OPR-K387-KR

NOAA FORM 76-35A
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey: Hydrographic Multibeam & 200% Sidescan

Project Number: OPR-K387-KR-07

Time Frame: Beginning Februrary 2007

LOCALITY

State: Louisiana

General Locality: Approaches to Vermillion Bay

2009

CHIEF OF PARTY
Scott Croft, Joseph Burke

LIBRARY & ARCHIVES

DATE:

NOAA FORM 77-28 (11-72)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	PROJECT NUMBER:
	HYDROGRAPHIC TITLE SHEET **Data Acquisition and Processing Report**	OPR-K387-KR
		FIELD NUMBER: Sheets A - C

State: Louisiana

General Locality: Approaches to Vermillion Bay

Locality: Approaches to Freshwater Bayou Canal and Southwest Pass, and Southwest Pass

Scale: 1:20,000 (A & B), 1:5,000 (C) Date of Survey: Beginning August 2007

Instructions Dated: Februrary 2007 Project Number: OPR-K387-KR

Vessels: R/V *Inez McCall, Captain Blake, C-Ghost*

Chiefs of Party: Scott Croft, Joe Burke

Surveyed by: C & C Technologies

Soundings taken by echosounder, hand lead line, or pole: Simrad EM3002 Multibeam Echosounders

Graphic record scaled by: N/A

Graphic record checked by: N/A

Protracted by: N/A Automated plot by: HP 1055 Plotter

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
Grab samples
Tidal Zones and Correctors from NOS, CO-OPS

NOAA FORM 77-28 SUPERSEDES FORM C & GS - 537

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A. EQUIPMENT

The major operational systems used to acquire hydrographic data include Odom 200 kHz Hydrotrac single beam echosounders, Simrad EM3002 multibeam echosounders, and Klein 5000 side scan sonars, and GeoAcoustics side scan sonars. A combination of PCs and Sun Workstations were used to collect and process the data. All computers were networked to allow for precise time tagging and georeferencing of the data, and for efficient data transfer.

A.1 SURVEY VESSEL

Survey operations were conducted aboard the *Inez McCall*, *Captain Blake*, *C-Ghost*, and *C-Wolf*. The *Inez McCall* was leased from Cameron Offshore Boats of Cameron, Louisiana. The *Captain Blake*, *C-Ghost*, and *C-Wolf* are owned and operated by C&C Technologies.

Vessel diagrams and specifications are included in Appendix A. The diagrams show all offsets from the vessel center reference points to the antennas and to all survey equipment. The details of the vessels include registration numbers, capacity, and equipment.

A.2 SINGLE BEAM SONAR OPERATIONS

An Odom Hydrotrac was used to collect single beam data on board all survey vessels. Data from the Hydrotrac 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 SONAR OPERATIONS

Survey operations were conducted using a single head Simrad EM 3002 on board all four survey vessels. The *Inez McCall's* transducer head was mounted at the base of a pole attached to the bow of the vessel. The transducers on board both the *Captain*

Blake and the *C-Wolf* were mounted in a moon pool configuration. The transducer on board the *C-Ghost* was mounted on an over the side pole.

Multibeam sonar operations were conducted in a manner such that the accuracy and resolution standards set forth in Section 5.2 of the Specifications and Deliverables document were met. The swath was reduced to an angular sector of 45° to 60°, which provided over 2 times water depth of coverage and ensured that the detection criteria of being able to detect a 2 x 2 x 1 meter object was met. The survey speed was generally held to under 8 knots, and with a ping rate of 6 to 8 pings per second the criterion of 3.2 beam footprints per 3 meter along track distance was met.

C&C Technologies' proprietary Hydromap software was used for data collection, processing, quality assurance, and quality control. During data collection, the quality of the data was monitored in real time. The display included a coverage map, several ping 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.

A.4 SIDE SCAN SONAR OPERATIONS

On board the *Inez McCall*, the Klein 5500 side scan sonar was operated in a towed configuration. The tow point was at the stern of the boat, 17.97 meters astern of the vessel reference center.

GeoAcustics side scan sonars were towed for the bow of the other three vessels, the *Captain Blake*, *C-Ghost*, and *C-Wolf*. This configuration resulted in an approximately –3.5 meter layback for all three vessels.

Survey operations were conducted at speeds averaging 5 knots. Both the GeoAcustics and Klein 5500 exceeded the requirement that a 1-meter target be ensonified a minimum of three times per pass. The side scan sonar was operated at range scales of 50 or 75 meters, depending upon the depth. Line spacing was set a various ranges, from as little as 20 meters in shallow areas inside of Southwest Pass, up to 65 meters in deeper areas in Sheet A (20 – 35 feet). Due to the shallowness of the water, the side scan sonar was frequently towed at heights of less than the required 8 to 20 percent of the range scale. Confidence checks were performed a minimum of once a day.

Chesapeake Technologies SonarWiz software was used for data collection and processing of the side scan sonar data.

B. QUALITY CONTROL

B.1 MULTIBEAM

All multibeam data collected for H11669 was processed using Caris Hips and Sips 6.1. 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 ships 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 project submitted in conjunction with this report.

Both survey H11669 (sheet A), and H11670 (sheet B), were broken into 6 separate survey areas, named subareas 1 – 6. Survey H11671 (sheet C) consisted of only a single survey area. In order to allow for more efficient processing of the data, subareas were treated as independent surveys. Following the completion of processing of all subareas within a survey, the areas were combined into a single project on an external USB hard drive for submission to the Atlantic Hydrographic Branch for review.

Caris project directory structures were created according to the format required by Caris. All lines converted were assigned a project, vessel, and day. Tides were applied to all multibeam data in Caris using tidal data downloaded form the NOAA CO-OPS website, and corrected using a tidal zone definition file (.zdf) supplied by NOAA. After reviewing the processed data along the edges of the tidal zones, it was determined that no alterations to the .zdf file were required. Both the tide (.tid) and .zdf are included in the Caris project submitted in conjunction with this report. An angle from nadir filter that rejected all data outside of a 52-degree angle on both sides of the swath was applied to all data. All multibeam data collected was reviewed in the swath editor, and erroneous bathymetry was rejected from the project.

Separate BASE surfaces were created for each subarea. BASE surfaces were named as recommended by the NOAA Specs and Deliverables. All BASE surfaces were created as uncertainty surfaces with a single resolution of 5 meters. All BASE surfaces were created based upon the IHO special order 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 the subset editor, swath editor, and comparison to side scan sonar data. If data was found to misrepresent the seafloor, it was rejected.

All contact investigation data was cleaned in the swath editor before being incorporated into a BASE surface. After data was cleaned in swath editor, the 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, all five BASE surfaces were finalized for submission.

B.1.2 PARAMETERS

During collection the swath width was restricted to between 45° and 60°. The parameters used for processing the data for the smooth sheet are listed in the following table.

Maximum Beam Spacing:	1.2 meters
Maximum RMS Difference	0.25 meters
Maximum Raw Standard Deviation	0.40 meters
Elevation Offset	0.18 meters
Bin Size	3 meters
Minimum Points Per Bin	8
Median Percentage	60
Multi-Median Bin Size	3 meters
Multi-Median Shift Size	1 meter

B.2 SIDE SCAN

B.2.1 REVIEW PROCESS

All data was reviewed at least twice in the field. The side scan operator reviewed all data during collection and noted in the survey logs any significant features or surface/water column effects. Within hours of collection the data was reviewed for a second time by a geoscientist.

The reviewer first decided the order in which to view the lines. Since we were producing mosaics as proof of coverage it was best to view all lines in the first 100% first and then the remaining lines second. This way the coverage map that was generated during the review process contained only the data for the lines that were to be used for that particular mosaic (first or second 100% coverage).

