OPR-K354-KR-10

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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey: Hydrographic Multibeam & 200% Sidescan

Project Number: OPR-K354-KR-10

Time Frame: June 2010 - December 2011

LOCALITY

State: Louisiana

General Locality: Gulf of Mexico

2012

CHIEFS OF PARTY
Scott Croft, Tara Levy

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NOAA FORM 77-28 (11-72)

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

PROJECT NUMBER:

OPR-K354-KR-10

HYDROGRAPHIC TITLE SHEET
Data Acquisition and Processing Report

State: Louisiana

General Locality: Gulf of Mexico

Scale: 1:40,000 Date of Survey: June 2010 - December 2011

Instructions Dated: May 2010 Project Number: OPR-K354-KR-10

Vessels: M/V *Inez McCall*

Chiefs of Party: Scott Croft, Tara Levy

Surveyed by: C&C Technologies Personnel

Soundings taken by echosounder: Simrad EM3002 Multibeam Echo sounder

Verification by: C&C Technologies Personnel

Soundings in: Feet: X Fathoms: ___ Meters: ___ at MLW: ___ MLLW: X

Remarks: Multibeam Hydrographic Surveys
Data collection in meters, referenced to MLLW, later converted into feet
200% side scan sonar coverage
UTC time
Tidal Zones and Correctors from NOS, CO-OPS

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LIST OF ACRONYMS AND ABBREVIATIONS

AWOIS	Automated Wreck and Obstruction Information System
C/I	Cable in
C/O	Cable out
CTD	Conductivity Temperature Depth
EOL	End of line
HM	Harmonic mean
HSSD	Hydrographic Survey Specifications and Deliverables Manual (2010)
HVF	HIPS Vessel File
LL	Lead line
MB	Multibeam
MLLW	Mean Lower Low Water
P/L	Pipeline
P/F	Platform
RR	Re-run
SB	Singlebeam
SOL	Start of line
SS	Ship Shoal (block name)
SSS	Side scan sonar
SSP	Sound Speed Profile
SWMB	Shallow Water Multibeam
TPU	Total Propagated Uncertainty
WD	Water depth
WOW	Wait on weather
Wpt	Waypoint
ZDF	Tide Zone Definition File

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A. EQUIPMENT

The major operational systems used to acquire hydrographic data were the Simrad EM3002 multibeam echo sounder (MBES) and the Klein 5000 side scan sonar (SSS). A full survey equipment list is shown in Table No. 1. A combination of PCs and Fedora Workstations were used to collect and process the data. A complete list of data acquisition and processing software systems are shown in Table No. 2. All computers were networked to allow for precise time tagging and geo referencing of the data, as well as for efficient data transfer. Refer to Appendix B for further documentation and information on survey equipment.

Table No. 1. Survey equipment list.

System	Manufacturer	Model	Serial Number
Multibeam Echo Sounder	Simrad	EM3002	Transducer - 605 (before 11/09/22) Transducer - 442 (after 11/09/22) Topside - 1010
Side Scan Sonar	Klein	5000	Topside – 156 Fish – 312
Single Beam Echo Sounder	ODOM	Echotrac DF3200 MK II	9392
Inertial Motion Sensor	Applanix	POS MV-320 V.3	15 – IMU 208 –Topside
Primary Positioning System	CNAV	2050	5310
Secondary Positioning System	CNAV	2050	1388
Tertiary Positioning System	Applanix	POS MV-320 V.3	IMU – 15 Topside - 208
Sound Speed at Transducer	YSI Electronics	R600	O1E1148
Sound Velocity Profiler	Seabird	SBE 19	1174, 5221, 5222
Cable Payout Indicator	Subsea Systems	PI-5600	0226

Table No. 2. Data acquisition and processing software

Purpose	Software	Version	Date of Installation
Multibeam data recording and monitoring	Hydromap	n/a	3-25-2010
Multibeam control Software	SIS	3.4.1	2007
Side Scan Collection	SonarWiz4	V4.03.0091	7-22-2011
Side Scan Processing (Field)	SonarWiz4	V4.04.0118	7-13-2010
Side Scan Processing (Office)	SonarWiz4	V4.04.0118	7-13-2010
Multibeam Processing (Field)	CARIS HIPS/SIPS	6.1	6-18-2007
Multibeam Processing (Office)	CARIS HIPS/SIPS	7.1 – Hotfixes 1 and 2	9-02-2011
Multibeam Processing (Office)	Notebook	3.1	09-08-2011
CTD Conversion Tool (Field)	Seabird Electronics Sea Term	1.58	8-3-2007
CTD Conversion Tool (Field)	Seabird Electronics Data	7.14c	8-3-2007
CTD Conversion Tool (Field)	Conversion SVTool	1.2.2	8-3-2007

A.1 SURVEY VESSELS

Survey operations were conducted aboard the *Inez McCall*. The *Inez McCall* is a 108-foot survey vessel that is leased from Cameron Offshore Boats, out of Cameron, Louisiana. A vessel diagram and specifications chart is included in Appendix A. The diagram shows all offsets from the vessel center reference point to the antennas and to all survey equipment. The specifications of the vessel include the registration numbers, capacity, and equipment.

A.2 SINGLE BEAM SONAR OPERATIONS

An Odom Echotrac MKII was used to collect single beam data. This data was continuously recorded and monitored in real-time as an independent check of the nadir beam (bottom-detect) of the multibeam sonar system.

A.3 MULTIBEAM ECHOSOUNDER OPERATIONS

Two hundred percent (200%) side scan sonar coverage with concurrent set line spacing MBES coverage was acquired, as outlined in the Project Instructions. Multibeam crossline data was acquired along transects perpendicular to the mainscheme lines prior to collection of mainscheme data. Refer to section B.1.2 for details on crossline comparisons.

Multibeam survey operations were conducted using a single head Simrad EM 3002 multibeam echo sounder. The transducer head was pole mounted on the bow of the vessel. The angular sector of the sonar was typically operated at 59 degrees on either side of nadir during data collection, which provided ~3.4 times water depth bottom coverage. The sounder was operated in high-density equidistant beam spacing mode, which increased the number of soundings to 254 per ping. The sonar is capable of operating at frequencies of 293, 300 and 307 kHz and transmit pulse lengths of 50, 100, 150, and 200 (us). These could be user adjusted based on water depth and sediment type to obtain the best quality data. The maximum ping rate was set to 20 Hz, which was automatically adjusted by the system according to the water depth below the transducer. The survey speed was generally held under 8.5 knots (4.37 m/s), and the ping rate between 10 – 20 pings per second in surveyed depths (Table No. 3). This ensured that the criteria of being able to detect a 2 x 2 x 1 meter object was met, in accordance with Section 5.2 of the HSSD (2010) for complete multibeam coverage.

Table No. 3. Observed ping rate in different water depths, and associated pings per meter at 8.5 kt.

Water Depth (m)	Ping Rate (Hz)	Pings per Meter (at 8.5 kt)
8	20	4.57
12	17	3.89
19	15.5	3.54
25	13	2.97
30	10	2.29

Bottom Detection Coverage was obtained over all potentially significant features that measured 1 x 1 x 1 m in water depths up to 20 m, in accordance with section 5.2 of the HSSD (2010). In addition, continuous along-track coverage was obtained, with no gaps greater than 3 nodes long. If gaps were found to be more than 3 nodes long, the lines were re-run.

Lead line comparisons were conducted at least once daily throughout the survey as an independent check on the multibeam bottom-detect. Lead lines were not taken in larger sea conditions and water depths greater than 15 -20 meters in order to avoid a misreading. The lead line logs are included in Separate I – Data Acquisition and Processing Logs.

Simrads Seafloor Information System (SIS) software version 3.4.1 was used as the control software for the multibeam. This software allowed sound speed, attitude, and position to be applied to the data in real time. Data was sent from SIS to C&C Technologies' proprietary Hydromap software to be recorded. Hydromap software was used for multibeam data collection, quality assurance, and quality control. The Hydromap display included a coverage map, bathymetric and backscatter display waterfalls, and other parameter displays. These tools allowed the operator to monitor coverage, compare between single beam and multibeam depths, compare between the different positioning systems, and identify any ray-bending effects in real time. Corrective measures were made whenever necessary, ensuring that only quality data was collected. In cases where reruns were necessary due to degraded quality of data or due to lack of coverage, this was recorded and the data later rerun. The Hydromap software was also used to monitor the survey line plan and maintain on-line control.

Multibeam data processing was conducted using CARIS HIPS/SIPS 6.1 in the field and CARIS HIPS/SIPS 7.1.0 with Hot Fixes 1 and 2 during post field operations. Hotfix 3 was added on October 13, 2011. The multibeam processing workflow is detailed in Section B.1.3.

A.4 SIDE SCAN SONAR OPERATIONS

The Klein 5000 was operated in a towed configuration. A hanging sheave mounted to a retractable A-frame at the stern of the vessel was used as the tow point for the side scan. This sheave was located 21.707 meters behind the Primary GPS along the centerline of the vessel. Survey operations were conducted at speeds between 4 and 8.5 knots, and generally, the survey speed of a towed side scan sonar would be limited by the range scale. However, the Klein 5000 can be towed at higher speeds with no loss of bottom coverage (refer to the product description in Appendix B), still ensuring that a 1-meter target be ensonified a minimum of three times per pass. The side scan sonar was continually monitored to ensure coverage.

The side scan sonar was operated at range scales of 50, 75, or 100 meters, depending upon the line spacing, which was determined by water depth. Line spacing was set to 40 meters in areas where the water depth was less than 12 feet, 60 meters at depths between 12 and 20 feet, and 90 meters in depths greater than 20 feet. The criteria of acquiring 200% SSS coverage for object detection was accomplished using the aforementioned parameters and Technique 1 as set forth in Section 6.1 of the HSSD (2010), in which a single survey was conducted with the tracklines separated by less than one-half the distance required for 100-percent coverage.

A Subsea Systems Cable Payout Indicator was used to digitally record the tow cable length from the sheave. These cable out values were recorded in the sidescan .xtf files, and later used for layback calculations. Cable out was also noted in the acquisition logs. The side scan sonar was generally towed at heights of the required 8 to 20 percent of the range scale, although due to factors depth and noise, the side scan sonar was occasionally towed at heights of less than 8 to 20 percent of the range scale. Confidence checks were observed and recorded in the logs.

Chesapeake Technologies SonarWiz4 Map4 V4.03.0091 software was used for data collection. C&C Technologies' proprietary Hydromap software was used to layback correct the side scan sonar data. Following layback correction, side scan sonar data was processed, evaluated and contacts identified using SonarWiz4 Map4 V4.04.0118 in the field and during post-field operations. Details on the processing workflow are outlined in section B.2.

B. QUALITY CONTROL

B.1 MULTIBEAM

B.1.1 CROSSLINE COMPARISONS

B.1.1.1 HYDROMAP STATISTICAL COMPARISONS

Cross line statistical comparisons are performed for every line of multibeam data. Hydromap contains a tool that compares data from a main line with data from crosslines. The comparison calculates the mean difference and noise level as a function of cross-track position. The measurements are used for quantitative quality assurance for system accuracy and ray-bending analysis. In general, crosslines are used to produce reference data. The reference data is considered to be an accurate representation of the bottom. Since the data is taken from an orthogonal direction, the errors should at least be independent.

The cross lines are processed to produce the best possible data. Sound velocity profiles are taken to minimize any possible ray bending, and the multibeam swath angle is filtered to five degrees, which ensures that there are no measurable ray bending or roll errors. The data is binned and thinned using a median filter. The crossline swath data is then merged into a single file, and edited to ensure that there are no remaining outliers.

The line to be evaluated is processed to produce a trace file. Trace files are binned soundings that have not been thinned. The files contain x, y, and z data, as well as information on ping and beam numbers that is used for analysis. Processing parameters are set to use all beams with no filtering, and tidal affects are removed using predicted tides generated from Micronautics world tide software.

The effects of ray-bending can be measured by observing the values of the mean difference curve. Ray-bending produces a mean difference which curves upward or downward at the outer edges of the swath in a symmetric pattern around nadir. The value of the difference at a given across-track distance indicates the amount of vertical error being introduced by incorrect ray-bending corrections.

The accumulated statistics of all main line soundings compared to all crosslines is processed to produce four across-track profiles. The profiles represent the mean difference, standard deviation, root-mean-square difference, and percentile confidence interval. The data is provided in graphical form in a separate pdf document for each main line. These pdfs are found in Separates IV of the reports.

B.1.1.2 CARIS HIPS/SIPS COMPARISONS

In addition to the Hydromap crossline statistics, crossline comparisons were performed in CARIS HIPS/SIPS 7.1 using the surface difference tool as well as the CARIS QC Report utility. A 1-m BASE surface of the mainscheme lines was created as well as a 1-m BASE surface of the crosslines. A difference surface between the mainscheme and crossline BASE surfaces was then computed. The difference surface was used as a data cleaning tool as well as a quality control tool. As outlined in Section 5.2.4.3 of the HSSD (2010), it was noted if the depth values for the two datasets differed by more than the maximum allowable Total Vertical Uncertainty (TVU) for IHO order 1a surveys for the depth range (Table No. 4). Areas were investigated where the depth values for the two datasets differed by more than the maximum allowable TVU and the source of error identified and explained.

Table No. 4. Maximum TVU values for IHO order 1a for water depths of 5 – 25 m in increments of 5m.

a	b	Water Depth (m)	Maximum (TVU)
0.5	0.013	5	0.504207
		10	0.516624
		15	0.53668
		20	0.56356
		25	0.596343

Crossline comparisons were also generated using the CARIS QC report utility. Each crossline was compared to the depth layer of the 1-m BASE surface of the survey mainscheme lines. The crossline sounding data was grouped by beam number (1 – 254 in increments of 1) and survey statistic outputs include the total soundings in the range, the maximum distance of soundings above the reference surface, the maximum distance of soundings below the reference surface, the mean of the differences between the crossline soundings and the surface, the standard deviation of the mean differences, and the percentage of soundings that fall within the depth standards for a selected IHO Order. Although all IHO Orders (Special Order, Order 1a, Order 1b and Order2) were selected, the percentage of crossline soundings that are within Order 1a specifications is of primary interest for this survey. The quality control statistics were evaluated for extreme values and are shown in Separates IV. The BASE surfaces and difference surface have been submitted in the CARIS directory (Refer to section B.1.2.1).

