	2008-304	11:03:00	0.02
36	2008-306	11:03:00	0.02
37	2008-307	11:57:00	0.00
38	2008-308	11:59:00	0.01
39	2008-309	11:58:00	0.00
40	2008-310	11:59:00	0.00
41	2008-311	11:41:00	0.01
42	2008-312	11:40:00	0.01
43	2008-313	12:08:00	0.00
44	2008-314	11:41:00	0.01
45	2008-318	11:54:00	0.01
46	2008-319	12:12:00	0.01
47	2008-321	12:00:00	0.01
48	2008-322	12:11:00	0.01
49	2008-324	12:11:00	0.01
50	2008-330	19:47:00	0.01
51	2008-331	12:00:00	0.01
52	2008-332	11:58:00	0.02
53	2008-333	12:45:00	0.02
54	2008-334	12:30:00	0.01
55	2008-336	14:08:00	0.01
56	2008-337	16:35:00	0.01
57	2008-341	11:42:00	0.01
58	2008-342	11:45:00	0.01
59	2008-347	11:40:00	0.01
60	2008-351	12:59:00	0.01
61	2008-352	13:06:00	0.01
62	2008-353	12:42:00	0.01
63	2008-354	11:40:00	0.01
64	2008-355	12:59:00	0.01
65	2008-356	12:37:00	0.01
66	2008-365	11:00:00	0.01
67	2008-366	11:45:00	0.02

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
68	2009-001	11:45:00	0.02
69	2009-002	11:45:00	0.01
70	2009-003	12:19:00	-0.01
71	2009-004	11:59:00	0.00
72	2009-007	17:16:00	0.02
73	2009-008	11:51:00	0.01
74	2009-009	11:51:00	0.00
75	2009-013	12:53:00	0.01
76	2009-014	12:59:00	0.01
77	2009-017	11:52:00	0.01
78	2009-018	20:29:00	0.00
79	2009-019	11:52:00	0.00
80	2009-020	11:43:00	0.03
81	2009-021	11:40:00	-0.01
82	2009-023	12:32:00	-0.01
83	2009-024	11:51:00	0.00
84	2009-025	11:53:00	-0.01
85	2009-026	11:44:00	0.00
86	2009-027	11:47:00	0.00
87	2009-030	18:05:00	0.00
88	2009-031	11:47:00	0.00
89	2009-032	11:43:00	0.00
90	2009-034	12:20:00	0.00
91	2009-036	11:47:00	0.00
92	2009-037	11:43:00	0.00
93	2009-043	11:46:00	0.00
94	2009-044	11:40:00	0.00
95	2009-048	12:05:00	0.00
96	2009-051	11:49:00	0.00
97	2009-052	11:41:00	-0.01
98	2009-055	11:40:00	0.01
99	2009-056	11:42:00	0.01
100	2009-057	12:07:00	0.01
101	2009-061	17:58:00	0.00
102	2009-062	12:38:00	0.01
103	2009-063	12:12:00	0.01
104	2009-064	12:01:00	0.01
105	2009-065	11:37:00	0.00
106	2009-067	11:55:00	-0.01
107	2009-068	11:49:00	-0.01

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
108	2009-069	11:46:00	-0.01
109	2009-070	11:45:00	0.00
110	2009-072	11:47:00	-0.01
111	2009-073	11:43:00	0.00
112	2009-076	11:45:00	-0.01
113	2009-077	11:47:00	-0.01
114	2009-078	13:44:00	0.00
115	2009-089	11:45:00	0.00
116	2009-093	11:43:00	0.00
117	2009-095	11:50:00	-0.01

Table 4 - Draft Measurements for the R/V Locator for Reson 8101 MBES

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
1	2008-214	00:00:00	1.50
2	2008-281	10:55:00	1.58
3	2008-283	11:17:00	1.59
4	2008-290	19:01:00	1.58
5	2008-291	11:20:00	1.58
6	2008-294	11:18:00	1.59
7	2008-295	11:11:00	1.58
8	2008-306	11:00:00	1.59
9	2008-310	11:59:00	1.59
10	2008-325	12:04:00	1.59
11	2008-329	13:40:00	1.60
12	2008-337	13:06:00	1.60
13	2008-341	13:49:00	1.59
14	2008-365	13:51:00	1.59
15	2009-022	11:47:00	1.58
16	2009-045	13:19:00	1.58
17	2009-046	15:47:00	1.59
18	2009-055	12:37:00	1.59
19	2009-071	11:55:00	1.58

Table 5 - Draft Measurements for the R/V Chinook for ODOM SBES

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
1	2008-229	12:27:00	0.24
2	2008-230	11:33:00	0.25