B.2.2 CONTACT SELECTION

As each line was reviewed sonar contacts were tagged and recorded. All contacts with shadows were recorded. All existing infrastructure, such as pipelines, wells, platforms, and buoys was tagged, as were other features. Many of the targets that were tagged were described as insignificant debris that is associated with shipping and/or oil and gas field activities in the area.

All contacts which displayed a height of 1 meter or greater, calculated from shadow length, were deemed to be significant within water depths of 20 meters or less, per Attachment #1 of the Statement of Work; Specifications and Deliverables. Other contacts may have been deemed significant based on their characteristics (dimensions, strength of return, etc.). Contacts were tagged, recorded and plotted in AutoCAD. Sonar contacts from adjacent lines were correlated and noted in the sonar contact table.

B.2.3 PROOF OF COVERAGE

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.

For the coverage map requirement of the interim and final deliverables we submitted side scan sonar mosaics. A mosaic for each 100% of coverage was submitted. These mosaics were generated in the field and served as another quality control tool. The mosaics 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.

C. CORRECTIONS TO ECHO SOUNDINGS

C.1 INSTRUMENT CORRECTIONS

No instrument corrections were necessary.

C.2 VESSEL CONFIGURATION CORRECTIONS

C.2.1 *INEZ MCCALL, CAPTAIN BLAKE, C-GHOST, C-WOLF*

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 vessel (bow, stern, antennas, transducers, etc.) using traditional survey techniques incorporating plumb bobs, tape measures, and digital levels. CRPS were established as an arbitrary point on the central along track axis of the vessel within one meter of the multibeam mounting pole.

The results of the vessel survey are shown in diagram form in Appendix A.

C.3 STATIC AND DYNAMIC DRAFT CORRECTIONS

Settlement and squat tests was performed for all vessels. The vertical corrections applied to the data, described in the following chart, varied with speed. All values were post applied in Caris.

Inez McCall (01/22/2008)

Vertical Correction (m)	Speed (m/s)
-0.03	3
-0.07	5
-0.11	7
-0.23	9

Captain Blake (06/06/2008)

Vertical Correction (m)	Speed (Knts)
-0.03	4.5
-0.04	5
-0.11	6.5
-0.14	8
0.18	18

C-Ghost (06/06/2008)

Vertical Correction (m)	Speed (Knts)
0.0	2.5
-0.01	4
-0.06	7
-0.05	10
0.06	17.5

C-Wolf (06/06/2008)

Vertical Correction (m)	Speed (Knts)
-0.01	2.3
-0.02	3.8
-0.06	6.0
-0.02	11.5
0.10	18

The *Inez McCall* is equipped with a draft tube, which was read once daily while at sea, and the water level/draft entries were updated in each system as required. In addition to the daily readings, readings were also taken prior to each departure from the dock.

Draft values were checked on board the *Captain Blake* and *C-Wolf* by directly measuring the depth of water above the transducer in the moon pool. A lead line was used to verify draft on board the *C-Ghost*.

Lead lines were performed on a daily basis on board the *Captain Blake* and *C-Ghost*.

C.4 VESSEL MOTION CORRECTIONS

A Coda Octopus F180 was integrated with the multibeam and navigation software as the primary positioning and motion sensor aboard the *Captain Blake, C-Ghost, and C-Wolf*. The F180 provided real-time heave, pitch, and roll corrections, as well as primary navigation.

A POS/MV motion sensor was integrated with the multibeam echosounder aboard both the *Inez McCall* to provide real-time heave, pitch, and roll corrections.

Prior to the survey, standard patch test were performed on each vessel to determine correctors for latency, pitch, roll, and heave. Patch tests were performed in the following manor.

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 was run over the target at a low speed.

Heading:

Two sets of collinear reciprocal lines were run

Roll:

A set of collinear reciprocal lines was run with each head in single head mode.

Patch tests were performed on board all vessels prior to the commencement of survey operations. The results of those tests are shown below.

Inez McCall (Sept.26 – South of Cameron, La.):

Roll	Pitch	Heading
-4.5°	9.3°	0.0°

Captain Blake (July 31 – Southwest Pass):

Roll	Pitch	Heading
6.067°	0.0°	0.0°

C-Ghost (Sept. 15 – Lake Duplecin):

Roll	Pitch	Heading
5.27°	-5.0°	0.0°

C-Wolf (March 21 – Lake Duplecin):

Roll	Pitch	Heading
1.03°	-5.0°	0.0°

C.5 SOUND VELOCITY CORRECTIONS

Seabird sound velocity profilers were used on board all four survey vessels. The *Inez McCall* used Seabird S/N 5222. The *C-Ghost* used Seabird S/N 5221. The *Captain Blake* used Seabird S/N 5214, and the *C-Wolf* used Seabird S/N 1174. On board the *Inez McCall*, casts were performed at least twice daily and more often as needed. On board the three smaller vessels, casts were typically taken only once a day because of the limited amount of time available for working during daylight only operation, and because of the shallowness and relative homogeneity of the water column within the survey area. The multibeam data was corrected for the water column sound velocity in real-time. The mean water column sound velocity was applied to the single beam echosounder data. Endeco YSI sound speed profiles were used to determine sound speed at the transducers.

C.6 TIDE AND WATER LEVEL CORRECTIONS

Tide and water level corrections were applied as set forth in the Statement of Work.

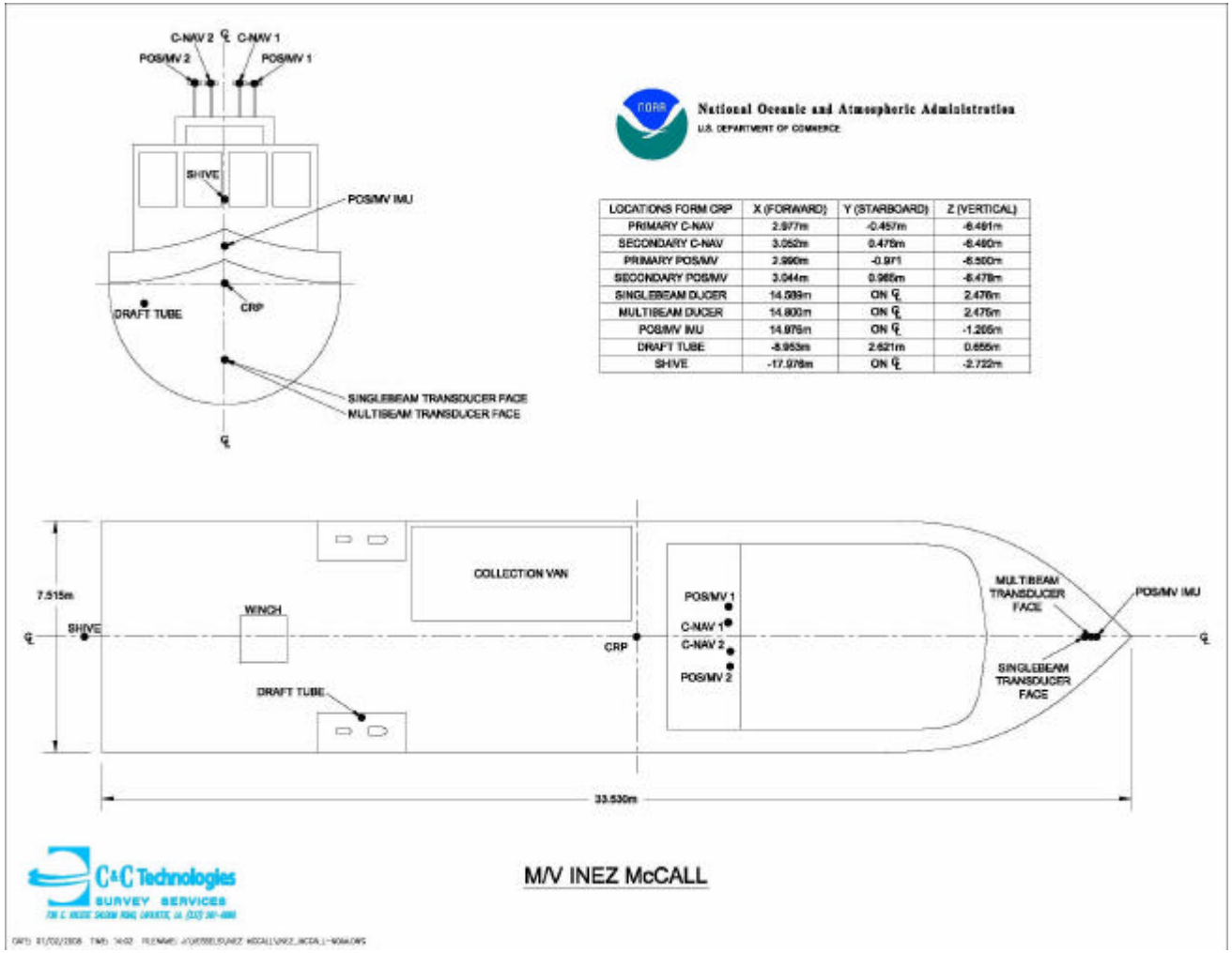
Several tide zone files were created by CO-OPS to be used for tidal correction of multibeam data collected for this survey. The initial tidal zone files were not used due to the failure of the gauge at the Freshwater Bayou locks (8766072). A new zone file was created that uses the Calcasieu tide gauge (876094) as the primary source for tidal correctors. The final and correct file was named K378KR2007RevCORP.zdf, and is included in the Caris projects submitted in conjunction with this report.