B.1.2 PROCESSING

All multibeam data collected for OPR-K354-KR-10 was processed using CARIS HIPS/SIPS. Prior to importing any sounding data into CARIS, a HIPS vessel file (.hvf) was created. This vessel file includes significant physical dimensions of the vessel, as well as error estimate values for all major equipment integral in the collection of the data. Error estimates assigned to the survey equipment utilized in determining the ship dimensions and physical offsets between equipment were based upon the manufacturers' specifications. Error estimates assigned to major survey equipment used in determining water depths and horizontal positions were based upon manufacturers' specifications as listed within the TPE resource link provided on the CARIS web page. The vessel file used for this project is included in the CARIS projects submitted in conjunction with this report.

In order to allow for more efficient processing of the data, subareas within each Sheet were treated as independent surveys. CARIS project directory structures were created according to the format required by CARIS. All lines converted were assigned a project, vessel, and day. Multibeam data was reviewed in the CARIS HIPS/SIPS 6.1 swath editor, and erroneous bathymetry was rejected from the project.

CARIS HIPS/SIPS 7.1 was used to apply tides, compute TPU, merge and create BASE surfaces as well as for final multibeam data cleaning and sidescan sonar contact correlation. Tides were applied to all data in CARIS using verified tidal data downloaded from the NOAA CO-OPS website, and corrected using a tidal zone definition file (.zdf) supplied by NOAA. (Refer to Section C.6 for detailed tide correction information). CARIS HIPS was used to compute the Total Propagated Uncertainty (TPU) for each sounding using the parameters shown in Illustration No. 1.

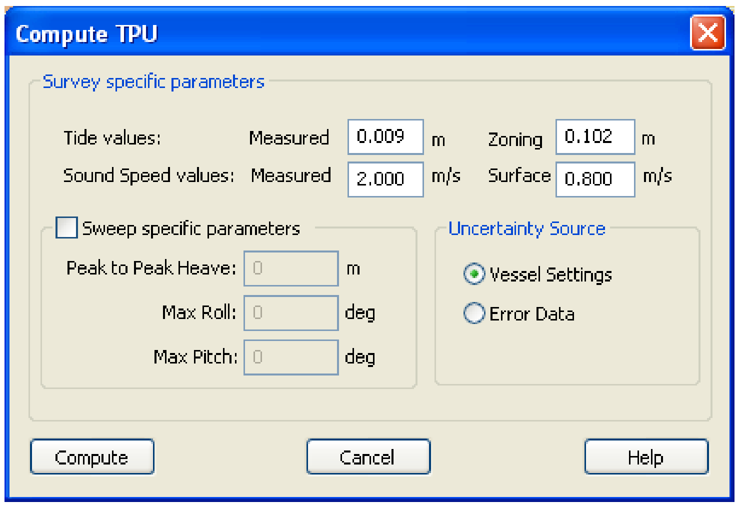


Illustration No. 1. Total Propagated Uncertainty (TPU) values.

According to CO-OPS, the sensor at 8762075 Port Fourchon, LA, is an Aquatrak acoustic sensor and the understood uncertainty for these sensors is 0.009 m, which was used as the measured tide TPU value. Also according to CO-OPS, the tidal zoning error is not expected to exceed the 0.45 m tolerance (at the 95% confidence level) as listed in Section 4.1.6 of the HSSD (2010). However, this section also states that typical errors associated with tidal zoning are 0.20 m at the 95% confidence level and this is the zoning error used for this survey. All error values entered in CARIS for the TPU calculation are assumed to be at the 1 sigma level, and the value provided by CO-OPS should be divided by 1.96, according to the Field Procedures Manual Section 4.2.3.8. Therefore, a final value of 0.102 m was entered as the zoning tide value for the CARIS TPU calculation.

The measured sound speed value was set at 2 m/s since if the sound speed measured at the transducer compared to the sound speed calculated by the previous cast changes by this value (2 m/s), a new sound speed cast is necessary. The surface sound speed value was set at 0.8 m/s with the following reasoning:

The YSI 600R sonde is used to calculate the sound speed at the multibeam transducer. The resultant sound speed is a function of temperature and salinity (ignoring the effects of depth/pressure because the sensor is near the sea surface). The Law of the Propagation of Variances states that the uncertainty associated with an unknown (in this case sound speed) can be calculated if the variance associated with a series of known variables (in this case salinity and temperature) is known.

The specifications for the 600R (http://www.ysi.com/productsdetail.php?600R-9) are shown in Table No. 5 and the known amount by which a certain change in salinity and temperature affect sound speed are shown in Table No. 6.

Table No. 5. Accuracies associated with salinity and temperature measured by the YSI 600R sonde

Parameter	Accuracy
Salinity	± 1% of reading or 0.1 ppt (whichever is greater)
Temperature	± 0.15 °C

Table No. 6. The amount that sound speed changes with changes in salinity and temperature.

Parameter	Change in parameter	Change in Sound Speed
Salinity	1 ppt	1.3 m/s
Temperature	1 °C	4.5 m/s

If the salinity is, for example, 30 ppt at the sea surface, then the uncertainty surrounding this measurement (using values in Table No.6) is: 30 * .01 = ± 0.3 ppt. The amount that 0.3 ppt salinity would change sound speed is:

$$0.3\,ppt * \left(\frac{1.3\frac{m}{s}}{1ppt}\right) = 0.39\frac{m}{s}$$

The accuracy associated with the temperature measurement is ± 0.15 °C (Table No.6) and the amount that this value would change the sound speed is:

$$0.15°C * \left(\frac{4.5\frac{m}{s}}{1°C}\right) = 0.675\frac{m}{s}$$

The total uncertainty of the sound speed measurement is determined by calculating the square root of the quadratic sum of the individual uncertainty sources.

$$\sigma_{ss}^2 = \sigma_{sal}^2 + \sigma_{temp}^2$$

$$\sigma_{ss}^2 = (0.39\frac{m}{s})^2 + (0.675\frac{m}{s})^2$$

$$\sigma_{ss}^2 = (0.607735\frac{m}{s})^2$$

$$\sigma_{ss} = 0.7795\frac{m}{s}$$

This value of approximately $0.8\frac{m}{s}$ is within the range of values provided in the CARIS HVF Uncertainty Values document in Appendix 4 of the Field Procedures Manual, which is 0.2 to 2 m/s.

After the tides were applied to the multibeam data and the TPU computed, the multibeam lines were merged. Separate BASE surfaces were created for each subarea. BASE surfaces were generally named as <Survey registry number>_<Subarea>_<units of resolution>. All BASE surfaces were created as uncertainty surfaces with a single resolution of 1 meter (in water depths of 0 – 20 m). This resolution ensured that a 2 x 2 x 1 m object would appear in the grid, in accordance with Section 5.2.2.2 of the HSSD (2010). All BASE surfaces were created based upon the IHO Order 1a standards.

The standard deviation layers of the BASE surfaces were used as a basis for data cleaning. Areas of high standard deviation were investigated by all means appropriate, including subset editor, swath editor, and comparison to charts, side scan sonar data and side scan sonar contacts imported from SonarWiz4 (see Section B.2). If data was found to misrepresent the seafloor, it was rejected.

Object Detection Coverage (investigation data) was obtained over all potentially significant features that measured 1 x 1 x 1 m in water depths up to 20 m. All contact investigation data was cleaned in the swath editor before being incorporated into a BASE surface. All investigations in a subarea were incorporated into one BASE surface named <Survey registry number>_<Subarea>_<Investigations>_<units of resolution>. All investigation BASE surfaces were created as uncertainty surfaces with a single resolution of 0.5 m to ensure that a 1 x 1 x 1 m object would appear in the grid. The investigation data was reviewed with respect to mainscheme multibeam lines, charted data and side scan sonar contact information. The investigation data was reviewed in the subset editor and, if needed, a designated sounding was assigned to the least depth sounding of an identified contact.

After all data had been cleaned, and all least depths on contacts had been designated, the BASE surfaces were finalized for submission. The final BASE surfaces were generated from the higher of the standard deviation or uncertainty values in order to maintain a conservative uncertainty estimate, as outlined in section 4.2.6 of the 2010 Field Procedures Manual. Following the completion of processing of all subareas within a survey, the areas were combined onto one external USB hard drive for submission to the Atlantic Hydrographic Branch for review.

B.1.2.1 CARIS DIRECTORY STRUCTURE

Two CARIS projects were submitted, one for each Subarea. Illustration No. 2 shows the general directory structure for one subarea. Background data includes Local Notice to Mariners, nautical charts, survey bounds and a survey line file. In addition to the 1-m BASE surface of the entire survey and the 0.5 m BASE surface of the investigations, the separate BASE surfaces of the mainscheme lines and crosslines and the difference surface between them was also retained. The Notebook folder contains a .hob and S-57 file of all contacts picked from side scan sonar data (refer to section B.2.4 for more information).

Illustration No. 3 shows the general directory structure of the submitted CARIS Notebook project. Background data is nearly identical to that of the CARIS projects, although the nautical chart is in a separate folder. One Final Feature File was created that contains all obstructions, oil and gas infrastructures. This was submitted as a CARIS .hob file and is located within the Edit Layers folder. The Multimedia folder contains all images associated with the Final Feature File.

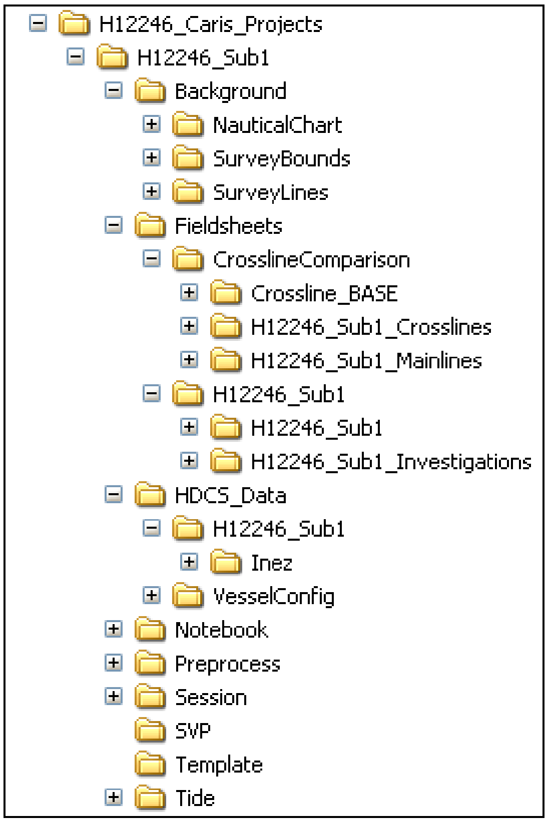


Illustration No. 2. CARIS Directory Structure

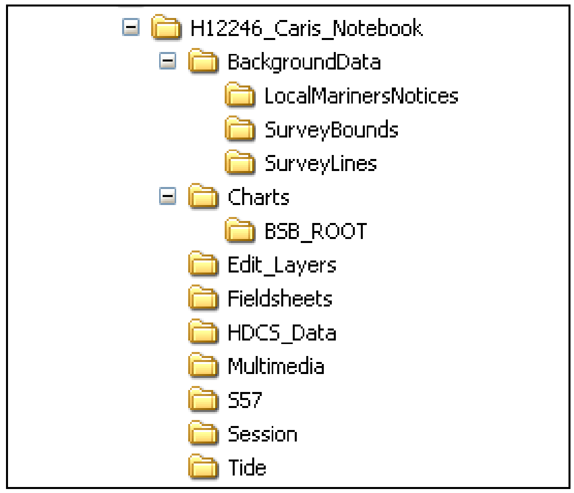


Illustration No. 3: Notebook Directory Structure

B.1.3 CHART COMPARISON

Chart comparisons were performed in CARIS HIPS/SIPS 7.1 using cleaned BASE surfaces of mainscheme and investigation lines, colored depth ranges, and sounding layers. The data was compared to the largest scale chart in this area, summarized in Tables No. 7 and 8.

Table No. 7. Nautical charts used for comparison

Chart Number	Scale	Edition	Edition Date
11356	1:80,000	38	Jun 08
11357	1:80,000	40	Jun 09

Table No. 8. Nautical chart correction dates

Chart Number	Corrected Through	
	NM	LNM
11356	Jun 14/08	Jun 03/08
11357	Jun 06/09	Jun 02/09

The sounding layer to which charted soundings were compared was generated from a 1-m BASE surface created for each of the subareas in each Sheet. The shoal biased radius option was always selected. Either distance on the ground or mm at map scale was used, and a single-defined radius adjusted to obtain an adequate number of soundings within the region.

B.2 SIDE SCAN

B.2.1 IMAGE PROCESSING

Side scan sonar data was processed using SonarWiz4 V4.03.0091 in the field and with SonarWiz4 V.4.04.0118 during post-field operations. In the field, side scan sonar data was layback corrected using C&C Technologies' proprietary Hydromap software. The sidescan sonar data (in XTF format) was then imported into SonarWiz4. When the data is imported into SonarWiz, various gains ranging from 8X to 16X were applied depending on what is needed for that particular set of data. The water column was bottom tracked in the field and the data slant range corrected after importation into SonarWiz4. The side scan sonar data was evaluated and contacts identified. Contacts were always picked on slant-range corrected data and a gamma correction was often applied to the contact images to enhance contrast.

B.2.2 REVIEW PROCESS AND PROOF OF COVERAGE

The side scan operator reviewed all data during data collection and noted in the survey logs any significant features or surface/water column effects. All side scan data was then reviewed at least twice post-collection, once in the field by a side scan sonar operator and a second time by a geoscientist during post-field operations.