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
3	2008-231	11:10:00	0.27
4	2008-232	11:46:00	0.27
5	2008-233	11:01:00	0.25
6	2008-234	11:55:00	0.24
7	2008-235	11:01:00	0.25
8	2008-236	12:15:00	0.27
9	2008-237	12:55:00	0.27
10	2008-239	11:55:00	0.23
11	2008-240	11:06:00	0.25
12	2008-241	10:56:00	0.26
13	2008-263	15:47:00	0.26
14	2008-264	11:14:00	0.22
15	2008-265	11:18:00	0.21
16	2008-266	11:15:00	0.23
17	2008-267	11:21:00	0.22
18	2008-268	11:32:00	0.22
19	2008-269	11:21:00	0.22
20	2008-270	11:19:00	0.20
21	2008-271	11:19:00	0.23
22	2008-272	11:32:00	0.23
23	2008-273	11:28:00	0.23
24	2008-274	11:31:00	0.23
25	2008-275	11:41:00	0.24
26	2008-277	11:37:00	0.25
27	2008-278	11:07:00	0.23
28	2008-281	11:19:00	0.23
29	2008-283	11:12:00	0.22
30	2008-284	11:14:00	0.23
31	2008-285	11:10:00	0.24
32	2008-287	12:06:00	0.24
33	2008-288	19:28:00	0.24
34	2008-290	11:40:00	0.28
35	2008-291	11:16:00	0.27
36	2008-294	11:20:00	0.24
37	2008-295	11:24:00	0.25
38	2008-296	11:29:00	0.25
39	2008-299	11:21:00	0.25
40	2008-300	10:53:00	0.25
41	2008-303	11:00:00	0.26
42	2008-306	11:05:00	0.26

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
43	2008-307	12:02:00	0.26
44	2008-308	11:47:00	0.26
45	2008-309	11:44:00	0.26
46	2008-310	11:47:00	0.26
47	2008-311	11:46:00	0.27
48	2008-312	11:44:00	0.26
49	2008-313	12:12:00	0.26
50	2008-314	11:43:00	0.26
51	2008-318	12:07:00	0.26
52	2008-319	12:23:00	0.27
53	2008-321	13:00:00	0.26
54	2008-322	12:05:00	0.26
55	2008-323	11:55:00	0.26
56	2008-324	12:00:00	0.26
57	2008-325	12:00:00	0.26
58	2008-330	18:00:00	0.26
59	2008-331	11:45:00	0.26
60	2008-332	11:51:00	0.26
61	2008-333	12:44:00	0.27
62	2008-334	12:11:00	0.26
63	2008-337	11:42:00	0.26
64	2008-341	12:16:00	0.26
65	2008-342	12:00:00	0.25
66	2008-347	12:54:00	0.24
67	2008-348	23:58:00	0.22
68	2008-350	22:12:00	0.25
69	2008-351	00:30:00	0.25
70	2008-352	00:30:00	0.27
71	2008-353	00:30:00	0.27
72	2008-354	00:30:00	0.26
73	2008-355	00:01:00	0.22
74	2008-355	12:05:00	0.27
75	2008-355	23:36:00	0.23
76	2008-364	13:01:00	0.24
77	2008-364	19:00:00	0.24
78	2008-365	11:44:00	0.24
79	2008-366	11:52:00	0.22
80	2009-001	12:00:00	0.23
81	2009-001	18:36:00	0.23
82	2009-002	11:40:00	0.24

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
83	2009-003	11:58:00	0.23
84	2009-004	11:52:00	0.25
85	2009-004	17:49:00	0.24
86	2009-005	11:42:00	0.24
87	2009-005	23:56:00	0.24
88	2009-007	17:27:00	0.24
89	2009-007	23:53:00	0.25
90	2009-008	11:52:00	0.24
91	2009-009	00:18:00	0.24
92	2009-013	13:04:00	0.25
93	2009-014	12:27:00	0.23
94	2009-014	23:32:00	0.24
95	2009-015	12:47:00	0.28
96	2009-016	23:54:00	0.25
97	2009-017	11:23:00	0.27
98	2009-018	11:34:00	0.26
99	2009-019	11:26:00	0.27
100	2009-020	11:35:00	0.27
101	2009-021	11:20:00	0.28
102	2009-021	23:38:00	0.24
103	2009-022	11:29:00	0.27
104	2009-023	12:20:00	0.27
105	2009-023	23:28:00	0.27
106	2009-024	12:39:00	0.27
107	2009-024	23:54:00	0.24
108	2009-025	11:31:00	0.27
109	2009-025	23:34:00	0.25
110	2009-026	11:32:00	0.26
111	2009-027	11:38:00	0.25
112	2009-027	23:40:00	0.26
113	2009-028	12:16:00	0.27
114	2009-028	22:21:00	0.23
115	2009-029	10:59:00	0.25
116	2009-030	18:12:00	0.27
117	2009-031	00:58:00	0.25
118	2009-031	11:15:00	0.26
119	2009-031	23:32:00	0.26
120	2009-032	11:42:00	0.26
121	2009-032	23:01:00	0.25
122	2009-034	11:26:00	0.26

