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NATIONAL OCEAN SURVEY

DATA ACQUISITION AND PROCESSING REPORT

NOAA Ship THOMAS JEFFERSON

August - November 2003

LOCALITY

U.S. Atlantic Coast

2003

CHIEF OF PARTY
LCDR Donald W. Haines

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DATA ACQUISITION AND PROCESSING REPORT

to accompany

PROJECTS COMPLETED AUGUST - NOVEMBER 2003

NOAA Ship THOMAS JEFFERSON
LCDR Donald W. Haines, Commanding

A. EQUIPMENT

All hydrographic data were acquired by THOMAS JEFFERSON S222 and Survey Launches 1005 and 1014 between August and November, 2003. THOMAS JEFFERSON acquired side scan sonar (SSS) data, multibeam (MB) echosounder data, vertical beam echosounder (VBES) data, and sound velocity profile (SVP) data. Launch 1005 acquired multibeam (MB) data, SSS data, VBES data, detached positions (DPs), and SVP data. Launch 1014 acquired MB data, SSS data, VBES data, detached positions, and SVP data, and also supported diver least-depth investigations. Vessel description and offset measurements are included in Appendix III of this report. Any unusual vessel configurations or problems will be addressed in survey-specific Descriptive Reports.

The methods and systems used to meet full-coverage requirements for this project were determined by the hydrographer and are in accordance with the Standing Letter Instructions (April, 2003), the Specifications and Deliverables (March, 2003), and the Field Procedures Manual (May, 2001). Other considerations included system performance limitations, complexity of bathymetry, water depth, and ability of vessel to safely navigate a particular area.

A.1. SOUNDING EQUIPMENT

Odom Echotrac Echosounder – Vertical Beam Echosounder (VBES)

THOMAS JEFFERSON, Survey Launch 1005, and Survey Launch 1014 are equipped with an Odom Echotrac DF3200 MKII echosounder. The Odom Echotrac is a dual-frequency digital-recording echosounder with an analog paper recorder. The high frequency transducer on Launch 1005 and Launch 1014 operates at 100 kHz with a circular beam footprint of 7.5° at the –6 dB point. The high frequency transducer on THOMAS JEFFERSON operates at 200 kHz. The low frequency on all three platforms operates at 24 kHz with a rectangular beam of 27° (fore-aft direction) by 47° (athwartship direction) at the –6 dB point. Soundings were acquired in meters on both frequencies, with the high frequency selected for all sounding data. If MB data were acquired, VBES data were archived in raw form, but not processed.

Reson Seabat 8101 - Multibeam (MB) Echosounder

Launch 1005 is equipped with a hull-mounted Reson SeaBat 8101 multibeam echosounder (Fig. 1). The SeaBat 8101 is a 240 kHz MB system which measures water depths across a 150º swath; each swath consisting of 101 individually formed 1.5º x 1.5º beams. This system was used to obtain full-bottom bathymetry coverage in depths generally from 5 meters to 75 meters, with range scale set between 10 meters and 150 meters, depending on water depth and across-track slope.

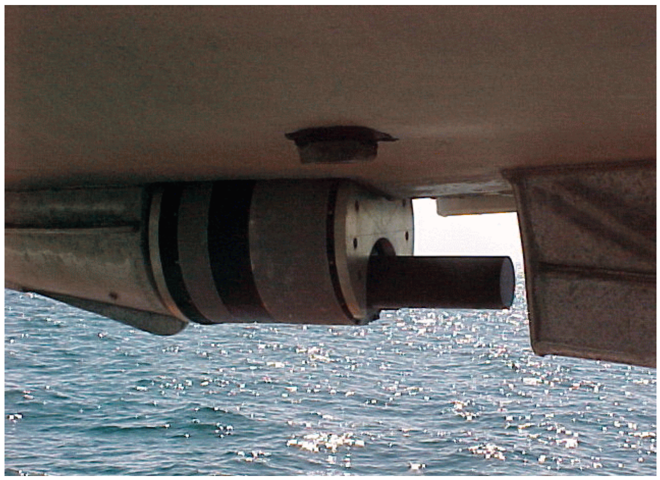


Figure 1: Reson SeaBat 8101 hull mounted in keel cut-out of Launch 1005.

MB data are monitored in real-time using the 2-D and 3-D data display windows in **Isis**, and the on-screen display for the Reson SeaBat 8101 sonar processor. Adjustable parameters used to control the Reson from the **Isis** software include range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure best data quality. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Mainscheme MB sounding lines were generally run parallel to the contours at a line spacing approximately three times the water depth. For discrete item developments, line spacing was often reduced to two-times water depth to ensure least-depth determination by MB near-nadir beams.

Reson Seabat 8125 - Multibeam (MB) Echosounder

Launch 1014 is equipped with a hull-mounted Reson SeaBat 8125 multibeam echosounder (Fig 2). The SeaBat 8125 is a 455 kHz MB system which measures two-way sound travel times across a 120º swath; each swath consisting of 240 individually formed 1.0º x 0.5º beams. This system was used to obtain full-bottom bathymetry coverage in depths generally from 4 meters to 40 meters, with range scale set between 10 meters and 100 meters, depending on water depth and across-track slope.

Figure 2: Hull-mounted Reson 8125 transducer attached; yellow facing towards the bow.

MB data are monitored in real-time using the 2-D and 3-D data display windows in **Isis**, and the on-screen display for the Reson SeaBat 8125 sonar processor. The Reson sonar processor incorporates real time sound velocity measurements from a Digibar Pro Profiling Sound Velocimeter (section C.1). These measurements are used for initial beam forming and steering. Four adjustable parameters used to control the Reson from the **Isis** software include range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure best bottom tracking for bathymetry. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Standing Project Instructions, to ensure the required along-track coverage for object detection.

Mainscheme MB sounding lines were generally run parallel to the contours at a line spacing approximately three times the water depth. For discrete item developments, line spacing was often reduced to two-times water depth to ensure least-depth determination by MB near-nadir beams.

Simrad EM 1002 - Multibeam (MB) Echosounder

THOMAS JEFFERSON is equipped with a hull-mounted Simrad EM 1002 multibeam echo sounder. The Simrad EM1002 is a 95 kHz multibeam system that measures two-way sound travel times across a 150º swath; each swath consisting of 111 individually formed 2º beams. This system was used to obtain full-bottom bathymetry coverage in depths generally from 10 meters to 1000 meters.

MB data acquisition is monitored in real-time using the EM 1002 operator station and Simrad's Merlin software. Adjustable parameters used to control the Simrad include beam angle, ping mode, spike filter strength, and beam spacing. Beam angle was set to full 75º swath width. Ping mode was set to auto, enabling the system to use the appropriate mode (shallow, medium or deep) to obtain maximum coverage. Spike filter strength was set to weak. Mainscheme line beam spacing was typically set to equidistant to offer a uniform distribution of soundings.

Mainscheme MB survey lines were generally run parallel to the contours at a line spacing approximately three to five times the water depth. Wider line spacings were used with sounding error estimation.

Diver Least Depth Gauge

Dive investigations were primarily for contact/AWOIS verification and/or least depth confirmation of selected contacts. Least depths of investigated items were determined with MB. Diver Least-Depth Gauges (DLDG) were used by divers during item investigations to acquire least depths over selected contacts. The DLDG measures pressure, and together with a CTD cast, is processed using HSTP's (N/CS11) **Velocwin** software to compute a fully-corrected depth. These depths were compared to SWMB least depths processed in **Pydro**. Copies of the calibration reports are included in Appendix IV.

Leadline

Leadlines were used for multibeam echosounder comparisons. Calibration reports for the leadlines are included in Appendix IV of this report.

A.2. SIDE SCAN SONAR EQUIPMENT

General Operations

Line spacing for side scan sonar (SSS) operations is determined by the required range scale. Typically, to acquire two hundred percent coverage, 40 meter line spacing is used at the 50 m range scale, 60 meter line spacing is used at the 75 m range scale, and 80 m line spacing is used at the 100 meter range scale.

A towfish altitude of eight to twenty percent of the range scale was maintained during data acquisition. SSS altitude for towed operations is adjusted by the amount of deployed tow cable, and to a lesser degree by vessel speed. See Descriptive Reports for any areas that exceeded the altitude window.

Confidence checks were performed daily by observing changes in linear bottom features extending to the outer edges of the digital side scan image, features on the bottom in survey area, and by passing aids to navigation.

Klein 5500 Side Scan Sonar

The Klein System 5500 includes the Model 5250 tow fish and the T5100 Transceiver Processing Unit (TPU). The Model 5250 tow fish operates at a frequency of 455 KHz and has a vertical beam angle of 40˚. The T5100 contains a network card for transmission of the sonar data to the **Isis** acquisition computer. The Klein System 5500 is unique in that each transducer simultaneously forms five dynamically focused beams per side (channel), allowing increased resolution along track (20–75 cm) and across track (7.5cm at 100 meter range scale).

There are two standard configurations for using the Klein System 5500 aboard THOMAS JEFFERSON and Launches 1014 and 1005, towed SSS and hull-mounted SSS.

Configuration 1: Klein System 5500 Towed Operations

The 5250 tow fish is deployed using a SeaMac electric-hydraulic winch spooled with approximately 200 meters of armored coaxial cable. The tow cable is lead from the winch through the stern C-frame over a snatch block with a metered sheave. The tow cable at the winch is connected to a deck cable through a slip ring assembly mounted coaxially on the winch. Cable-out is controlled remotely at the acquisition station (or locally at the winch) and is monitored on an MD-TOTCO cable counter. This sensor computes cable out by the number of revolutions of the block's sheave. The MD-TOTCO cable counter provides a serial message to the **Hypack** and **Isis** acquisition computers. The cable-out value was checked, and if necessary adjusted, for every SSS deployment. The MD-TOTCO cable counter was calibrated on April 14, 2003. The calibration report can be found in Appendix IV.

Klein System 5500 towed operations are typically limited to seven or eight knots, speed-over-ground aboard THOMAS JEFFERSON. This is to allow an increased margin for safe navigation, to optimize vessel fuel consumption, minimize towing gear stress, and reduce "strumming" in the tow cable which can interfere with the side scan imagery.

Configuration 2: Hull-Mounted Side Scan

This configuration is unique to Launches 1014 and 1005. The launch is outfitted with a hull-mounted sled to which the 5250 SSS is attached by a pair of omega brackets (Fig. 5). The 5250 SSS is connected to the T5100 TPU by a 10-meter lightweight Kevlar-jacketed deck cable passed through a watertight hull penetration. In this configuration, the 10-meter cable is fitted with a 6db inline attenuator to compensate for the shortened cable length.
The hull-mounted 5250 SSS is used primarily in shallow water (less than 20 meters) or along shore to locate shoreline features (piers, bulkheads, etc.). This configuration eliminates offset, layback, and heading errors associated with a towed system, thereby increasing the accuracy of the processed imagery. An added benefit of this configuration is its ability to avoid entanglement with lobster and crab trap floats as compared to the towed configuration.

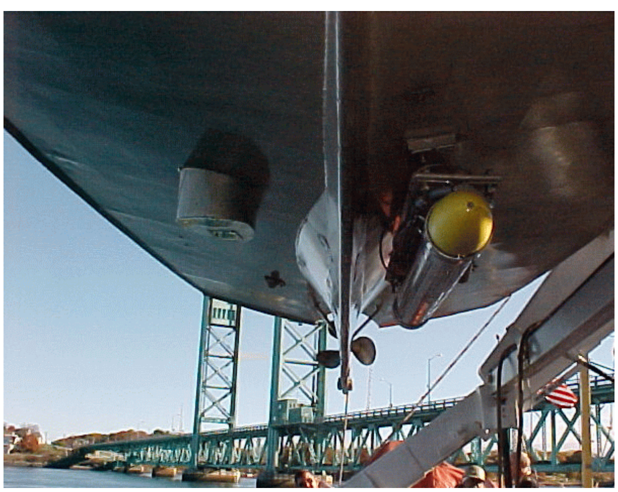


Figure 5: Hull mounted Klein towfish under Launch 1014

Speed over ground in this configuration is typically limited by the launch's top speed of ten knots or prevailing sea condition. Wave heights in excess of one-half meter generally cause excessive aeration and signal quenching at the 5250 SSS transducer, consequently degrading the sonar imagery. In these cases, launch speed is reduced, or line direction reversed, to preserve image quality.

A.3. POSITIONING EQUIPMENT

Trimble DSM212L DGPS Receivers

THOMAS JEFFERSON is equipped with a Trimble DSM212L DGPS receiver for reception of U.S. Coast Guard (USCG) differential GPS beacons, which are used for horizontal position control. The DSM212L is an integrated 12-channel GPS receiver and dual-channel differential beacon receiver. The beacon receiver can simultaneously monitor two USCG differential GPS (DGPS) beacon stations. The Trimble DSM212L was configured in manual mode to allow reception of only one beacon station during data acquisition. On THOMAS JEFFERSON, the TSS POS/MV was used for the ship position as part of the SSS position computation (See TJ Configuration Note, Appendix V).

DSM212L parameters were configured using Trimble **TSIPTalker**. Configuration was checked frequently throughout the project period. Parameters set included number of visible satellites (≥4 SV's), positional dilution of precision (PDOP < 8), maximum pseudo range corrector age (≤30 sec), and satellite elevation mask (≥8˚).

Position quality was monitored real time in the POS/MV controller software. The primary positional quality monitored was HDOP. Where HDOP exceeded 4.0, the data were examined during post-processing, and if necessary, positions interpolated or rejected. The **Hypack** nmea.dll configuration includes a 1000-ms update rate and a non-differential alarm in the acquisition window to alert the operator when the signal is lost.

TSS POS/MV Position and Orientation Sensor

THOMAS JEFFERSON and Launch 1014 are equipped with a TSS POS/MV Model 320 (Position and Orientation System for Marine Vessels) to determine position. Launch 1005 is equipped with a TSS POS/MV model 220. The POS/MV, an aided strapdown inertial navigation system, provides a composite position solution derived from both an Inertial Measurement Unit (IMU) and dual-frequency GPS receivers. The IMU and GPS receivers are complementary sensors; data from one are used to filter and constrain errors from the other resulting in high position accuracy. On THOMAS JEFFERSON, Launch 1005, and Launch 1014, the TSS POS/MV was used for both MB and SSS position.

Position accuracy and quality were monitored in real time during data acquisition using the POS/MV Controller software to ensure positioning accuracy requirements in the NOS Hydrographic Surveys Specifications and Deliverables were met. The POS/MV Controller software provides clear visual indications whenever accuracy thresholds are exceeded.

A.4. HEADING AND ATTITUDE EQUIPMENT

TSS POS/MV Position and Orientation System

THOMAS JEFFERSON and Launch 1014 are equipped with a TSS POS/MV Model 320 for vessel heading and attitude determination. Launch 1005 is equipped with a TSS POS/MV model 220. The POS/MV is an aided strapdown inertial navigation system (INS), consisting of an Inertial Measurement Unit (IMU) sensor and two GPS receivers. The IMU senses linear acceleration and angular motion along the three major axes of the vessel. The POS/MV's two GPS receivers determine vessel heading using carrier-phase differential position measurements.

POS/MV Heading Computation

The POS Computer System (PCS) blends data from both the IMU and the two GPS receivers to compute highly accurate vessel heading. The IMU determines accurate heading during aggressive maneuvers and is not subject to short-period noise. However, IMU accuracy characteristically diminishes over time. The GPS receivers compute a vector between two fixed antennas and provide azimuth data using the GPS Azimuth Measurement Subsystem (GAMS). GPS heading data is accurate over time, but is affected by short-period noise. The POS/MV combines both heading measurement systems into a blended solution with accuracies greater than either system could achieve alone. On all vessels, the TSS POS/MV was used for both MB and SSS heading.

POS/MV Heave, Pitch, and Roll Computation

Heave is computed in the POS/MV by performing a double integration of the IMU-sensed vertical accelerations. The POS/MV v3 controller heave filter was used for all data aboard Thomas Jefferson and launch 1014; a heave bandwidth between 80 and 200 seconds and heave damping ratio of 0.71 were used depending on the conditions at the time of data acquisition. The POS/MV v2 controller heave filter was used for all data aboard launch 1005; a heave corner period between 80 and 200 seconds and heave damping of 0.71 were used depending on the conditions at the time of data acquisition.

Both roll and pitch measurements are computed by the IMU after sensor alignment and leveling. The IMU mathematically simulates a gimbaled gyro platform and applies the sensed angular accelerations to this model to determine roll and pitch. On all vessles, the TSS POS/MV was used for MB heave, pitch, and roll.

A.5. SOFTWARE

Coastal Oceanographic's **Hypack MAX** was used for vessel navigation and line tracking during acquisition of MB, side scan sonar, and VBES data. All VBES data were acquired in **Hypack** in the "RAW" format.

MB data from THOMAS JEFFERSON' Simrad EM1002 unit were acquired on a SOLARIS based, Sun workstation using **Merlin**. The ship's offset configurations for the transducer and motion sensor were entered into the Caris Vessel Configuration File. Sound velocity and attitude data were not inputted directly at the transceiver unit, but were applied during processing. A detailed report on the configuration change can be found in Appendix V.

MB and SSS data were acquired on Survey Launch 1005 and 1014 using Triton-Elics' **Isis** software, and logged in the Extended Triton Format (*.xtf). Side scan and multibeam echosounder data were processed using Caris **HIPS and SIPS** (**HIPS**).

All MB soundings, and side scan and MB features were analyzed during post-processing using **Pydro**. This program was created by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP) using the **Python 22** programming language to interface with the **HIPS** data directly.

Soundings and features were exported from **Pydro** in MIF/MID (**MapInfo** Interchange) format, and imported into **MapInfo**. **MapInfo** was used for final data analysis and for creating final plots. **Fledermaus** (IVS, Fredericton, New Brunswick), **GeoZui** (UNH, Durham, NH), and **HIPS** were used for visualization and data comparisons.

Raw sound velocity data were processed using **Velocwin,** supplied by NOAA Hydrographic Systems and Technology Program (HSTP). **Velocwin** uses raw salinity, temperature, and pressure measurements to create a sound velocity profile.

A complete list of software and versions is included in Appendix I.

B. DATA PROCESSING AND QUALITY CONTROL

B.1. MULTIBEAM ECHOSOUNDER DATA

Raw XTF multibeam data were converted to HDCS format in **HIPS**. Transformation parameters pertaining to the source of the attitude packet is stored in the LogFile located in line directory of the **HIPS** data. After conversion, the Total Propagated Error (TPE) was calculated in **HIPS** to determine the quality of the multibeam data. TPE was calculated using the Caris implementation of the multibeam error model (Hare et al., 1995). Input parameters to the error model were entered into the HVF file (5.4 version of the VCF). A table of these values is provided in Appendix V. If the Simrad 1002 data did not meet the requirements for the survey, the lines were filtered to IHO Order 1. On Dn 133 through 261, there was a problem with the outer beam roll calibration in the Simrad system affecting soundings greater than 50˚ off nadir (See Simrad configuration note). All soundings outside 50˚ during this period were rejected.

