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

Data Acquisition and Processing Report

Type of Survey: Hydrographic

Project No.: M-T901-AHI-07

Time Frame: May 2007

LOCALITY

State: Commonwealth of the Northern Mariana Islands

General Locality: North Pacific Ocean

2007

CHIEF OF PARTY
Corey Allen, NOAA

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APPENDICES

INTRODUCTION

This hydrographic project was completed as specified by Hydrographic Survey Letter Instructions M-T901-AHI-07, signed March 15, 2007. This Data Acquisition and Processing Report includes project level information common to sheets A (H11674), sheet B (F00534), sheet C (F00535).

All sheets have the general locality of North Pacific Ocean and are located in the Commonwealth of the Northern Mariana Islands.

Survey specific details will be listed in Descriptive Reports as needed. Unless otherwise noted, the acquisition and processing procedures used and deliverables produced are in accordance with the *Standing Instructions for Hydrographic Surveys (February 10, 2006)*, the NOAA *Hydrographic Survey Specifications and Deliverables Manual (HSSDM April 2007*, and the *Field Procedures Manual (FPM), March 2007*. Hydrographic Surveys Technical Directives (HTD) 2004-1, and 2007-1 through 2007-8 were followed during the course of this project.

R/V AHI – F2505

A EQUIPMENT

Descriptions of the equipment and systems used during project M-T901-AHI-07, including hardware and software used for data acquisition, data processing and horizontal and vertical control operations are listed below.

1.0 Hardware

1.1 Hardware Systems Inventory

Information on the hardware used during project M-T901-AHI-07 is included in the 2007 RV AHI Systems Inventory spreadsheet located in Appendix III of this report.

1.2 RESON 8101ER Multibeam Echosounder (MBES)

The AHI is equipped with a RESON SeaBat 8101 MBES with the Extended Range and snippet option. The 8101ER is a 240 kHz multibeam system with a swath coverage of 150°. The swath is made up of 101 discrete beams with an along-track and across-track beamwidth of 1.5°. It has a specified depth range of up to 500 meters. The typical operational depth range of the 8101 during the project was 3 to 20 meters.

The 8101 transducer is rigidly attached along the keel of the vessel as shown in Figures 1 and 2 below.

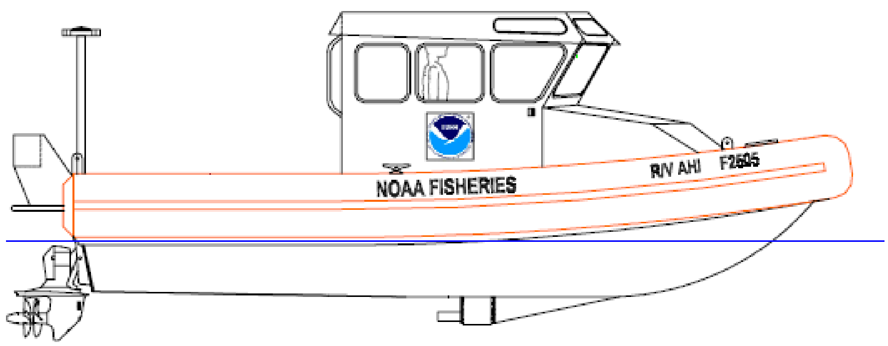

Figure 1 – Side View of Reson 8101 Transducer Mount

Figure 2 – Reson 8101 Transducer

1.3 Manual Sounding Equipment – Lead Lines

A description of the lead line used for echosounder comparison tests is included in the 2007_AHI Lead Line Comparison Report located in Appendix IV.

1.4 Klein 5500 Side Scan Sonar

AHI has been outfitted with a Klein 5500 side scan sonar (SSS) system consisting of a towfish, a transceiver/processor unit, and a laptop PC for system control, data logging, and data viewing. The system operates at a frequency of 455 kHz with two transducer arrays (port and starboard) which each form five dynamically focused beams, allowing increased resolution along track.

The towfish is towed from a shackle attached to the starboard side, aft rail of the AHI's cabin. No adjustments to the amount of cable out were possible once the towfish was rigged. Cable out was measured from the towpoint using a steel tape and input manually into the SonarPro software during acquisition.

A calibration test on the Klein 5500 was conducted on March 16, 2007 and the results are contained in the 2007 RV AHI_SSS_Cal_Table spreadsheet located in Appendix IV.

Photos of the Klein 5500 system setup are included in Appendix VI.