As the geoscientist reviewed the data a coverage map was produced. Any gaps in coverage were noted, logged in the rerun log, and brought to the attention of the party chief and the operators on shift.

A mosaic for each 100% of coverage was created and submitted for the requirement of the interim and final deliverables. The coverages were designated by an even/odd numbering system. These mosaics served as another quality control tool and were not only used for coverage but could be used to correlate contacts seen on adjacent lines. The mosaic images were also overlain with the nautical charts, sonar contact plot and bathymetry data to give a full picture of the survey area.

B.2.3 CONTACT SELECTION

Sonar contacts were tagged and recorded as each line was reviewed. All contacts with shadows were recorded. All existing infrastructure, such as pipelines, wells, platforms, and buoys was also tagged.

In addition to measuring the dimensions of each contact in SonarWiz4, each contact was assigned two attributes to aid in the processing workflow. The first attribute (UserClass1) provides the coverage from which the contact was tagged. The coverages were designated by an even/odd numbering system and therefore each contact was described as either 100_ODD (first 100% coverage being odd line numbers) or 200_EVEN (second 100% coverage being even line numbers). The second attribute (UserClass2) was related to the nature of the contact and one of nine descriptors was chosen for each contact. These were: insignificant contact (INSCON), significant contact (SIGCON), offshore platform (OFSPLF), submerged pipeline (PIPSOL), submerged cable (CBLSUB), fish contact (FSHGRD), obstruction (OBSTRN), seabed area (SBAREA) and unknown contacts (UNKCON).

All contacts which displayed a height of 1 meter or greater, calculated from the shadow length in SonarWiz4, were deemed to be significant within water depths of 20 meters or less, in accordance with Section 6.3.2 of the HSSD (2010). These were always given the attribute ‘SIGCON’. Other contacts may have been deemed significant based on their characteristics (dimensions, strength of return, location etc.). Large schools of fish were identified by shape, detached shadows and observations recorded in the acquisition logs and although generally not picked as contacts were explicitly noted as FSHGRD. The 2nd

100% SSS was evaluated to confirm the fish contact and to make sure no other contacts were obscured. The label 'seabed area' (SBAREA) was used to include seabed change and features such as can holes. The 'unknown' (UNKCON) label was used in moderation and only if no shadow could be measured (this does not include pipelines, which are linear features and were marked as 'PIPSOL'). The majority of the UNKCON are found where either a significant or insignificant feature has been found on an adjacent line.
Once all contacts were tagged and assigned the aforementioned attributes and dimensions, the significant contacts were filtered out using CARIS Notebook 3.1 and exported as an S-57 file. The S-57 file was brought into CARIS HIPS/SIPS 7.1 and evaluated in the map window with BASE surfaces of the mainscheme lines and completed investigations to ensure complete coverage over the targets. All significant contacts not fully developed with multibeam data were investigated further.

B.2.4 CONTACT CORRELATION

In order to aid with the multibeam cleaning process, all contacts were exported from SonarWiz as a .csv file in the form of Sheet_Subarea_AllContacts_year-JD.csv. If excessive pipelines existed in the region, these were filtered out using Microsoft Excel and saved as a separate file. Pipelines could then be identified separately and toggled on and off in the CARIS map window interface so as not to interfere with the correlation of other contacts; pipelines were noted as either charted or uncharted but not correlated. Contacts were brought into Notebook 3.1 as points under the LNDMRK class. The contacts were exported as an S-57 file and brought into CARIS. In the CARIS selection window several columns were modified to display the attribute information of the contacts. Table No. 9 describes the attribute mapping for the S-57 contact file and associated CARIS column name.

Table No. 9. S-57 Contact attribute mapping

CSV Field	Attribute	CARIS column name
TargetName	OBJNAM	Object Name
ClickX	EASTING	n/a
ClickY	NORTHING	n/a
PingNumber	CARIS KEY	n/a
MapImageName	PICREP	Pictorial Representation
UserClass1	NINFOM	Information in national language
UserClass2	NTXTDS	Textural description in national language
Description	INFORM	Information

The .csv file exported from SonarWiz4 was also saved as a Microsoft Excel spreadsheet and served as the basis of the Side Scan Sonar Contact List contained in Separate V. The columns retained were shifted in the order shown in Table No. 10. Many of these were retained in addition to the columns required as stated in Section 8.3.2 of the HSSD (2010).

As shown in Table No. 10, Columns R (Contact Correlation) and S (Distance from Primary) were added to aid in the contact correlation process and columns T (Comparison with SWMB) and U (Contact Depicted in S-57 Feature File) added in accordance with Section 8.3.2 of the HSSD (2010). Once the multibeam BASE surfaces had been reviewed for anomalous data points in conjunction with charts and side scan sonar contacts (refer to Section B.1), the contacts were systematically reviewed in the CARIS HIPS/SIPS map window with respect to BASE surfaces and charted features. The attributes of each contact were examined in the CARIS selection window and the final four columns of the side scan sonar contact list were populated as each contact was reviewed.

The ‘Contact Correlation’ column was filled in as (1) No duplicate contact, (2) Primary, or (3) Secondary to the <Target Name of Primary>. The Primary contact was chosen from the SSS as the image that best represented the contact. When a Primary contact was picked for a platform, not only was the image quality taken into account, but also the line on which the contact was tagged. This was done to obtain the best possible position and to avoid picking a contact on lines that exhibited excessive turning. The information from the Primary contacts was used in creation of the S-57 Feature File. The distance between the primary and secondary contacts was measured in CARIS and recorded in the ‘Distance from Primary’ column. The ‘Comparison with SWMB’ column is the result of comparing the side scan sonar data to the multibeam data. These were recorded as follows: (1) contact did not appear in MB or (2) provide the least depth: swmb least depth = x.x. Information regarding investigations that proved or disproved the significance of a specific contact is also provided in this column. The final column ‘Contact Depicted in S-57 Feature File’, was populated by 4 statements, 3 of which are provided in Section 8.3.2 of the HSSD (2011). These are: (1) yes, obstr, (2) yes, sounding only, or (3) no. An additional option was added for platforms as (4) yes, ofsplf. If a contact is represented by a primary and secondary contact and also represented in the S-57 Feature File, the final column will say ‘yes’ for all primary and secondary contacts. However, only the Primary contact information will be used in the S-57 Feature File.

Table No. 10. Side scan sonar contact list template.

Spreadsheet Column	Column Name
Column A	TargetName
Column B	LineName
Column C	EventNumber
Column D	SonarDateTime
Column E	ClickLat
Column F	ClickLon
Column G	ClickX
Column H	ClickY
Column I	FishAltitude
Column J	RangeToTarget
Column K	MeasuredHeight
Column L	MeasuredLength
Column M	MeasuredShadow
Column N	MeasuredWidth
Column O	UserClass1
Column P	UserClass2
Column Q	Description
Column R	Contact Correlation
Column S	Distance from Primary
Column T	Comparison with SWMB
Column U	Contact Depicted in S-57 Feature File

C. CORRECTIONS TO ECHO SOUNDINGS

C.1 INSTRUMENT CORRECTIONS

A draft correction was required for the multibeam sounding between 23:20 UTC on Julian day 193 (2010) to 22:30 UTC on Julian day 194 (2010). An incorrect waterline to CRP value of 0.80 meters was entered in the SIS software, which caused a depth error of approximately 0.30 meters for all soundings that were recorded over this time period. To correct this error, a draft entry of –0.30 meters was added to the Inez McCall vessel file in CAIRIS HIPS and SIPS for this time. Sheet 3 (H12245) was the only sheet affected by this error.

Between the dates of October 1st and October 7th 2010, the computer for the EM3002 multibeam control software was swapped out due to hardware failure. At this time, the positional and angular EM3002 mounting offsets in the control software (SIS) were also changed. No change should have been made to the offsets and all future data was collected using the incorrect values. To correct this error, the HIPS vessel file was updated with a second entry under Swath 1. The angular offsets were corrected with the patch test results from June 30th, 2011 (Refer to Section C.4). This was done because after testing, the roll value from this patch test better corrected the data. This entry, beginning on October 7th (2010-280), uses the HVF correction values found in Tables

No. 11 and No. 12 below to adjust the data. These tables also show the correct and the incorrect positional and angular offset values.

The incorrect values were used for the remainder of the OPR-K354-KR-10 survey, and due to the shallow water in the area, the angular, along track, and across track values entered after the multibeam control software was changed went unnoticed. However, a vertical offset was noticed when the lead line was performed prior to data collection on 2010-280. This error was corrected for in the multibeam control software as a subtraction to the waterline to CRP (draft) value. However, although the logs state that a 0.4 m correction was made, it was determined that the vertical offset of 0.398 m was only partially accounted for because the waterline to CRP value was reduced to 1.05 m, which is only 0.15 m less than the 1.2 m value used prior to transiting to the dock. The waterline to CRP value should have been changed to 0.8 m initially and for this reason, a 0.25 m vertical offset was entered into the HIPS vessel file for 2010-280 through 02:30 UTC on 2010-289. An additional -0.2 m waterline to CRP correction was made on October 18, 2010 during H12249 survey operations to bring the waterline to CRP value to 0.85 m. Because of these real-time corrections, the 0.398-meter vertical offset is not entered in the HIPS vessel file and only the HVF file for Sheet 10 (H12252) was corrected.

Table No. 11: Multibeam positional offsets (from CRP)

	Y (Forward)	X (Starboard)	Z (Vertical)
Correct value	14.518 m	0.170 m	3.048 m
Incorrect value	14.800 m	0.000 m	2.650 m
HVF correction	-0.282	0.170	0.00

Table No. 12: Multibeam angular offsets

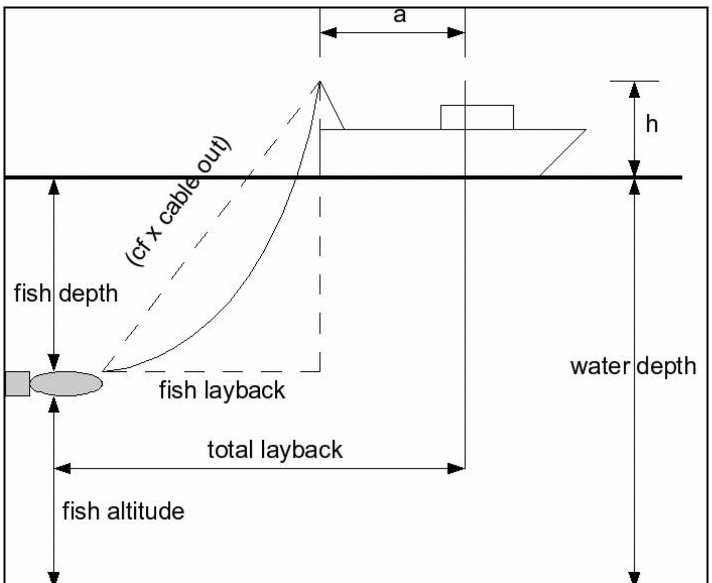
	Roll (deg)	Pitch (deg)	Heading (deg)
Correct value (SIS)	-0.125	4.463	-1.665
Incorrect value (SIS)	0.10	9.3	3.28
HVF correction	-0.225	-4.837	-4.945

C.2 VESSEL OFFSET MEASUREMENTS AND CONFIGURATION

Prior to survey operations, offsets to the antennas and other survey equipment were measured. Offsets were measured from the Central Reference Point (CRP) to all relevant points on the survey vessels (bow, stern, antennas, transducers, etc.) using traditional survey techniques that incorporated plumb bobs, tape measures, and digital levels. The CRP was established as an arbitrary point on the central across track axis of the vessel. The results of the vessel survey are shown in diagram form in Appendix A.

Layback was applied to all sidescan .xtf files using the hydromap layback correction tool. Illustration No. 4 explains the numbers and the calculations for this process. The catenary factor (cf) was set at 1.0 for all lines. This was done because the use of a depressor wing, combined with very little cable out, made it very unlikely that there was enough catenary to factor into the equation. The static setback from nav to cable block (a) was a constant value of 21.707 m. This was the along track distance from the primary GPS to the sidescan sheave on the a-frame. Height of cable block above echo sounder (h) was also a constant value. A measurement of 4.0 meters from the waterline to the sheave was used for this value.

Fish depth, water depth, and fish altitude are values that are recorded into the raw .xtf file. The fish depth was obtained from either the pressure sensor on the sidescan, or the fish altitude (bottom track) subtracted from the water depth. If the pressure sensor in the fish was not working properly, fish altitude was used for this calculation.



fish layback = sqrt [(cf x co)² - (h + fd)²]
total layback = a + fish layback

a = static setback from nav to cable block
cf = catenary factor
h = height of cable block above echo sounder
fd = fish depth = water depth – fish altitude

Illustration No. 4: Hydromap layback correction diagram.

An Applanix POSMV 320 motion sensor was integrated with the multibeam echo sounder to provide real-time heave, pitch, and roll corrections. Lever arms from the Primary IMU and Primary POSMV to the vessel CRP were entered into the POSMV control software (Illustration No. 5). POS MV position and motion were output with respect to the CRP and input into the EM3002 topside for real-time correction. The POSMV GPS position was used as the tertiary positioning system, and not used in post processing.