Tide gauge number 8765551 was established in Southwest Pass, at 29°35'25. 720"N, 92°01'06. 647"W on red day marker 16. Data was collected from July 21st 2008 to Aug 11th 2008. Data from this gauge will be submitted with the vertical and horizontal control report.

Tide Gauge 8765551

APPENDIX A - VESSEL DESCRIPTIONS

INEZ McCALL


C-NAV 2
C-NAV 1
POS/MV 2
POS/MV 1
SHIVE
POS/MV IMU
DRAFT TUBE
CRP
SINGLEBEAM TRANSDUCER FACE
MULTIBEAM TRANSDUCER FACE
National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
LOCATIONS FORM CRP | X (FORWARD) | Y (STARBOARD) | Z (VERTICAL)
PRIMARY C-NAV | 2.977m | -0.457m | -6.491m
SECONDARY C-NAV | 3.052m | 0.479m | -6.460m
PRIMARY POS/MV | 2.990m | -0.911 | -6.500m
SECONDARY POS/MV | 3.044m | 0.965m | -6.478m
SINGLEBEAM DUCER | 14.589m | ON ℄ | 2.476m
MULTIBEAM DUCER | 14.800m | ON ℄ | 2.476m
POS/MV IMU | 14.976m | ON ℄ | -1.206m
DRAFT TUBE | -5.953m | 2.621m | 0.655m
SHIVE | -17.976m | ON ℄ | -2.722m
7.515m
SHIVE
WINCH
COLLECTION VAN
DRAFT TUBE
CRP
POS/MV 1
C-NAV 1
C-NAV 2
POS/MV 2
MULTIBEAM TRANSDUCER FACE
POS/MV IMU
SINGLEBEAM TRANSDUCER FACE
33.530m
C&C Technologies
SURVEY SERVICES
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

RV Captain Blake

Vessel Particulars

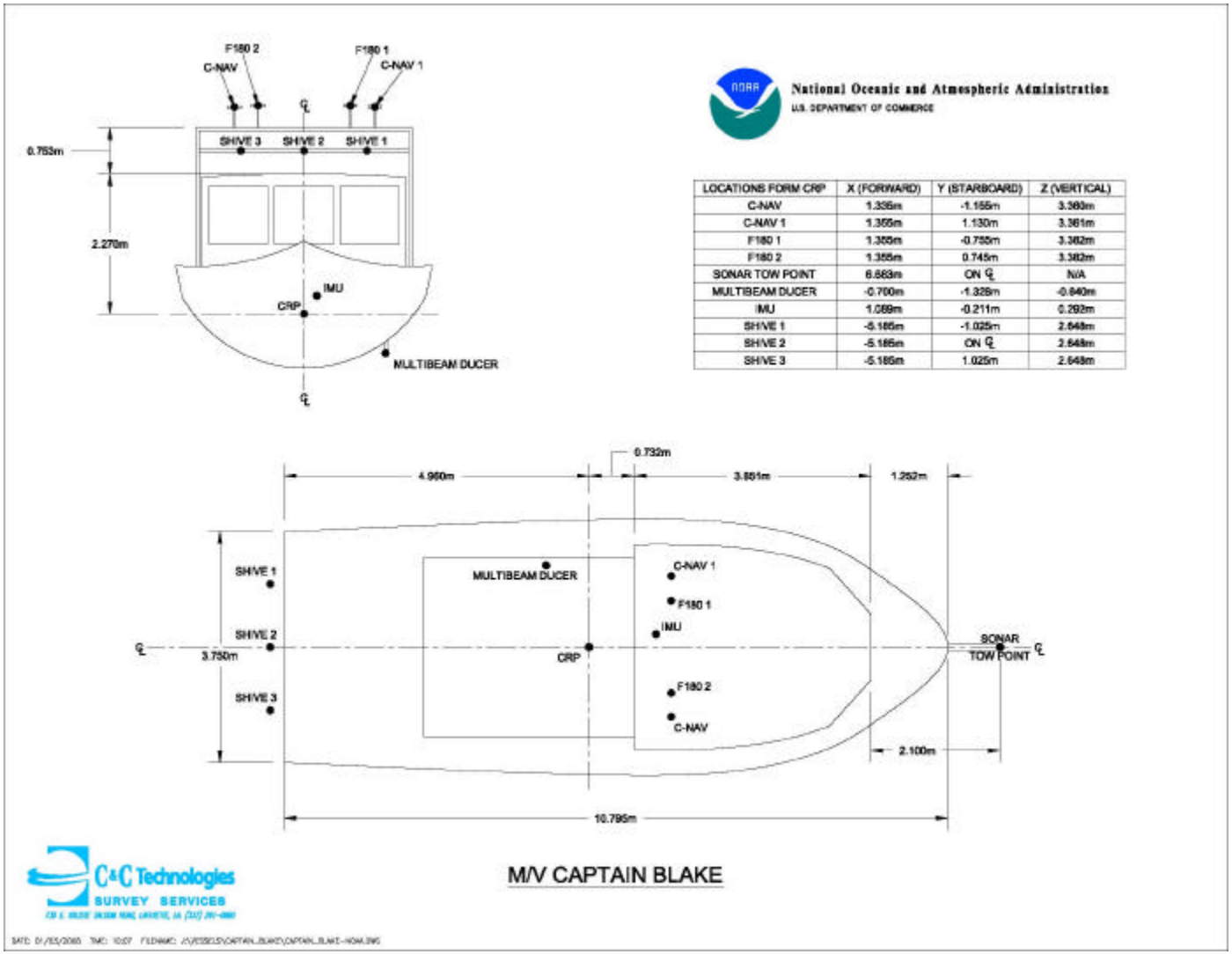
- Official # LA 1795 CA
- Dimensions:
  - Length: 35 ft
  - Beam: 14 ft
  - Draft: 2 ft
- Construction: Fiberglass (built in 1989)
- Propulsion
  - (1) Catapillar Model 3126
- Electronics
  - Radar: Raytheon
  - VHF: Raytheon
  - Chart Plotter / Depth Finder
  - Generator - Northern Lights, Model M753K.3 110 volts
  - (2) 1400 btu AC units
  - Phone: 337-504-0300