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
123	2009-035	22:14:00	0.26
124	2009-036	11:18:00	0.27
125	2009-037	11:40:00	0.26
126	2009-037	22:43:00	0.26
127	2009-038	11:28:00	0.26
128	2009-043	11:27:00	0.27
129	2009-043	21:32:00	0.25
130	2009-044	11:27:00	0.27
131	2009-045	11:24:00	0.29
132	2009-046	11:17:00	0.26
133	2009-046	23:17:00	0.26
134	2009-048	11:24:00	0.27
135	2009-050	21:50:00	0.26
136	2009-051	11:19:00	0.28
137	2009-051	23:32:00	0.27
138	2009-052	11:30:00	0.27
139	2009-054	23:37:00	0.28
140	2009-055	23:30:00	0.27
141	2009-056	11:20:00	0.27
142	2009-057	11:41:00	0.26
143	2009-061	17:20:00	0.26
144	2009-061	23:26:00	0.24
145	2009-062	12:25:00	0.26
146	2009-064	12:08:00	0.26
147	2009-065	11:43:00	0.27
148	2009-066	23:00:00	0.26
149	2009-066	23:10:00	0.26
150	2009-067	12:08:00	0.27
151	2009-067	23:23:00	0.25
152	2009-068	11:31:00	0.27
153	2009-068	23:30:00	0.26
154	2009-069	11:34:00	0.27
155	2009-069	23:25:00	0.26
156	2009-070	11:58:00	0.26
157	2009-073	23:10:00	0.27
158	2009-075	23:14:00	0.25
159	2009-076	11:39:00	0.25
160	2009-076	22:14:00	0.26
161	2009-077	11:55:00	0.25
162	2009-078	11:17:00	0.26

Draft Number	Year – Julian Day	Time (UTC)	Draft (meters)
163	2009-079	11:51:00	0.25
164	2009-088	16:51:00	0.26
165	2009-089	12:41:00	0.25

TIDES

Observed tidal data was assembled from the National Water Level Observation Program accessed through the NOAA tides and currents website (http://tidesandcurrents.noaa.gov/). A cumulative file for the gauge in use was updated daily by appending the new data as it became available.

On April 12, 2009, verified tide data was acquired from the National Water Level Observation Program accessed through the NOAA tides and currents website (http://tidesandcurrents.noaa.gov/). The verified data was smoothed and applied to all sounding data in CARIS HIPS using tidal zones provided by NOAA. All sounding data was then remerged. The Grand Isle, LA (8761724) was used as the primary tidal station while Port Fourchon (8762075) was used as the secondary tidal station. Verified tidal data were used for all final Navigation Base Surfaces, soundings, and S-57 Feature files. Refer to the Vertical & Horizontal Control Report for additional information and any unusual tidal conditions encountered during the course of the OPR-K977-FU-08 survey.

VESSEL ATTITUDE: HEADING, HEAVE, PITCH, AND ROLL

Vessel heading and dynamic motion were measured by the Applanix POS MV 320 V4. The system calculated heading by inversing between two Trimble GPS generated antenna positions. An accelerometer block (the IMU), which measured vessel attitude, was mounted as near as possible over the single beam transducer on each vessel. The operational accuracy specifications for this system, as documented by the manufacturer, are as follows:

Table 6 - 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) between the motion sensor and sonar systems for the Reson Seabat 8101 on October 7, 2008 (Julian day 2008-281). Additional patch tests were performed as checks on October 9 and October 10, 2008.

Note that when the multibeam system was used, usually on a weekly or bi-weekly basis, the POSMV IMU was physically moved from midship on the Locator and remounted at the top of the mounting pole for the Reson 8101. Additionally patch tests confirmed calibration values did not change when remounted, and offsets were changed as required in the POSMV and in CARIS HIPS to correct for the new IMU location.

Patch test calibration values used to correct all multibeam soundings for the survey were as follows:

Table 7 - Patch Test Results for Locator Reson Seabat 8101

Test	Mean Correction
Navigation Timing Error	0.000 seconds
Pitch Offset	-0.800 degrees
Roll Offset	0.600 degrees
Yaw Offset	-0.700 degrees

D - Approval Sheet

Approval Sheet

For

H11804, H11805, H11806, and H11807

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

OPR-K977-FU-08 Statement of Work
NOS Hydrographic Surveys Specifications and Deliverables (May 2008)
Fugro Pelagos, Inc. Acquisition Procedures (2008-NOAAAcquisitionProcedures);
Fugro Pelagos, Inc. Processing Procedures (2008-NOAAProcessingProcedures);

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, Atlantic Hydrographic Branch.