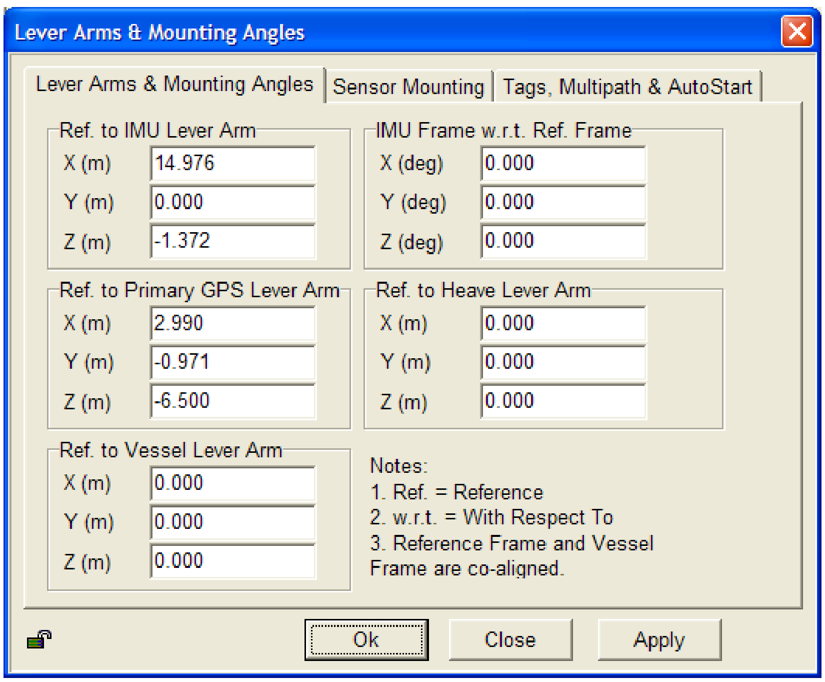
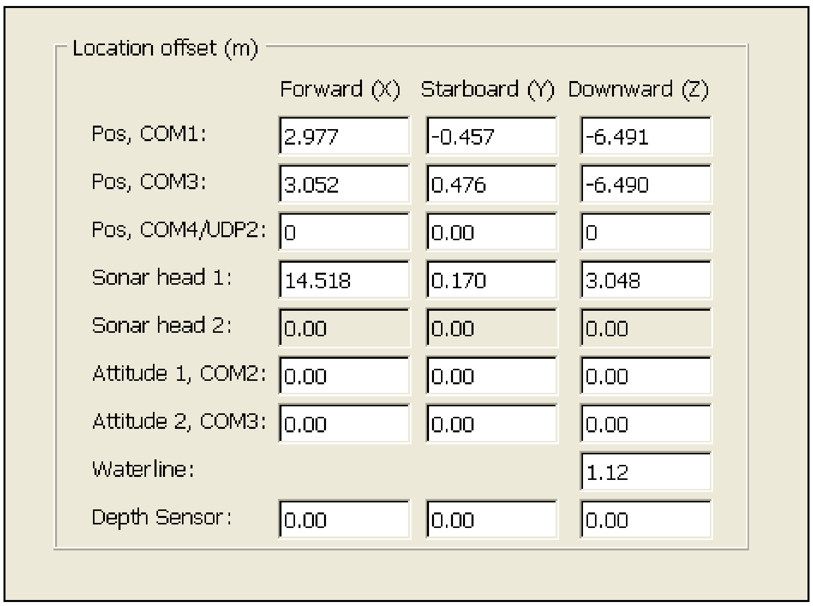


Illustration No. 5: POSMV GPS and IMU lever arms from the CRP.

In the SIS control software, position and motion corrections were applied using lever arms to the EM3002 transducer. Equipment offsets from the CRP were entered into the Simrad SIS software (Illustration No. 6). The Primary C-NAV 2050 GPS offsets were entered into POS, Com1 and the Secondary C-NAV offsets were entered into Pos, Com3. The multibeam transducer offsets were entered in Sonar head 1. The offsets for Pos, COM4 (POSMV Position) and Attitude 1, Com2 (POSMV Attitude) are entered as zero because the lever arms in the POSMV control software cause the position and the attitude of the POSMV to be output with respect to the CRP.



Location offset (m)

	Forward (X)	Starboard (Y)	Downward (Z)
Pos, COM1:	2.977	-0.457	-6.491
Pos, COM3:	3.052	0.476	-6.490
Pos, COM4/UDP2:	0	0.00	0
Sonar head 1:	14.518	0.170	3.048
Sonar head 2:	0.00	0.00	0.00
Attitude 1, COM2:	0.00	0.00	0.00
Attitude 2, COM3:	0.00	0.00	0.00
Waterline:			1.12
Depth Sensor:	0.00	0.00	0.00

Illustration No. 6: Equipment offsets entered into the SIS software.

C.3 STATIC AND DYNAMIC DRAFT CORRECTIONS

In order to correct for the dynamic draft of the vessel, a squat and settlement test was performed.

A CNAV RTK base station was set up on land over an arbitrary point, and one hour of static GPS observations were made to establish an accurate base station position. A location with hard ground, good satellite visibility, and a clear line of site to the test area was chosen for this setup. The RTK rover was pole mounted on the vessel directly over top of the CRP.

Five lines in total were run for this test, with each line included three minutes of RTK data collection at 0000, 0700, 1000, 1400, and 1800 RPMs. To run these five lines and stay within range of the base station corrections, a single line was run back and forth along the shoreline. RTK ellipsoid heights were extracted from the GPS data, and then tide corrected using tide station 8760894 (Calcasieu Pass, LA).

The vertical corrections varied with speed, as shown in Table No. 13. All values were applied to the data in CARIS during post-processing.

Table No. 13: Squat and Settlement test results
(South of Port Fourchon, LA-December 1st, 2010)

Vertical Correction (m)	Speed (m/s)
0.00	0.00
0.03	1.80
0.06	2.68
0.12	3.70
0.22	4.63

A second squat and settlement test was performed for the commencement of the 2011 NOAA project OPR-K354-KR-11.The results from this test are found in Table No. 14.

Table No. 14 : Squat and Settlement test results
(South of Cameron, LA-June 29 and 30, 2011)

Vertical Correction (m)	Speed (m/s)
0.00	0.00
0.01	1.58
0.07	2.29
0.14	3.29
0.26	4.15

The Inez McCall was equipped with a draft tube, which was read at least once daily during survey operations. Water level/draft entries were updated directly into the SIS system software as required.

C.4 MULTIBEAM CALIBRATION

An Applanix POS MV motion sensor was integrated with the multibeam echo sounder to provide real-time heave, pitch, and roll corrections and tertiary navigation. Prior to the survey, standard patch tests were performed to determine correctors for latency, pitch, roll, and heading.

An initial patch test, took place south of Cameron, LA on June 7, 2010. Another four patch tests were performed; the first outside of Port Fourchon, LA on the 14th of June 2011, the second was south of Cameron, LA on June 30th, 2011, a third on September 22th, 2011 outside Port of Fourchon, LA and the fourth south of Port Fourchon, LA, on November 11, 2011.

On June 14th, 2011 a patch test was performed for the commencement of the 2011 NOAA project OPR-K354-KR-11. A second test was done as a check on the quality of the first calibration. The results from the July 30th patch tests were used as the final angular offsets. This was done because of concerns with the accuracy of the heading results.

On September 22th, 2011 another patch test was performed due to equipment failure. The EM3002 stopped working; after troubleshooting the topside and connections, it was determined that the problem was below the waterline, either with the cable or with the transducer. The boat was put into dry dock; the transducer and cable were replaced and a new patch test was performed.

On November 11, 2011 another patch test was conducted after noticing misalignment in investigation multibeam data in CARIS. The vessel file in CARIS was updated and correctors applied for data between September 22 and November 11, 2011.

In general, the angular offsets from the patch tests were entered directly into the Simrad SIS software for correction in real-time (Illustration No. 7). The pitch and roll offsets were entered under Sonar head 1 (found as S1H in the emdump file), while the heading offset was entered under Attitude 1, Com2 (found as MSG in the emdump file). However, the heading value from the November 11th patch test was not entered in SIS where it would be corrected for in real-time (Illustration No. 7). Therefore, the CARIS vessel file was updated to correct for the heading in post-processing with the correct heading value of 2.521°.

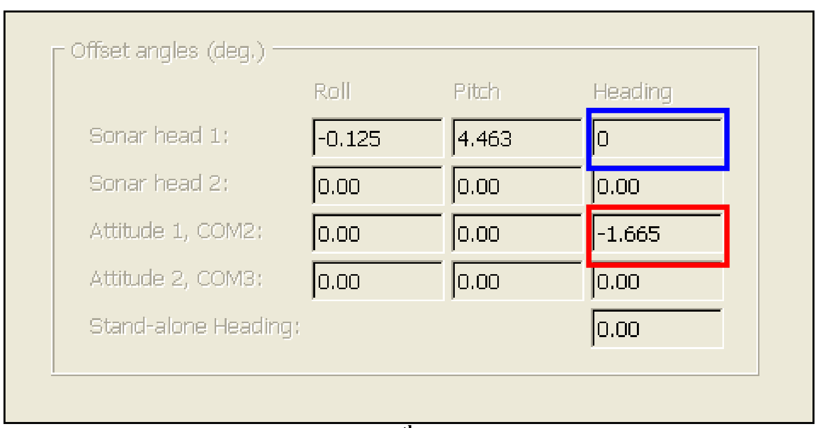


Illustration No. 7. Patch test results from June 30th, 2011 and where they were entered in SIS. When the heading is entered under Attitude 1, COM2, it is corrected for in real-time (red box). However, the November 11th heading value was entered in Sonar head 1 where it is not corrected for in real-time (blue box), and therefore was corrected for in the CARIS vessel file.

The patch tests were performed using the following procedures:

Latency:
Two lines were run directly over the same target. The line was run once at a slow speed (<4 knots) and again at a fast speed (>8 knots). The location of the target was inspected and had there been a difference in its location on each of the passes, latency would have been calculated. No timing error was detected.

Pitch:
A set of reciprocal lines were run over the target at a low speed.

Roll:
A set of collinear, reciprocal lines were run.

Heading:
Two sets of collinear reciprocal lines were run

Results of the patch tests are shown in the tables below.

Table No. 15: Patch Test results (June 7, 2010 – South of Cameron, LA)

Roll	Pitch	Heading
-0.236°	2.440°	-1.570

Table No. 16: Patch Test results (June 30, 2011 – South of Cameron, LA)

Roll	Pitch	Heading
-0.125°	4.463°	-1.665°

Table No. 17: Patch Test results (September 22, 2011 – South of Port Fourchon , LA)

Roll	Pitch	Heading
-0.117°	4.755°	-1.569°

Table No. 18: Patch test results (November 11, 2011 – South of Port Fourchon , La)

Roll	Pitch	Heading
-0.17°	3.72°	2.521°*

*Heading value entered in CARIS vessel file because it was not corrected for in real time; refer to above text and Illustration No. 7 for more information.

C.5 SOUND SPEED CORRECTIONS

Sea Bird Electronics SBE19 CTDs were used for speed of sound measurements. Casts were performed at least once daily and more often as needed. Each sound speed profile collected was reviewed for anomalies and extended by at least an additional 50 feet beyond the deepest reading of the CTD. The intent of the extended data is strictly to avoid error messages associated with bad multibeam pings that were deeper than the sound speed cast. Extending the profile was accomplished by averaging the last ten to twenty data points in the profile. The onboard processor of the cast determined how many points to average in order to create an extension that accurately reflected the downward trend of the data. Sound speed casts were always performed at the deeper end of the survey area. If water depths began to exceed the depth of the cast, another sound speed cast would be taken. The multibeam data was corrected for the water column sound speed in real-time and an Endeco YSI R600 sound speed profiler was used to determine sound speed at the transducer. The difference between the sound speed measured by the SBE19 CTD and the sound speed at the transducer was monitored in the SIS software. A difference of more than 2 m/s required a new cast be taken. The mean water column sound velocity was applied to the singlebeam echo sounder data. Weekly confidence checks were performed with a secondary SBE19 CTD unit.

C.6 TIDE AND WATER LEVEL CORRECTIONS

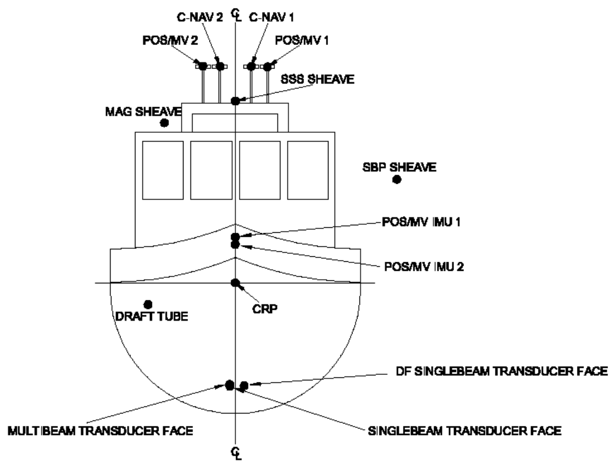
Tides were applied to all data in CARIS during post-processing using tidal data downloaded from the NOAA CO-OPS website, and corrected using a tidal zone definition file (.zdf) supplied by NOAA. This zone file, called K354KR2010CORP.zdf, uses station number 8762075 (Port Fourchon, LA) as the primary gauge. No secondary gauge was assigned for tidal zoning. Table No. 19 shows the tidal zone and correctors that were used. Tidal data were processed using the 1983-01 epoch. The tide (.tid) and zone definition (.zdf) files are included in the CARIS projects submitted in conjunction with this report.