1.5 Positioning, Heading, and Attitude Equipment

1.5.1 TSS Positioning and Orientation System for Marine Vehicles (POS/MV)

The AHI is equipped with a TSS POS/MV 320 V4, configured with TrueHeave. The POS/MV calculates position, heading, attitude, and vertical displacement (heave) of a vessel. It consists of a rack mounted version 2.12 POS Computer System (PCS), a strap down IMU-200 Inertial Measurement Unit (IMU), and two Trimble GPS antennas corresponding to GPS receivers in the PCS. The AHI's POS MV IMU is located along the centerline of the vessel, 0.80 m. forward of the reference point. The primary GPS antenna is mounted on the forward, port side of the cabin and the secondary antenna is mounted on the aft, starboard side of the cabin.

Timing between the sonar swath, position, heading and attitude information was synchronized by utilizing the POS/MV 320 PPS signal and a time card in the ISS-2000 acquisition computer. The PPS signal synchronized the time the ISS-2000 computer which then sent a serial timing signal to the RESON topside unit. Vessel wiring diagrams are included in Appendix I.

POS/MV controller software was used to monitor position accuracy and quality during data acquisition. This ensured that positioning accuracy requirements were met, as outlined in the *HSSDM*. The POS/MV controller software provides clear visual indications whenever accuracy thresholds are exceeded.

GAMS (GPS Azimuth Measurement Sub-system) calibrations were performed on the AHI's POS/MV unit on March 13, 2007. The GAMS calibration procedure was conducted in accordance with instructions in chapter 4 of the *POSMV V4 Installation and Operation Guide*, 2005. Results are included in the 2007 RV AHI POS-MV spreadsheet located in Appendix IV.

Screen grabs of the POS/MV setup are included in Appendix VI.

1.5.2 NavCom SF-2050G

R/V AHI is equipped with a NavCom C-Nav SF-2050G satellite DGPS Receiver. The SF-2050G is a satellite based DGPS system that supplied differential (RTCM) correctors to the POS/MV which in turn provided vessel positioning during data acquisition. Screen grabs of the C-Nav setup are included in Appendix VI.

1.6 SBE 19 SEACAT Profiler

An SBE 19 SEACAT Conductivity, Temperature, and Depth (CTD) sound velocity profiler (s/n 3029) was used to acquire all sound velocity data during the project. The SBE 19 SEACAT sound velocity profiler was calibrated by the manufacturer and the calibration file is located in Appendix IV.

Periodic quality assurance checks include comparison casts between CTD instruments. Data quality assurance (DQA) checks include comparison casts between two instruments as per section 1.5.2.2 of the *FPM* for each survey. Results of the comparison casts are located in the SVP_comparison spreadsheet in Appendix IV. Any DQA checks subsequent to this DAPR will be included in Separate II of the survey's descriptive report.

1.7 Vertical Control Equipment

1.7.1 Water Level Gauges

No water level gauges were installed by NOAA personnel. A VegaPuls62 water level gauge was installed in Saipan Harbor by University of Hawaii personnel in February, 2007. This station will serve as a backup gauge if water levels from the primary station in Guam (163-0000) or post-processed kinematic (PPK) GPS measurements are not used. See the Tide Requirements document (T901AHI2007.doc) included with the project data for further information on stations and tide requirements.

1.7.2 Leveling Equipment

A Leica DNA03 laser level supplied by NGS was used for leveling the water level station in Saipan Harbor.

1.7.3 Ashtech Z-Xtreme

An Ashtech Z-Xtreme 12 channel L1/L2 GPS receiver was used to record GPS measurements for producing PPK water level measurements.

2.0 Software

2.1 Software Systems Inventory

Information on the software used during project M-T901-AHI-07 is included in the 2007 RV AHI Systems Inventory spreadsheet located in Appendix III of this report.

2.2 Data Acquisition Software

2.2.1 SAIC ISS-2000 Software

R/V AHI is equipped with Science Applications International Corporation (SAIC) ISS-2000 Integrated Survey System. This is a fully integrated data planning, acquisition, and processing software package. The software is described in the SAIC_ISS2000.pdf document located in Appendix V.

2.3 Data Processing Software

2.3.1 NOAA Hydrographic Systems and Technology Programs (HSTP) Software

Sound velocity data is processed with Velocwin, in-house software produced and maintained by NOAA's Hydrographic Systems and Technology Programs (HSTP) division, along with Sea-Bird SeaTerm and Sea-Bird SBE Data Processing software.