Approved and forwarded,

Andrew Orthmann

Digitally signed by Andrew Orthmann
DN: cn=Andrew Orthmann, l=Anchorage, Alaska, o=Fugro Pelagos, email=aorthmann@fugro.com
Location: Anchorage, Alaska
Date: 2009.05.30 11:36:39 -05'00'

Andrew Orthmann, ACSM Certified
Lead Hydrographer
Fugro Pelagos, Inc. Survey Party

Appendix I – Equipment List and Software Versions

Equipment

Table 8 - Equipment List

System	Manufacturer	Model	Serial No.
Side Scan Sonar	Klein	Klein Model 3000 Processor	477
		Klein Model 3000 Towfish	609
Side Scan Sonar	Klein	Klein Model 3000 Processor	487
		Klein Model 3000 Towfish	3210
Single Beam Sonar	ODOM	ODOM DF3200 Processor	9313
Single Beam Sonar	ODOM	ODOM DF3200 Processor	9735
POS MV	Applanix	320 V4	2355
POS MV	Applanix	IMU	49
POS MV	Applanix	320 V4	2148
POS MV	Applanix	IMU	730
GPS Antenna	Trimble	L1/L2 (SPOT)	191
GPS Antenna	Trimble	L1/L2 (SPOT)	192
GPS Antenna	Trimble	L1/L2	60009264
GPS Antenna	Trimble	L1/L2	12286246
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4820
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4703
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	5385
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4431
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4656
RTCM	CSI Inc.	CSI MBX-3	9834-2211-0002
RTCM	CSI Inc.	CSI-MBX-3	102-502-8618
RTCM	CSI Inc.	CSI MBX-3	00550055
RTCM	CSI Inc.	CSI GBX Pro	0001900A
GPS Receiver	Novatel	DL-4	NYB05140001
GPS Receiver	Novatel	DL-4	NYB06140004

Software

Applanix POSPac 4.31
Autodesk AutoCAD 2008
CARIS HIPS/SIPS V 6.1
CARIS Notebook V 3.0
ESRI ArcMap V 9.3
Fugro Pelagos, Inc. Winfrog V 3.08.23
Fugro Pelagos, Inc. MBSurveyTools V 2.00.17.00
Fugro Pelagos, Inc. TargetAnalyst V 3.0.1.0 (for ArcMap)
Fugro Pelagos, Inc. Raw2Line
IrfanView V 3.98
IVS Fledermaus V 6.3
Microsoft Office 2007
NOAA Chart Reprojector V 2.0.6
Nobeltec Tides and Currents V 3.5
Triton ISIS V 7.1.500.111

Appendix II – Vessel Descriptions

R/V Chinook

The R/V Chinook, a catamaran-style vessel, was modified to accommodate a survey crew and acquisition hardware. A retractable pole was installed amidships on the starboard side as a rigid mount to accommodate the Klein Model 3000 SSS Tow Fish. A 200 kHz single beam transducer connected to an Odom DF3200 echosounder was hull-mounted near midship on the starboard hull. The accelerometer package (IMU) for a POSMV was mounted in the hull of the vessel on the centerline abeam and above the single beam transducer.

Two Trimble L1/L2 antennas were mounted atop the vessel's house for positioning and heading. The two POS MV antennas were separated by 2.06 m from each other. The port side antenna (L1/L2) functioned as the POSMV master antenna; the starboard side antenna functioned as the POSMV secondary.

The AML Smart Probe SV&P sensors were deployed from a hand line.

Offset values were derived from a total station survey and applied to the data in CARIS HIPS as specified in the HIPS vessel 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 POSMV is already corrected to the CRP.

Table 9 - Vessel Offsets (Chinook SSS/SBES)

Chinook Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POSMV	0.000	0.000	0.000
CRP	Klein SSS Mounting Point	1.892	0.068	-2.819
CRP	Single Beam Transducer	1.283	-1.360	0.777
CRP	GPS1 – Master Antenna	-1.000	0.120	-2.896
CRP	GPS2 – Slave Antenna	1.063	0.120	-2.864
CRP	Draft Measuring Point, Port	-1.528	-1.396	-0.933
CRP	Draft Measuring Point, Starboard	1.579	-1.396	-0.875

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 10 - Vessel Specifications (Chinook)

Survey Launch	R/V Chinook
Official Number	AK-1437-K
Owner	Zephyr Marine
Length	28 ft
Beam	10 ft
Draft	1.5 ft
Mechanical Power	225 HP Honda Outboards (2)
Electrical	Inboard Diesel