Table No. 19: Tide zones and correctors

Tide Zone	Reference Station	Primary/ Secondary	Time Corrector	Range Ratio
CGM716	8762075	PRIM	-18	1.05
CGM717	8762075	PRIM	-12	1.09
CGM718	8762075	PRIM	-12	1.09
CGM732	8762075	PRIM	-6	1.09
CGM733	8762075	PRIM	-6	1.17
WGM266	8762075	PRIM	-18	1.21
WGM414	8762075	PRIM	-12	1.21
WGM415	8762075	PRIM	-6	1.21
WGM416	8762075	PRIM	-6	1.21

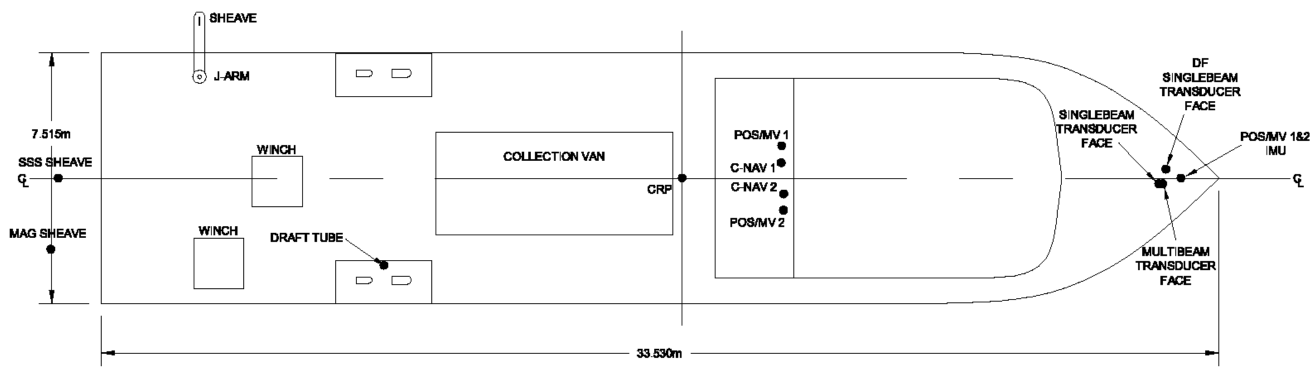
APPENDIX A - VESSEL DESCRIPTION

INEZ McCALL



National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE

LOCATIONS FORM CRP	Y (FORWARD)	X (STARBOARD)	Z (VERTICAL)
PRIMARY C-NAV	2.977m	-0.457m	-6.491m
SECONDARY C-NAV	3.052m	0.476m	-6.490m
PRIMARY POS/MV	2.990m	-0.971	-6.500m
SECONDARY POS/MV	3.044m	0.965m	-6.478m
SINGLEBEAM DUCER	14.304m	0.170m	3.098m
MULTIBEAM DUCER	14.518m	0.170m	3.048m
POS/MV IMU	14.976m	ON ℄	-1.372m
DRAFT TUBE	-8.953m	2.621m	0.655m
SSS SHEAVE	-18.730m	ON ℄	-5.452m
MAG SHEAVE	-18.955m	2.133m	-4.480m
SBP SHEAVE	-14.485m	-4.85m	-3.100m
DF SINGLEBEAM DUCER	14.426m	-0.265m	3.090m
POS/MV 2 IMU	14.976m	ON ℄	-1.157m



M/V INEZ McCALL

VESSEL PROFILE

Vessel Name	INEZ McCALL

Owner/Operator	Cameron Offshore Vessels
Flag/Home Port	USA/Cameron, La
US Coast Guard Official Number	648625
Year Built	1982
Place Built	Biloxi, MS
Hull Material	Steel
Official Number	648625
Intended Service	Supply Vessel
Operational Area	Gulf of Mexico
Tonnage Certificate	Issued by ABS
Loadline Certificate	Issued by ABS
Certificate of Classification	Issued by ABS full hull & machinery

SPECIFICATIONS

Length	108 ft. LOA
Breadth	24 ft
Depth	11.5 ft
Draft (summer load)	8 ft
Gross Tonnage	92 US regulation tons
Net Tonnage	63 US regulation tons

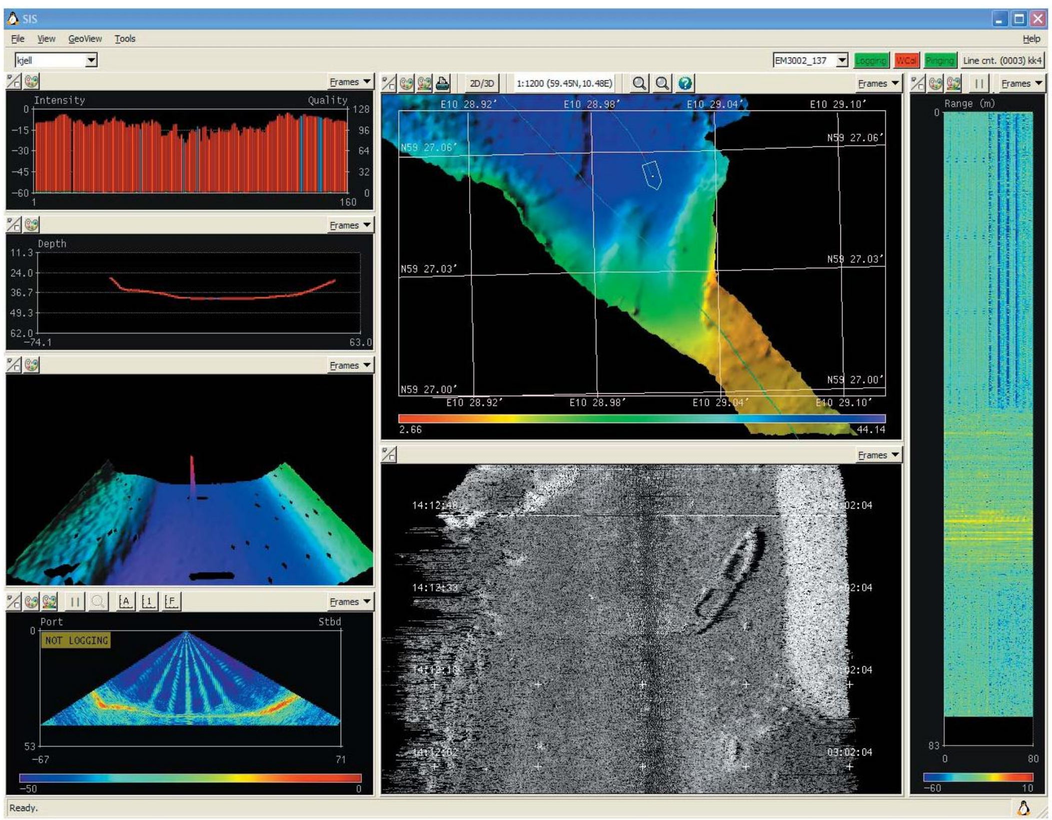
APPENDIX B – EQUIPMENT DESCRIPTIONS

EM 3002

KONGSBERG

Multibeam echo sounder

The new generation high performance shallow water multibeam



(855-164771 / Rev.D / March 2004)

System description

Key facts

The **EM 3002** is a new advanced multibeam echo sounder with extremely high resolution and dynamically focused beams. It is very well suited for detailed seafloor mapping and inspection with water depths from less than 1 meter up to typically 150 meters in the ocean. Maximum depth capability is strongly dependant on water temperature and salinity, up to 300 meters is possible under favorable conditions. Due to its electronic pitch compensation system and roll stabilized beams, the system performance is stable also in foul weather conditions.

The spacing between soundings as well as the acoustic footprints can be set nearly constant over the swath in order to provide a uniform and high detection and mapping performance. Dynamic focusing of all receive beams optimizes the system performance and resolution for short range applications such as underwater inspections.

Typical applications

- Mapping of harbours, inland waterways and shipping channels with critical keel clearance
- Inspection of underwater infrastructure
- Detection and mapping of debris and other underwater objects
- Detailed surveys related to underwater construction work or dredging
- Environmental seabed and habitat mapping
- Mapping of biomass in the water column

Features

The EM 3002 system uses one of three available frequencies in the 300 kHz band. This is an ideal frequency for shallow water applications, as the high frequency ensures narrow beams with small physical dimensions. At the same time, 300 kHz secures a high maximum range capability and robustness under conditions with high contents of particles in the water.

EM 3002 uses a new and very powerful sonar processor in combination with the same sonar head used with the popular and highly acclaimed EM 3000 system. The increase in processing power makes it possible to apply sophisticated and exact signal processing algorithms for beamforming, beam stabilisation, and bottom detection. The bottom detection algorithm is capable of extracting and processing the signals from only a part of each beam, thus making it possible to obtain independent soundings even when beams are overlapping.

EM 3002 will in addition to bathymetric soundings, produce an acoustic image of the seabed. The image is obtained by combining the acoustic return signals inside each beam, thus improving signal to noise ratio considerably, as well as eliminating several artifacts related to conventional sidescan sonars. The acoustic image is compensated for the transmission source level, receiver sensitivity and signal attenuation in the water column, so that reliable bottom backscatter levels in dB are obtained.

The acoustic seabed image is compensated for acoustic raybending and thus completely geo-referenced, so that preparation of a sonar mosaic for a survey area based upon data from several survey lines is easy. Objects observed on the seabed image are correctly located and their positions can be readily derived.

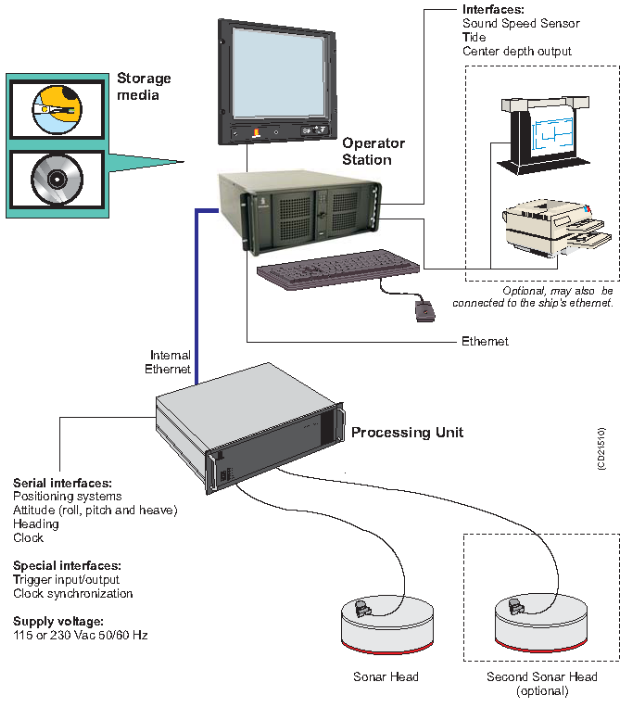
Operator Station

The Operator Station is a ruggedized PC workstation running on either Linux® or Microsoft Windows XP®. The Operator Station software, SIS, has been completely redesigned and expanded compared to the EM 3000 software, adding 3D graphics, real-time data cleaning and electronic map background.

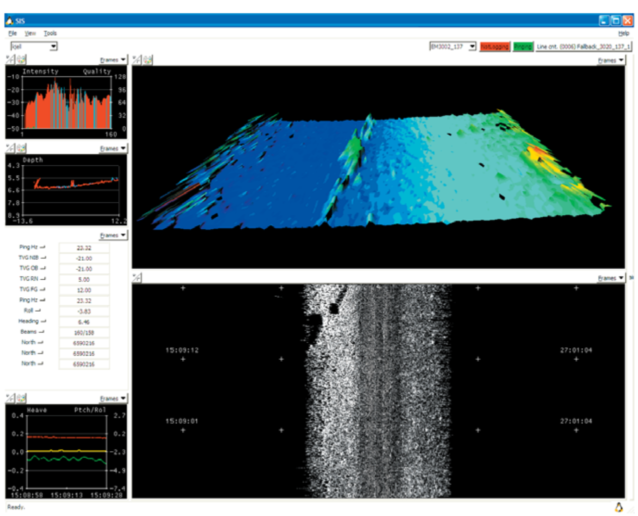
The EM 3002 can be set up to use other operational software than SIS, for example QPS "QINCy" or Coastal Oceanographics "HYPACK Max", and is also supported by software from Triton Elics International, EIVA and others.

Note that Kongsberg Maritime AS does not take any responsibility for system malfunction caused by third-party software.

- Full swath width accuracy to the latest IHO standard
- Swath width up to 10 x water depth or 200 m
- Depth range from < 1 meter to > 150 meters
- Bottom detection by phase or amplitude
- 100% bottom coverage even at more than 10 knots vessel speed
- Real-time ray bending and attitude compensation
- Seabed image (sidescan) data output
- Sonar heads for 500 or 1500 meters depth rating



Typical system configuration with desktop Operator Station, Processing Unit and one or two Sonar Heads.



This is an example on how the SIS software can be used.

Advanced functions

- Bottom detection uses a combination of amplitude and phase processing in order to provide a high sounding accuracy over the whole swath width.
- All beams are stabilized for pitch and roll movements of the survey vessel, by electronically steering the transmit beam as well as all receive beams.
- Dynamic focusing of the receive beams is applied in order to obtain improved resolution inside the acoustic near-field of the transducer.
- Swath coverage with one sonar head reaches 130 degrees, but can be manually limited while still maintaining all beams inside the active swath. For deeper waters the swath width will be reduced due to reduced signal-to-noise margin. The system will automatically re-locate all beams to be within the active swath.
- With two sonar heads the swath width will reach 200 degrees to allow for inspection of constructions up to the water surface, as well as for efficient mapping of beaches, rivers and canals.
- Operator controlled equidistant or equiangular beam spacing.
- Real time compensation for acoustic raybending is applied.
- Imaging of objects in the water column is offered as an option.

Technical specifications

Operational specifications

Frequencies .... 293, 300, 307 kHz
Number of soundings per ping:
- Single sonar head .... Max 254
- Dual sonar heads .... Max 508

Maximum ping rate .... 40 Hz
Maximum angular coverage:
- Single sonar head .... 130 degrees
- Dual sonar heads .... 200 degrees

Pitch stabilisation .... Yes
Roll stabilisation .... Yes
Heave compensation .... Yes
Pulse length .... 150 μs
Range sampling rate .... 14, 14.3, 14.6 kHz
Depth resolution .... 1 cm
Transducer geometry .... Mills cross
Beam pattern .... Equidistant or equiangular
Beamforming:
- Time delay with shading
- Dynamically focused receive beams

Seabed image data

- Composed from beamformed signal amplitudes
- Range resolution 5 cm.
- Compensated for source level and receiver sensitivity, as well as attenuation and spherical spreading in the water column.
- Amplitude resolution: 0.5 dB.