Vessel heading, attitude, and navigation data were reviewed and edited in line mode (viewed as time series data). Fliers or gaps in heading, attitude, or navigation data were manually rejected or interpolated for small periods of time. Sound velocity correction was applied in **HIPS** (See THOMAS JEFFERSON system configuration Note, Appendix V). Tide correction was applied to the data during "merge", and dynamic draft corrections and sensor lever arms are applied in THOMAS JEFFERSON's MB VCF. (see Appendix III).

The TPE takes into account uncertainties in the measurements coming from each sensor (Heave, Pitch, Roll, Position, Heading, Sound Velocity, and Tide) and uncertainties in static measurements (Draft and Latency) to calculate the total uncertainty.

The TPE is then used by **CUBE** to formulate depth hypotheses at regularly spaced nodes throughout the survey area. **CUBE** will keep track of multiple hypotheses for a given node where the data is either not of a high enough density or too ambiguous to form a single depth hypothesis. **CUBE** will also output the hypothesis strength, or how consistently the data reflect a single depth, for a given node. **CUBE** was used for initial analysis of the new process but not for final product creation.

HIPS uses the vertical uncertanty from TPE to produce a BASE surface. The BASE surface for a given depth range were then combined in **HIPS** with BASE surfaces of other depth ranges to create a combined BASE surface.

To produce the final reduced data set, final BASE surfaces were created in **HIPS**. These BASE surfaces were imported into **Pydro** using "Insert → HIPS Weighted Grid" tool. As an additional quality assurance tool for the new procedure, bathymetry data were also imported into **Pydro** using the "Insert → Caris Line" tool or the "Insert → Caris Line Bathy" tool. Depths inserted in this way were inserted using a 1.5 mm grid size at the scale of the survey. Both methods use an over-plot removal (excessing) character size of 3 meters ensuring that the largest spacing between selected soundings would not exceed 7 millimeters at the survey scale. These excessed soundings were then exported to **Mapinfo** to produce reference sounding plots. Both data from the BASE surfaces and the line by line shoal biased data could be viewed in **Pydro** for comparison.

HIPS BASE surface products (Depth, Uncertainty, Density, Std_Dev, Mean, Shoal, Deep) could then be used to demonstrate MB coverage, and to further check for systematic errors such as tide, sound velocity, or attitude and timing errors. Sun-illumination is used to highlight the seabed features. **HIPS** gridded images were created as specified in the NOS Hydrographic Surveys Specifications and Deliverables.

B.2. VERTICAL-BEAM ECHOSOUNDER DATA

Vertical-beam echosounder data were collected in conjunction with side scan sonar data, but not processed. These data were used primarily for troubleshooting and confidence check purposes. The data are submitted for archival purposes only. It is not recommended that VBES data be used for the creation of any product.

B.3. SIDE SCAN SONAR DATA

Side scan sonar data were converted from *.xtf (**Isis** raw format) to **HIPS.** Side scan data were processed using **HIPS.**

Post-processing side scan data includes examining and editing fish height, vessel heading (gyro), and vessel navigation records. Fish navigation is recalculated using **HIPS**. Tow point measurements (C-frame and cable out), fish height, and depth are used to calculate horizontal layback.

After fish navigation is recalculated, side scan imagery data are slant-range corrected to 0.1m with beam pattern correction. Side scan sonar contacts were picked only in areas of incomplete multibeam coverage, on man made features, and ambiguous features. The slant-range corrected side scan imagery data are closely examined for any targets. Targets-of-interest are evaluated as potential contacts based on apparent shadow length and appearance; particularly targets which do not appear to be natural in origin. Contacts are selected and saved to a contact file for each line of SSS data. Contact selection includes measuring apparent height, selecting contact position, and creating a contact snapshot (*.tif) image.

All contacts were imported into **Pydro** using the "Insert Caris Line Features" tool. Contacts were arranged by day and line and could be selected in the data "Tree" window. Information concerning a specific contact was reviewed in **Pydro**'s "Editor Notebook Window" including contact position, AWOIS item positions, surrounding depths, contact cross references, and charting recommendations. Each contact was reviewed, and information flags were set accordingly. The available flags were "Resolved", "Rejected", "Primary Hit", "Significant", "Chart", and "DTON". "Resolved" was chosen after the contact had been reviewed by the Sheet OIC. If the contact was significant, then the "Significant" flag was chosen. If there were multiple contacts for a single feature, then the one providing the best SSS image of the feature was chosen as the "Primary Hit". Any items that were to be addressed in the Item Investigation section of the Descriptive Report were flagged as "Chart". Items which had the "Chart" flag set could also be further designated for inclusion in the Danger To Navigation Report by choosing the "DTON" flag. "Snapshots" of contacts were displayed in **Pydro**'s "Image Notebook Editor". Contacts appearing significant were further investigated by multibeam. Final positioning and least depth determination of significant items was accomplished using multibeam and/or diver investigation.

Side scan sonar coverage was determined by using mosaics generated in **SIPS** and imported into **MapInfo**. Any deficiencies in the side scan sonar data were found, and a holiday line file was created from the mosaics, and swath plots to complete the 200 percent requirement.

Side scan sonar contacts were picked only in areas of incomplete MB coverage, man-made features, or ambiguous features.

B.4. PRELIMINARY SMOOTH SHEET

Once all sounding data (weighted grids and HDCS lines) and features were reviewed and analyzed using **Pydro**, the data was saved into a Preliminary Smooth Sheet (PSS). The PSS is a working file, that does not actually contain data, but contains links to the data with specific path information as well as ancillary data flag information which is not supported in the **HIPS** file structure. There are six files which make up a PSS; an .fsl file (Field Sheet Layer) for bathymetry, a .wfsl file for bathymetry from weighted grids, a .xml file (Extended Markup Layer) for features, a .charts file (contains a list of raster charts for display in the Chart Window), a .treestate file (contains configuration information about the Data Tree Window), and a .txt file (which contains the text entered into the Notes Window). For all Danger to Navigation submissions, a DtoN *.xml file is generated in **Pydro,** which consists only of all the flagged DtoN's. This file, which is submitted with the report to Marine Chart Division, can be opened on any computer with **Pydro** and displays the item's co-ordinates and attributes without the need of the actual **HIPS** data.

C. CORRECTIONS TO ECHO SOUNDINGS

C.1. SOUND VELOCITY

SBE19 Conductivity, Temperature, and Depth (CTD) profilers

Sound velocity profiles were acquired with Sea-Bird Electronics SeaCat SBE19 CTD profilers. Raw conductivity, temperature, and pressure data were processed using the program **Velocwin** which generates sound velocity profiles for **HIPS**. Sound velocity correctors were applied to MB and VBES soundings in **HIPS** during post processing only. Calibration reports for the SBE19 CTD profilers are included in Appendix IV of this report.

The speed of sound through water was determined by a minimum of one cast every four hours of MB acquisition, in accordance with the Standing Letter Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Casts were conducted more frequently when changing survey areas, or when it was felt that conditions, such as a change in weather, tide, or current, would warrant additional sound velocity profiles.

The sound velocity casts were extended in **Velocwin** and applied to the Simrad MB and Reson MB data in **HIPS** during post processing (See Appendix V, System Configuration Note).

Kongsberg Simrad Surface Sound Velocity System

THOMAS JEFFERSON is equipped with a Kongsberg Simrad Surface Sound Velocity System. The SSVS uses an Applied Microsystems Limited Sound Velocity and Temperature Smart Sensor to measure sound velocity and temperature at the depth of the Simrad EM 1002 transducer. Mounted in THOMAS JEFFERSON's transducer void, the smart sensor samples water pumped through insulated stainless steel pipes passing through the void. This unit calculates and outputs temperature and sound velocity ten times per second to the EM1002 Sun operator workstation for real-time sound velocity corrected MB data. These values were averaged by Simrad before application by 3 seconds. This averaging mitigated the effects of erroneous measurements.

Reson 8125 Surface Sound Velocity System

Launch 1014 is equipped with an Seabird Digibar Pro surface sound velocity sensor. The sensor is used to measure sound velocity at the depth of the Reson 8125 transducer. The sensor is mounted next to the transducer on the hull mounted equipment sled.

C.2. VESSEL OFFSETS AND DYNAMIC DRAFT CORRECTORS

The following table lists each Vessel Configuration File.

VCF NAME	SURVEY SYSTEM
S222_mb	THOMAS JEFFERSON EM 1002 Multibeam
S222_100	THOMAS JEFFERSON Towed Klein SSS 100% Coverage
S222_200	THOMAS JEFFERSON Towed Klein SSS 200% Coverage
1005_mb	Launch 1005 Reson 8101Multibeam
1005_100	Launch 1005 Hull-Mounted Klein Side Scan Sonar 100% Coverage
1005_200	Launch 1005 Hull-Mounted Klein Side Scan Sonar 200% Coverage
1014_mb	Launch 1014 Reson 8125 Mulitbeam
1014_100	Launch 1014 Hull-Mounted Klein Side Scan Sonar 100% Coverage
1014_200	Launch 1014 Hull_mounted Klein Side Scan Sonar 200% Coverage

Static draft corrections for THOMAS JEFFERSON were measured on April 22, 2003 and can be found in Appendix III.

Dynamic draft measurements were made on THOMAS JEFFERSON on April 24, 2003. The procedure and results are in Appendix III.

Vessel offset diagrams and dynamic draft tables are included in Appendix III of this report. The Vessel Configuration Files themselves are included with the digital **HIPS** data.

The Reson Seabat 8101 sensor offsets were stored in the HIPS Vessel Configuration File (1005_MB) and were applied to MB data acquired with Launch 1005. The Reson Seabat 8125 sensor offsets were stored in the HIPS Vessel Configuration File (1014_MB) and were applied to MB data acquired with Launch 1014. The Simrad EM1002 sensor and vessel offsets were stored in the **HIPS** Vessel Configuration File (S222_MB) and were applied during post processing.

The Klein side scan sonar sensor offsets were stored in the Caris Vessel Configuration Files and were applied to side scan data during processing in **HIPS**.

C.3. HEAVE, PITCH, ROLL AND HEADING, INCLUDING BIASES AND NAVIGATION TIMING ERRORS

Heave, pitch, roll, and navigation latency biases for Survey Launch 1005's Reson 8101 were determined during Patch Tests conducted on August 23, 2003 near One-half Fathoms Ledge, offshore from Boston, MA. A similar Patch Test for Launch 1014's Reason 8125 was conducted on August 6, 2003 near Old Point Comfort, VA. MB vessel offsets, dynamic draft correctors, and system bias values are contained in Caris Vessel Configuration Files (VCFs) and were created using **HIPS**. Patch tests were conducted at the beginning and end of the field season, and whenever a physical change was made to the system. In addition, bracketing checks were made at the start of each project. These offsets and biases are applied to the sounding data during processing in **HIPS**. The VCFs and Patch Test data are included with the digital data. Patch Test Reports for the launches can be found in Appendix V.

For the Simrad EM1002, a Sea Acceptance Test (SAT) was conducted on April 23-25, 2003 ninety miles off the coast of Cape Henry, Virginia. The purpose of this test is to ensure that the equipment was successfully installed, the configuration settings were valid, and to calibrate the instrument with the external sensors. The latter was a patch test, the results of which were saved in the **HIPS** VCF. A detailed report on vessel configuration change for the Em1002 can be found in Appendix V. The SAT report can be found in Appendix IV.

All platforms performed closing MB patch tests near the end of the field season. These patch test were performed in Eastern Long Island Sound, near the Race and Fishers Island on October 30, 2003 for Launch 1014's Reson 8125 and 1005's Reson 8101. The ships EM 1002 was done November 2, 2003. Changed values were input into the **HIPS** VCF.

Calibration coefficients for launch 1005 (Depth sensor roll and pitch offsets, navigation time error) were changed for the closing patch test mainly due to the hull leakage from a hull penetration. Calibration coefficients for launch 1014 (Depth sensor roll, pitch, and azimuth offsets, navigation time error) could be the result of re-mounting the Reson 8125 sensor in the mounting sled. The only change to the Thomas Jefferson **HIPS** VCF was for the depth sensor roll offset. This change can be attributed to the Simrad outer beam roll coefficient value change entered into the Simrad acquisition software.

C.4. WATER LEVEL CORRECTORS

Soundings were reduced to Mean Lower-Low Water (MLLW) using verified tide data from the local, primary tide gauge obtained from the Center for Operational Oceanographic Products and Services (CO-OPS) web site. For all projects, a simple predicted tide table was applied to MB data in HIPS during the Merge process. A zone-corrected verified tide file is supplied by CO-OPS which is then reapplied to all MB using **HIPS**. Refer to individual Descriptive Reports for further information regarding water level correctors specific to each survey.

Refer to the project-specific Vertical and Horizontal Control Report (January 20, 2004) for information on the gauges used for this project. All maintenance for the local tide gauges was conducted by the Field Operations Division of the Center for Operational Oceanographic Products and Services (CO-OPS) unless otherwise noted in the project Descriptive Report.

D. APPROVAL

As Chief of Party, I have ensured that standard field surveying and processing procedures were adhered to during this project in accordance with the Hydrographic Manual, Fourth Edition; Hydrographic Survey Guidelines; Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables, as updated for March, 2003.

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

Submitted:	Approved and Forwarded:
______________________________	______________________________
LT Shepard Smith, NOAA Field Operations Officer	LCDR Donald W. Haines, NOAA Commanding Officer

APPENDIX I

- Software Versions
- Hardware Serial Numbers

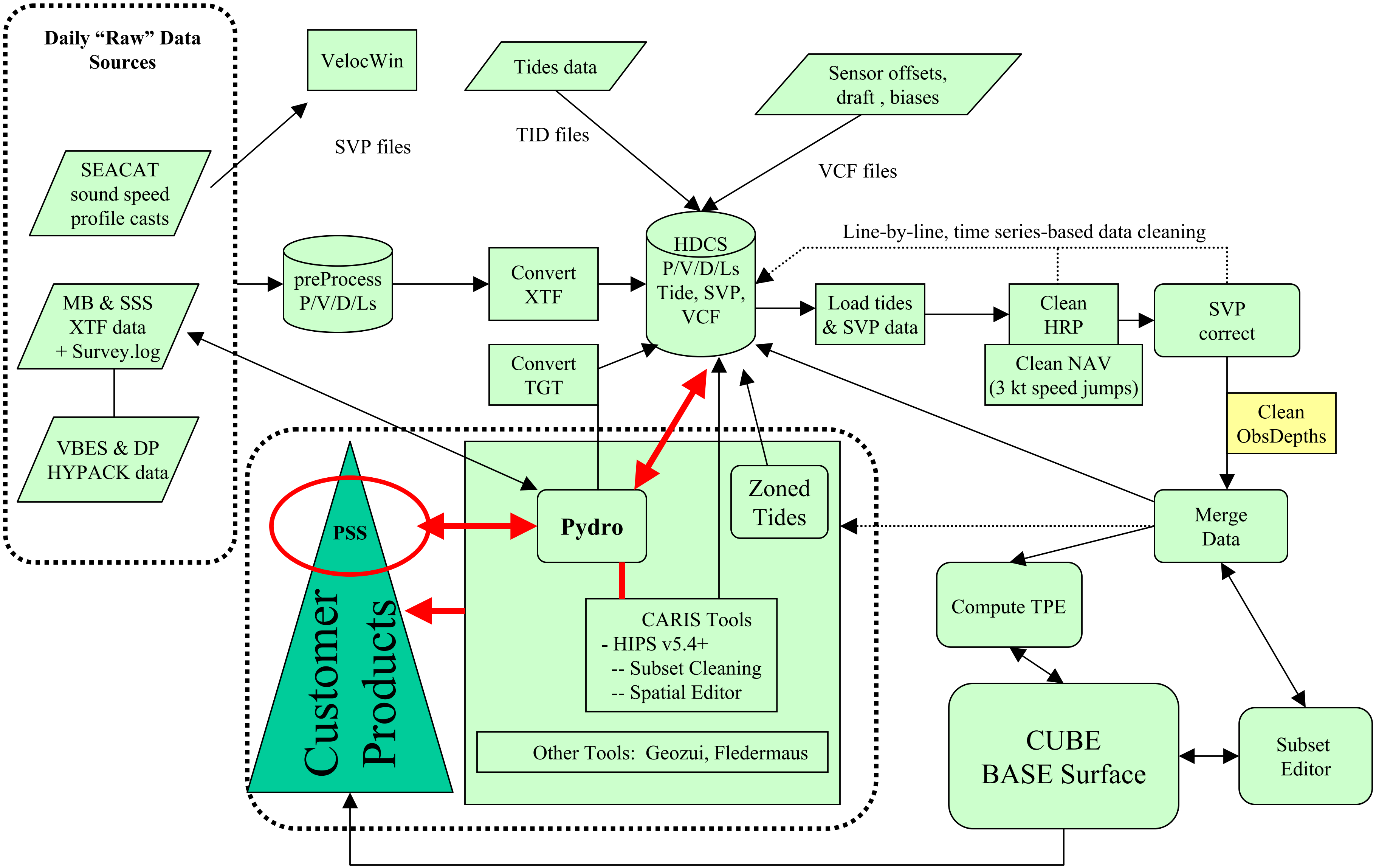
S222 Acquisition/Processing Software November 2003		
Software	**Version**	**Installed**
Acquisition		
Hypack Max	2.12	1/03
ISIS	6.06	4/03
	6.20	7/03
Merlin	5.1v25B	6/03
Horizontal Control		
TSIP Talker	2.0	
POS/MV Controller	1.3	5/03
Sound Velocity		
Velocwin	8.21	5/28/03
	8.30	8/03
	8.30Beta	8/29/03
Processing		
Pydro	3.6.1	7/03
	3.7.0	9/17/03
	3.7.0b	10/15/03
MapInfo	6.5	
MapBasic	5.0	
Vertical Mapper	3.0	5/03
Fledermaus	5.2.2	6/03
	5.2.3	9/23/03
GeoZui	3.4	8/03
Grid Manipulator		8/03
CARIS GIS	4.4a 3.0	7/03
	4.4a 3.0 HF1-18	10/27/03
	4.4a 3.0 HF20-23	11/17/03
CARIS HIPS & SIPS	5.3.1	3/03
	5.3.2	7/03
	HF 1,3,4,5,7,9	8/28/03
	HF 10,12,13,14	9/18/03
	HF 15	9/26/03
	5.3.3 HF1-2	10/23/03
	5.3.3 HF4,5,8,9	11/14/03
	5.3.3 HF 10	11/17/03
CARIS HIPS & SIPS ALPHA	5.4.7	10/27/03
CARIS HIPS & SIPS BETA	5.4 various versions/times	
Utilities		
KapConv	3.4.1	7/03
HydroMI	3.6.3	7/03
Tides and Currents	2.56	
Cygwin		10/31/03
WorldReg	1.0	
NOAA Chart Reprojector	2.0.4	2/03