Figure 3 - R/V Chinook

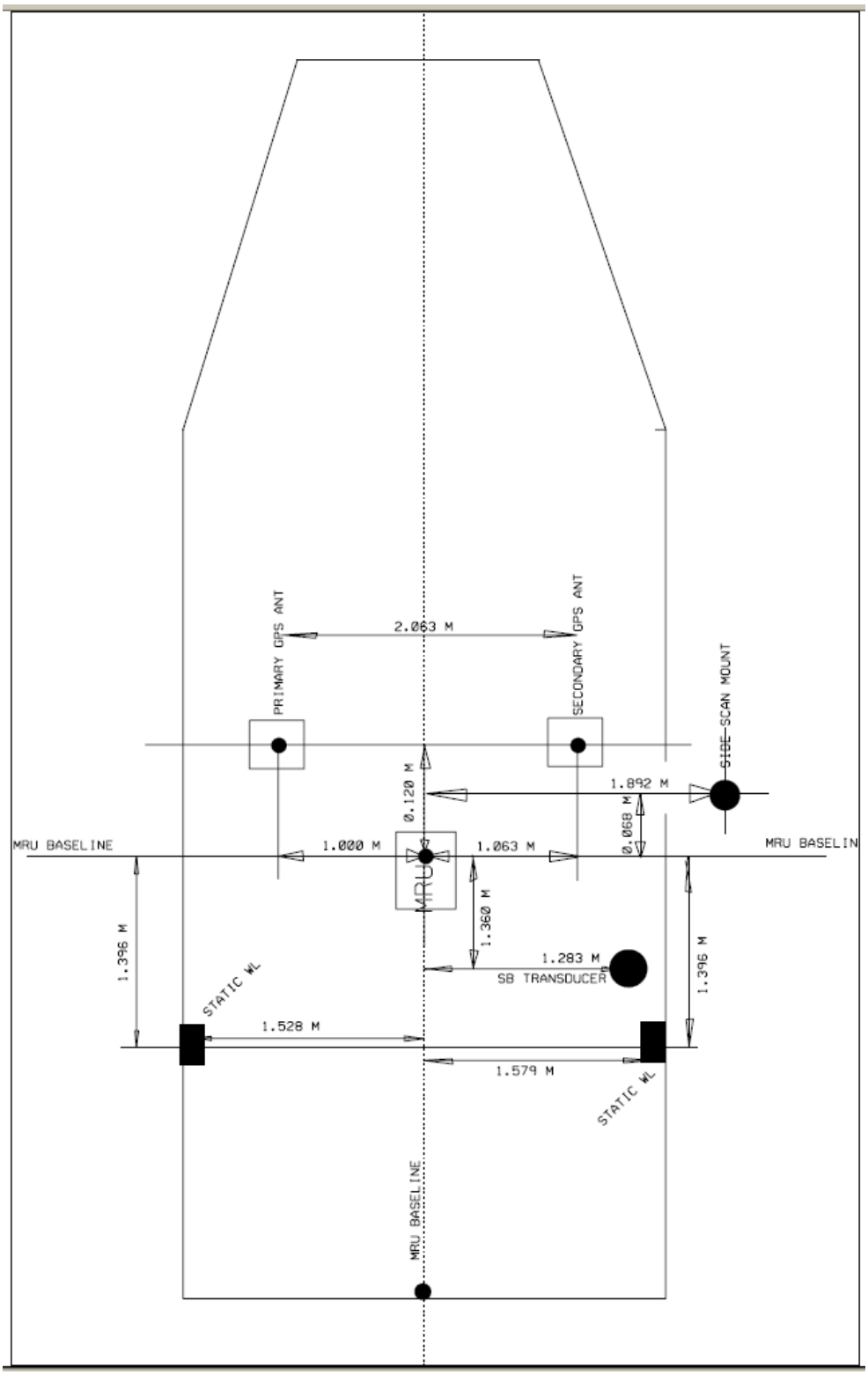


Figure 4 - R/V Chinook Offsets (X,Y)