Positioning & Geophysical Equipment

- (2) C-Nav Satellite Based Differential GPS System
- Kongsberg EM3002 Multibeam Sonar (threw hull moon pool)
- Coda F180 Internial Navigation System
- GeoAcoustics Side Scan Sonar model umber ss982 (114/410 kHz)

- Optional equipment -

- Edgetech SB-424 Subbottom Profiler
- Odem 200 KHz single beam echo sounder
- Geometric Model 880 Cesium Magnetometer


F180 2
C-NAV
F180 1
C-NAV 1
SHIVE 3
SHIVE 2
SHIVE 1
0.753m
2.270m
IMU
CRP
MULTIBEAM DUCER
National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
LOCATIONS FORM CRP | X (FORWARD) | Y (STARBOARD) | Z (VERTICAL)
C-NAV | 1.336m | -1.155m | 3.393m
C-NAV 1 | 1.355m | 1.130m | 3.361m
F180 1 | 1.355m | -0.755m | 3.382m
F180 2 | 1.355m | 0.745m | 3.382m
SONAR TOW POINT | 6.883m | ON ℄ | N/A
MULTIBEAM DUCER | -0.700m | -1.328m | -0.840m
IMU | 1.069m | -0.211m | 0.292m
SHIVE 1 | -5.185m | -1.025m | 2.648m
SHIVE 2 | -5.185m | ON ℄ | 2.648m
SHIVE 3 | -5.185m | 1.025m | 2.648m
0.732m
4.960m
3.851m
1.252m
SHIVE 1
SHIVE 2
SHIVE 3
3.750m
MULTIBEAM DUCER
C-NAV 1
F180 1
IMU
CRP
F180 2
C-NAV
SONAR
TOW POINT
2.100m
10.795m
C&C Technologies
SURVEY SERVICES
M/V CAPTAIN BLAKE

RV C-Ghost

Vessel Particulars

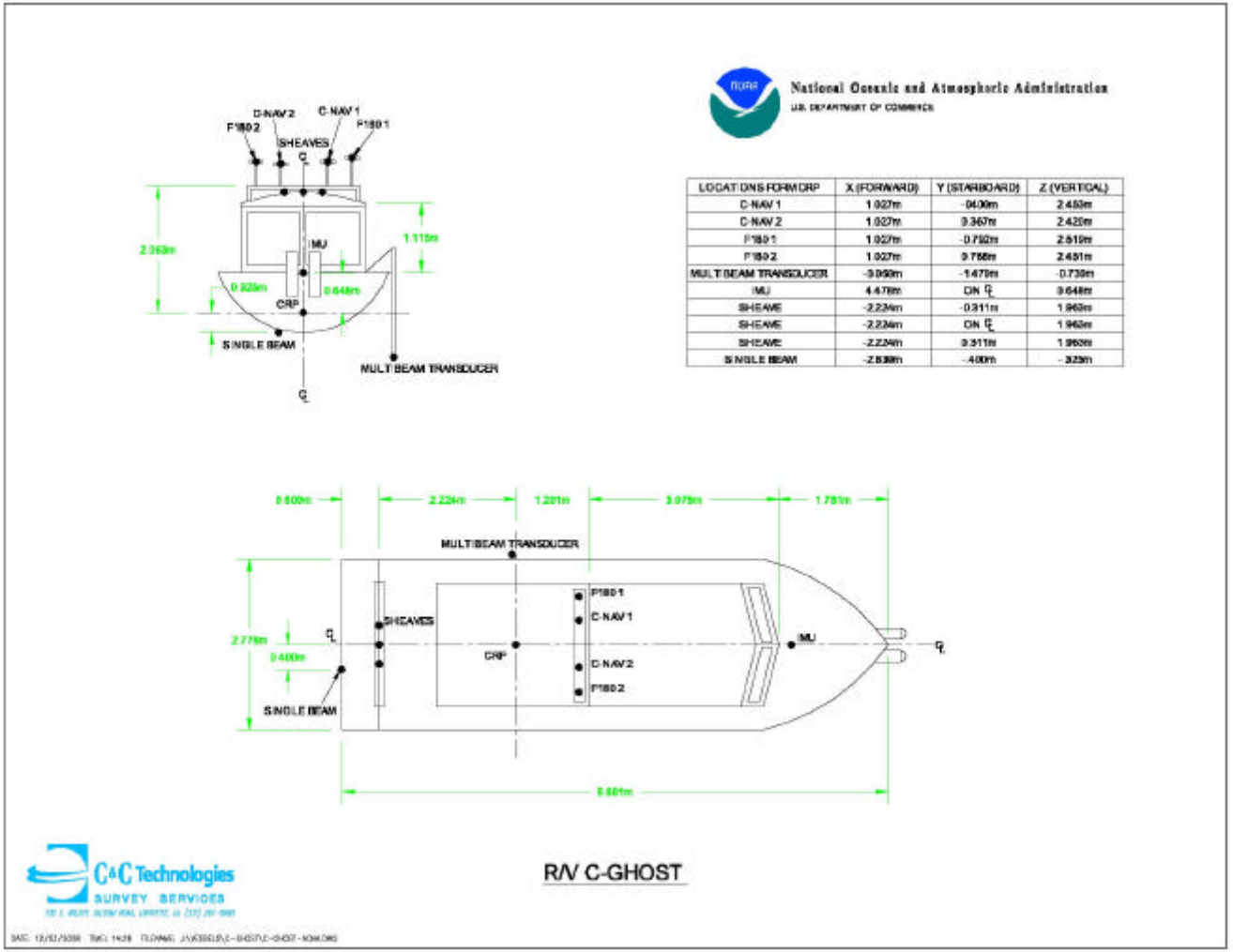
- Official # LA 4402 FR
- Dimensions:
  - Length: 30 ft
  - Beam: 8.5 ft
  - Draft: 2 ft
- Construction: Aluminum – Built 2007
- Propulsion
  - (2) Honda 150 HP (4 stroke)
- Electronics
  - Radar: Furuno
  - VHF: Raytheon
  - Chart Plotter / Depth Finder
  - 7.1 KW water cooled genset 110 volts
  - (2) 1400 btu AC units
  - Phone: 337-504-0888

Positioning & Geophysical Equipment

- (2) C-Nav Satellite Based Differential GPS System
- Kongsberg EM3002 Multibeam Sonar (pole mounted)
- Coda F180 Internial Navigation System
- GeoAcoustics Side Scan Sonar model umber ss982 (114/410 kHz)

- Optional equipment -

- Edgetech SB-424 Subbottom Profiler
- Odem 200 KHz single beam echo sounder
- Geometric Model 880 Cesium Magnetometer


C-NAV 2
C-NAV 1
P1802
P1801
SHEAVES
IMU
CRP
SINGLE BEAM
MULT BEAM TRANSDUCER
2.363m
1.115m
0.825m
0.648m
National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
LOCATIONS FROM CRP
X (FORWARD)
Y (STARBOARD)
Z (VERTICAL)
C-NAV 1 1.027m -04.0cm 2.453m
C-NAV 2 1.027m 0.367m 2.420m
P1801 1.027m -0.792m 2.519m
P1802 1.027m 0.756m 2.451m
MULT BEAM TRANSDUCER -3.050m -1.479m -0.738m
IMU 4.478m ON ℄ 0.648m
SHEAVE -2.224m -0.311m 1.963m
SHEAVE -2.224m ON ℄ 1.962m
SHEAVE -2.224m 0.311m 1.960m
SINGLE BEAM -2.838m -.400m -.329m
0.600m
2.224m
1.201m
3.075m
1.781m
MULTIBEAM TRANSDUCER
P1801
C-NAV 1
SHEAVES
IMU
2.778m
0.400m
CRP
C-NAV 2
P1802
SINGLE BEAM
9.881m
C&C Technologies
SURVEY SERVICES
R/V C-GHOST