Equipment	Serial Number(s)
Odom Echotrac DF3200 MKII Echosounder	Launch 1014 - 9644
	Launch 1005 - 9708
	TJ - 9643
Simrad EM1002 Sonar Transceiver	222
Reson 8101 Sonar Processor	13976
Reson 8125 Sonar Processor	31381
Klein 5500 high speed, high resolution, multiple beam, side scan sonar processor	Launch 1005 - 91184
	Launch 1014 - 91566
	TJ - 91182
Klein 5500 high speed, high resolution, multiple beam, side scan sonar towfish	276
	278
	279
Trimble DSM212L	Launch 1005 - 0220168291
	Launch 1014 - 0220157923
	TJ - 0020159721
	TJ - 0220159716
TSS Position & Orientation System POS/MV PCS	Launch 1005 - 02
	Launch 1014 - 207
	TJ - 226
Trimble GPS Pathfinder Pro XRS Receiver	224025052
Diver Least Depth Gauges	68338
	68339
Seabird SBE 19-02 Seacat Sound Velocity Profiler	196093-1060
	192472-0285
Seabird SBE 19-01 Seacat Sound Velocity Profiler	196723-1251
Seabird SBE 19 Plus Sound Velocity Profiler	19P30242-4281
Odom DIGIBAR-Pro Profiling Sound Velocimeter	98129-012402
Applied Microsystems Smart SV & Temperature probe	4823

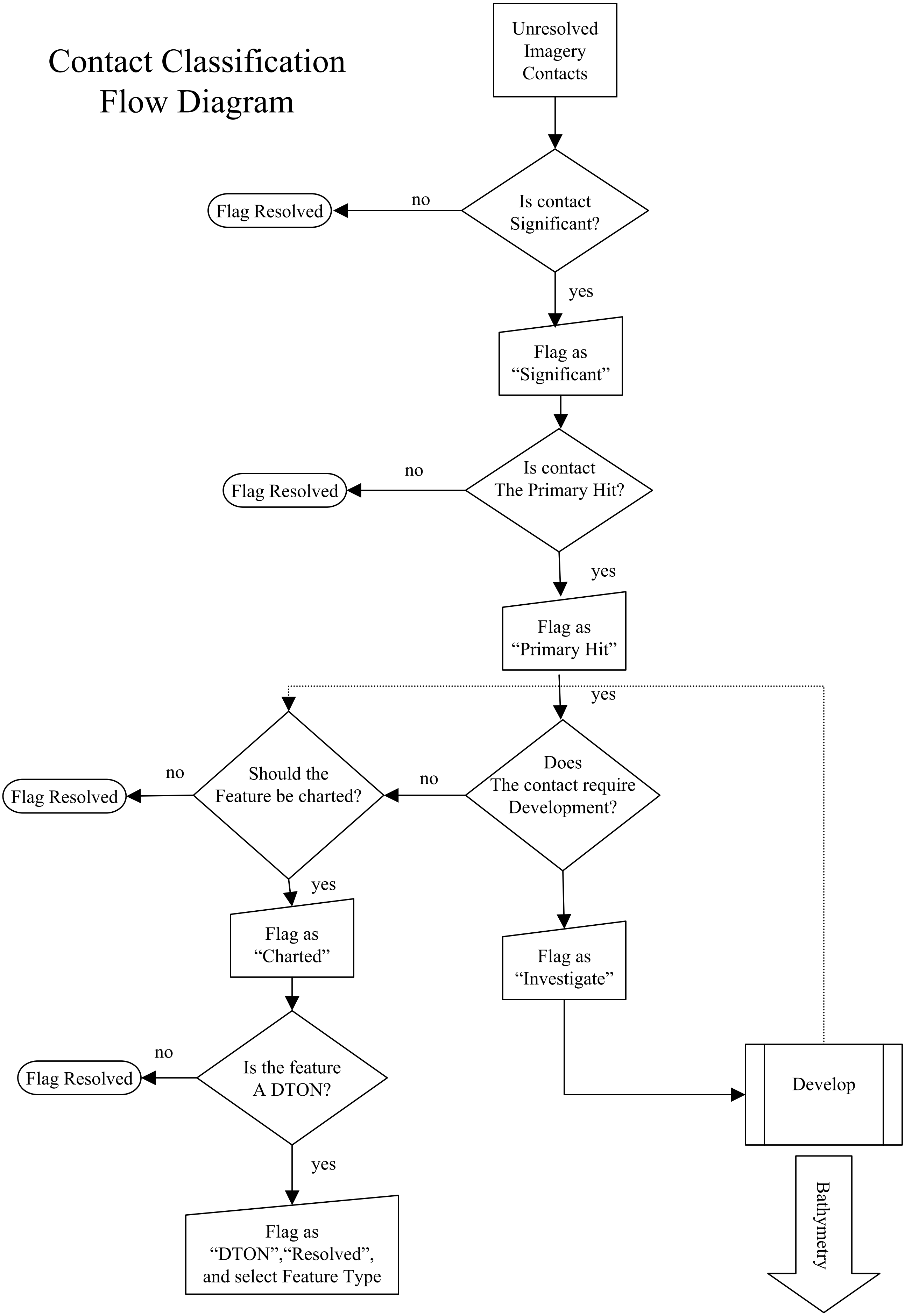
APPENDIX II

- Bathymetry Data Cleaning Flow Chart
- Pydro Contact Classification Flow Diagram
- Pydro Bathymetry Classification Flow Diagram
- Pydro Chart Comparison Classification Flow Diagram

Bathymetry Data Cleaning to PSS



Contact Classification Flow Diagram



Bathymetry Classification Flow Diagram

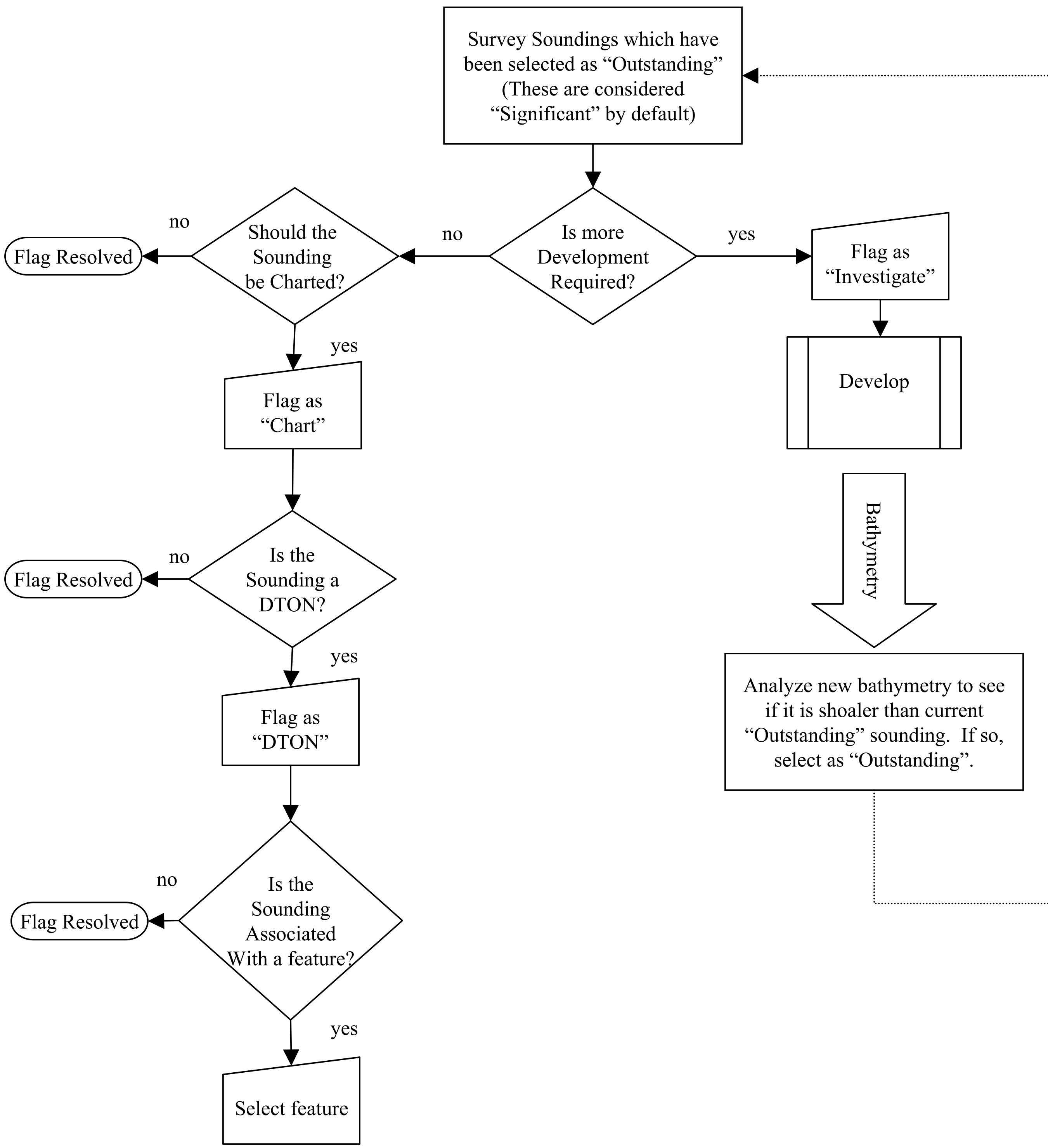
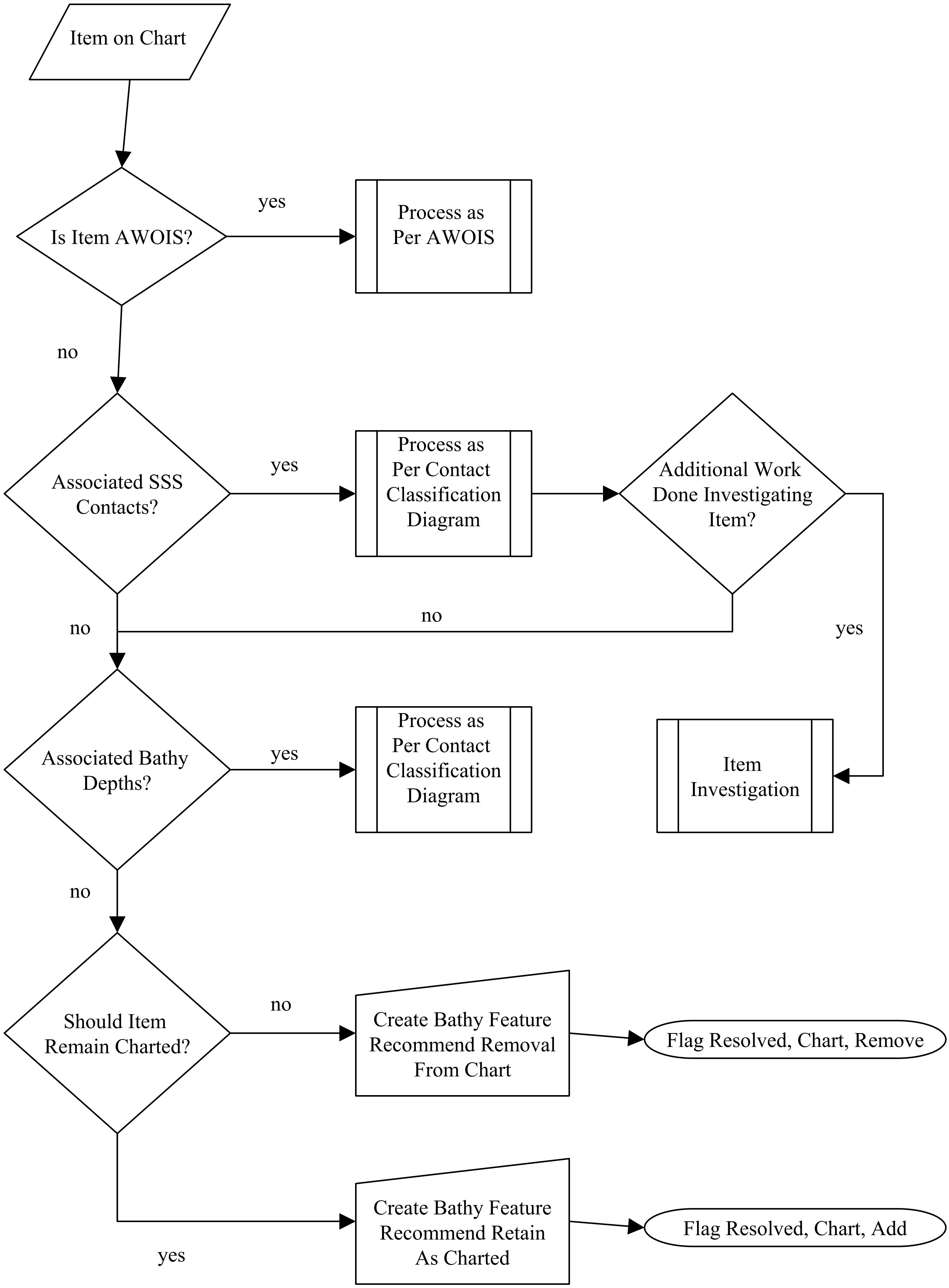


Chart Comparison Classification Flow Diagram



APPENDIX III

- Static Draft Determination
- Dynamic Draft Determination

S222 Static Draft Determination

NOAA Ship *THOMAS JEFFERSON* 2003 DN 114-239

Background

The purpose of a static draft measurement is to correct for the difference in distance from the waterline and the transducer face. It also accounts for the long-term differences in loading due to fuel, water and supplies. In our current software the term draft is not used. The Z value of the transducer below the Inertial Motion Unit (IMU) and the waterline will give the surveying draft of the ship. The term waterline is the distance from the waterline to the IMU. On May 4-7 NGS surveyed the distance from IMU to the Notch Reference Point (RP). It updated the transducer to Notch RP distance.

A comparison was made on Aug 27, 2003 DN 239 with the bubble tube measurement. It was found that the IMU to Notch RP using the NGS measurement had a difference of .221 meters. This was attributed to the ship being out of trim at the time of measurement. The correction was determined to be a positive value added to the original waterline. Waterline changes can be seen in the POS/MV settings, the Simrad installation parameters, and the VCF. They may not match each other depending on the system configuration used.

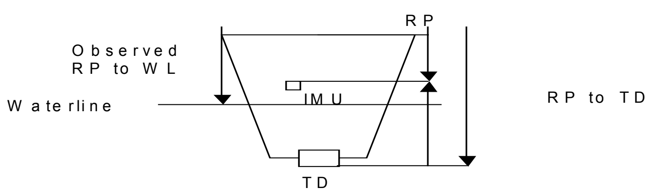
The system configuration in the beginning of the year has the lever arm position from the Pos/MV at the Simrad Transducer. With this type of setup no offsets or waterline were used in the Caris VCF on DN 111 –150. The second configuration has the position at the IMU and offsets for SVP pole and waterline are entered. Corrections to NGS data were not applied until after the system change on DN 221

Location

Static draft measurements were performed at the following locations.
April 22, 2003 (DN112) AMC Norfolk, VA
May 14, 2003 (DN 134) Chesapeake Bay,
May 30, 2003 (DN 150) Chesapeake Bay
Aug 11, 2003 (DN223) Chesapeake Bay.
Aug 25, 2003(DN237) Boston Harbor.
Aug 27, 2003 (DN239) Offshore Boston.

Procedure

Two methods of determining the static draft were employed. The first was the indirect method. A leadline was used and a reading taken from a notch located athwartships of the EM1002 transducer under the port and starboard bridge wings to the observed waterline. The formula used for draft is (RP to TD) – (RP to Observed WL) =Draft. The formula for Caris Waterline and Simrad water level is (IMU to TD) -Draft= Waterline.



The second method is to read a bubble tube installed from the sound speed velocimeter to a point near the IMU. It is located under the cargo hatch that leads from the electronic stores to survey stores. A level was run from the IMU down to a mark and a meter stick attached to the bulkhead inline with the level mark. The bubble tube was then attached next to meter stick. The valves our opened from the SSV tank and the pump is turned off. By reading the water level in the tube against the meter stick an insitu reading of waterline can be made.

It is recommended that all readings be taken after ballasting. Constants for various tests including Static draft and lead line checks are based on the recent bubble tube data and are accurate for future use. The constants are as follows

RP(notch) to IMU= **7.72m** IMU to TD(transducer)**= 5.153** RP to TD **= 12.873**

Results

The following table shows the waterline and draft measurements at the time of survey and the adjustments to be made according to the type of system configuration. DN 221 marks the lever arm change Simrad TD Position to POS/MV IMU Position. Ballasting and an trim were performed before data collection on DN 149 but the static draft was not confirmed until DN 150. The caris entry on DN139 of -0.368 compensates for this difference until DN 150 when it was entered into Simrad.

INSITU Static Readings and Aquisition Entry's

DN	VCF DN	Method	Static Draft	Pos MV Z	Simrad Z	Simrad Waterlevel
112	111	TJ	4.502	5.153	0.000	-4.500
134	N/A	TJ	4.372	5.153	0.000	-4.370
150	N/A	NGS	4.740	5.153	0.000	-4.740
N/A	221	NGS	4.740	5.153	5.150	0.410
223	223	NGS	4.968	5.153	5.150	0.210
237	237	NGS	4.855	5.153	5.150	0.300
239	239	Bubble	4.593	5.153	5.150	0.560

Preliminary VCF Draft Waterline Entries

DN Draft	VCF	Adjustments	Swath offsets Z	SVP pole Bot Z offsets	Apply Flag	Velocity Applied	Projected Caris Waterline
112	111	N/A	0	0	N	N	0.000
134	N/A	N/A	0	0	N	N	0.000
149		***	0	0	Y	N	-0.368
150	N/A	UNK	0	0	N	N	0.000
N/A	221	+.221	0	5.15	Y	Y	0.631
223	223	+.221	0	5.15	Y	Y	0.431
237	237	+.221	0	5.15	Y	Y	0.521
239	239	N/A	0	5.15	Y	Y	0.560

Recommendations for Use:

These results are adequate for correcting soundings for hydrographic surveys.
Performed by:
Peter Lewit
Senior Survey Technician
NOAA Ship Thomas Jefferson

S222 Static Draft Determination

NOAA Ship *THOMAS JEFFERSON* 2003 DN 239-309

Background

Subsequent static draft readings were taken in the course of survey as shown here. If no major changes to the Pos/MV or Simrad are made, then no change in Vessel Configuration is recorded and the last major change is used throughout. The ship was trimmed and ballasted after the DN 295 reading and before survey operations resumed.

INSITU Static Readings and Acquisition Entry's

DN	VCF DN	Method	Bubble reading	Static Draft (Z minus Bubble)	Pos MV Z	Simrad Z	Simrad Waterlevel
239	239	Bubble	.56	4.593	5.153	5.150	0.560
295	239*	Bubble	.43	4.723	No Changes made to POS/MV or Simrad		
306	239*	Bubble	.56	4.593			
309	239*	Bubble	.57	4.583			

Preliminary VCF Draft Waterline Entries

DN Draft	VCF	Adjustments	Swath offsets Z	SVP pole Bot Z offsets	Apply Flag	Velocity Applied	Projected Caris Waterline
*239	*239	N/A	0	5.15	Y	Y	0.56

Dynamic Draft Determination

NOAA Ship *THOMAS JEFFERSON*
2003-114
Chesapeake Bay

Background

This method of determining the dynamic draft of a vessel is adapted from an older practice where successive lines were run over a flat bottom at different speeds. At the time of this trial, no GPS equipment was available for GPS dynamic draft and it was not deemed practical to use a level and rod on a large ship in restricted waters.

Location

The trial was conducted in southern Chesapeake Bay on a broad, flat area of seafloor approximately 4 NM west of Cape Charles City, VA.