Pydro, also produced and maintained by HSTP, was used to review and correlate SSS contacts.

2.3.2 CARIS

CARIS HIPS (Hydrographic Information Processing System) is used to process all shallow water multibeam data including data conversion, filtering, tide correcting, merging and cleaning. CARIS HIPS also calculates the Total Propagated Error (TPE) used to produce Bathymetry Associated with Statistical Error (BASE) surfaces which assist the Hydrographer in data cleaning and analysis.

2.3.3 Fledermaus

Fledermaus, an Interactive Visualization Systems 3D (IVS 3D) program, is used for data visualizations and creation of data quality control products, public relations material and reference surface comparisons.

2.3.4 MapInfo

MapInfo is used to review tables and workspaces associated with assigned projects received from Hydrographic Survey Division (HSD). MapInfo may also be used to produce scaled plots produced for public relation purposes. HydroMI, an HSTP produced MapBasic program, is used through MapInfo to convert tide and tidal zoning files into a format that is useable in CARIS HIPS, and obtain latitude/longitude coordinates for pre-survey planning.

3.0 Vessels

The NOAA Research Vessel AHI (F-2505), a 25 ft. aluminum-hulled launch, was used to acquire all multibeam, SSS, and sound velocity data during the project.

A description of the vessel and offset measurements are included in Appendix I.

4.0 Data Acquisition

4.1 Horizontal Control

Due to the remote location of the project area all data were acquired in UTM (WGS84).

Differential GPS (DGPS) was the sole method of positioning used during the project.

Differential correctors were supplied to the POS/MV by a NavCom C-Nav SF-2050G DGPS receiver. The C-NAV system is a subscription service that uses dual L-band receivers to receive differential correctors that are broadcast worldwide via INMARSAT Geostationary Communications Satellites. These correctors are created for each GPS satellite from the raw GPS data acquired from reference receivers located around the world.

4.2 Multibeam Echosounder Acquisition and Monitoring Procedures

All multibeam data were acquired in Generic Sensor Format (GSF) using Science Applications International Corporation's (SAIC) ISS-2000 software. The data were monitored in real-time using the ISS-2000 data display windows and the on-screen displays for the RESON SeaBat 8101ER. Range scale, power, gain, and pulse width were adjusted directly using the Reson controller to ensure best data quality. Additionally, vessel speed was adjusted as necessary to ensure the required along-track coverage for object detection in accordance with the HSSDM and FPM. Vessel speed generally ranged from four to five and a half knots.

4.3 Shoreline Verification

Shoreline verification was not required for this project.

5.0 Bottom Sample Acquisition

Bottom samples were not required for this project.

B QUALITY CONTROL

1.0 Uncertainty Modeling

Error values for the multibeam and positioning systems on R/V AHI were compiled from manufacturer specification sheets for each sensor (Heave, Pitch, Roll, Position, and Heading) and from values set forth in NOAA HTD 2007-2.

The following TPE values for tide and sound velocity were used during the project:

TPE Type	Value Used	Comments
Tide Value Measured	0.01	RSS of error estimates associated with each six minute tidal value.
Tide Value Zoning	0.07	1 sigma value derived from T901AHI2007 tide document.
Sound Speed Value Measured	0.50	Estimated error for SeaBird 19 Profiler.
Sound Speed Value Surface	0.00	No sound velocity correction was used at the transducer face.

The final uncertainty values for R/V AHI are shown in the 2007 RV Vessel Offsets spreadsheet located in Appendix I. Uncertainty values relating to vessels and survey systems were entered into the HIPS Vessel File (HVF). Uncertainty values for tide and sound velocity were entered during the CARIS Compute TPE process.

2.0 Data Processing and Review

Raw GSF multibeam data were converted to Caris HDCS format. True Heave and water level data were then applied to all lines and the lines merged. Once lines were merged Total Propagated Error (TPE) was computed.

Vessel heading, attitude, and navigation data were reviewed in HIPS navigation editor and attitude editor. Where necessary, fliers or gaps in heading, attitude, or navigation data were manually rejected or interpolated for small periods of time.

BASE surfaces were created using the Combined Uncertainty and Bathymetric Estimator (CUBE) algorithm and parameters contained in the Cubeparams.xml file which contains settings for “Deep” or “Shallow” surveys. Although the project Instructions call or full coverage corresponding to the “Deep” configuration (see HTD 2007-2), all BASE surfaces were created using the “Shallow” configuration corresponding to “object detection coverage” to maximize object detection.