RV C-Wolf

Vessel Particulars

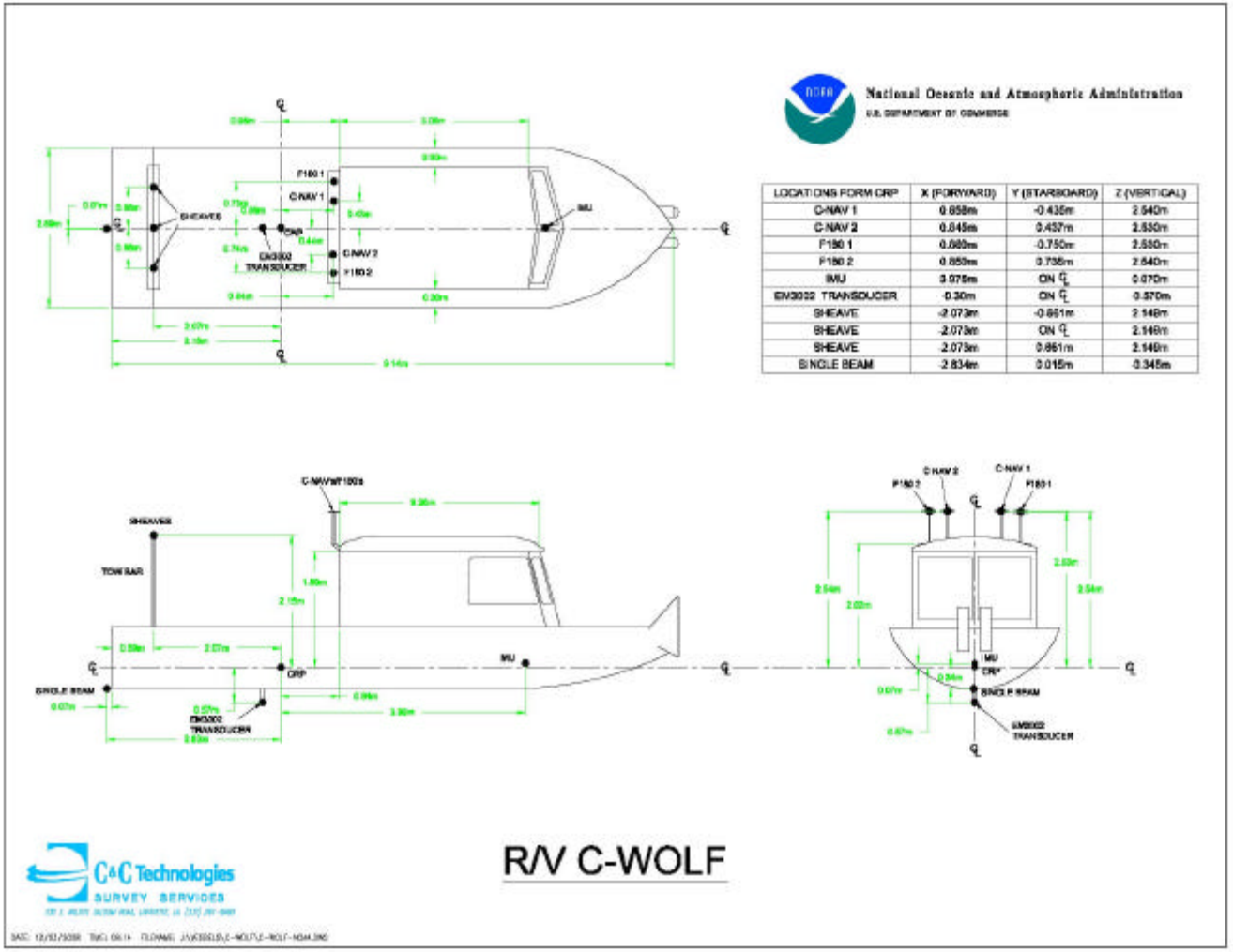
- Official # LA 2935 FS
- Dimensions:
  - Length: 30 ft
  - Beam: 8.5 ft
  - Draft: 2 ft
- Construction: Aluminum – Built 2007
- Propulsion
  - (2) Yamaha 150 HP (4 stroke)
- Electronics
  - Radar: Furuno
  - VHF: Raytheon
  - Chart Plotter / Depth Finder
  - 7.1 KW water cooled genset 110 volts
  - (2) 1400 btu AC units
  - Phone: 337-504-0889

Positioning & Geophysical Equipment

- (2) C-Nav Satellite Based Differential GPS System
- Kongsberg EM3002 Multibeam Sonar (threw hull moon pool)
- Coda F180 Internial Navigation System
- GeoAcoustics Side Scan Sonar model umber ss982 (114/410 kHz)

- Optional equipment -

- Edgetech SB-424 Subbottom Profiler
- Odem 200 KHz single beam echo sounder
- Geometric Model 880 Cesium Magnetometer


National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
LOCATIONS FORM CRP
X (FORWARD)
Y (STARBOARD)
Z (VERTICAL)
C-NAV 1
0.658m
-0.435m
2.540m
C-NAV 2
0.645m
0.457m
2.550m
P180 1
0.660m
-0.750m
2.550m
P180 2
0.650m
0.735m
2.540m
IMU
0.975m
ON ℄
0.070m
EM3002 TRANSDUCER
0.30m
ON ℄
-0.570m
SHEAVE
-2.073m
-0.661m
2.149m
SHEAVE
-2.073m
ON ℄
2.149m
SHEAVE
-2.073m
0.661m
2.149m
SINGLE BEAM
-2.834m
0.015m
-0.345m
R/V C-WOLF

APPENDIX B – EQUIPMENT DESCRIPTIONS

ODOM HYDROTRAC ECHOSOUNDER

The HYDROTRAC echo sounder by ODOM Hydrographic Systems, Inc. can collect analog paper records as well as digitized depth information for output to a data logger. Digital depth data can be logged directly to the navigation computer along with date, time, and position for later post processing and mapping. The system includes a recording unit with built in digitizer and transceiver, and a side mountable transducer. The unit utilizes a combination of dynamic gating and velocity fit to track the true bottom through advanced microprocessor technology, solving the normal problems associated with conventional depth sounders. For example, if the "fixed gate" mode is activated, signal digitizing can be restricted to a user-defined range, rejecting unwanted returns during bar-check calibrations.

The acoustic pulse is generated with the Model OHS 200/9 transducer, which operates at single frequency of 200 kHz with a beam width of 9°. This system is very much similar to ODOM ECHOTRAC SF3200, except that ECHOTRAC has capabilities of operating on dual frequencies of 24 and 200 kHz. The shipboard transceiver automatically adjusts power output in proportion to the return signal yielding a clear, unambiguous record in shallow as well as deep water. The self-adjusting power varies from 1 to 225 watts at 200 kHz. Return signals are optimized by Time Varied Gain (TVG) and Automatic Gain Control.

A thermal paper recording is printed in real-time where automated scale changes prevent the bottom from "running" off the chart. Scale widths are selectable in meters, 2 to 1,000, or feet, 10 to 3,000; however, routine operating scales are 10 to 100 feet. Key system parameters, i.e. velocity of sound, draft, and time, are input from the recorder's front panel. A tide correction may be introduced without altering the analog record in

any way. A line is added to the chart to indicate where the bottom would be if corrected for water level.

Recording resolutions of the HYDROTRAC, ranging from 8 mm to 4 meters dependent upon the selected scale width, permit detailed assessments of local water depths. Reference to a tidal datum permits the evaluation of navigable waterways, subsidence and scour features around seafloor based structures, and pre/post dredging or construction water bottom conditions.