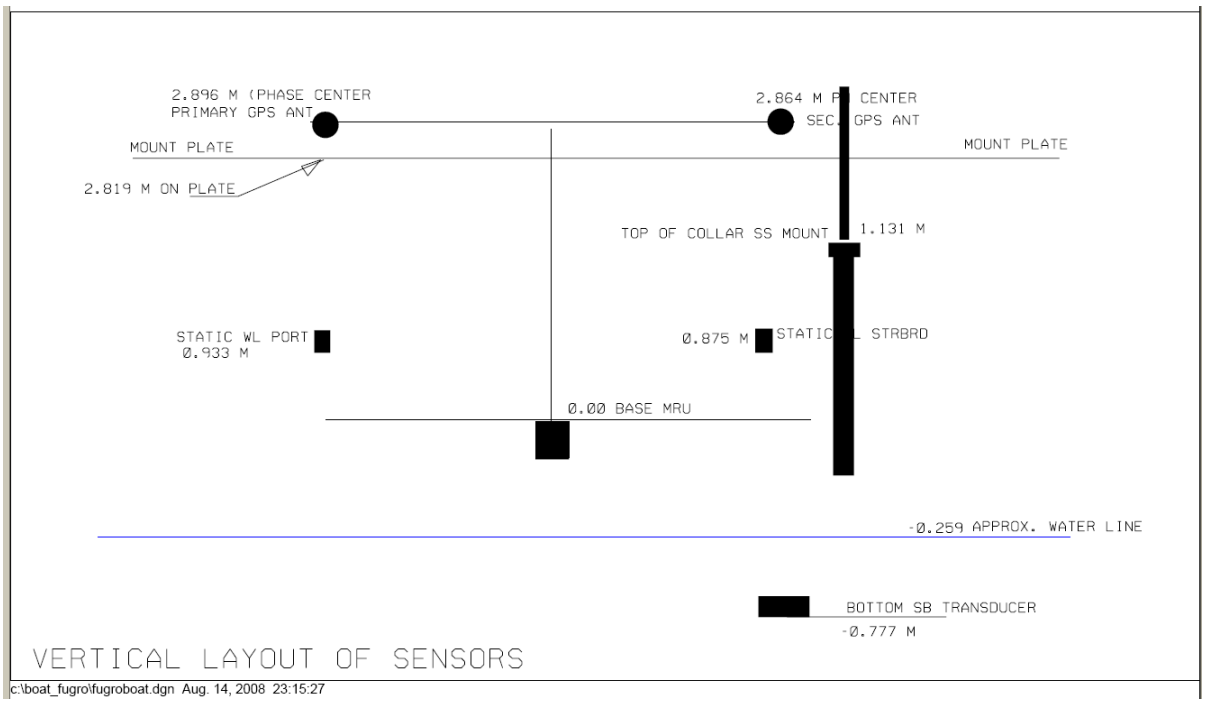


Figure 5 - R/V Chinook Offsets (Z)

R/V LOCATOR

The R/V Locator accommodated a survey crew and acquisition hardware. A retractable pole was installed slightly aft from amidships on the starboard side as a rigid mount to accommodate the Klein Model 3000 SSS Tow Fish. The 200 kHz single beam transducer was mounted amidships along the keel through an acoustically clear window. Another retractable pole was installed slightly aft from amidships on the port side to accommodate the Reson Sebat 8101 sonar head. The accelerometer package (IMU) for a POSMV was mounted along the keel of the vessel just above the single beam transducer head. During multibeam operations the IMU was remounted at the top of the multibeam pole.

Two Trimble L1/L2 GPS antennas (Figure 8) were mounted on poles extending from the ship's radar arch to determine positioning and heading. The two POS MV antennas were separated by 1.2m 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. During multibeam operations the antennas were remounted in a fore-aft configuration atop the multibeam pole.

The AML Smart Probe SV&P sensors were deployed from a hand line.

Offset values were applied to the data in CARIS HDCS as specified in the HIPS vessel 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 POSMV is already corrected to the CRP.

Table 11 - Vessel Offsets (Locator SSS/SBES)

Locator Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS MV	0.000	0.000	0.000
CRP	Klein SSS Mounting Point	1.648	-1.667	-0.983
CRP	Single Beam Transducer	0.002	-0.012	-0.466
CRP	GPS 1 - Master Antenna	-0.647	0.325	2.324
CRP	GPS 2 - Slave Antenna	0.589	0.318	2.339
CRP	Draft Measuring Point, Port	-1.507	-1.669	0.901
CRP	Draft Measuring Point, Starboard	1.449	-1.499	0.981

Table 12 - Vessel Offsets (Locator MBES)

Locator Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS MV	0.000	0.000	0.000
CRP	Reson 8101 (Acoustic Center)	0.014	-0.139	2.420
CRP	GPS 1 - Master Antenna	0.002	0.560	-0.281

CRP	GPS 2 - Slave Antenna	0.000	-0.545	-0.287
CRP	Draft Measuring Point, Port	0.141	-0.101	0.670
CRP	Draft Measuring Point, Starboard	3.093	0.123	-0.613