Multibeam data were reviewed and edited in HIPS swath editor and in subset mode as necessary. The BASE surface was used for directed data editing in subset editor, to demonstrate coverage, and to check for errors resulting from tide, sound velocity, attitude and timing.

A detailed listing of the resolutions and depth ranges used during the processing of each survey, along with the corresponding fieldsheet(s), will be provided in the descriptive report of each survey.

In areas of navigational significance where the BASE surface did not depict the desired depth for the given area, a designated sounding was selected. Designated soundings were selected as outlined in Chapter 5 of the *HSSDM*.

C Corrections to Echo Soundings

1.0 Vessel HVFs

CARIS HIPS Vessel Files (HVF) were created for multibeam and SSS data. The multibeam HVF is used only to define the AHI’s equipment uncertainty, as all offsets and sound velocity are applied during acquisition. The SSS HVF is used to define only the offset to the SSS tow point. Two HVFs were created for SSS data; one for 100% and one for 200% coverage.

The HVFs used for the current project are included in Appendix II.

2.0 Vessel Offsets

Sensor offsets were measured with respect to the AHI's reference point (RP). A vessel survey was completed for the R/V AHI on March 15, 2007 and the vessel offset report is included in Appendix I.

3.0 Dynamic Draft

Dynamic draft observations were conducted for the AHI on May 24, 2007 (DN 144) in Saipan Harbor using a surface analysis method. The final results are included in the DDSSM_AHI spreadsheet located in Appendix IV.

4.0 Patch Test

A patch test was conducted for the multibeam acquisition system on the AHI on March 14, 2007. The results of the patch test are included in the 2007 RV AHI MBES_Cal_Table.xls spreadsheet located in Appendix IV.

5.0 Attitude

All attitude corrections were generated by the POS/MV using data from the IMU-200 Inertial Measurement Unit (IMU). IMU values for uncertainty of heave, pitch and roll are included in the 2007 RV AHI Vessel Offsets.xls spreadsheet located in Appendix I.

5.1 True Heave

R/V AHI is equipped with the POS/MV TrueHeave (TH) option. True Heave is a ‘delayed’ heave corrector as opposed to ‘real time’ heave corrector and is fully described in Section 6 of the *POS/MV Version 4 Installation and Operation Manual*. Daily TH files were logged through the Ethernet Logging function in the POS/MV controller software. To ensure proper calculation of TH, files were logged for at least three minutes past the end of each day’s survey operations.

6.0 Sound Velocity

Sound velocity profiles were acquired with a SeaBird Electronics SeaCat SBE 19 Conductivity, Temperature, and Depth (CTD) profiler. Daily sound velocity profiles from the SBE 19 were downloaded using Velocwin and Sea-Bird SeaTerm software. Sea-Bird SBE Data Processing software was then used to process and create a converted data (.cnv) file which was loaded into the ISS-2000 software and used to correct multibeam data for sound velocity during data acquisition. Sound velocity profiles were not applied in during CARIS data processing.

Sound velocity casts were conducted at a minimum of one cast for every four hours of data acquisition.

7.0 Water Level

The vertical datum for this project is Mean Lower-Low Water (MLLW). Predicted water level correctors from the primary tide station at Guam (163-0000) were downloaded from the CO-OPS website and used for water level corrections during the course of the project.

The files for the relevant days were collated into a tide station master file which was converted to CARIS .tid file format in MapInfo using HydroMI. Water level data in the .tid files were applied to data using the zone definition file (T901AHI2007CORP.zdf) supplied by CO-OPS.

At the time of this report it is unclear whether final water level data derived from PPK GPS measurements or from one of the water level stations on Guam and Saipan will be used to correct the data. The Descriptive Report for each survey will indicate the source of final approved water levels and the date they were applied to the data.

See the Tide Requirements document (T901AHI2007.doc) included with the project data for further information on stations and tide requirements.

D Approval Sheet

As project leader, I have ensured that standard field surveying and processing procedures were used during this project in accordance with the Field Procedures Manual (March, 2007) and the NOS Hydrographic Surveys Specifications and Deliverables Manual (April, 2007), and all relevant Technical Directives issued through May, 2007. All departures from these standard practices are described in this Data Acquisition and Processing Report and/or the relevant Descriptive Reports.

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

J. Corey Allen
2007.06.14
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Approved and Forwarded: ______________________________
Corey Allen, Physical Scientist, NOAA