Specifications:

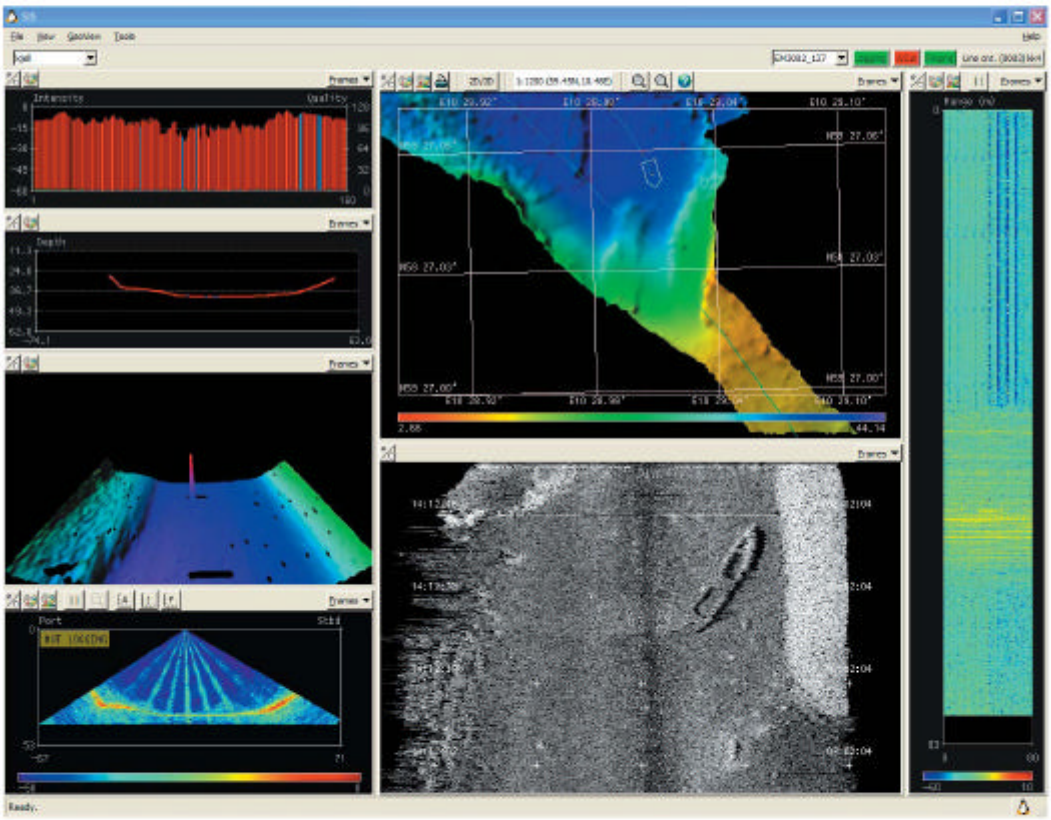
Frequency	200 kHz
Output Power	500 Watts
Power Requirement	11-28 VDC
	110/220 VAC (Optional)
Ports	RS 232

EM 3002

KONGSBERG

Multibeam echo sounder

The new generation high performance shallow water multibeam



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

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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.

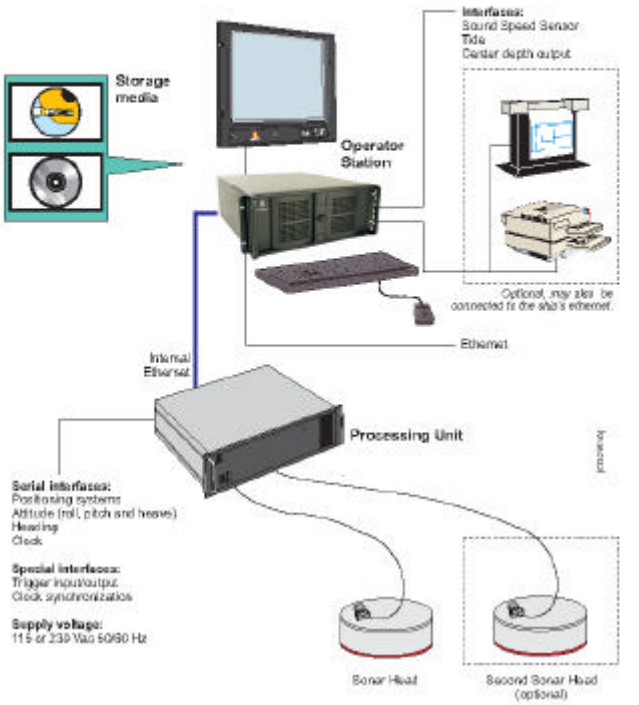
Operator Station

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.

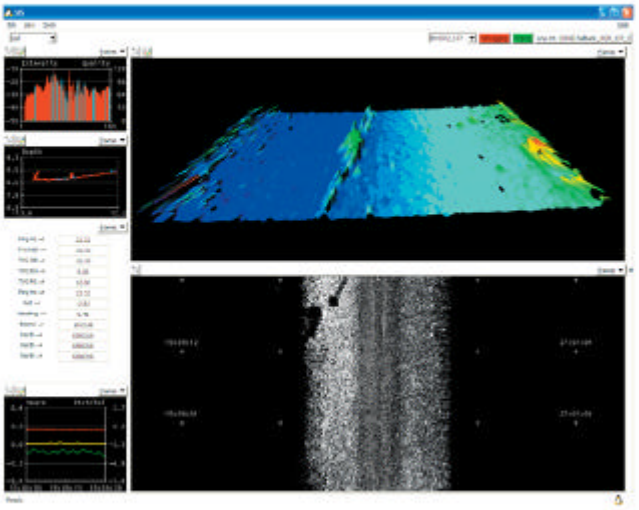
The EM 3002 can be set up to use other operational software than SIS, for example QPS "QINCy" or Coastal Oceanographics "HYPACK Max", and is also supported by software from Triton Elics International, EIVA and others.

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.

C&C Technologies
SURVEY SERVICES

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.

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KONGSBERG

KLEIN 5500 SIDE SCAN SONAR

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 and requires speeds of 5 knots or less to insure 100 percent bottom coverage. From a design perspective, both of these shortcomings can be eliminated by designing a side scan sonar that, through beam steering and focusing techniques, simultaneously generates several adjacent, parallel beams per side. This design approach, principally employed by military side scan sonar systems designed for high-speed mine hunting applications, has been prohibitively expensive for commercial operations. Klein Associates 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 5500 systems are: higher towing speeds with no loss of bottom coverage and range independent high-resolution imagery capability. Since operation costs are dependent on the amount of at-sea time required to complete a survey, the new Klein 5500 Multi-Beam Side Scan Sonar Systems with survey speeds more than twice that of conventional side scan sonars, minimize at-sea time, thus greatly reducing survey costs.

The sonar system consists of a towfish, tow cable, transceiver/processor unit (TPU), and a PC display and control unit for viewing data. The stainless steel towfish incorporates two multi-channel acoustic arrays and a pressure bottle that houses all of the electronics and sensors necessary for sonar data acquisition, attitude sensing, system control and telemetry. The sonar and sensor data is transmitted up the tow cable via a high-speed digital telemetry link, requiring only a single coaxial or fiber-optic cable. The surface mounted TPU receives this data, performs all necessary digital processing functions on the acoustic data, and relays control command to the towfish. Processed data is then distributed to one or multiple PC Display and Control Units (DCU) via a 100 Base T

Ethernet LAN Network where the tasks of data viewing, storage and analysis can be accomplished.