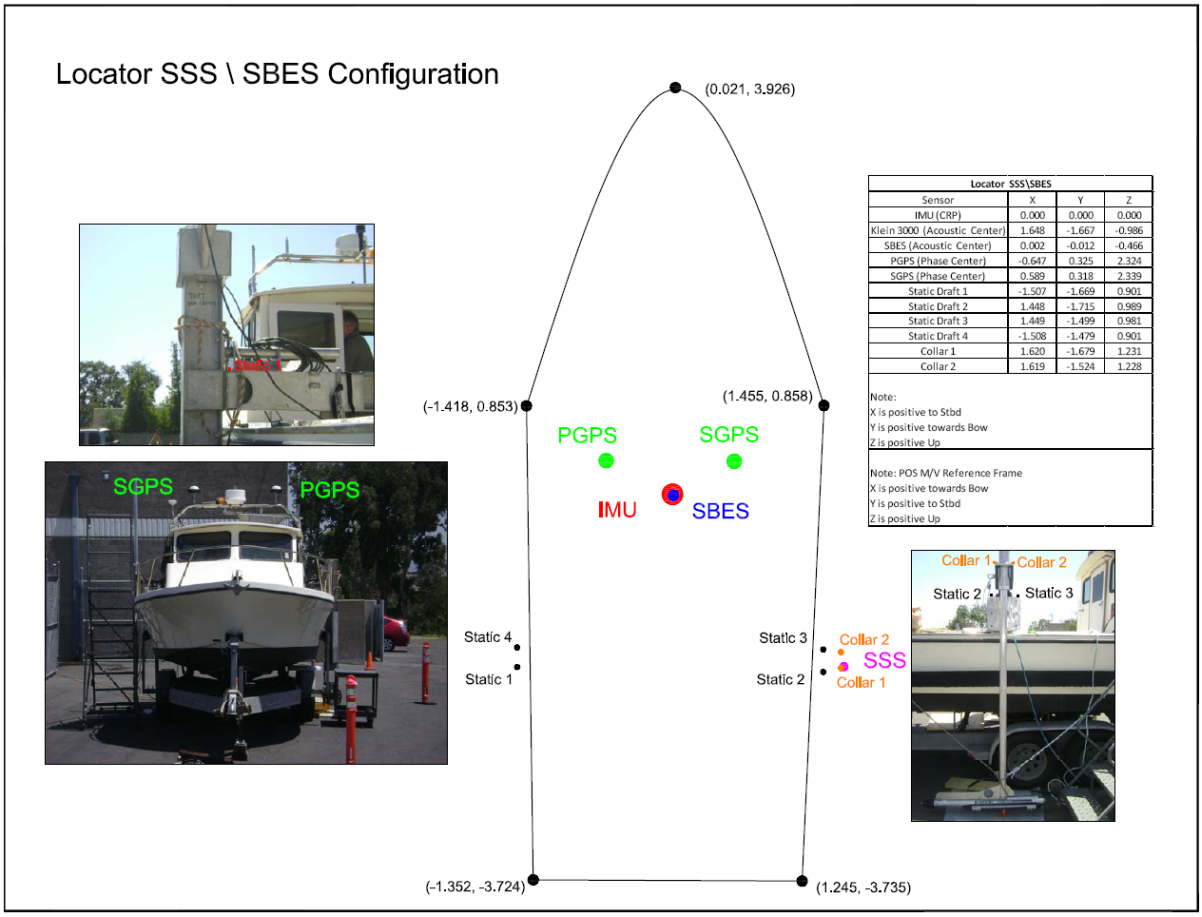
Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 13 - Vessel Specifications (Locator)

SURVEY LAUNCH	R/V LOCATOR
Official Number	CF-4540-NB
Owner	Fugro Pelagos, Inc.
Length	25 ft
Beam	9 ½ ft
Draft	1.5 ft
Dry Weight	3900 lbs.
Main Engine	Outboard Yamaha 250hp