External sensors

- Position
- Heading
- Motion sensor (Pitch, roll and heave)
- Sound velocity profile
- Sound velocity at transducer.
- Clock synchronisation (1 PPS)

Environmental and EMC specifications

The system meets all requirements of the IACS E10 specification.The Operator Station, LCD monitor and Processing Unit are all IP22 rated.

Dimensions and weights

Sonar head:
- Shape .... Cylindrical
- Housing material .... Titanium
- Diameter .... 332 mm
- Height .... 119 mm
- Weight .... 25 kg in air, 15 kg in water
- Pressure rating .... 500 m (1500 m option)

Sonar Processing Unit:
- Width .... 427 mm
- Depth .... 392 mm
- Height .... 177 mm
- Weight .... 14.5 kg

Operator Station:
- Width .... 427 mm
- Depth .... 480 mm
- Height .... 127 mm
- Weight .... 20 kg

17.4" industrial LCD monitor:
- Width .... 460 mm
- Depth .... 71 mm
- Height .... 400 mm
- Weight .... 9.2 kg
- Resolution .... 1280 x 1024 pixels

All surface units are rack mountable. Dimensions exclude handles and brackets.

Kongsberg Maritime AS
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Klein Associates, Inc.

KLEIN SYSTEM 5000

HIGH-RESOLUTION, DYNAMICALLY FOCUSED, MULTI-BEAM SIDE SCAN SONAR

The System 5000 is a 5-beam side scan sonar designed for hydrographic, military and commercial applications requiring high-resolution images of the sea floor and bottom obstructions, while operating at tow speeds up to 10 knots and with an overall swath width of 300 meters.

Conventional side scan sonar systems use a single sonar beam per side to generate an image of the seafloor. The physics of this type of sonar results in degradation of image resolution with range poor along track resolution, and requires speeds of 5 knots or less to insure 100 percent bottom coverage.

From a design perspective, these shortcomings can be eliminated by designing a sonar that, through beam steering and focusing techniques, simultaneously generates several adjacent, parallel beams per side. Such a multi-beam design approach permits higher towing speeds with 100 percent bottom coverage, while providing high-resolution imaging to the maximum range of the sonar.

This design approach is principally employed by military side scan sonar systems designed for high speed mine hunting applications. L-3 Klein is the first commercial company to offer a multi-beam side scan sonar using similar design techniques to military sonars, but at a fraction of the cost.

The two main benefits of the high-speed, high- resolution System 5000 series are: higher towing speeds with no loss of bottom coverage, and range independent high-resolution image capability.

Since operation costs are dependent on the amount of at-sea time required to complete a survey, the Klein System 5000 Multi-Beam Side Scan Sonar with survey speeds more than twice that of conventional side scan sonars, minimize at-sea time, thus greatly reducing survey costs.

KEY FEATURES

- Multiple simultaneous beams per side each ping
- High tow speed capability
- Dynamic digital auto-focusing
- Very high resolution and 100% coverage
- Sonar connected to PC display on Ethernet LAN

THE DIFFERENCE IS IN THE IMAGE

L3

C³ISR > GOVERNMENT SERVICES > AM&M > SPECIALIZED PRODUCTS

C&C Technologies SURVEY SERVICES

Klein Associates, Inc.

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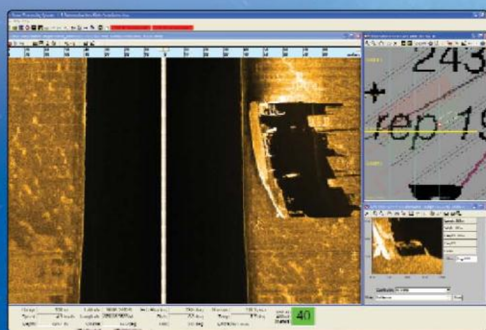
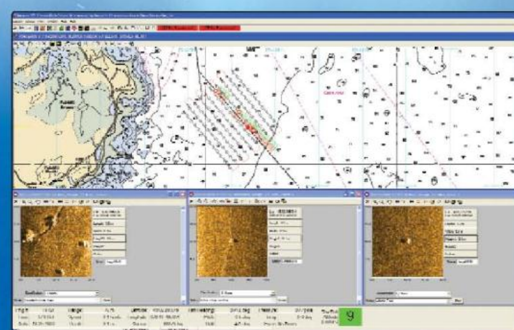
HIGH-RESOLUTION, DYNAMICALLY FOCUSED, MULTI-BEAM SIDE SCAN SONAR





Towfish Specifications	
Number of beams	5 port & 5 starboard
Frequency	455 kHz ± 1%
Range scales	50, 75, 100, 150 m
Pulse length	50 to 200 µsec.
High-resolution mode (along track)	10 cm to 38 m
Standard resolution mode (along track)	20 cm to 75 m, thereafter increasing to maximum of 36 cm @ 150 m maximum range
Resolution (across track)	7.5 to 30 cm
Operating speed envelope	2-10 knots @ 150 m sonar range
Sonar digitization	16 bit / channel
Maximum operating range	150 m (300 m Swath)
Array length	120 cm (47.2 in)
Body length	194 cm (76.4 in)
Body diameter	15.2 cm (6 in)
Weight (in air)	70 kg (155 lbs)
Sensors: Heading Pitch & roll	 Standard Standard
Pressure / altimeter	Standard
Depth rating*	200 m standard

Options
Yaw rate and high-resolution roll sensors
Responder / transponder
Splash-proof TPU housing
Fiber optic interface

* For deeper depth rated systems, please contact Klein

Transceiver Processor Unit (TPU) Specifications	
Width	Standard 19-in rack-mount
Height	13.2 cm (5.2 in)
Depth	54.6 cm (21.5 in)
Weight	12.7 kg (28 lbs)
Input voltage	115/240 VAC, 50/60 Hz
Power	120 W (includes towfish)
Navigation input	NMEA 0183
Data output	100 BaseT Ethernet LAN

Tow Cable	
Type: steel	Coaxial or fiber-optic double armored

Workstation PC	
Workstation PC SonarPro® installed Windows OS installed	Optional, with SonarPro software installed

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L3 communications
Klein Associates, Inc.

L-3. Headquartered in New York City, L-3 Communications employs over 64,000 people worldwide and is a prime contractor in aircraft modernization and maintenance, C^3ISR (Command, Control, Communications, Intelligence, Surveillance and Reconnaissance) systems and government services. L-3 is also a leading provider of high technology products, subsystems and systems.

C&C Technologies
SURVEY SERVICES

C-Nav®
WORLD DGPS

C-Nav2050

C-NAV DGPS

The C-Nav2050 is an "All-in-view" receiver with 26 tracking channels (12 channels for L1 GPS, 12 channels for L2 GPS and two channels for Satellite Based Augmentation System [SBAS]) and an L-Band demodulator for reception of C-Nav correction service. The sensor can output raw data as fast as 50Hz and Position Velocity Time (PVT) data as fast as 25Hz through two 115kbps serial ports.

THE C-NAV2050 FAMILY OF RECEIVERS:

- The **C-Nav2050G** navigation system is fully compliant with IMO and IEC specifications for shipboard GPS (Wheelmark and US Coast Guard compliant).
- The **C-Nav2050G** provides 64MB internal memory for data storage and provides the user with up to 5Hz measurement and position solutions. In addition, optional 10Kz and 25Hz Fast Positioning Update rates are available as well as raw data measurement outputs at 10Hz, 25Hz or 50Hz.
- The **C-Nav2050M** has all the standard features of the C-Nav2050G plus a 1PPS output port and a combined Event/CAN Bus interface port. In addition, 25Hz Fast Position Update rate is available and optional raw data measurement outputs up to 50Hz, and optional Real-Time Kinematic PVT solution is available at 5Hz.
- The **C-Nav2050R** has all the standard features of the C-Nav2050G yet provides two L-Band signal connections, one for the Dual Frequency GPS antenna and the second for a hi-gain L-Band communication satellite antenna.

The C-Nav2050 GPS family of receivers provides positioning services on a global basis.

*IMO require all SOLAS class ships to carry a type-approved GPS and further that any new GPS installation shall be compliant with the new performance standard for GPS. This was defined by MSC 112(73) and resulted in the associated test standard IEC 61108-1 Ed. 2.

GSA Contract Holder
FSS Contract GS-07F-5671P

0191

C-NAV GPS GIVES YOU THE WORLD. ONE DECIMETER AT A TIME.

C&C Technologies SURVEY SERVICES

C-NAV2050

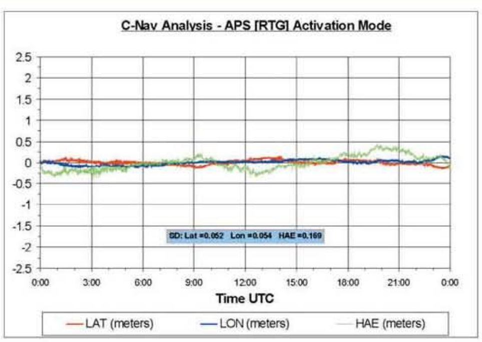
TECH SPECS

FEATURES

- "All-in-view" tracking on 26 channels (12-channels for L1/L2 GPS + 2-channels for SBAS)
- Global decimeter-level accuracy using C-Nav corrections
- Fully automatic acquisition of satellite broadcast corrections
- Configurable for global L-band satellite coverage – RTG, WAAS, EGNOS
- Rugged and lightweight package for mobile applications
- Accepts external GPS correction input in NCT, RTCM v2.2 or CMR format
- L1 & L2 full wavelength carrier tracking
- C/A, P1 & P2 code tracking
- User programmable output rates
- Minimal data latency
- 2 separate SBAS (WAAS/EGNOS) channels
- Superior interference suppression
- Patented multipath rejection
- Supports NMEA 0183 v3.01 messages
- Self-survey mode (position averaging)
- CAN bus interface (C-Nav2050M only)
- 1PPS Output (C-Nav2050M only)
- Event Marker (C-Nav2050M only)

PHYSICAL/ENVIRONMENTAL

- Size (L x W x H): 8.18" x 5.67" x 3.06" (20.8 x 14.4 x 7.8 cm)
- Weight: 4 lbs (1.81 kg)
- External Power
  - Input Voltage: 10-30 VDC
  - Consumption: <8 W
- Connectors
  - I/O Ports: 2 x 7 pin Lemo
  - DC Power: 4 pin Lemo
  - RF Connector: TNC (with 5 VDC bias for antenna/LNA)
  - CAN bus + Event: 5 pin Lemo (2050M only)
  - 1PPS Output: BNC (2050M only)
- Temperature (ambient)
  - Operating: -40° C to +55° C
  - Storage: -40° C to +85° C
- Humidity: 95% non-condensing
- Tested in accordance with MIL-STD-810F for: Low pressure, solar radiation, rain, humidity, salt fog, sand and dust, and vibration



PERFORMANCE

GPS RECEIVER PERFORMANCE

- Real-time Kinematic Accuracy (RTK Option Only)
  - Relative position: Centimeter level
- Real-time C-Nav DGPS Accuracy
  - Position (H): <10 cm
  - Position (V): <15 cm
  - Velocity: 0.01 m/s
- Pseudo-range Measurement Precision (RMS)
  - Raw C/A code: 20cm @ 42 dB-Hz
  - Raw carrier Phase noise: L1: 0.95 mm @ 42 dB-Hz; L2: 0.85 mm @ 42 dB-Hz
- User Programmable Output Rates
  - PVT: 25Hz, 10Hz, 5Hz, or slower
  - Raw data: 50Hz, 25Hz, 10Hz, 5Hz, or slower
- Data Latency
  - PVT: < 20 ms at all nav rates
  - Raw data: < 20 ms at all rates
- Time-to-first-fix
  - Cold Start, Satellite Acquisition: < 60 seconds (typical)
  - Satellite Reacquisition: < 1 second
- Dynamics
  - Acceleration: up to 6g
  - Speed*: < 515 m/s
  - Altitude*: < 60,000 ft
- 1PPS Resolution 12.5nS (C-Nav2050M only)

*Restricted by export laws

I/O CONNECTOR ASSIGNMENTS

- Data Interfaces: 2 serial ports; from 1200 bps to 115.2 kbps; CAN Bus I/F (C-Nav2050M only); Event Marker I/P (C-Nav2050M only)

COMMUNICATIONS PORT FUNCTIONS

- NCT Proprietary: Data, Control
- RTCM I/O: Code Corrections
- NMEA Output: Data

INPUT/OUTPUT DATA MESSAGES

- NCT Proprietary Data: PVT, Raw Measurement, Satellite Messages; Nav Quality, Receiver Commands
- NMEA Messages (Output): ALM, GGA, GLL, GSA, GSV, RMC, VTG, ZDA, and GST
- Code Corrections: RTG (proprietary) – Internal LBM; WCT (proprietary) – Internal LBM; SBAS (WAAS/EGNOS) – Internal GPS; DGPS (RTCM Type 1, 3 & 9) – External I/O; RTK (RTCM, CMR, NCT)

LED DISPLAY FUNCTIONS (DEFAULT)

- Link (Selectable)
- Base Station
- GPS Position Quality

COMPLIANCE/APPROVALS

- Compliance with the following standards:
  - > IMO performance standard for GPS
  - > IEC 61108
  - > IEC 60945
  - > IEC 61162
- Type approvals:
  - > Wheelmark
  - > USCG

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WWW.CNAVGPS.COM

APPLANIX - THE PREFERRED CHOICE OF MARINE SURVEY

Applanix is transforming the world of marine mobile mapping. As pioneers of the first commercial position and orientation systems for marine survey vessels, and now with over 10 years of established market leadership, we supply superior technology, expertise, and support to customers, partners, and equipment manufacturers around the world. With over 500 systems in use worldwide, the Applanix POS MV is the "industry standard" in positioning and orientation systems for hydrographic vessels.

The APPLANIX Marine Team

We have the industry's most experienced team of marine survey engineers, geospatial experts, and quality assurance personnel – all here to guarantee you the highest quality solution and the highest level of performance. Every Applanix product comes with our company-wide commitment to world-class customer care, so whether you're looking for information on using your system with a new sensor, or just need some expert advice, Applanix is here to serve you in any way.