The Klein 5500 is a 5-beam side scan sonar designed for hydrographic applications requiring high- resolution images of the seafloor and bottom obstructions while operating at tow speeds up to 10 knots and with an overall swath width of 300 meters. Applications of the side scan sonar include hydrographic surveys, mine hunting, pipeline surveys, debris searches, archaeological surveys, geologic surveys and autonomous underwater vehicle surveys. Specifications for the Klein 5000 are outlined below:

Towfish

Number of beams:	5 Port / 5 Starboard
Frequency:	455 kHz
Pulse Length:	50 to 200 usec. (operator selectable)
Resolution Along Track:	20 cm @ 75 meter range, thereafter increasing to a maximum of 36 cm @ 150 meter maximum range
Resolution Across Track:	Determined by selected pulse length
Operating Speed Envelope:	2 – 10 knots @ 150 meter maximum range
Sonar Digitization:	12 bit / channel
Maximum Operating Range:	150 meters (300-meter swath)
Array Length:	120 centimeters (47.2 inches)
Body Length:	194 centimeters (76.4 inches)
Body Diameter:	15.2 centimeters (6 inches)
Weight in air:	70 kg (155 lbs.)
Sensors:	Heading, pitch, roll, temperature and pressure
Tow Cable:	Coaxial or fiber

Transceiver Processor Unit

Width:	19-inch rack mount
Height:	13.2 centimeters (5.2 inches)
Depth:	54.6 centimeters (21.5 inches)
Weight:	12.7 kilograms (28 pounds)
Voltage:	115/240 VAC; 50/60 Hz
Power:	120 Watts
Navigation Input:	NMEA 0183
Data Output:	100 Base-T Ethernet LAN
PC Display/Control Unit:	Klein ruggedized or customer supplied PC

Dual Frequency Side Scan Sonar

Introduction

The GeoAcoustics Dual Frequency Side Scan Sonar system is the ideal tool for seabed feature mapping, offering flexibility and high quality results in a simple and reliable package. The system offers high resolution, switch selectable, dual frequency operation (114/410 kHz), which when combined with multiplexed data transmission enables a low drag co-axial tow cable to be used. The modular design of the system makes it ideal for combining with our GeoChirp and GeoPulse sub-bottom profilers.

The versatility, ease of operation and cost effectiveness of the system has made it a popular choice with commercial survey companies.

Transceiver

The transceiver unit allows the operator a simple means of controlling various Side Scan operating parameters. The unit includes standard controls such as: Gain, Time Varying Gain (TVG) and Automatic Gain Control (AGC), with duplicated controls for Port and Starboard channels. The operating frequency can also be switched from 114 kHz to 410 kHz directly from the Transceiver. The choice of frequencies means that long range scanning and short range high resolution investigations are both possible.

Multiplexer

The Multiplexer Unit (SS982) is the sub-sea processing section of the Side Scan Sonar system. The SS982 is mounted in the tail of the towfish, on the tail of a combined towfish or on a ROV, as required. The use of standard sub-sea connectors throughout allows easy installation in all situations. The SS982 includes all of the transmitter and multiplexing electronics, thereby ensuring that transmission power is not lost in the towcable and also reducing the risk of high voltage defects.

The multiplexed data transmission technique employed allows the system to be used with a wide selection of towcables, including twisted pair and co-axial cables. Data from the Dual Frequency Side Scan Sonar can be input to a wide range of third party sonar processing systems, or it can be displayed on a wide variety of industry standard graphic recorders.

The multiplexed data offers a resolution equivalent to a 16 bit analogue to digital converter operating at 50k samples/sec per channel, when used with short towcables.

Standard System

The standard system employs a lightweight towfish, which is easily deployed by one person and can operate to a depth of 1000 metres. There are separate controls for each channel, which makes the system very easy to operate.

The basic system includes the following:

- Transceiver (model SS981)
- Towfish (model 159D), which houses the Multiplexer (model SS982) and Two Dual Frequency Transducers (model 196D/Port and Starboard).

Features

- 1000 metre depth rating (standard)
- Switch selectable dual frequencies
- Fully multiplexed signals
- Simple user controls
- Low cost
- High efficiency/low power
- Operates over long towcables
- Outputs to all standard recorders/processors
- High reliability (MTBF > 10,000 hours)
- Simple maintenance
- Low drag coaxial towcable
- High system bandwidth and resolution

Specifications

Transceiver Model SS981

General

Power requirements:	95/265VAC switchable, 40-60 Hz, 50W optional 24VDC
Size:	43.2cm W x 45.7cm D x 18.7cm H
Weight:	16kg
Temperature:	Storage: -20 to 75°C Operating: -5 to 50°C
Humidity:	10% to 95% RH, non-condensing
Mounting:	The unit is suitable for either bench or rack mounting

Operating Specification

Power output to tow vehicle:	150 VDC ±3 VDC, 100 mA average, 320 mA peak
Key burst out:	455 kHz, pulse width selectable 16 Vpp, PRR determined by key source
Key input:	Positive CMOS to TTL, 10kW input impedance.

Receivers

Modulation freq.:	Port 135 kHz, Starboard 65 kHz
Bandwidth:	15 kHz
Sensitivity:	6mV rms input produces 800 mV rms output with a 20dB signal-to-noise ratio (all gain maximum)
Input impedance:	5kΩ
Output impedance:	600Ω on all outputs
Dynamic range:	Gain: adjustable over 60dB range TVG: -20 to +20dB maximum AGC: -34dB maximum
Output:	Selectable signal envelope or amplitude modulated 12 kHz
TVG delay:	3.3ms minimum, 330ms maximum
Event mark:	5Vpp, 12 kHz, front panel push button or BNC input requiring CMOS or TTL level pulse. Produces visual mark on recording media.
Key out:	0.6ms CMOS/TTL compatible
Modes:	100 kHz and 500 kHz operation Raw signal and processed signal

Front Panel connectors

BNC:	Seven each for signals & keys
Amphenol:	MS3102A-22-34S for deck cable

Towfish Model 159D

Tow speed:	1 to 12 knots
Weight:	16.3kg, 22.5kg, or 38.6kg depending on ballast used
Dimension:	11.4cm D by 128.5cm L, 3 fins on tail protrude 7.5cm
Frame:	Cast aluminium with shear release carry handle/towpoint
Nose:	Shock absorbing, abrasive resistant urethane. Cavity can carry small auxiliary transducer.

Multiplexer – Model SS982

Transmitter Section

Frequency:	114/410 kHz ±1%
Power output:	3 kW pulse ±20%
Pulse length:	167 µsec/88 µsec ±1%
Pulse repetition rate:	50 pulses per second maximum
Protection:	Open and short circuit protected
Efficiency:	Greater than 80%

Receiver Section

Port channel:	114/410 kHz, heterodyned to 135 kHz
Starboard channel:	114/410 kHz, heterodyned to 65 kHz
Bandwidth:	20 kHz
TVG:	Transmission loss curve compensated at both frequencies. Approximately + 40dB at 100m range

Keyburst:

Frequency:	455 kHz ±2%
Pulse length:	300µsec for 114 kHz operation 600µsec for 410 kHz operation

General:

Power requirements:	150 VDC at 100mA
Size:	10.2cm D x 34.5cm L
Weight:	3.2kg in air, 0.45kg in water

Transducers Model 196D

Source level:	223 ±3dB re 1µPa@ 1m
Beamwidth:	114 kHz - 50° by 1° 410 kHz - 40° by 0.3°
Sensitivity:	-180dB re 1V/µPa
Depression angle:	10° ±1° down

Options

- Deeper rated towfish
- Stainless Steel towfish
- Lightweight Kevlar Towcable for shallow water use
- 60kHz operating frequency for increased range
- Towfish pitch, roll and heading sensors
- Towfish responder for acoustic tracking
- Towfish height off bottom measurement
- Towfish depth sensor

Specification sheet subject to change without notice (9-SS940-69-04 05/2005)

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CODA OCTOPUS F180 INERTIAL ATTITUDE AND POSITIONING SYSTEM

The Coda Octopus F180 is a highly accurate inertial attitude, heading and positioning system that provides high-speed vessel motion data including heave, pitch, roll, heading and position in real time. The system uses the fastest Kalman filter on the market enabling it to track small and fast changes in orientation and calculate their overall error contribution and correct for them much faster. Mobilization is minimal due to the automatic self-alignment between the IMU and GPS antenna and automatic calculation of GPS lever arms and GAMS angles. The F180 uses velocity rather than acceleration to measure heave, thus reducing heave drift.