Figure 6 - R/V Locator

Figure 7 – Pole mounted SSS on Locator

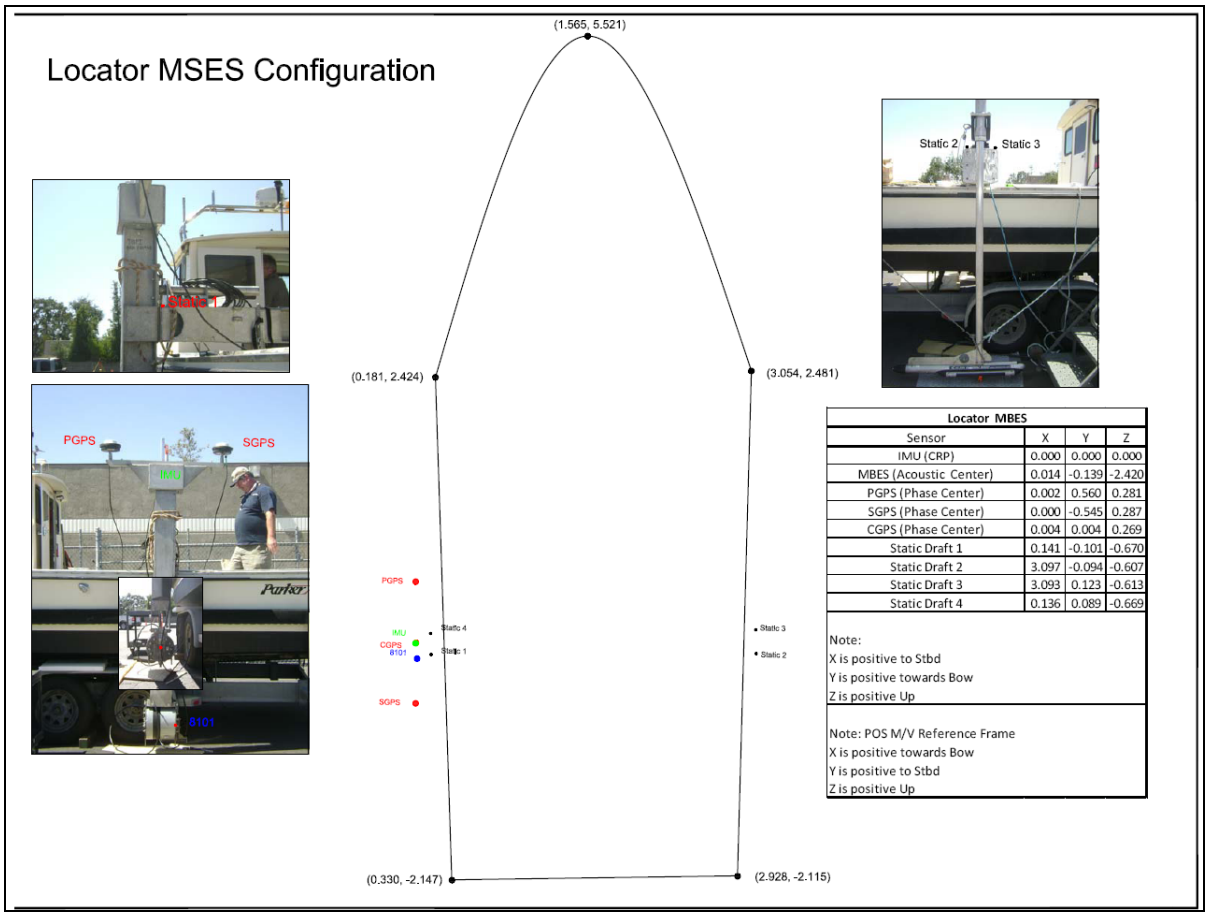


Locator SSS\SBES			
Sensor	X	Y	Z
IMU (CRP)	0.000	0.000	0.000
Klein 3000 (Acoustic Center)	1.648	-1.667	-0.986
SBES (Acoustic Center)	0.002	-0.012	-0.466
PGPS (Phase Center)	-0.647	0.325	2.324
SGPS (Phase Center)	0.589	0.318	2.339
Static Draft 1	-1.507	-1.669	0.901
Static Draft 2	1.448	-1.715	0.989
Static Draft 3	1.449	-1.499	0.981
Static Draft 4	-1.508	-1.479	0.901
Collar 1	1.620	-1.679	1.231
Collar 2	1.619	-1.524	1.228

Note:
X is positive to Stbd
Y is positive towards Bow
Z is positive Up

Note: POS M/V Reference Frame
X is positive towards Bow
Y is positive to Stbd
Z is positive Up

Figure 8 – Locator Offsets for SSS/SBES



Locator MBES			
Sensor	X	Y	Z
IMU (CRP)	0.000	0.000	0.000
MBES (Acoustic Center)	0.014	-0.139	-2.420
PGPS (Phase Center)	0.002	0.560	0.281
SGPS (Phase Center)	0.000	-0.545	0.287
CGPS (Phase Center)	0.004	0.004	0.269
Static Draft 1	0.141	-0.101	-0.670
Static Draft 2	3.097	-0.094	-0.607
Static Draft 3	3.093	0.123	-0.613
Static Draft 4	0.136	0.089	-0.669

Note:
X is positive to Stbd
Y is positive towards Bow
Z is positive Up

Note: POS M/V Reference Frame
X is positive towards Bow
Y is positive to Stbd
Z is positive Up

Figure 9 – Locator Offsets for MBES (Reson 8101)

Appendix III – Calibration Reports

Located in accompanying Appendix III directory are certificates and calibration reports for sound velocity probes used on this project, which were:

SN 4431
SN 4656
SN 4703
SN 4820
SN 5385

Appendix IV – SSS Daily Confidence Checks

Included in accompanying Appendix IV directory:

OPR-K977-FU-08 Daily Confidence Checks_Locator.xls
OPR-K977-FU-08 Daily Confidence Checks_Chinook.xls