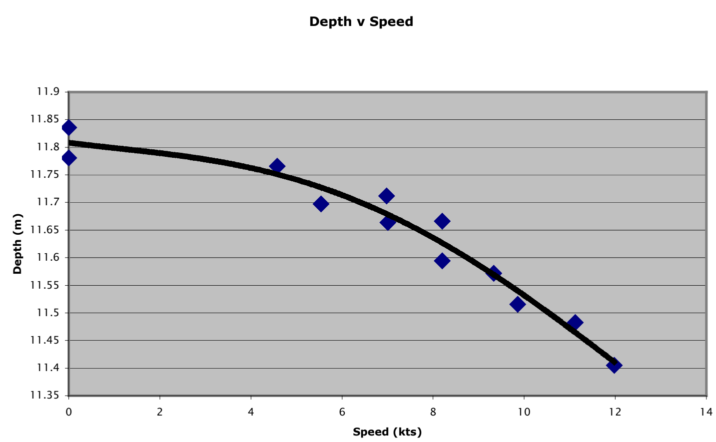
Procedure

Lines were run north-south over a central area of interest with ½ mile runups at each end for the ship to settle into steady state motion. Each line was run in each direction at the same speed. Data was collected at rest at the beginning and end of the trial. The speed of the ship was computed using speed made good since the Doppler speed log was malfunctioning at the time.

All multibeam data was fully processed using standard procedures in Caris HIPS, except that no dynamic draft was applied. A small area was chosen in the center of the lines at the location of the all stop lines. The average depth measured in the area for each line was computed and summarized in a spreadsheet. The depths and speeds for each RPM setting were averaged and the results summarized in the table below.

Results

Avg. Speed	Draft Increase
0.0	0.00
5.8	0.07
6.9	0.13
8.2	0.19
9.7	0.27
10.9	0.35



Recommendations for Use

These results are adequate for correcting soundings for hydrographic surveys. When the opportunity presents itself, they should be checked against another source (GPS or level rod method).

Performed by:
LT Shepard Smith, NOAA
Operations Officer,
NOAA Ship Thomas Jefferson

APPENDIX IV

- Cable Counter Calibration
- Applied Microsystems Smart SV & Temperature Probe Calibration
- SBE 19 SEACAT Profiler S/N 192472-0285 Calibration Report
- SBE 19 SEACAT Profiler S/N 196093-1060 Calibration Report
- SBE 19 SEACAT Profiler S/N 196723-1251 Calibration Report
- SBE 19 SEACAT Profiler S/N 19P30242-4281 Calibration Report
- Diver Least Depth Gauge S/N 68334 Calibration Report
- Diver Least Depth Gauge S/N 68338 Calibration Report
- Diver Least Depth Gauge S/N 68339 Calibration Report
- Lead Line Calibration Report

Cable Counter Calibration

NOAA Ship *THOMAS JEFFERSON*
2003-114

Background

The TODCO and the 3PS cable counters are devices used to measure cable out during Side Scan operations and CTD operations. For Side Scan operations, the TODCO is interfaced with the HYPACK and ISIS acquisition software. A 16” McKissick steel block is used and has one target or magnetic sensor in the sheave. For CTD operations a 3 TON 3/8” Kahl Scientific block with ¼ “ cable was used and also has one target.

Location

The Todco calibration was performed alongside of Atlantic Marine Center Pier April 14, 2003 in Norfolk VA. The 3PS was calibrated alongside the Baltimore Aquarium, MD June 6, 2003.

Procedure

The first steps in this procedure were to measure the diameter of the cable using an Engineering micrometer followed by the diameter of sheave. The values are converted to meters. The formula: Payout Slope or Scale factor= [(ROOT DIA BLOCK + CABLE DIA)* PI] / TARGETS was used for both types of unit. The Payout Slope is entered in the Data Calibration Screen of the TODCO unit. For the 3PS unit the Scale Factor is entered into the Payout scaling menu. During Side Scan operations the tow fish is put to the waters edge and the cable out is set to 4.8 meters, the distance from the tow point at the top of the block to the waterline. An alternative is to place a mark on the cable 10 meters away from the tow fish center, and reset the TOCO when the mark reaches the tow point. This prevents the tow fish from jumping out of the prop wash. For CTD operations the Cable out is set to zero at the waters edge. Periodic checking of the cable out during operations was done to insure that slipping does not occur during payout and take in of the cable.

Results

Formula: Slope or Scale factor= [(ROOT DIA BLOCK + CABLE DIA)* PI] / TARGETS

UNIT	Cable diameter	Sheave Diameter	Targets	Payout Slope
TODCO /SSS	0.010345	0.340591	1	1.102499
3PS/CTD	0.00625	0.303668	1	0.954001

Recommendations for Use

These results are adequate for correcting soundings for hydrographic surveys

Performed by:
Peter G. Lewit
Senior Survey Technician
NOAA Ship Thomas Jefferson

Calibration Coefficients
Smart SV & Temperature 4823

03-27-2003

Kongsberg Simrad Inc. Lynnwood

Applied Microsystems Ltd.

2071 Malaview Ave. West, Sidney, British Columbia, Canada V8L 5X6

Phone: (250) 656-0771 Fax: (250) 655-3655

Canada & USA: 800-663-8721

Email: info@AppliedMicroSystems.com Web: http://www.aml.bc.ca

Smart SV & Temperature 4823

Temperature Calibration

Job Information

Date	03-25-2003
Job Number	3740
Customer	Kongsberg Simrad Inc. Lynnwood

Sensor Information

Manufacturer	YSI/AML
Model Number	YSI
Serial Number	125-1
Range	-2 to +45 Deg C
Channel	1
Calibrated By	JR
Standards	Hart/T2128

Calibration Data

Raw	Standard
52046	45.0008
49451	39.9906
46560	34.9671
44699	31.9626
40036	24.9801
36479	19.9821
32828	14.9985
29148	9.9631
25639	5.0548
22443	0.3664

Coefficients

A = -4.937447E+01
B = 3.182104E-03
C = -5.579857E-08
D = 5.664776E-13

=A+B*Raw+C*Raw^2+D*Raw^3

RMS = 0.0321

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Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

Smart SV & Temperature 4823

Smart SV Calibration

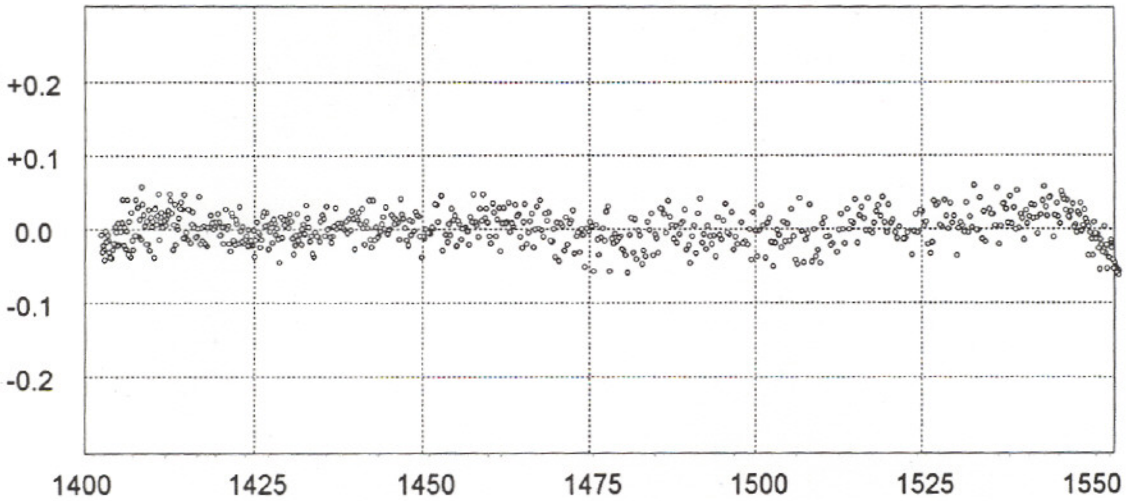
Job Information

Date	03-26-2003
Job Number	3740
Customer	Kongsberg Simrad Inc. Lynnwood

Sensor Information

Manufacturer	AML
Model Number	Time of Flight
Serial Number	139-7
Range	1400 to 1570 m/s
Channel	2
Calibrated By	JR
Standards	Smart T 9998

Deviation vs. Sound Speed (m/s)



Coefficients

A = 1.529452E+03
B = -1.075542E+02
C = 8.948467E+00
D = -1.160856E+00

=A+B*((N-NL)/(NH-NL))+C*((N-NL)/(NH-NL))^2+D*((N-NL)/(NH-NL))^3

RMS = 0.0233

Applied Microsystems Ltd.
2071 Malaview Ave West, Sidney, British Columbia, Canada V8L 5X6
Phone: (250) 656-0771 Fax: (250) 655-3655
Canada & USA: 800-663-8721
Email: info@AppliedMicrosystems.com Web: http://www.aml.bc.ca

1.2 Tests, Quality Control, and General Specifications

The following tests have been performed on the Sound Velocity & Temperature Smart Sensor S/N 4823 before leaving the factory.

✓ - Burn In.

✓ - Cold Chamber.

✓ - Electronic Drift.

✓ - Sensor Drift.

✓ - Water Tight Integrity "Pressure Test"

✓ - Calibration.

✓ - Post Calibration Verification.

IMPORTANT

THIS APPARATUS WAS PRESSURE TESTED

TO: 500 Metres

BEFORE LEAVING THE FACTORY.

OPERATOR: Justin Romito

The Sound Velocity & Temperature Smart Sensor S/N 4823 was shipped from the factory with the following configuration:

- Sound Velocity Sensor	type - Time of flight	range - 1400 to 1570 m/s
- Temperature Sensor	type - YSI /AML	range - -2°c to +45°C
- Firmware version	Analog - 1.04	SV - 1.13

Options:

_____ - RS-485 communications_____ - RS-232 communications

_____ - Blanking plug

✓ - Data/Power cable with 2 metre pigtail

_____ - Data/Power cable with right angle connector and 2 metre pigtail

✓ - Delrin housing (500 metres)

_____ - T-316 stainless steel housing (4500 metres)

_____ - Mounting bracket

_____ - Custom connector configuration

APPLIED MICROSYSTEMS Because it's not just H_2O

Conformity Certificate

Customer: Kongsberg Simrad Inc. Lynnwood

NOAA / LITTLEHALES.
4/8/03

Reference: Job#: 3740 PO#: WO9175

Part No: Smart SV & Temperature

Serial No: 4823

Description: Direct measurement of sound velocity and temperature.

Comments: This unit operates as a stand alone unit with an RS-232 auto-baud communications interface. Maximum depth, 500 metres. Extended Temperature and Sound Velocity paramaters have been implemented.

Justin Romito

Justin Romito
Technologist

Certification Date: 03-28-2003

APPLIED MICROSYSTEMS LTD. CERTIFIES THAT THE ABOVE DESCRIBED EQUIPMENT HAS BEEN TESTED IN ACCORDANCE WITH THE CONDITIONS AND REQUIREMENTS OF THE CONTRACT/PURCHASE ORDER. UNLESS OTHERWISE NOTED ABOVE, THE EQUIPMENT CONFORMS IN ALL RESPECTS TO THE SPECIFICATIONS AND/OR RELEVANT DRAWINGS.

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	32903	**Date of Report:**	7/1/2003
Model Number	SBE 19	**Serial Number:**	192472-0285

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 7/1/2003 Drift since last cal: 0 PSU/month*

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: PSU/month*

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington, 98005 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 01-Jul-03

SBE19 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

g = -4.06877460e+000
h = 4.85232284e-001
i = 1.26603319e-003
j = -2.48623147e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 1.31966361e-002
b = 4.68905304e-001
c = -4.05302582e+000
d = -9.76040772e-005
m = 2.3
CPcor = -9.5700e-008 (nominal)

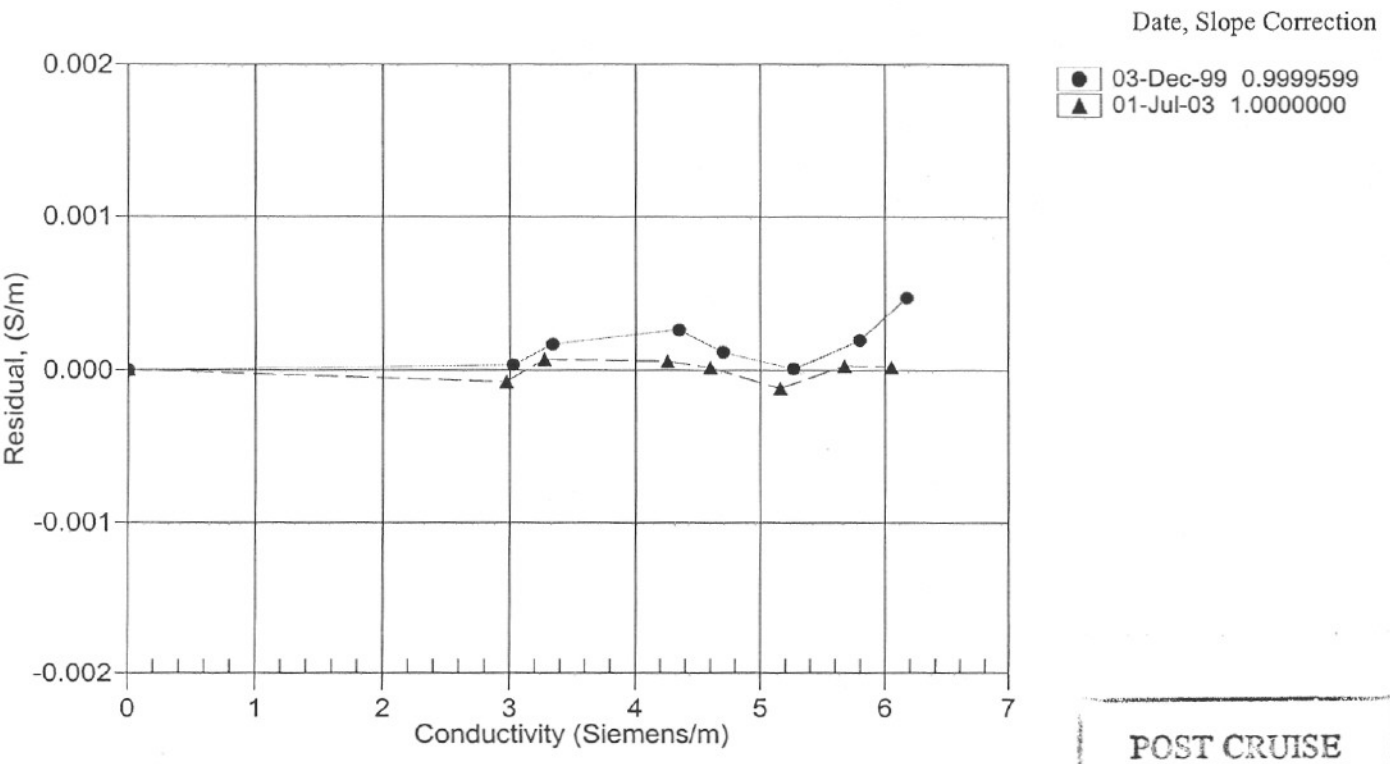
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88550	0.00000	0.00000
1.0000	34.7149	2.96812	8.26551	2.96805	-0.00008
4.5000	34.6946	3.27437	8.62991	3.27444	0.00007
15.0000	34.6508	4.25345	9.70156	4.25351	0.00006
18.5000	34.6414	4.59766	10.05072	4.59768	0.00002
24.0000	34.6312	5.15413	10.59038	5.15401	-0.00012
28.9998	34.6259	5.67461	11.07124	5.67464	0.00003
32.5000	34.6239	6.04622	11.40185	6.04624	0.00002

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 01-Jul-03

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.12643345e-003
h = 5.78968503e-004
i = 2.31706023e-006
j = -2.19249408e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.64762987e-003
b = 5.70696723e-004
c = 7.81242578e-006
d = -2.19221086e-006
f0 = 2297.770

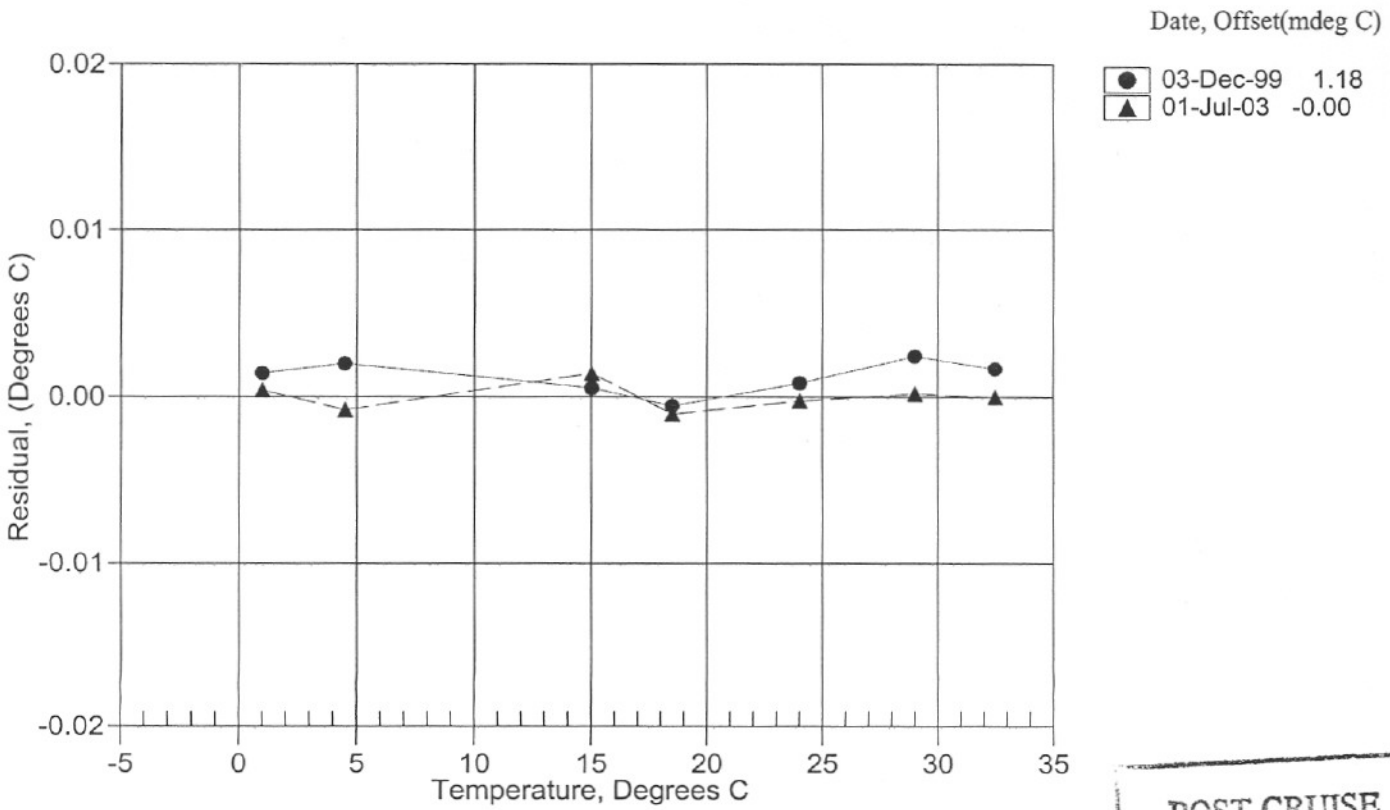
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2297.770	1.0004	0.00038
4.5000	2490.774	4.4992	-0.00076
15.0000	3139.359	15.0014	0.00139
18.5000	3379.640	18.4990	-0.00099
24.0000	3783.442	23.9998	-0.00022
28.9998	4179.024	29.0000	0.00019
32.5000	4472.673	32.5000	0.00001