The technical specifications of the system are provided below.

PERFORMANCE*	***RTK***	***DGPS***
Position accuracy (CEP)	0.02 / 0.2**	0.5 – 4.0m
Velocity	0.03ms-1	0.03ms-1
Roll and pitch	<0.025°	<0.025°
True heading	1m baseline – 0.1° 2m baseline – 0.05° 4m baseline – 0.025°	1m baseline – 0.1° 2m baseline – 0.05° 4m baseline – 0.025°
Heave	5% of heave amplitude or 5 cm	5% of heave amplitude or 5 cm
PHYSICAL	***Component***	***Specification***
Weight	Splash-proof ‘one-box’ solution	2.5kg
Power	Splash-proof ‘one-box’	9 – 18Vdc, 25 Watts

	solution
Antennas	Novatel Pinwheel Technology with integral choke rings to reduce multipath effects

INTERFACES	***Function***	***Output***
Ethernet Interface (I00base-T)	Control, set-up and diagnosis of F180 using F180 windows application software.	High data rate comprehensive information output packet (100Hz) for high speed interfacing.
Serial 1	Attitude data	TSS1, Simrad EM3000 and other standard attitude strings.
Serial 2	NMEA position data	GGA position, HDT heading.
Serial 3	RTK / Differential correction input	RS232 (DB9) up to 115k baud

*All performance errors to within 1 sigma

**0.02m performance requires optional L1/L2 upgrade

C-NAV DIFFERENTIAL GPS

C-Nav is a globally corrected differential GPS system owned and operated by C & C Technologies, Inc. The C-Nav GPS Receiver combines a dual-frequency, geodetic grade, GPS Receiver with an integrated L-BAND communication RF detector and decoder all linked by an internal microprocessor. C-Nav uses monitoring stations strategically located around the globe to provide worldwide accuracies in the order of 0.25m (1 sigma)*.

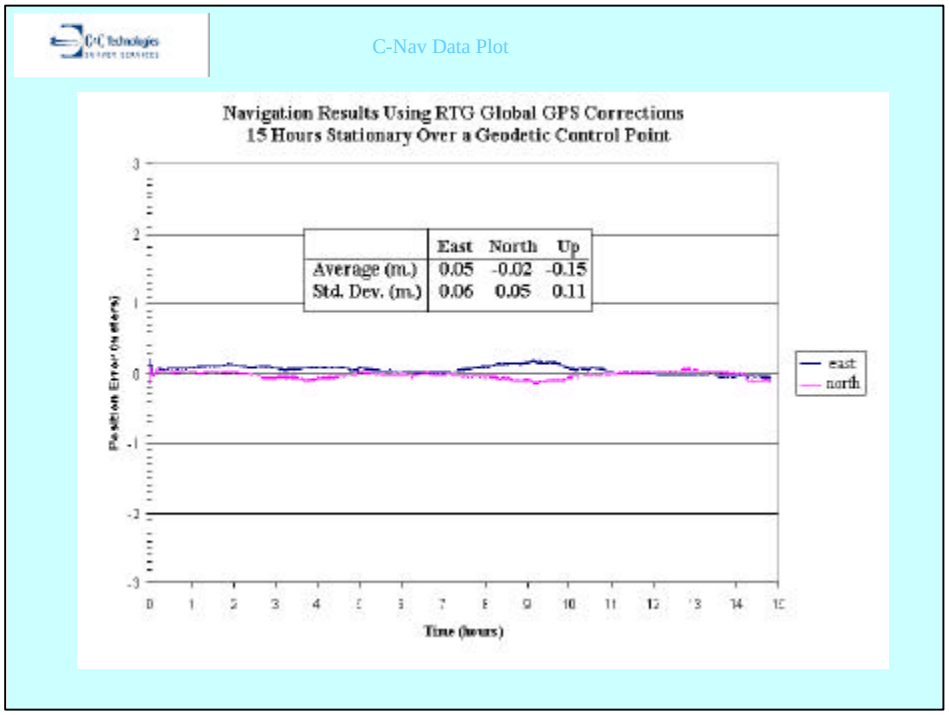
The technique, developed by the Jet Propulsion Lab for the National Aeronautics Space Administration, uses a global network of reference stations to track the entire constellation of GPS satellites. The raw GPS observations are transmitted via the Internet back to the Network Control Center where the GPS constellation satellite orbital corrections and clock-offset values are calculated and modeled in real-time. These corrections are universally valid and can be applied to GPS measurements from any location on earth.

The multi-function antenna assembly is capable of receiving the L1 and L2 GPS frequencies as well as the Inmarsat L-BAND receive frequency band. The gain pattern of this antenna is designed to be relatively constant even at lower elevations. This allows

for an efficient link budget when the unit is operated at higher latitudes where the elevation of the geo-stationary communication satellite is low and close to the horizon. Atmospheric delays are eliminated from local measurements by comparing the L1 and L2 frequencies in the internal GPS receiver.

The C-Nav GPS System provides an output of RTCM (Type 1) pseudorange differential correction messages via a second RS232 interface. Raw GPS observation information can be collected from the C-Nav GPS Receiver system for recording and analysis. The raw GPS observation information can be converted to RINEX ASCII data (observation and navigation) file format as and when required.

The C-Nav GPS Receiver requires at least four (4) usable GPS satellites to compute a three dimensional (3D) solution. The C-Nav GPS Receiver will yield an autonomous horizontal position accuracy of 2 to 5 meters (1 sigma), depending on the GPS satellite geometry configuration and tracking (DOP index values).



Receiver Specifications:

Features

- Real-time sub meter accuracy
- Single integrated package – simple installation
- Rugged, waterproof housing
- Wide-range (10-40VDC) power supply
- RTCM and NMEA {GGA, GSA, RMC, VTG, ZDA) outputs
- Patented multipath mitigation significantly reduces noise
- Geodetic quality dual frequency GPS virtually eliminates ionospheric effects

Performance

- L-band receiver frequency
- Automatically selected 1525 to 1560 MHz
- GcGPS Accuracy:

  Position (H): <30cm
  Position (V): <70cm
  {1–sigma and HDOP = 1}
  Velocity <0.02m/s
- Time to first fix: Cold Start: 90 sec(typical)
- Reacquisition

  Coast for 30 sec with GPS lock <2sec
  L-band loss with less than 30 sec with GPS lock <30 sec

Physical/Environmental

- Size: 9.2 in (H) x 7.2 in (D) (24.8 x 18.7 cm)
- Weight: 5.5 lbs (2.4 kg)
- Power: Input voltages: 10-40 VDC
  Consumption: <10W average power
  1.2 A max @12 VDC
- I/O Connector 8 pin waterproof connector
- Temperature: Operating: -20°C to +70°C
  Storage: -40°C to 85°C
- Humidity: 100% non-condensing

Display Unit Specifications:

Features

- 4 x 20 character LCD screen
- 12 key membrane button input pad
- Rugged, stainless steel housing
- Wide-range (20-40VDC) power supply

- RTCM and NMEA and raw data outputs

Physical/Environmental

- Size: 9.6 in (L) x 6.7 in (W) x 3.3 in (H) (24.4 x 17.0 x 3.3 cm)
- Weight: 3.8 lbs (1.75 kg)
- Power: Input voltages: 20-40 VDC
  Consumption: <1W average power
  100 mA max @28 VDC typical
- I/O Connectors: 3 db-9, 1 cat-5 and 1 8 pin waterproof connector
- Temperature: Operating: -20°C to +70°C
  Storage: -40°C to 85°C
- Humidity: 100% non-condensing

APPENDIX C – CALIBRATION RECORDS

LETTER OF APPROVAL

Data Acquisition and Processing Report

H11671

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.

Joseph Burke

Chief of Party

C&C Technologies

March 2009