POS MV™

The Applanix POS MV system is a GPS-aided inertial navigation system which provides a complete set of position and orientation measurements, including exceptional estimates of heave and ellipsoidal altitude. POS MV was launched onto the world market in 1996 and since that time has been the industry leader for users who are serious about making the most of their investment in multibeam technology.

The POS MV 320, POS MV Elite and the POS MV WaveMaster (for smaller survey launches) are tightly-coupled systems which use Applanix' unique approach to Inertially-Aided Real-Time Kinematic (IARTK) technology. They are user-friendly, turnkey systems which maintain positioning accuracy under the most demanding conditions, regardless of vessel dynamics.

With its high data update rate, POS MV delivers a full six degrees-of-freedom position and orientation solution. The POS MV is designed for use with multibeam sonar systems, enabling adherence to IHO (International Hydrographic Survey) standards on sonar swath widths of greater than ± 75 degrees under all dynamic conditions.

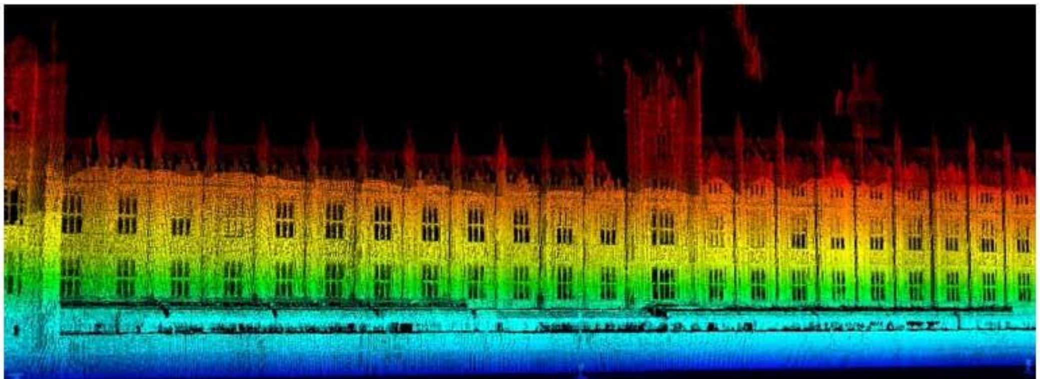
The POS MV Elite offers true heading accuracy without the need for dual GPS installation and offers users the highest degree of accuracy in motion measurement for their marine applications.

TrueHeave Technology

Applanix has redefined accuracy and reliability of heave data with TrueHeave. Based on advanced two-sided filtering techniques, TrueHeave uses both past and present vertical motion to compute a highly accurate heave estimate.

Hydrographic Mapping on the Ellipsoid

Unmeasured changes in the water level mean difficult challenges for hydrographers. Applanix has paved the way in providing centimetric level accuracy of the ellipsoidal altitude, allowing for coherent sea floor images to be obtained in even the most difficult tidal regimes.



Thames River Survey utilizing LANDMark™ Marine which uses the POS MV system and LIDAR technology for surface mapping

POS MV BENEFITS

Applanix' POS™ technology was originally developed as part of an extensive military project. This proven technology was enhanced, customized and packaged to yield an off-the-shelf commercial product, uniquely suited to the requirements of precision marine motion sensing, hydrographic surveying and charting. It has been rigorously tested and proven in trials with numerous national hydrographic offices and commercial survey organizations. POS MV delivers:

- Reliable and repeatable performance under all dynamic conditions
  - Very low noise L1 and L2 carrier phase measurements
  - Superior low-elevation tracking performance regardless of latitude
  - Continuous sensor monitoring to compute a robust navigation solution. Continuity of all data is thereby assured when GPS reception is compromised
- Improved accuracy and productivity with "TrueHeave"
  - TrueHeave software enables heave data to meet and exceed the highest marine industry standards. TrueHeave users reap the double benefits of significant improvements in accuracy and productivity.
- Immunity to GPS outages
  - Provides almost instantaneous reacquisition of RTK following GPS signal loss. The system uses accurate inertial data aided by GPS observables from as few as one satellite to compute a robust navigation solution, thereby assuring continuity of all data including position and heading when GPS reception is compromised. Short-term loss of GPS does not significantly degrade the POS MV roll, pitch or heading solution.
- Robust centimetric positioning with Inertially Aided RTK
  - Applanix' proprietary Inertially Aided RTK (IARTK) algorithms enable the rapid re-acquisition of fixed integer RTK positioning. In difficult GPS environments POS MV with IARTK affords a significantly more robust and accurate position solution than can be achieved with stand-alone RTK.
- Operation in a high multipath environment
  - POS MV uses high performance GPS components that enable excellent carrier phase tracking capability even in a high multipath environment. The result is robust, dynamically accurate true heading data to accuracy better than 0.02°.
- Post-Processing Capabilities
  - POS MV is the only marine POS solution with post-processing capabilities.
- Self-Calibration
  - POS MV continually monitors the status of its sensors and if required, automatically reconfigures itself to provide the best navigation solution.
- Upgradeability
  - POS MV uses the latest Trimble BD960 24-channel GNSS receivers with Trimble Zephyr L1/L2 antennas. POS MV offers a low cost upgrade path from DGPS to L1/L2 IARTK (Applanix' unique tightly coupled Inertially Aided RTK technology) without modifying the hardware.

THE COMPONENTS

POS MV provides the functionality of a GPS receiver, gyrocompass and conventional motion sensor in a single, user-friendly, turnkey solution:

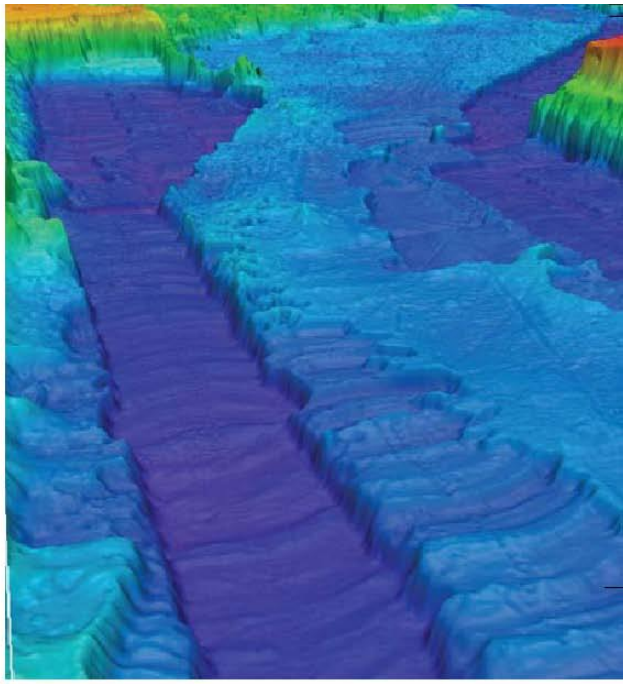
POS Computer System (PCS):

The PCS contains firmware to perform all functions necessary to control the IMU and GPS receivers, outputting

data in the correct format to interface with other systems aboard the survey vessel. The processor software functions include the Strapdown Inertial Navigation Algorithm to compute velocity, roll, pitch and true heading from the accelerometer and gyro outputs, a Kalman filter that estimates long term drift in the inertial solution using GPS aiding measurements, and an error corrector that applies the Kalman Filter estimates to the strap-down navigator to continually calibrate the inertial sensor. The PCS also contains a GPS Azimuth Measurement Subsystem for computing true heading from carrier phase measurements output by the dual GPS receivers. The processor firmware and software provide sensor calibration, and also fault detection, isolation and automatic reconfiguration.

Inertial Measurement Unit (IMU):

The IMU contains 3 high quality gyroscopes and 3 high quality accelerometers. The IMU is entirely solid state for high reliability, and is housed in its own rugged, water and salt resistant case. Power for the IMU is provided by the PCS.



GPS Sub-system:

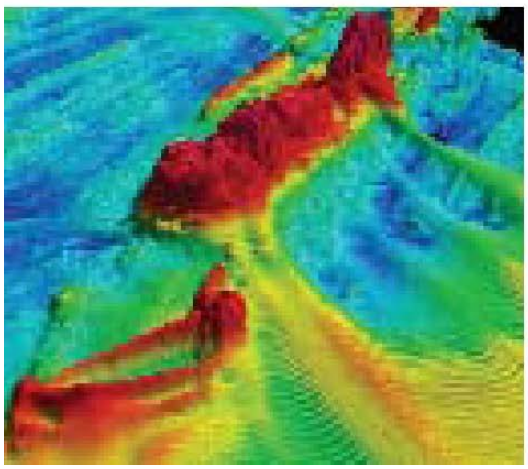
The GPS subsystem is comprised of two antennas and two low noise, survey grade twelve channel receiver cards embedded in the PCS. The GPS subsystem computes position to 0.02 m with optional RTK, or 1 m or better with standard differential corrections.

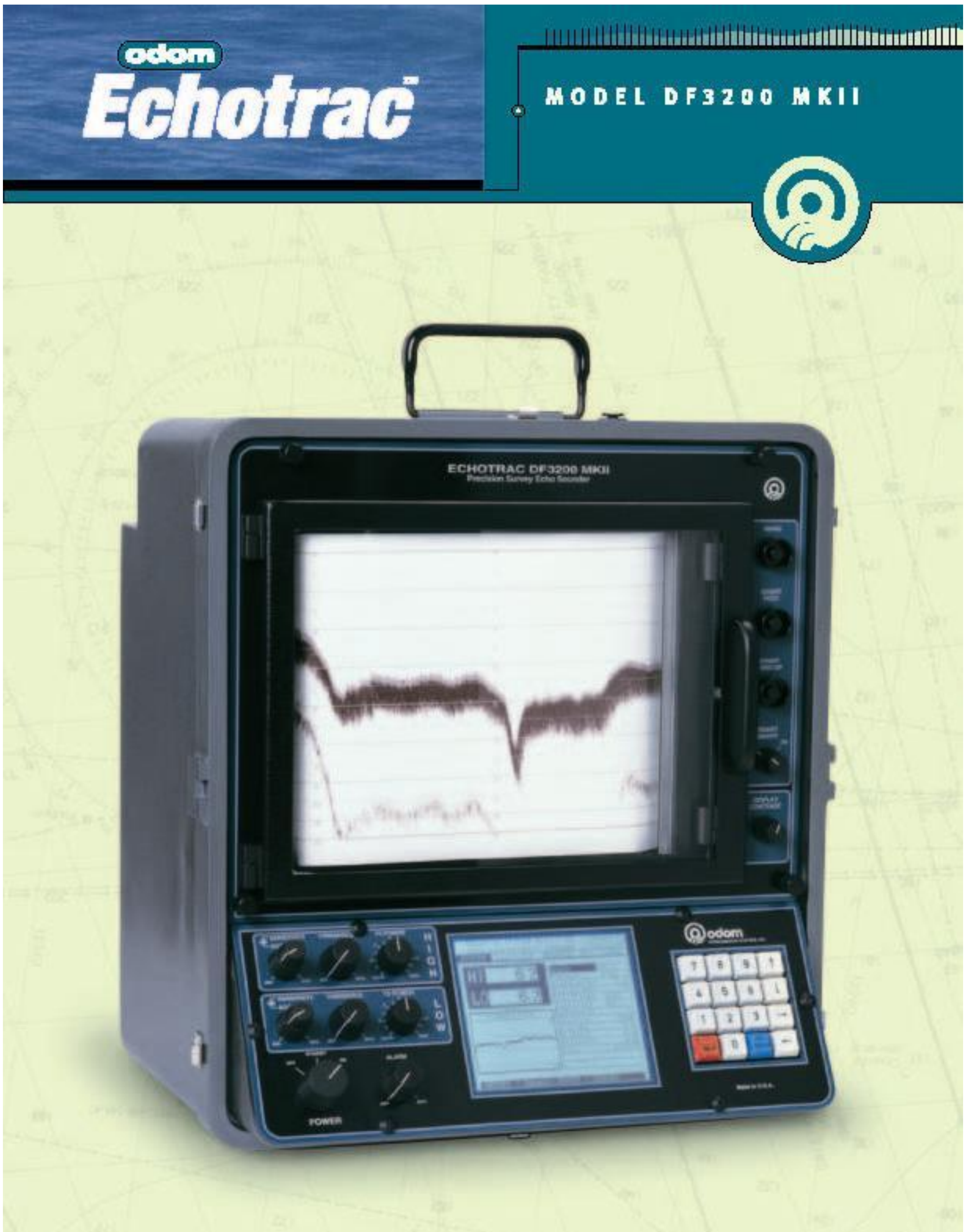
APPLICATIONS

Whether in shallow, narrow or rough waters where the GPS environment may be compromised by large vessels, cranes and other dock-side structures, or in calm and open seas, the POS MV system provides accurate, robust results in the following applications:

- Harbour Mapping
- Seafloor Mapping
- Dredging
- Wreck and Salvage Charting
- Surface Mapping with LIDAR

Above right: Multibeam image of dredged channel.
Bottom right: USCGC Healy in Northern latitudes.
Below left: Multibeam image.




odom
Echotrac
MODEL DF3200 MKII
ECHOTRAC DF3200 MKII
Precision Survey Echo Sounder
POWER

odom **Echotrac**™ this latest generation of the echotrac dual frequency survey echo sounder brings into use the best of available technologies in high-resolution thermal printing, microprocessor and dsp techniques, and flat screen graphic displays. the sonar transceiver, echo processor, graphical operator interface and hard copy recorder are all housed in one portable, splash-proof case. the unit is suited to table top, bulkhead or rack mounting and is equally at home on either small survey launches or large ships. well suited for use in the shallows of rivers and harbors, the mission variable unit is also capable of working to depths of over 2,000 meters.

FEATURES

Frequencies: Either single or dual frequency configurations of the unit are available: Standard frequencies are 200 and 24kHz or 210 and 33kHz.