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature ITS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	32903	**Date of Report:**	7/1/2003
Model Number	SBE 19	**Serial Number:**	192472-0285

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 7/1/2003 Drift since last cal: -.00033 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

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SENSOR SERIAL NUMBER: 0285
CALIBRATION DATE: 03-Jul-03

SBE19 PRESSURE CALIBRATION DATA
5000 psia S/N 133807 TCV: -121

QUADRATIC COEFFICIENTS:

PA0 = 2.492719e+003
PA1 = -6.503265e-001
PA2 = -5.660093e-008

STRAIGHT LINE FIT:

M = -6.503225e-001
B = 2.492329e+003

PRESSURE PSIA	INST OUTPUT(n)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.68	3808.5	15.13	0.01	15.58	0.02
1014.82	2272.9	1014.33	-0.01	1014.24	-0.01
2015.01	736.0	2014.04	-0.02	2013.69	-0.03
3015.15	-802.7	3014.71	-0.01	3014.35	-0.02
4015.18	-2341.2	4014.92	-0.01	4014.83	-0.01
5015.25	-3879.8	5015.01	-0.00	5015.46	0.00
5015.25	-3879.8	5015.01	-0.00	5015.46	0.00
4015.15	-2342.7	4015.95	0.02	4015.87	0.01
3014.99	-805.2	3016.35	0.03	3015.99	0.02
2014.98	735.0	2014.72	-0.01	2014.37	-0.01
1014.79	2271.5	1015.21	0.01	1015.12	0.01
14.65	3809.4	14.52	-0.00	14.97	0.01

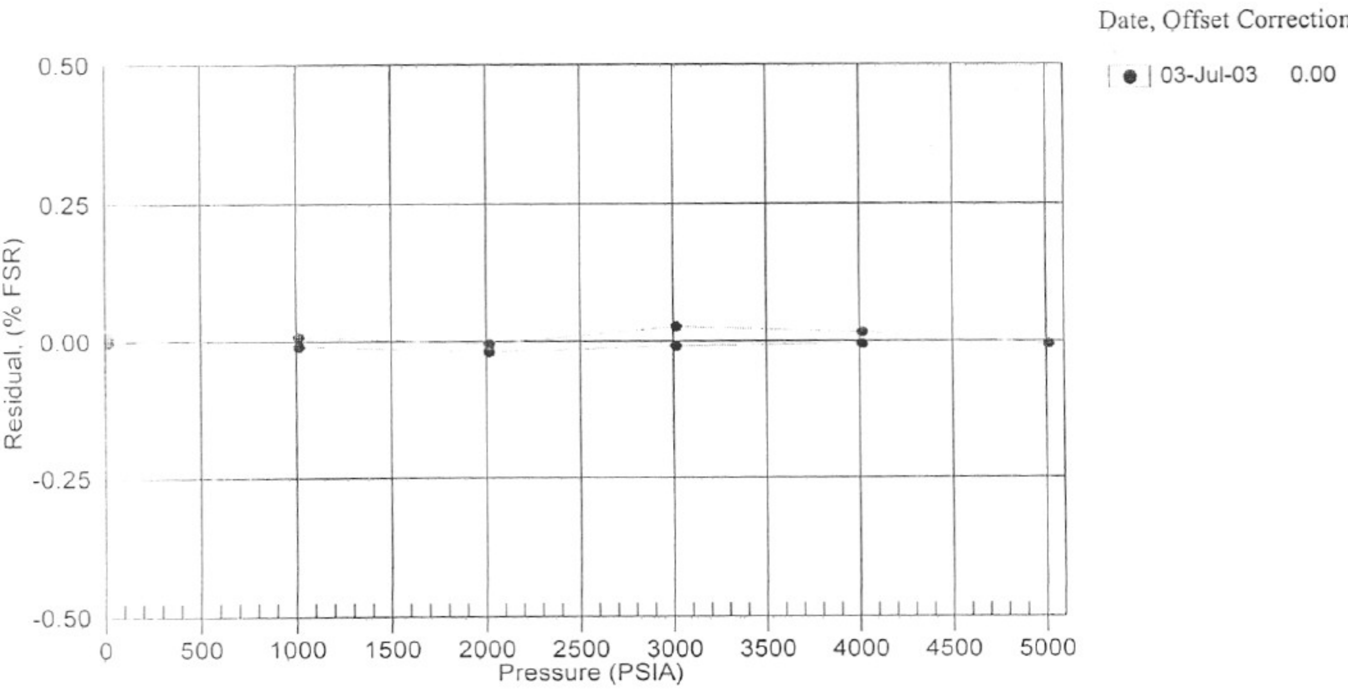
Straight Line Fit:

Pressure (psia) = M * N + B (N = binary output)

Quadratic Fit:

pressure (psia) = PA0 + PA1 * n + PA2 * n^2

Residual = (instrument pressure - true pressure) * 100 / Full Scale Range



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Conductivity Calibration Report

Customer:	Atlantic Marine Center

Job Number:	30929R	*Date of Report:*	04-Dec-02
Model Number:	SBE 19-02	*Serial Number:*	196093-1060

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 04-Dec-02 *Drift since last cal:* +.00050 *PSU/month**

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *PSU/month**

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

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SENSOR SERIAL NUMBER = 1060
CALIBRATION DATE: 04-Dec-02

CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHIJ COEFFICIENTS

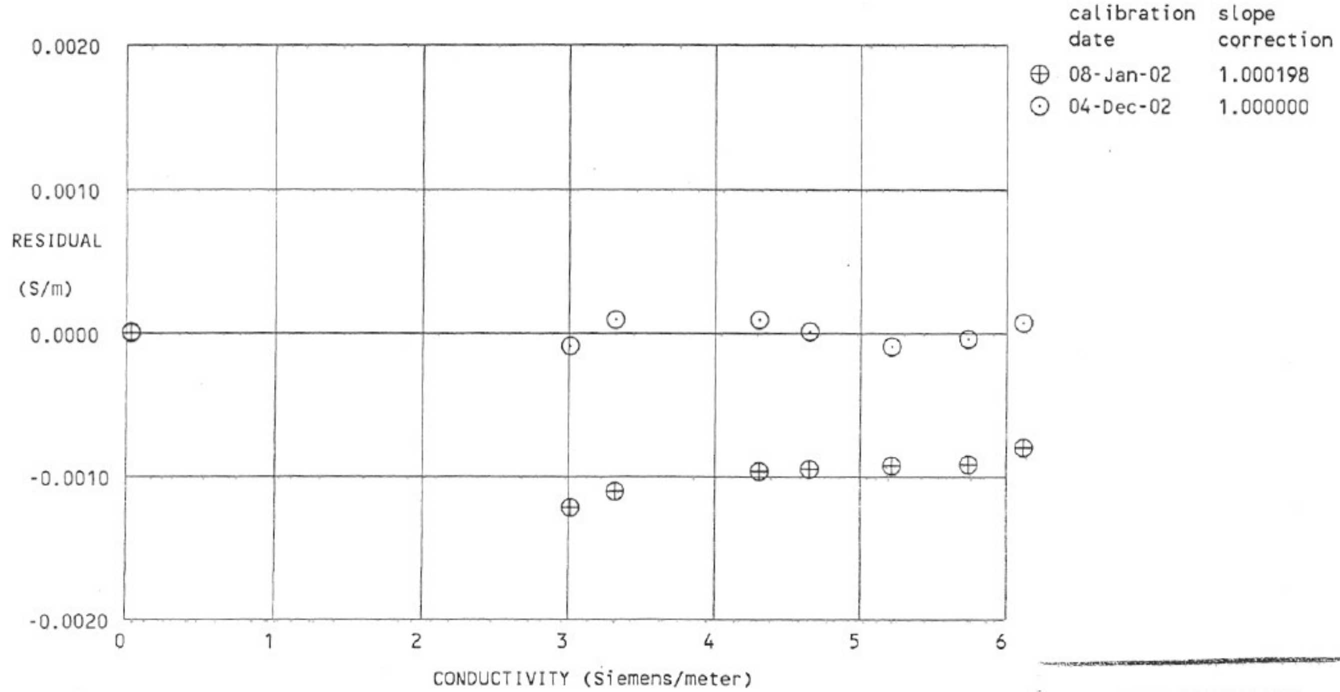
g = -4.10996990e+00
h = 4.90196933e-01
i = 1.30711697e-03
j = -3.55125937e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 4.95847011e-02
b = 4.37137269e-01
c = -4.09662697e+00
d = -1.33073199e-04
m = 2.1
CPcor = -9.57e-08 (nominal)

BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88537	0.00000	0.00000
1.0000	34.8682	2.97997	8.24701	2.97987	-0.00010
4.5000	34.8666	3.28900	8.61264	3.28909	0.00009
15.0000	34.8662	4.27708	9.68794	4.27717	0.00009
18.5000	34.8664	4.62430	10.03813	4.62430	0.00000
24.0000	34.8665	5.18527	10.57923	5.18517	-0.00010
28.9999	34.8658	5.70951	11.06093	5.70946	-0.00005
32.5000	34.8639	6.08335	11.39196	6.08342	0.00007

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

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SENSOR SERIAL NUMBER = 1060
CALIBRATION DATE: 04-Dec-02

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.16430502e-03
h = 5.89527282e-04
i = 3.65827208e-06
j = -1.80302320e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64763854e-03
b = 5.78981343e-04
c = 8.46043300e-06
d = -1.80264739e-06
f_0 = 2418.997

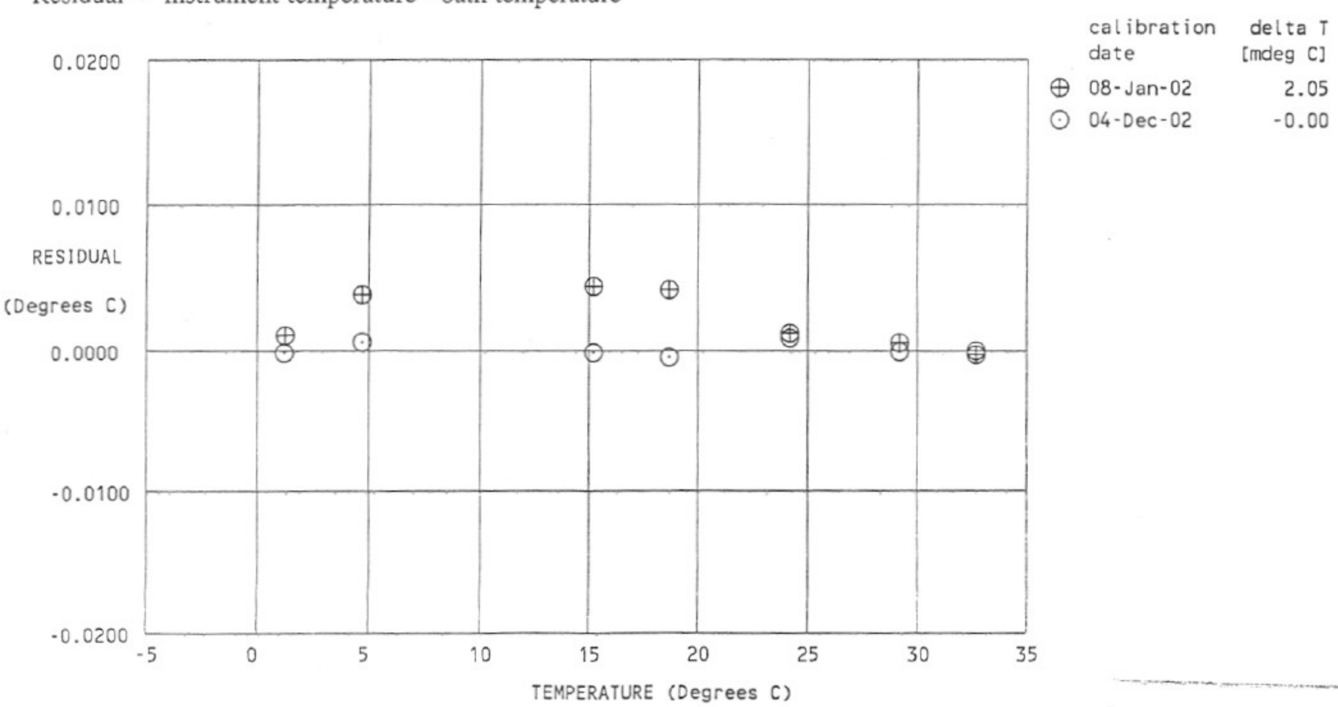
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	2418.997	0.9997	-0.00027
4.5000	2619.283	4.5005	0.00049
15.0000	3290.346	14.9998	-0.00023
18.5000	3538.653	18.4995	-0.00053
24.0000	3955.173	24.0008	0.00079
28.9999	4362.410	28.9997	-0.00016
32.5000	4664.401	32.4999	-0.00009

Temperature ITS-90 $= 1/\{g + h[\ell n(f_0/f)] + i[\ell n^2(f_0/f)] + j[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 $= 1/\{a + b[\ell n(f_0/f)] + c[\ell n^2(f_0/f)] + d[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 °C).

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

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Temperature Calibration Report

Customer:	Atlantic Marine Center

Job Number:	30929R	*Date of Report:*	04-Dec-02
Model Number:	SBE 19-02	*Serial Number:*	196093-1060

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 04-Dec-02 *Drift since last cal:* -.00227 *Degrees Celsius/year*

Comments:

'CALIBRATION AFTER REPAIR' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *Degrees Celsius/year*

Comments:

SBE

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Email: seabird@seabird.com

SBE S/N 196093-1060 — 09 December 2002

Pressure calibration: PAINE 211-75-710-01 300 psia S/N 195086

Temperature Compensation (TC) value = 218

Straight Line Fit:

Pressure(psia) = M * N + B (N = Binary output)

M = -0.03955 B = 150.28

Quadratic Fit:

Pressure(psia) = A0 + A1 * N + A2 * N * N (N = binary output)

A0 = 150.09153 A1 = -3.953833e-002 A2 = 3.062608e-008

		Straight Line Fit		Quadratic Fit	
Pressure (psi)	Output (N)	error, psi	error, %FS	error, psi	error, %FS
14.58	3437.22	-0.230	-0.08	-0.029	-0.01
59.76	2294.04	-0.195	-0.07	-0.205	-0.07
119.76	773.91	-0.079	-0.03	-0.245	-0.08
179.77	-749.28	0.148	0.05	-0.033	-0.01
239.77	-2263.19	0.015	0.00	-0.040	-0.01
299.77	-3773.23	-0.270	-0.09	-0.059	-0.02
239.77	-2269.12	0.248	0.08	0.194	0.06
179.77	-755.00	0.374	0.12	0.193	0.06
119.76	767.01	0.190	0.06	0.023	0.01
59.76	2286.00	0.118	0.04	0.107	0.04
14.65	3430.98	-0.048	-0.02	0.152	0.05

Output binary values are averages of 101 samples taken at 2 Hz.

SEASOFT Versions 3.3M and higher will prompt for A0, A1, and A2

SEASOFT Versions 3.3L and lower will prompt for M and B

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Conductivity Calibration Report

Customer:	Atlantic Marine Center

Job Number:	30929R	*Date of Report:*	04-Dec-02
Model Number:	SBE 19-01	*Serial Number:*	196723-1251

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 30-Nov-02 *Drift since last cal:* +.00170 *PSU/month**

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *PSU/month**

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

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SENSOR SERIAL NUMBER = 1251
CALIBRATION DATE: 30-Nov-02

CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHIJ COEFFICIENTS

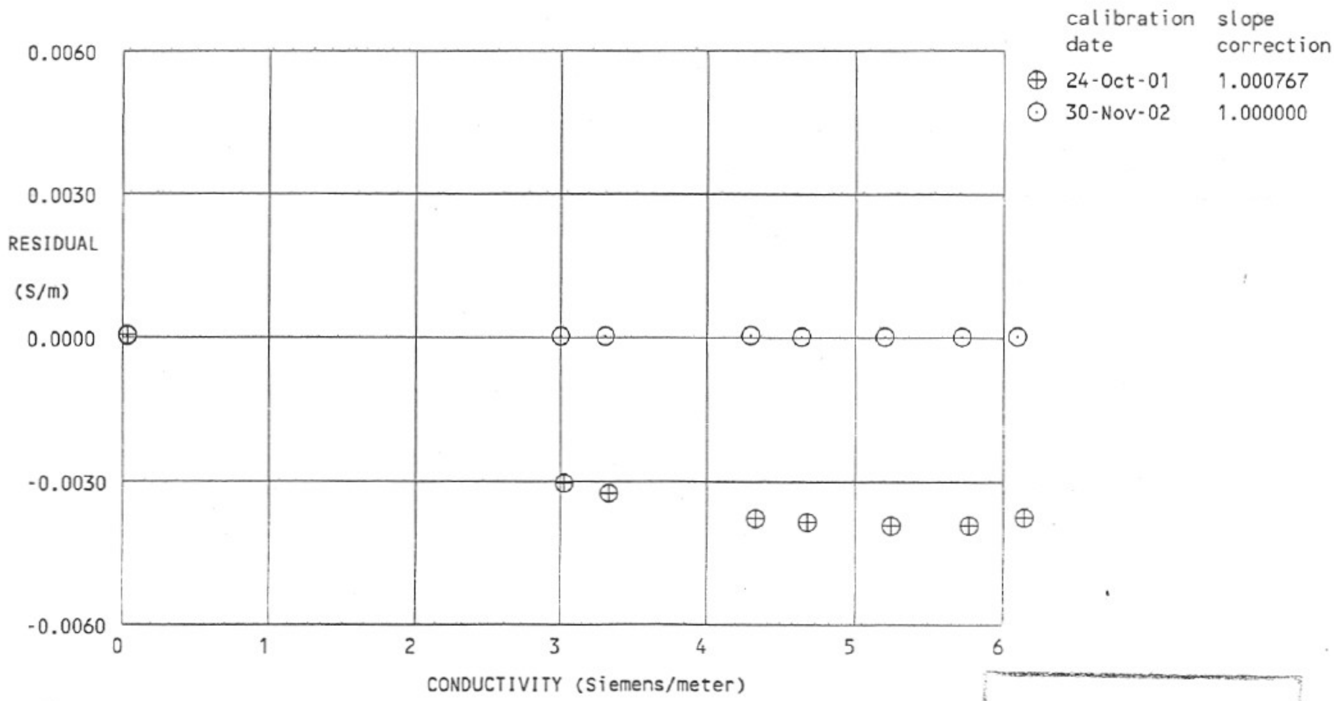
g = -4.14435171e+00
h = 4.94394449e-01
i = 1.28210138e-03
j = -3.28704401e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 5.19238383e-02
b = 4.38379958e-01
c = -4.12829750e+00
d = -1.17573875e-04
m = 2.1
CPcor = -9.57e-08 (nominal)

BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88531	0.00000	0.00000
0.9999	34.7494	2.97078	8.20613	2.97078	-0.00000
4.5000	34.7468	3.27882	8.56915	3.27882	-0.00000
14.9999	34.7462	4.26391	9.63766	4.26393	0.00002
18.5000	34.7465	4.61010	9.98571	4.61009	-0.00001
24.0000	34.7465	5.16939	10.52350	5.16939	-0.00000
29.0001	34.7458	5.69207	11.00210	5.69207	-0.00000
32.5000	34.7438	6.06478	11.33093	6.06478	0.00000

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

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Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 1251
CALIBRATION DATE: 30-Nov-02

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.19970940e-03
h = 5.84741263e-04
i = -8.82836093e-07
j = -2.86357268e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64764005e-03
b = 5.78848104e-04
c = 7.27572073e-06
d = -2.86343374e-06
f_0 = 2577.770

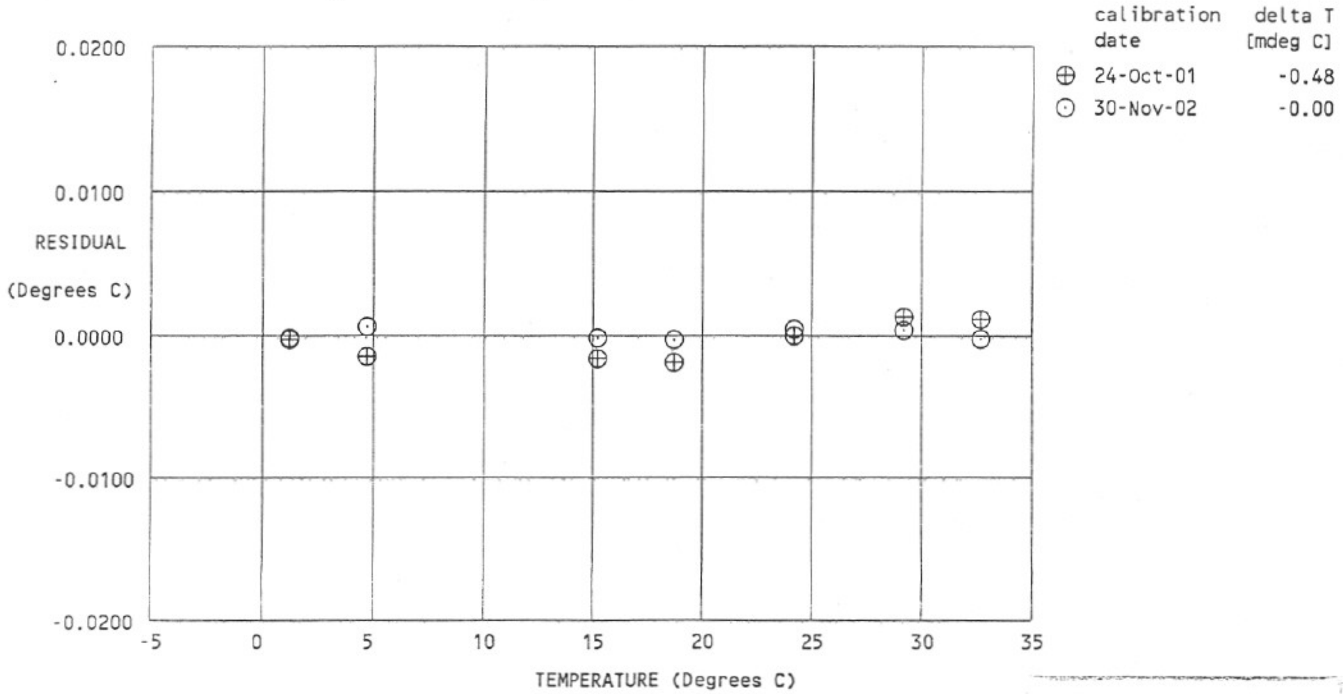
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
0.9999	2577.770	0.9996	-0.00028
4.5000	2791.228	4.5005	0.00051
14.9999	3506.064	14.9996	-0.00026
18.5000	3770.528	18.4996	-0.00036
24.0000	4214.049	24.0004	0.00038
29.0001	4647.864	29.0004	0.00031
32.5000	4969.467	32.4997	-0.00029

Temperature ITS-90 $= 1/\{g + h[\ell n(f_0/f)] + i[\ell n^2(f_0/f)] + j[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 $= 1/\{a + b[\ell n(f_0/f)] + c[\ell n^2(f_0/f)] + d[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C).

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

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Temperature Calibration Report

Customer:	Atlantic Marine Center

Job Number:	30929R	*Date of Report:*	04-Dec-02
Model Number:	SBE 19-01	*Serial Number:*	196723-1251

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 30-Nov-02 *Drift since last cal:* +.00043 *Degrees Celsius/year*

Comments:

'CALIBRATION AFTER REPAIR' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *Degrees Celsius/year*

Comments:

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Email: seabird@seabird.com

SBE S/N 196723-1251 09 December 2002

Pressure calibration: PAINE 211-75-710 300 psia S/N 186220

Temperature Compensation (TC) value = -17

Straight Line Fit:

Pressure(psia) = M * N + B (N = Binary output)

M = -0.03911 B = 146.74

Quadratic Fit:

Pressure(psia) = A0 + A1 * N + A2 * N * N (N = binary output)

A0 = 146.49497 A1 = -3.909441e-002 A2 = 3.794529e-008

		Straight Line Fit		Quadratic Fit	
Pressure (psi)	Output (N)	error, psi	error, %FS	error, psi	error, %FS
14.58	3385.20	-0.247	-0.08	0.007	0.00
59.78	2229.38	-0.235	-0.08	-0.248	-0.08
119.76	690.16	-0.014	-0.00	-0.224	-0.07
179.77	-848.81	0.168	0.06	-0.061	-0.02
239.77	-2379.21	0.022	0.01	-0.047	-0.02
299.77	-3904.72	-0.315	-0.11	-0.048	-0.02
239.77	-2384.99	0.247	0.08	0.179	0.06
179.77	-854.51	0.391	0.13	0.162	0.05
119.76	681.98	0.302	0.10	0.091	0.03
59.76	2220.00	0.146	0.05	0.132	0.04
14.65	3381.03	-0.149	-0.05	0.104	0.03

Output binary values are averages of 101 samples taken at 2 Hz.

SEASOFT Versions 3.3M and higher will prompt for A0, A1, and A2

SEASOFT Versions 3.3L and lower will prompt for M and B

SBE
Sea-Bird Electronics, Inc. FAX: (425) 643-9954
1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866
Website: http://www.seabird.com Email: seabird@seabird.com

Service Report

SBE Job Number: 33172 Date: 7 August 2003

Customer: Atlantic Marine Center

Customer Identified Problem:

1. Calibrate SBE 19 PLUS SEACAT Profiler, S/N 19P30242-4281.

Services Performed:

1. Calibrations and services performed on SBE 19 PLUS SEACAT Profiler, S/N 19P30242-4281.
   Post calibrated the temperature and conductivity sensors.
   Calibrated the pressure sensor.
   Performed full diagnostic evaluation.

SBE
SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	33172	**Date of Report:**	8/1/2003
Model Number	SBE 19Plus	**Serial Number:**	19P30242-4281

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 7/31/2003 Drift since last cal: -.00030 PSU/month*

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: PSU/month*

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4281
CALIBRATION DATE: 31-Jul-03

SBE19plus CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.008451e+000
h = 1.456278e-001
i = -3.677265e-004
j = 4.869275e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006

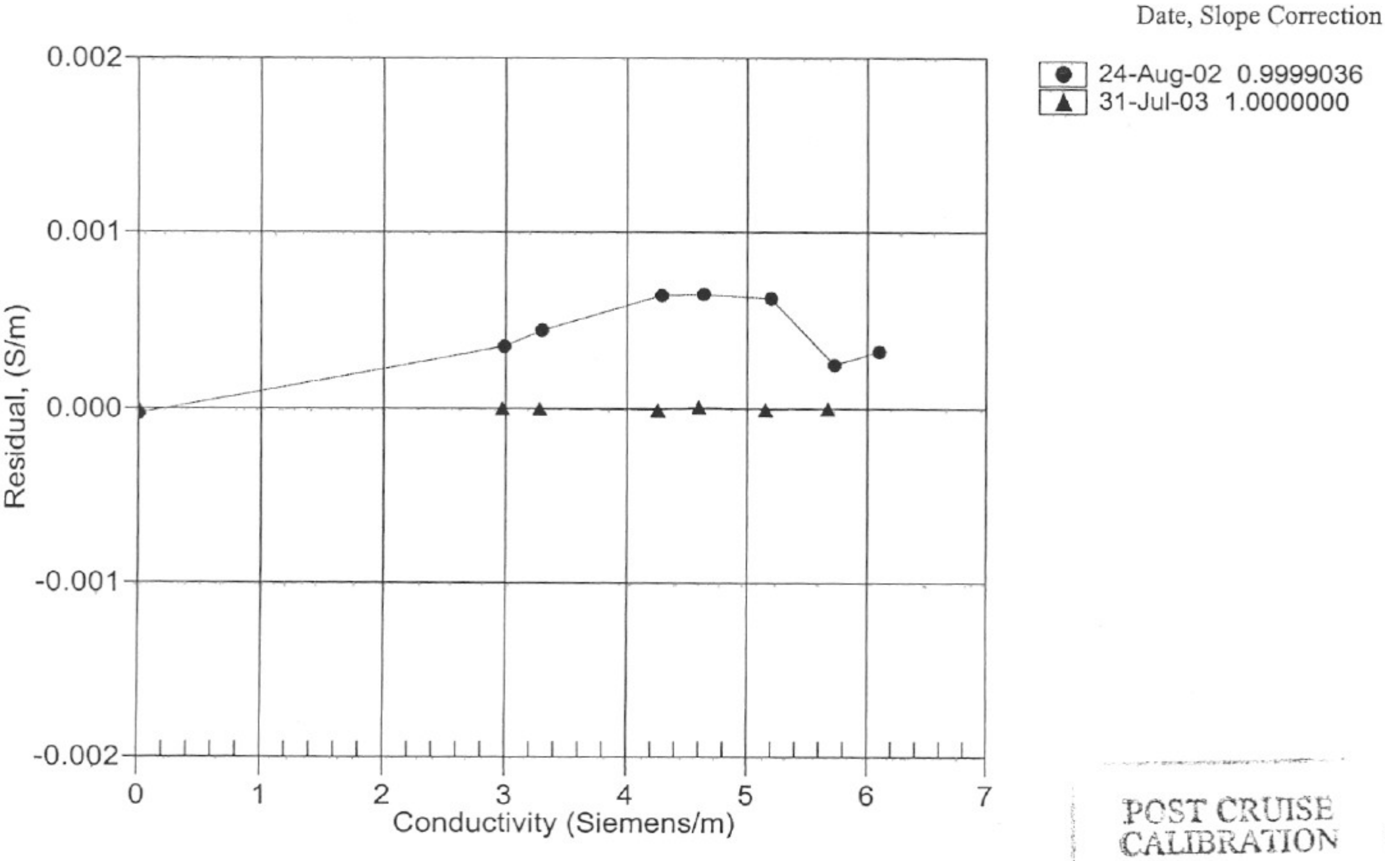
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2637.23	-0.0000	-0.00000
1.0000	34.6851	2.96582	5234.67	2.9658	0.00000
4.5000	34.6648	3.27184	5431.93	3.2718	-0.00000
15.0000	34.6214	4.25023	6018.60	4.2502	-0.00001
18.5000	34.6121	4.59419	6211.42	4.5942	0.00001
24.0000	34.6020	5.15026	6510.73	5.1503	-0.00000
29.0000	34.5969	5.67041	6778.41	5.6704	0.00000

f = INST FREQ / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4281
CALIBRATION DATE: 31-Jul-03

SBE19plus TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.055929e-003
a1 = 3.382038e-004
a2 = -1.188383e-005
a3 = 7.491440e-007

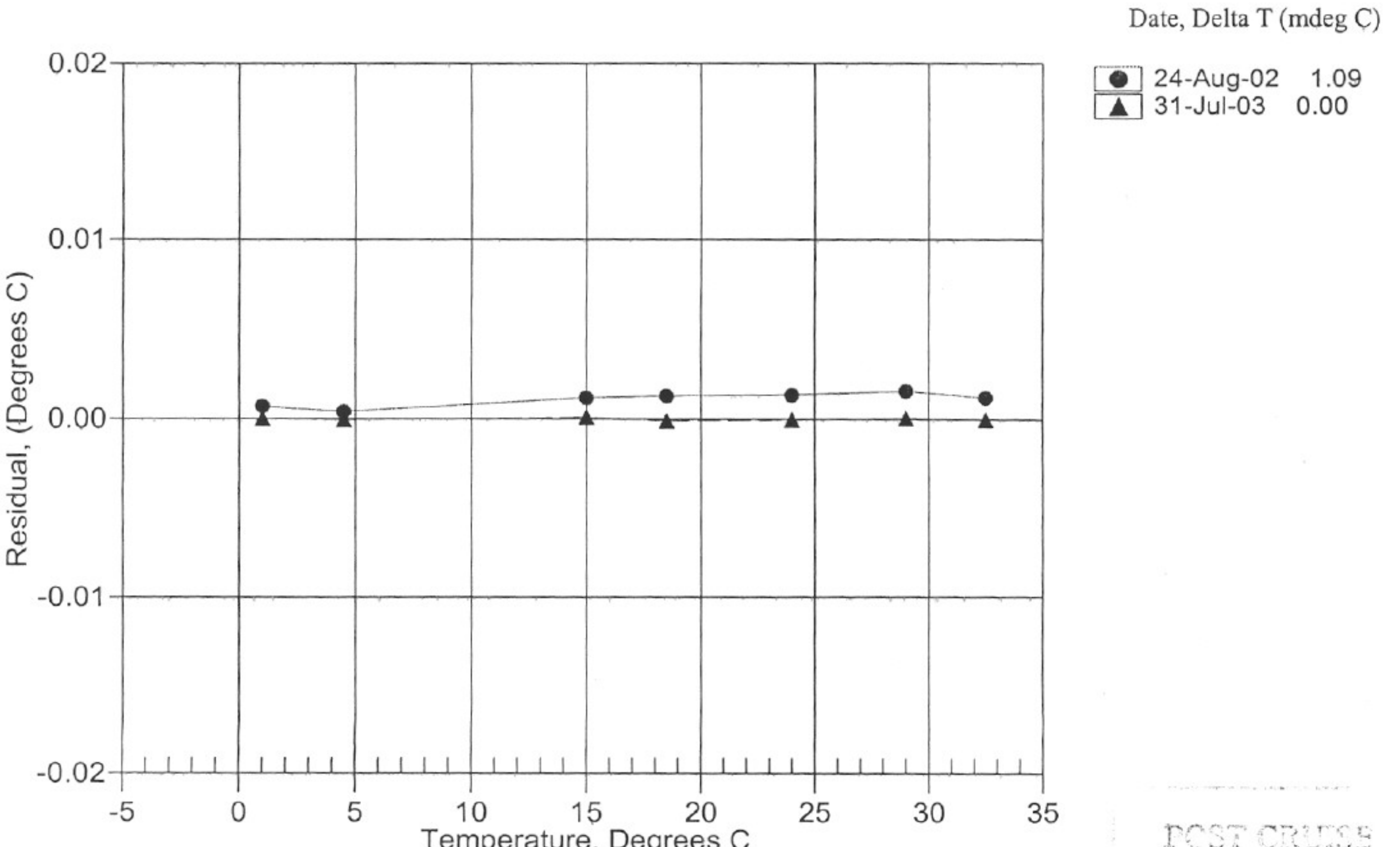
BATH TEMP (ITS-90)	INSTRUMENT OUTPUT(n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	691070.044	1.0000	0.0000
4.5000	618931.204	4.5000	-0.0000
15.0000	435068.100	15.0001	0.0001
18.5000	384472.692	18.4999	-0.0001
24.0000	314915.919	24.0000	-0.0000
29.0000	261298.913	29.0001	0.0001
32.5000	228636.700	32.5000	-0.0000

MV = (n - 524288) / 1.6e+007

R = (MV * 2.900e+009 + 1.024e+008) / (2.048e+004 - MV * 2.0e+005)

Temperature ITS-90 = $1/\{a0 + a1[ln(R)] + a2[ln^2(R)] + a3[ln^3(R)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Atlantic Marine Center		
Job Number:	33172	**Date of Report:**	8/1/2003
Model Number	SBE 19Plus	**Serial Number:**	19P30242-4281

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 7/31/2003 Drift since last cal: -.00116 Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR' ☐ Performed ☑ Not Performed

Date: Drift since Last cal: Degrees Celsius/year

Comments:

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4281
CALIBRATION DATE: 29-Jul-03

SBE19plus PRESSURE CALIBRATION DATA
508 psia S/N 1985

COEFFICIENTS:

PA0 =	1.243204e-002	PTCA0 =	5.243574e+005
PA1 =	1.557886e-003	PTCA1 =	2.751942e+000
PA2 =	5.940779e-012	PTCA2 =	-1.146752e-001
PTEMPA0 =	-7.425812e+001	PTCB0 =	2.489050e+001
PTEMPA1 =	4.949220e+001	PTCB1 =	-1.700000e-003
PTEMPA2 =	-2.812107e-001	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.65	533749	1.976	14.66	0.00
99.76	588257	1.978	99.73	-0.00
199.75	652300	1.977	199.73	-0.00
299.74	716308	1.977	299.72	-0.00
404.74	783478	1.978	404.71	-0.01
504.72	847438	1.978	504.73	0.00
504.72	847438	1.978	504.73	0.00
404.74	783504	1.978	404.75	0.00
299.75	716339	1.979	299.77	0.01
199.75	652330	1.979	199.78	0.01
99.76	588283	1.979	99.77	0.00
14.66	533746	1.981	14.66	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2.184	533846
29.00	2.112	533857
24.00	2.008	533873
18.50	1.895	533890
15.00	1.822	533890
4.50	1.606	533887
1.00	1.534	533877