Optional frequencies
High: 100kHz to 1MHz
Low: 10kHz to 60kHz
Side Scan: Single channel 200kHz

Printer: The high-resolution, thin-film thermal printhead measures 216mm (8.5") wide. Resolution is 8 dots/mm (203/in.) along the print axis and 8 lines/mm along the paper axis. The unit is capable of printing up to 16 gray shades, the number of shades being selectable by the operator.

Display: The graphical LCD module (320 x 200 pixels) measures 156.4mm (6" diagonally). Fluorescent Back Lighting (CFL) of the paper-white display provides excellent visibility in all light conditions. In dual frequency operation, both high and low frequency depth values are displayed continuously.

Keypad: A 16-key NEMA, 12 sealed unit with tactile feedback is used by the operator for parameter selection and numerical value entry. Ten digits, Up, Down, Left and Right arrow keys, Decimal Point/HELP and Enter keys are provided.

Digitizer: The bottom tracking capabilities of the unit are enhanced by utilizing the DSP capabilities of the digitizer processor. These DSP algorithms yield reliable bottom detection even in the presence of high ambient noise and multiple returns.

COMMUNICATIONS

Interfacing & Annotation: Four bi-directional RS-232 serial ports are standard. Depth information is output after each sounding cycle with the standard string, including values for both the high and low channels in dual-frequency operation. Output strings conforming to NMEA and other major echo sounder formats are available. In addition, system parameters can be configured via Comm 1. The Echotrac accepts annotation of up to 80 characters (printed on the Fix Mark Line). Standard NMEA formats from GPS receivers, as well as proprietary strings from positioning and navigation systems, can also be annotated on the chart. Interfacing to data acquisition systems is asynchronous and does not require handshaking.

Heave Compensation: Interfacing to most available motion sensors is provided over a dedicated RS-232 serial port. In addition to the "raw seabed," both Heave data (scaled values from the motion sensor) and a "corrected seabed" (Heave data applied to the digital depth) are printed on the chart in real-time.

CONTROLS

Analog Controls: Immediate access to critical analog controls is via front panel mounted potentiometers and switches. They include: Receive Sensitivity, AGC (Automatic Gain Control) Transmit Power and Threshold (digitizer level). Also mounted on the front panel are controls for the printer including: Chart ON/OFF, Paper Advance, Paper Take-up and Mark.

Digital Parameters: Listed below are some of the functions of the MKII, which are controlled using the display (through its system of pull-down menus) and the keypad.

Frequency: High, Low or Dual

Chart Scale (phasing): Manual or Auto Bottom-tracking

Chart Center: Determines where the center of the chart is placed (at what depth) in Manual Scale.

Chart Width: Sets the width of the chart from 15 meters (60 ft.) minimum to 150 meters (360 ft.) maximum.

Chart Speed: Sync-for every sounding the printer advances the chart one dot row (varies with depth). In fixed speeds—from 1cm/min (1") to 20cm/min (8").

Print Parameters: Prints the values of all digital parameters on the chart.

Plot Signal: Plots a line on the chart scaled to the relative amplitude of each return pulse.

Annotation: Prints Fix Number, Time, Depth and Position on the chart.

Zoom: Changes the printer resolution so that the return is printed in 1/2 of the minimum scale width (7.5m or 30 ft.).

Units: Meters (cm. Resolution to 599.99m) Feet, or Fathoms

Cal Depth: Forces the digitizer to lock to the calibration target and ignore the bottom.

Velocity: Variable from 1,370 to 1,700 m/sec. (4,500 to 5,600 ft./sec)

Draft: Can be set from 0 to 40m (0-50 ft.) independently in both High and Low frequencies.

Blanking: Masks the digitizer from seeing returns shallower than the selected value. The value can be set from 0 to 5,920m.

Slope: Controls the response rate of the digitizer (tracking gate).

Ping Rate: Selectable from 1 to 20 "Pings"/sec. or automatic (based on end of scale value)

Pulse Width: The length of the transmit pulse is selectable based on the frequency installed. The number of cycles per "Ping" can be varied from a minimum of 2 to a maximum of 128.

Minimum Depth Alarm: 0-200m (0-700 ft.) Alerts the operator that the vessel has passed a depth shallower than the minimum selected.

Noise Filter: On – Off, the integrating filter eliminates high frequency noise in the return signal.

Gauge: Tide Gauge or River Stage correction.

HELP

A description of each parameter and its minimum and maximum value is available to the operator by pressing the HELP key.

DIAGNOSTICS

Communication to and from the MKII can be checked by turning the LCD display into a virtual computer terminal. This feature provides a positive check of all serial ports.

UNIT DIMENSIONS

Height: 470mm (18.5")
Width: 432mm (17")
Depth: 279mm (11")

WEIGHT

21.7kg (48 lb.)

POWER REQUIREMENTS

11-28 VDC, 110/220 VAC (50/60 Hz.) < 100 watts average power. Specify AC or DC at time of order.

OPERATING TEMPERATURE

0° to 55° C in conditions of humidity up to 95% non-condensing.

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http://www.odomhydrographic.com

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SEACAT Profiler

SBE 19*plus*

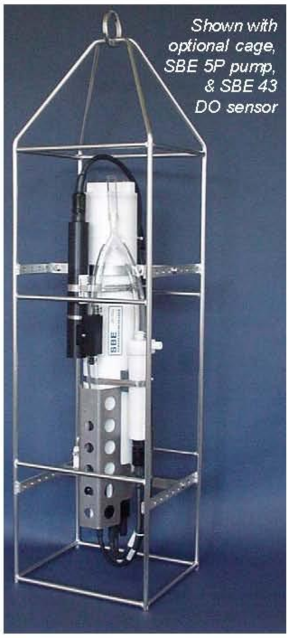
The SBE 19*plus* is the next generation *Personal CTD*, bringing numerous improvements in accuracy, resolution (in fresh as well as salt water), reliability, and ease-of-use to the wide range of research, monitoring, and engineering applications pioneered by its legendary SEACAT predecessor. The 19*plus* samples faster (4 Hz vs 2), is more accurate (0.005 vs 0.01 in T, 0.0005 vs 0.001 in C, and 0.1% vs 0.25% — with *seven* times the resolution — in D), and has more memory (8 Mbyte vs 1). There is more power for auxiliary sensors (500 ma vs 50), and they are acquired at higher resolution (14 bit vs 12). Cabling is simpler and more reliable because there are four differential auxiliary inputs on two separate connectors, and a dedicated connector for the pump. All exposed metal parts are titanium, instead of aluminum, for long life and minimum maintenance.

The 19*plus* can be operated without a computer from even the smallest boat, with data recorded in non-volatile FLASH memory and processed later on your PC. Simultaneous with recording, real-time data can be transmitted over single-core, armored cable directly to your PC's serial port (maximum transmission distance dependent on number of auxiliary sensors, baud rate, and cable properties). The 19*plus'* faster sampling and pump-controlled TC-ducted flow configuration significantly reduces salinity spiking caused by ship heave, and allows slower descent rates for improved resolution of water column features. Auxiliary sensors for dissolved oxygen, pH, turbidity, fluorescense, and PAR can be added. For moored deployments, the 19*plus* can be set to *time-series* mode using software commands. External power and two-way real-time communication over 10,000 meters of cable can be provided with the SBE 36 CTD Deck Unit and Power and Data Interface Module (PDIM).

The 19*plus* uses the same temperature and conductivity sensors proven in 5000 SEACAT and MicroCAT instruments, and a superior new micro-machined silicon strain gauge pressure sensor developed by Druck, Inc. Improvements in design, materials, and signal acquisition techniques yield a low-cost instrument with superior performance that is also easy to use. Calibration coefficients, obtained in our computer-controlled high-accuracy calibration baths, are stored in EEPROM memory. They permit data output in ASCII engineering units (degrees C, Siemens/m, decibars, Salinity [PSU], sound velocity [m/sec], etc.).

Accuracy, convenience, portability, software, and support: compelling reasons why the 19*plus* is today's best low-cost CTD.

CONFIGURATION AND OPTIONS


Shown with optional cage, SBE 5P pump, & SBE 43 DO sensor

A standard SBE 19*plus* is supplied with:

- Plastic housing for depths to 600 meters
- Strain-gauge pressure sensor
- 8 Mbyte FLASH RAM memory
- 9 D-size alkaline batteries
- Impulse glass-reinforced epoxy bulkhead connectors: 4-pin I/O, 2-pin pump, and two 6-pin (two differential auxiliary A/D inputs each)
- SBE 5M miniature pump with plastic housing for depths to 600 meters, and T-C Duct

Options include:

- Titanium housing for depths to 7000 meters
- SBE 5M miniature pump with titanium housing in place of plastic housing
- SBE 5P (plastic) or 5T (titanium) pump in place of SBE 5M for use with dissolved oxygen and/or other pumped sensors
- Bulkhead connector for use with PAR sensor
- Sensors for oxygen, pH (for integration in Profiling mode only), fluorescence, light (PAR), light transmission, and turbidity
- Stainless steel cage
- MCBH *Micro* connectors in place of glass-reinforced epoxy connectors
- Nickel Metal Hydride (NiMH) or Nickel-Cadmium (Ni-Cad) batteries and charger
- Moored mode conversion kit with anti-foulant device fittings

SOFTWARE

The SBE 19*plus* is supplied with a powerful Windows 2000/XP software package, SEASOFT®-Win32, which includes:

- SEATERM® — communication and data retrieval
- SEASAVE® — real-time data acquisition and display
- SBE Data Processing® — filtering, aligning, averaging, and plotting of CTD and auxiliary sensor data and derived variables

Sea-Bird Electronics, Inc.
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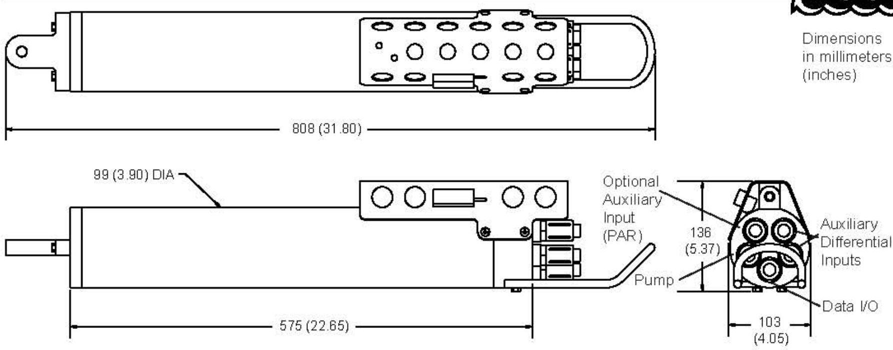
Fax: (425) 643-9954

SEACAT Profiler

SBE 19*plus*



SPECIFICATIONS

	Measurement Range	Initial Accuracy	Typical Stability (per month)	Resolution
Conductivity (S/m)	0 to 9	0.0005	0.0003	0.00005 (most oceanic waters; resolves 0.4 ppm in salinity) 0.00007 S/m (high salinity waters; resolves 0.4 ppm in salinity) 0.00001 S/m (fresh waters; resolves 0.1 ppm in salinity)
Temperature (°C)	-5 to +35	0.005	0.0002	0.0001
Pressure	0 to 20/100/350/600/ 1000/2000/3500/ 7000 meters	0.1% of full scale range	0.004% of full scale range	0.002% of full scale range

Memory 8 Mbyte non-volatile FLASH memory

Data Storage

Recorded Parameter	Bytes/Sample
T + C	6
pressure	5
each external voltage	2

Real-Time Clock 32,768 Hz TCXO accurate to ±1 minute/year

Internal Batteries 9 alkaline D-cells (Duracell MN1300, LR20) provide 60 hours profiling; optional 9-cell NiMH battery pack provides 40 hours profiling per charge; optional 9-cell Ni-Cad battery pack provides 24 hours profiling per charge

External Power Supply 9 - 28 VDC; consult factory for required current

Power Requirements

Sampling 65 mA
Pump SBE 5M: 100 mA Optional SBE 5T or 5P: 150 mA
Communications 60 mA
Quiescent 30 µA

Auxiliary Voltage Sensors

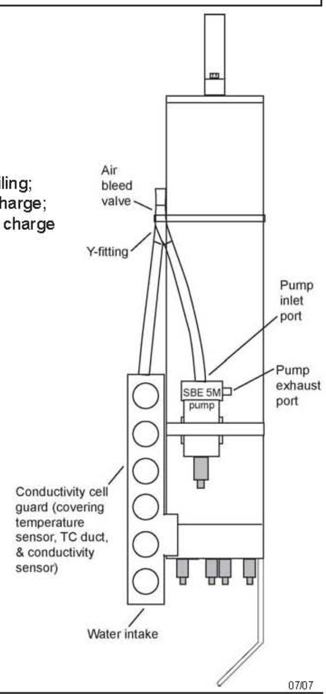
Auxiliary power out up to 500 mA at 10.5 - 11 VDC
A/D resolution 14 bits
Input range 0 - 5 VDC

Housing Materials, Depth Rating, Weight in air*, Weight in water*

Acetal Copolymer *Plastic* housing, 600 meter (1950 feet), 7.3 kg (16 lbs), 2.3 kg (5 lbs)
3AL-2.5V *Titanium* housing, 7000 meter (22,900 feet), 13.7 kg (30 lbs), 8.6 kg (19 lbs)
*Weights listed are without pump; pump adds (in air) 0.3 to 0.7 kg (0.6 to 1.5 lbs), depending on pump model selected. See pump brochures for details.

Optional Cage

1016 mm x 241 mm x 279 mm (40 in. x 9.5 in. x 11 in.), 6.3 kg (14 lbs)



07/07

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LETTER OF APPROVAL

Data Acquisition and Processing Report

OPR-K354-KR-10

This report is respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report has been closely reviewed and is considered complete and adequate as per the Statement of Work.

Tara Levy
Chief of Party
C&C Technologies
February 2012