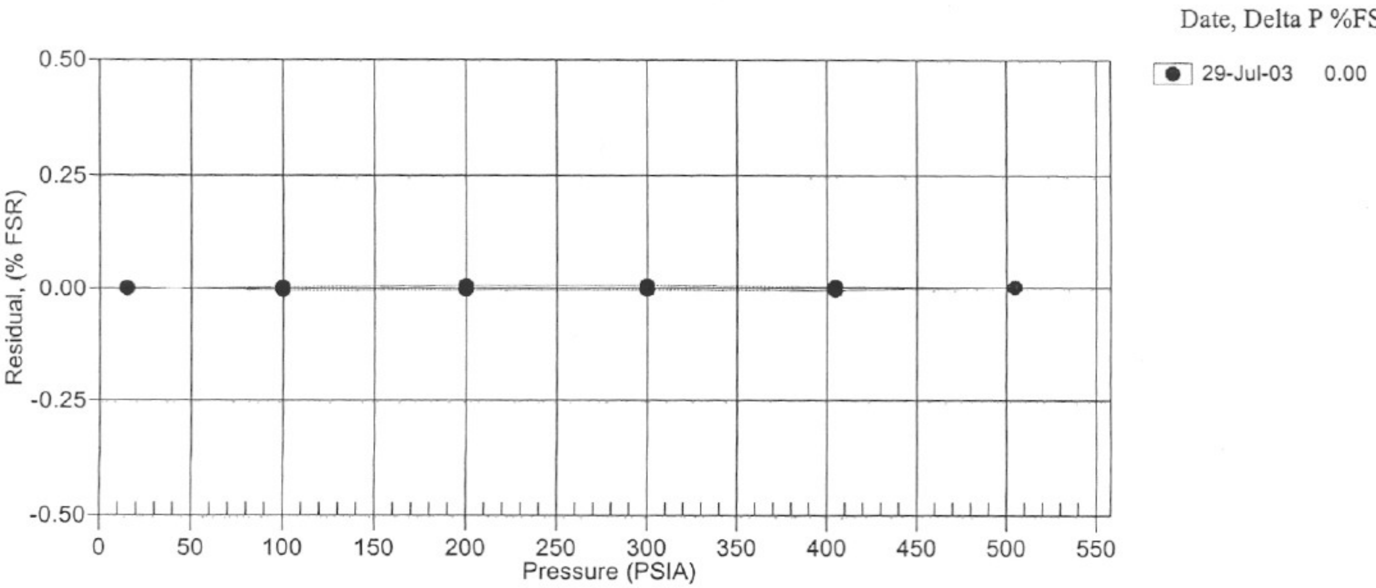
TEMP(ITS90)	SPAN(mV)
-5.00	24.90
35.00	24.83

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

x = pressure output - $PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2$

pressure (psia) = $PA0 + PA1 * n + PA2 * n^2$



PTC Electronics Incorporated

PO Box 72, Wyckoff, NJ 07481 Phone: (201) 847-0500 • Fax: (201) 847-1394 • URL: www.PTCElectronics.com

DATE	01/07/2003	
TRANSDUCER TYPE	Digital Pressure Gage-D2000	
SERIAL NUMBER	68334	
PRESSURE RANGE/ACC'Y	0-100psia	0.1% fs.
EXCITATION VOLTAGE	NA	
PRESSURE STANDARD USED	DRUCK DPI 610	
SPECIFIED ACCURACY	0.025%	
CALIBRATION PERIOD	Bi-annual	
LAST CALIBRATED	06/01/01	
READOUT	Digital	
DATA TAKEN BY	John C. Kicks	

CALIBRATION CONDITIONS:

BAROMETRIC PRESSURE	14.54 psia
AMBIENT TEMPERATURE	75°F
PRESSURE MEDIA	Air

PRESSURE APPLIED	REFERENCE PRESSURE	OUTPUT (UNITS) psia Increasing	Decreasing
-1.00	13.54	13.54	13.54
0.00	14.54	14.54	14.54
1.00	15.54	15.54	15.54
2.00	16.54	16.54	16.54
3.00	17.54	17.54	17.53
4.00	18.54	18.54	18.53
5.00	19.54	19.54	19.53
6.00	20.54	20.54	20.53
7.00	21.54	21.54	21.53
12.00	26.54	26.54	26.54
17.00	31.54	31.53	31.52
22.00	36.54	36.53	36.53
27.00	41.54	41.52	41.52
32.00	46.54	46.52	

APPROVED by [signature]

Alan F. Kicks, Q.A. Manager

PTC Electronics Incorporated

PO Box 72, Wyckoff, NJ 07481 Phone: (201) 847-0500 • Fax: (201) 847-1394 • URL: www.PTCElectronics.com

DATE	01/04/2002	
TRANSDUCER TYPE	Digital Pressure Gage-D2000	
SERIAL NUMBER	68338	
PRESSURE RANGE/ACC'Y	0-100psia	0.1% fs.
EXCITATION VOLTAGE	NA	
PRESSURE STANDARD USED	DRUCK DPI 610	
SPECIFIED ACCURACY	0.025%	
CALIBRATION PERIOD	Bi-annual	
LAST CALIBRATED	06/01/01	
READOUT	Digital	
DATA TAKEN BY	John C. Kicks	

CALIBRATION CONDITIONS:

BAROMETRIC PRESSURE	14.58 psia
AMBIENT TEMPERATURE	75°F
PRESSURE MEDIA	Air

PRESSURE APPLIED	REFERENCE PRESSURE	OUTPUT (UNITS) psia Increasing	Decreasing
-1.00	13.58	13.58	13.58
0.00	14.58	14.58	14.58
1.00	15.58	15.58	15.58
2.00	16.58	16.58	16.58
3.00	17.58	17.58	17.58
4.00	18.58	18.58	18.59
5.00	19.58	19.59	19.58
6.00	20.58	20.59	20.58
7.00	21.58	21.59	21.59
12.00	26.58	26.59	26.59
17.00	31.58	31.58	31.59
22.00	36.58	36.60	36.60
27.00	41.58	41.58	41.59
32.00	46.58	46.58	

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APPROVED by Alan F. Kicks

Alan F. Kicks, Q.A. Manager

01/15/02

PTC Electronics Incorporated

PO Box 72, Wyckoff, NJ 07481 Phone: (201) 847-0500 • Fax: (201) 847-1394 • URL: www.PTCElectronics.com

DATE	07/11/2002
TRANSDUCER TYPE	Digital Pressure Gage D2000
SERIAL NUMBER	68339R/71779
PRESSURE RANGE/ACC'Y	0-50psia 0.1% FS
EXCITATION VOLTAGE	na
PRESSURE STANDARD USED	DRUCK DPI 610
SPECIFIED ACCURACY	0.025%
CALIBRATION PERIOD	Bi-annual
LAST CALIBRATED	06/01/01
READOUT	Digital
DATA TAKEN BY	John C. Kicks

CALIBRATION CONDITIONS:

BAROMETRIC PRESSURE	14.59 psia
AMBIENT TEMPERATURE	75 °F
PRESSURE MEDIA	Air

PRESSURE APPLIED	REFERENCE PRESSURE	OUTPUT (UNITS) psia	
		Increasing	Decreasing
-1.00	13.59	13.59	13.59
0.00	14.59	14.59	14.59
1.00	15.59	15.60	15.59
2.00	16.59	16.60	16.60
3.00	17.59	17.60	17.60
4.00	18.59	18.61	18.61
5.00	19.59	19.62	19.62
6.00	20.59	20.61	20.63
7.00	21.59	21.61	21.63
12.00	26.59	26.63	26.63
17.00	31.59	31.63	31.63
22.00	36.59	36.64	36.63
27.00	41.59	41.62	41.63
32.00	46.59	46.60	

RECEIVED 7/17/02

APPROVED by [signature]

Alan F. Kicks, Q.A. Manager

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X

LEAD LINE / BAR LINE CALIBRATION

Lead-line Calibration

Bar Line Calibration

Lead / Bar Line Identifier WH01

DN

Date 3/11/02

Leadline / Stbd Bar Line			Port Bar line		
Steel Tape (M)	Mark (M)	Correction (M)	Steel Tape (M)	Mark (M)	Correction (M)
A	B	C = A - B	A	B	C = A - B
1	1.00	0	* 21	20.95	0.05
2	2.00	0	* 22	21.96	0.04
3	3.00	0	* 23	22.95	0.05
4	4.00	0	* 24	23.94	0.06
5	5.00	0	* 25	24.94	0.06
6	6.00	0	* 26	25.94	0.06
7	7.00	0	* 27	26.94	0.06
8	8.00	0	* 28	27.92	0.08
9	8.99	0.01	* 29	28.90	0.10
10	9.99	0.01	* 30	29.89	0.11
11	10.99	0.01	31		
12	11.98	0.02	12		
13	12.97	0.03	13		
14	13.97	0.03	14		
15	14.96	0.04	15		
16	15.96	0.04	16		
17	16.96	0.04	17		
18	17.96	0.04	18		
19	18.96	0.04	19		
20	19.96	0.04	20		
	Sum			**Sum**	
	Mean			**Mean**	

Read and record the steel tape readings to the nearest centimeter. If correction exceeds 0.1m, the line must be remarked.

* 21-30 have been corrected *

Measured by:
Checked by:

~~Extend [illegible] from lead to [illegible]~~ [illegible]

Done

LEAD LINE / BAR LINE CALIBRATION

Lead-line Calibration | **Bar Line Calibration**

Lead / Bar Line Identifier WH02 | **DN** | **Date** 3/11/02

Leadline / Stbd Bar Line			**Port Bar line**		
Steel Tape (M)	Mark (M)	Correction (M)	Steel Tape (M)	Mark (M)	Correction (M)
A	B	C = A - B	A	B	C = A - B
1	1.00		21	20.99	
2	2.00		22	21.99	
3	3.00		23	22.99	
4	4.00		24	23.99	
5	5.00		25	24.99	
6	6.00		26	25.99	
7	7.00		27	26.99	
8	8.00		28	27.99	
9	9.00		29	28.99	
10	10.00		30	29.99	
11	11.00		11		
12	12.00		12		
13	13.00		13		
14	14.00		14		
15	15.00		15		
16	16.00		16		
17	17.00		17		
18	18.00		18		
19	19.00		19		
20	20.00		20		
	Sum			**Sum**	
	Mean			**Mean**	

Read and record the steel tape readings to the nearest centimeter. If correction exceeds 0.1m, the line must be remarked.

Measured by:
Checked by:

X

LEAD LINE / BAR LINE CALIBRATION

Lead-line Calibration **Bar Line Calibration** ✓

Lead / Bar Line Identifier WH 4 WH 5 **DN** **Date** 3/11/02

Leadline / Stbd Bar Line WH 5			**Port Bar line** WH 4		
Steel Tape (M)	Mark (M)	Correction (M)	Steel Tape (M)	Mark (M)	Correction (M)
A	B	C = A - B	A	B	C = A - B
1	1.00		1	1.00	
2	2.00		2	2.00	
3	3.00		3	3.00	
4	4.00		4	4.00	
5	5.00		5	5.00	
6	6.00		6	6.00	
7	7.01		7	7.00	
8	8.01		8	8.00	
9	9.01		9	9.00	
10	10.01		10	10.00	
11	11.02		11	11.00	
12	12.02		12	12.01	
13	13.02		13	13.00	
14	13.02		14	14.01	
15	15.01		15	15.01	
16	16.01		16	16.01	
17	17.02		17		
18			18		
19			19		
20			20		
	Sum			**Sum**	
	Mean			**Mean**	

Read and record the steel tape readings to the nearest centimeter. If correction exceeds 0.1m, the line must be remarked.

Measured by:
Checked by:

APPENDIX V

- NOAA Ship THOMAS JEFFERSON Patch Test Report
- NOAA Ship THOMAS JEFFERSON Sea Acceptance Test
- Launch 1005 Patch Test Report
- Launch 1005 Leadline Comparisons
- Launch 1014 Patch Test Report
- Launch 1014 Leadline Comparisons
- THOMAS JEFFERSON System Configuration Note
- Error Estimates

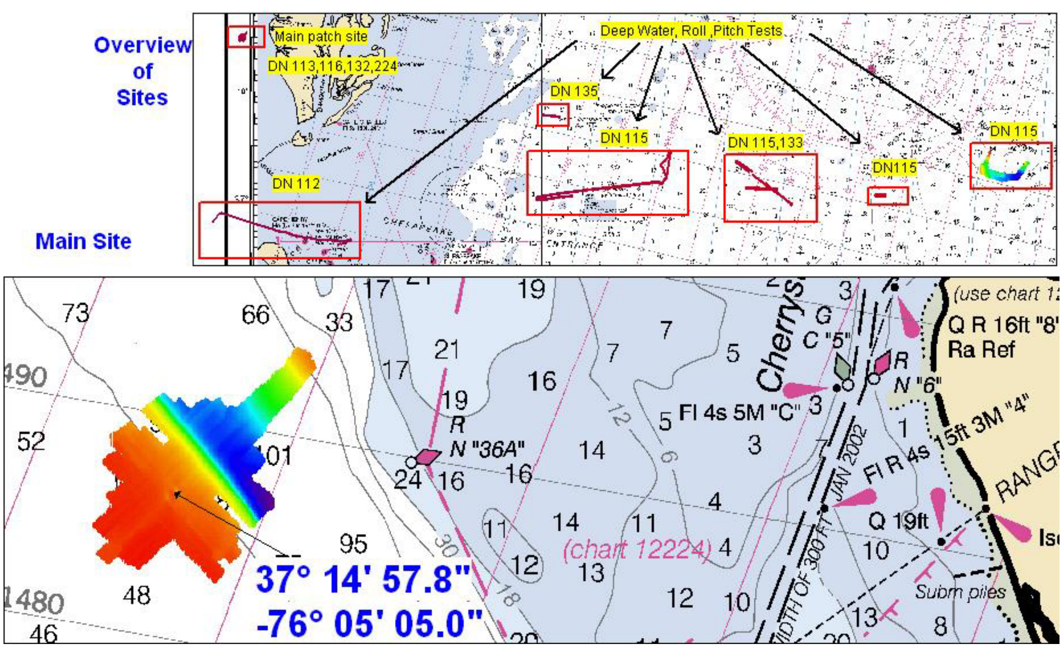
THOMAS JEFFERSON S222
CALIBRATION REPORT 2003

Background:

The Thomas Jefferson is a multi-purpose survey vessel capable of acquiring either multibeam bathymetry or high-resolution side scan sonar simultaneously. The sonar used is a SIMRAD EM1002. The transducer array is permanently mounted to the forward keel of the ship and incased in a fiberglass blister. It has a ping rate of more than 10 hz . The systems nominal frequency is 95 khz. There are 111 beams with a 2-degree beamwidth, and electronic roll stabilization. Residual biases due to misalignment of the sonar were assessed in CARIS HIPS and entered in the CARIS vessel configuration file S222_MB.VCF and the Simrad installation parameters. The 1st system configuration used on DN 133 has the Pos/MV the lever arm position of the sounding at the Simrad Transducer. The 2nd configuration on DN 221 has lever arm Position of the sounding at IMU.

Location, Date, and Personnel:

Preliminary tests For Hat, SAT and Pos/MV antenna calibration were performed April 23-24, 2003. A Calibration test was performed off shore of Cape Charles Harbor, VA and approaches to Chesepeake Bay (see graphic below) on May 13-14, 2003 (DN 133-134) by PS Dave Sinson and LT Shepherd Smith. Subsequent data was collected in the same area August 12, 2003 (DN224) by PS Kim Sampadian and SST Peter Lewit for confidence checks of roll and yaw biases. The patch test processing log is filed in the S222_MB offsets folder.



Equipment:

Simrad EM1002 multibeam echo sounder
TSS POS/MV 3 Inertial Motion sensor
Trimble DSM 212L DGPS receiver
Novetel GPS Antennas

Seacat SBE19 sound velocity profiler

Procedure:

Navigation time delay: Two pair of coincident lines were run at different speeds and same direction, one pair up slope and one down slope. Each line within a pair was run at 4.5 and 8.5 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Pitch: Two pairs of coincident lines were run at same speed and different direction, one pair up slope and one down slope. Each line was run at 5 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Roll: One pair of coincident lines was run at same speed and different direction in depths of 22 to 27 meters. One checkline was run perpendicular to the pair of lines at the same speed for outer beam comparison. The pair of lines was reviewed in CARIS calibration mode for an average across track displacement of soundings. The checkline was reviewed with the pair of coincident lines and averaged with the overall roll bias.

Yaw: One pair of lines, offset approximately 15 meters to either side of a charted wreck, was run at same speed in opposite direction. The pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Deep water lines use the same procedures for pitch and roll. An outer beam roll offset was also acquired. This calibration accounts for the deterioration of the outer coating of the Simrad transducer. These are run perpendicular to each other and the Roll offset tool is used. A notice from Simrad indicated their documentation had the incorrect sign for outer beam offset. An additional calibration was performed on September 18, 2003 and a new offset of +0.56 was obtained.

System configuration, Correction	Pos/MV Sounding Position at Simrad TD DN 133	Pos/MV Sounding Position at IMU DN 224	Outer beam offset Correction DN 261
Navigation Time Error	0.00	0.00	0.00
Pitch bias	0.00	0.00	0.00
Roll bias	0.00	-0.06	-0.06
Yaw bias	0.00	0.00	0.00
Outer beam Roll offset	-0.07	-0.07	0.56

Recommendations

These calibration results should be used from May 20, 2003 (DN 140) for the first system configuration and August 9th (DN 221) for the 2nd system configuration. The September 18, 2003 correction was implemented into the 2nd configuration and should be used until such a time or event warrants a new calibration. Subsequent confidence checks for roll and yaw confirmed the original bias and no adjustments were made.

THOMAS JEFFERSON S222
CALIBRATION REPORT
November 2, 2003

Background:

The THOMAS JEFFERSON performed an additional patch test at the closing of OPR-B370-TJ -03 to check for any major changes in alignment of the Simrad system.

Location, Date, and Personnel:

The test was performed on November 2, 2003, 2 nautical miles north of Gull Island by ST Nicholas Forfinski and LT Shepard Smith.

Equipment: (See Patch Test Calibration Report 2003)

Procedure: There were no changes to the procedure found in Calibration Report for 2003
If no change is observed for the outer beam offset calibration (0.0) then Simrad retains the last outer beam offset entered.

Results

System configuration, Correction	Results	Simrad OuterBeam Entry
Navigation Time Error	0.000	
Pitch bias	0.000	
Roll bias	-0.036	
Yaw bias	0.000	
Outer beam Roll offset	0.000	Retain .56

Recommendations

These calibration results should be used from November 2, 2003 (DN 306), and should be used until such a time or event warrants a new calibration. Subsequent confidence checks for roll and yaw confirmed the original bias and no adjustments were made.

Product/Project:

EM 1002
Multibeam Echo Sounder

Document title:

Sea Acceptance Test (SAT)

J					
I					
H					
G					
F					
E					
D					
C					
B					
A	28 Jan 2002	USA version			
Rev.	Issue date	Reason for issue	Made	Checked	Approved

Project no:	Contract identification:	Customer document number:

Archive no:	Registration no:
	USA: P/N 839-121252

NOAA

Littlehales

23 to 25 April 2003

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EM 1002 SEA ACCEPTANCE TEST

1. INTRODUCTION

The purpose of this procedure is to verify that the system as installed is fully functional at sea and to serve as a record of the successful completion of the Sea Acceptance Test (SAT). It is to be used to verify correct functioning of the multibeam echo sounder and the various external sensors or systems as an integrated mapping system. It will also verify that the system interfaces and peripherals are functional

The sea trials shall establish that the:

- EM 1002 unit works properly at sea
- heave, roll and pitch signals are correctly used
- heading signal is correctly used
- sound speed input data are correctly used
- positioning system data are correctly used
- system is capable of providing consistent depth data
- system during operation produces digital data to its internal storage devices and, if available, to an external logging system connected via Ethernet

The Sea Acceptance Test shall consist of a verification of correct interfacing of external sensors, a calibration of external sensor offsets and time delays, a test survey, and assessment of the data from the test survey. In addition, as far as time and external conditions allow, limitations on system performance as a function of water depth, vessel speed and sea state shall be established.

2. REFERENCES

Factory and Harbor Acceptance Test records.

3. TEST EQUIPMENT

No special test equipment is required for the Sea Acceptance Test, but all sensors normally needed for surveying with a multibeam echo sounder shall be available.

4. LIST OF ITEMS

The following items are to be tested during the SAT. Any replacement modules or circuit boards since the HAT must be noted.

List of items to be tested		
Item	Manufacturer, type and/or reg. number	Equipment
1a	211436	EM 1002 Transceiver Unit
1b	213191	EM 1002 Operator Station
1c	211679	EM 1002 TRANSDUCER
2a	POS/MV IMU	Motion Sensor No 1
2b		Motion Sensor No 2
2c	POS/MV	Heading Sensor
3	APPLIED MICRO	Fixed Sound Speed Sensor
4		Profile Sound Speed Sensor
5	S/N 137C52E1	SUN TAPE DRIVE
6		
7		
8		

5. CONFIGURATION

The transducer and circuit boards included in the system and their serial numbers were noted in the Factory and Harbor Acceptance Tests. Any replacement modules or circuit boards since the HAT must be noted.

Replacement list			
Item	Equipment	Registration number	Serial number
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

The system software version must be noted, including those of the subsystems, and reflecting any changes made during the trials:

Software Version			
Item	Software	Version number	Version date
1	Workstation software	Solaris 7	
2	Simrad software	5-1u25B	06.06.2002

Select the Installation Menu on the workstation. The menu sets standard parameters given by the physical installation of the system. Record the current system configuration on the ship.

EM 1002 Position Offsets (All locations in meters)			
	Forward (x)	Stbd (y)	Downward (Z)
Position Port 1			
Position Port 3			
Position Port 4			
Position Ethernet			
Transducer			
Motion Sensor 1			
Motion Sensor 2			
Transducer Installation Angles			
Heading (deg)	.16°		
Roll (deg)	Ø		
Pitch (deg)	Ø		
Motion Sensor			
Sensor Delay (ms)			
Roll Offset (deg)	-.05		
Pitch Offset (deg)			
Heading Offset (deg)	Ø		
Roll Reference Plane	Pos M/v / MRU		

6. INTERCONNECTION ARRANGEMENT

The system shall have been installed according to the Installation Manual and passed the Harbor Acceptance Test.

7. TEST PROCEDURE

The test will be documented through the tables on the following pages. The tests shall generally be done in the following order:

1. Interface tests
2. Calibration
3. Survey
4. Noise and sea state performance assessment

Assessment of the survey data collected should preferably be done on board.

Note that the check list, noise measurements and test of performance with regard to depth and sea state are to be run in the order which best suits the conditions during the test period. It is not expected that many different conditions will be encountered during the limited time available for the Sea Acceptance Test. However, it is strongly advised that as different conditions are encountered during later use of the system, the system performance as a function of external conditions be noted. This will be valuable for later use in survey planning and in ensuring the most efficient use of the system.

7.1 Test of interfaces

Tests of the external sensor interfaces should have been run during the Harbor Acceptance Test. However, these tests were necessarily limited (static only), and may not even have been done due to non-availability or non-functionality of external sensors. Thus the data from the external sensors should be observed on the system display during vessel maneuvering, and verified for correctness (positions and clock) or correct sign and/or reasonable magnitude (heave, roll, pitch, heading and sound speed).

During the test data will be logged, all connected hard-copy devices should be employed, and sound speed profiles loaded into the system. Observe that this is functional. Fill in the table below to record this:

Test no.	Function to be tested	Test result	Notes
1	Position input	OK	
2	External clock input	OK	
3	Transducer depth sound speed input	OK	
4	Sound speed profile input	NOT USED	FILE TRANSFER
5	Heading input	OK	
6	Motion data input	OK	
7	Data output to internal storage	OK	
8	Data output to external Ethernet	NOT USED	OK
9	Printer/plotter/recorder output	NOT USED	

7.2 Sensor offset/calibration

If at all possible the offset or zero bias of the roll, pitch and heading sensors and the time delay of the positioning system(s) should be measured or estimated before leaving port (this is especially important with regard to the heading sensor). A calibration of these offsets shall be performed at sea as the second part of the test in accordance with the procedures given in the Operator Manual. Finally, these offsets shall be estimated from the final test survey. Fill in the table below with the offsets as entered into the Operator Station:

	Port Estimate	Calibration result	Final Results
Roll offset	-.05	-.05	-.05
Pitch offset	0	0	0
Heading offset	0	—	—
Position time delay	0	0	0
Outer beam angle offset	N/A	-0.07	-0.07

Note the positioning system type(s) used during the Sea Acceptance Test and its estimated accuracy:

Positioning system no 1	Pos m/v
Estimated accuracy for position system	

Positioning system no 2	
Estimated accuracy for position system	

Positioning system no 3	
Estimated accuracy for position system	

7.3 Survey

The integrity of the total survey system consisting of the multibeam echo sounder as installed on the vessel, motion sensor, heading sensor, sound speed sensor(s), and positioning system(s) shall be assessed by doing a survey of a limited area and evaluating the collected data. The result should be compared against the specified accuracy of the echo sounder, taking into account the precision of the external sensors, and any limitations imposed by the vessel and its handling. Note that this test is **not** designed to measure the accuracy of the echo sounder itself, as this would require a much more extensive test period, and has been done on previous system installations.

The sea acceptance test's main part will be a sensor calibration followed by a system assessment survey in the calibration area. The area used for the sea trials should thus consist at least partly of a relatively flat bottom and partly of a significant slope as required for a calibration in accordance with the guidelines for calibration as given in the Operator Manual. In case this is not possible the calibration of the various sensors must be run in separate areas while the final assessment survey should be run in the flat part used for roll calibration. The depth should then ideally be in the 10-140 m range (not critical).

Five parallel lines should be run with a line spacing equal to about one quarter of the achieved coverage in the actual area. Neighboring lines should be run in opposite directions. The line length should be in the order of twice the achieved coverage. A sixth line should be run perpendicular to and across the five previous lines.

Assess the data with the system's grid display using a grid cell size giving about 10-20 soundings per cell. Using the various display options, investigate the frequency and magnitude of outliers, discrepancies between lines, and depth differences within cells. Use also the calibration profile displays to assess any remaining errors due to roll offset or sound speed profile problems. If the performance of the system is not according to expectation, describe the results in the Comment section below; otherwise note that the system performance is accepted. Any unresolvable performance problems should be further investigated and quantified with a postprocessing system such as Neptune from Kongsberg Simrad.

Note the area with position and depth where the Sea Acceptance Test has been performed:

SAT area	SHALLOW NORFOLK	Deep Norfolk
SAT position	N 37.239 W 76.08	N 37.05 W 74.64
SAT depth	13m-33m	100-1200M

7.4 Noise and sea state performance assessment

During the sea acceptance test, the performance of the whole system shall be assessed. The important factors limiting achievable accuracy and coverage are noise (vessel and environmental) and sea state. With heavy seas it is to be expected that the performance will also depend upon vessel heading with respect to wave direction. It is recommended to assess noise level and achieved coverage as a function of environmental parameters both during the sea acceptance test and later operation. The results should be entered in the table below, both to document conditions during the test and later to have a record of the system's performance according to external conditions.

The noise experienced by the system may be measured from the Operator Station as described in the Operator Manual. Several measurements should be taken and the result averaged before noting it in the table below:

Date	Depth (m)	Sea state	Heading Against Waves	Speed	RPM	Noise Level	Comments
04/23/03	10-30	1	FLAT	7KTS	630	51	
04/23/03	17	1	FLAT	9KTS	700	50	
04/24/03	100	1		.7 KTS	320	43	AVG OF TWO READINGS 98K = 41.9 93K = 43.9
04/24/03	96	1	000	5 KTS	385	43	

The coverage is assessed by observing the swath width on the Operator Station on a reasonably flat bottom. The average of several pings and any occurrence of missed pings should be noted in the table below:

Date	Depth (m)	Sea state	Heading Against Waves	Speed (kn)	RPM	Mode	Coverage (m)	Missing Pings, Comments
4/24	118	1	245	10.1	700	Shallow	889	

8. ACCEPTANCE

The SEA ACCEPTANCE TEST for the EM 1002 for *Littlehales* has been performed according to this test procedure.

Remarks:

IMU MIS-ALIGNMENT ISSUE DISCOVERED
ROLL / PITCH COUPLING OBSERVED.
STARTED TROUBLESHOOTING BY MOVING IMU IN 1mm STEPS
BUT DUE TO TIME CONSTRAINTS & CALM SEA STATE
THIS ISSUE WAS UNABLE TO BE RESOLVED.

POS/MV FIRMWARE VER SHOULD BE 1.22 WITH POS CONTROLLER 1.0.6
PRESENTLY INSTALLED: FIRMWARE VER. IS 1.190 CONTROLLER 1.0.5

The test is accepted / not accepted (circle one).

Test performed by [signature]

Print name CHARLES HOHING / MARK RICE

Position NORFOLK CANYON

Date 04/25/03

Test witnessed by [signature], LCDR/NOAA

Print name DOUGLAS D. BAIRD, JR

Position FIELD OPERATIONS OFFICER, NOAAS LITTLEHALES

Date 25 APRIL 2003

SURVEY LAUNCH 1005
CALIBRATION REPORT 2003

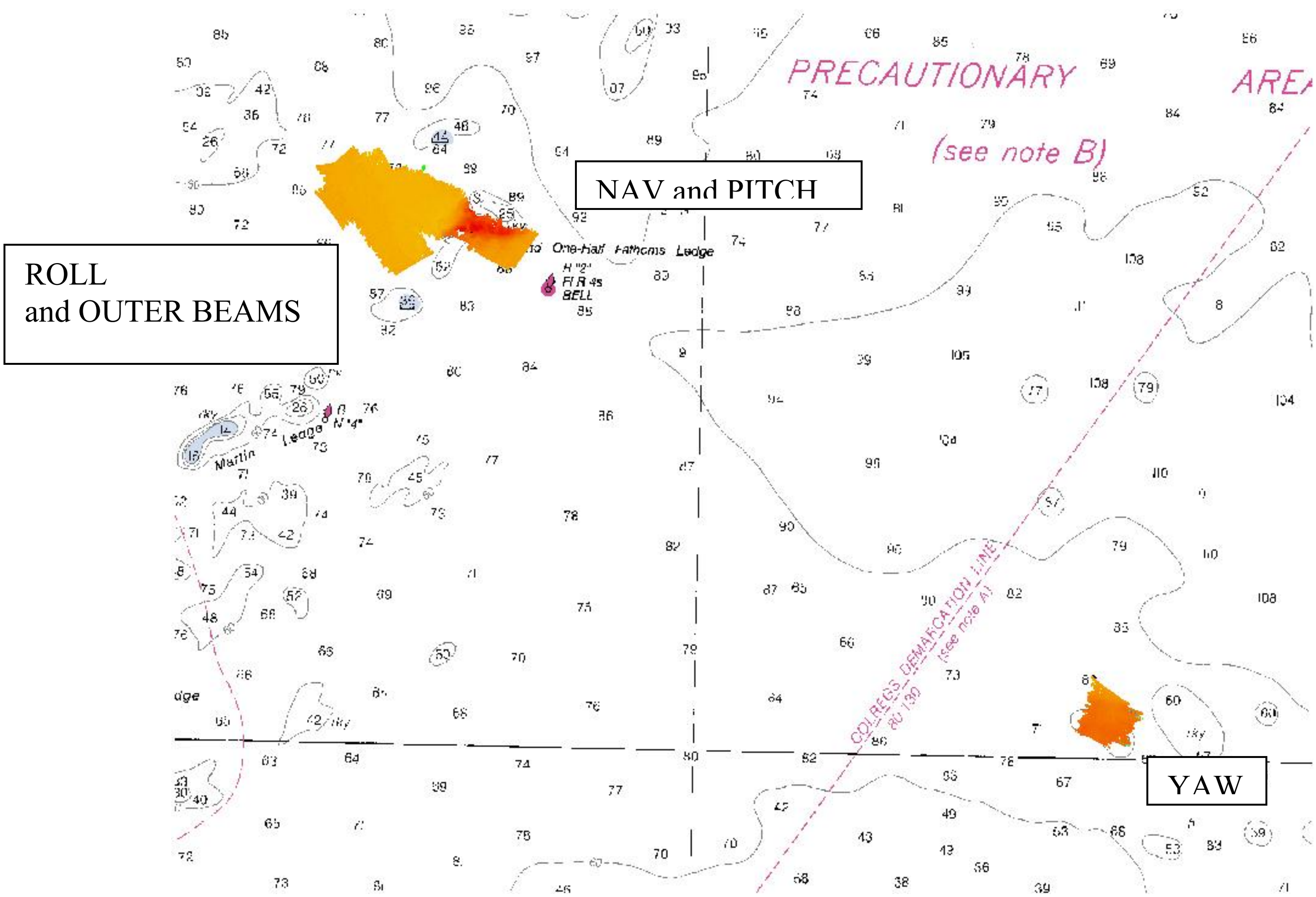
Background:

Launch 1005 was not used for acquisition during the 2003 field season until August 12, 2003 due to the retrofitting of the ship's davits, cradle, and launch bow/stern modifications.

Launch 1005 is a multi-purpose survey vessel capable of acquiring either multibeam bathymetry or high-resolution side scans sonar depending on which system is mounted. The sonar mounting is a rigid aluminum sled bolted to the hull of the vessel and designed for the interchangeability of a Reson 8101 shallow-water multibeam system or a Klein 5000 high-speed high-resolution side scan sonar. The launch is currently equipped with the Reson 8101. Residual biases due to misalignment of the sonar were assessed in CARIS HIPS and entered in the CARIS vessel configuration file "1005_mb".

Location, Date, and Personnel:

The initial calibration survey data was collected near One-half Fathoms Ledge, MA (see graphic below) on August 23, 2003 (DN 234) by ENS Héctor Casanova. The patch test processing log is filed in the 1005 offsets folder.



Equipment:

Reson 8101 multibeam echo sounder
TSS POS/MV 3
Trimble DSM 212L DGPS receiver

Procedure:

Navigation Time delay: two pair of coincident lines, run at different speeds and same direction. One pair up slope and one down slope, each line within a pair run at 4.5 and 8.5 knots over a well defined slope. The pair of lines were reviewed in CARIS calibration mode for an average along track displacement of soundings.

Pitch: two pair of coincident lines, run at same speed and different direction. Each line was run at 5 knots over a well-defined slope. The lines were reviewed in CARIS calibration mode for an average along track displacement of soundings.

Roll: one pair of coincident lines, run at same speed and different direction with one running perpendicular for outer beam comparison. They are run at the same speed and on a flat area. The pair of lines was reviewed in CARIS calibration mode for an average across track displacement of soundings. The checkline was reviewed with the pair of coincident lines and averaged with the overall roll bias.

Yaw- one pair of lines offset approximately 15 meters to either side of a known item, run at same speed in opposite direction. The pair of lines were reviewed in CARIS calibration mode for an average along track displacement of soundings.

Results and Recommendations:

Navigation Time Error	0.00
Pitch bias	0.60
Roll bias	-0.68
Yaw bias	1.50

These calibration results should be used from August 24, 2003 (DN236) until such a time or event that warrants a new calibration.

A small reference surface was created using the same data for roll bias determination. The "QC Report" utility was run in CARIS 5.4 and Pydro 3.7.0 to compare lines 007_1338 and 007_1343 with line 008_1348 that ran perpendicular across. The results are in file caris_qc and pydro_qc on the 1005 Patch test folder. Both reports shows that under the conditions at the time of the survey, beams 10-95 meet the IHO S44 4th Ed. "Order 1" standard, as required in the NOAA Specifications0 and Deliverables.

NOAA SHIP THOMAS JEFFERSON

SURVEY LAUNCH 1005
CALIBRATION REPORT 2003
DN292

Background: On Day 290 1005 sustained damage to the roll bar and the Novetell Antennas. The antennas and the Inertial Motion Unit were removed for welding repairs. After replacing the antennas and the IMU a patch test was performed on DN 292 to check for any bias in the alignment of the equipment.

Location, Date, and Personnel: The test for DN292 was near Gull Island, New York and was performed by SST Peter Lewit and ENS Matthew Ringel.

Equipment: (See Patch Test Calibration Report 2003)

Procedure: There were no changes to the procedure found in Calibration Report for 2003

Results:

1005 Test	DN292
Navigation Time Error	0.57
Pitch bias	0.00
Roll bias	-0.62
Yaw bias	0.00

Recommendations:
These calibration results should be used from DN292 indicated in the Vessel Configuration file and should be used until such a time or event warrants a new calibration. Subsequent confidence checks for roll and yaw confirmed the original bias and no adjustments were made.

NOAA SHIP THOMAS JEFFERSON

SURVEY LAUNCH 1005
CALIBRATION REPORT 2003
DN 303

Background: On October 30 (DN 303) a closing Patch test was performed for project OPR-B370-TJ-03. On that day the launch had a leak and 50 gallons of water (400 lbs) were bailed out after the test.

Location, Date, and Personnel: The test for DN 303 was also near Gull Island and was performed by SST Peter Lewit and ENS Héctor Casanova.

Equipment: (See Patch Test Calibration Report 2003)

Procedure: There were no changes to the procedure found in Calibration Report for 2003

Results:

1005 Test	DN 303
Navigation Time Error	0.0
Pitch bias	1.25
Roll bias	-0.63
Yaw bias	.08

Recommendations:
These calibration results should be used from daynumber 303 indicated in the vessel configuration file and should be used until such a time or event warrants a new calibration. Subsequent confidence checks for roll and yaw confirmed the original bias and no adjustments were made.

The Race

LEADLINE COMPARISON SIMRAD and Launch with processing added

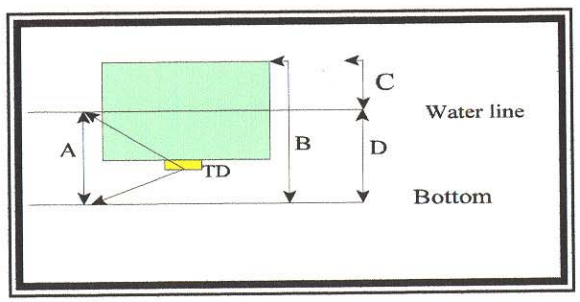
Depth units:
Date:

LAT:
LON:

Vessel: 1005

Raw Depth	+ draft	+ vel	=A Depth	Port Lead RP to Bottom	Star Lead RP to Bottom	B Avg Lead RP to Bottom	Port Lead RP to WL	Star Lead RP to WL	C Avg Lead RP to WL	D Lead Depth= B-C	Raw Error= D-A (.41 / .31)	E Processed depth	Processed error D-E
16.45	.54	.1	16.99 / 17.00	18.42	—	18.42	1.015		1.015	17.40	.41 / .02		
16.70	.54	.1	17.24 / 17.34	18.45	—	18.45	1.015		1.015	17.43	.19 / .09		
16.50	.54	.1	17.64 / 17.14	18.3	—	18.30	1.015		1.015	17.28	.24 / .14		
18. / 16.60	.54	.1	17.14 / 17.24	—	18.30	18.30	—	1.015	1.015	17.28	.14 / .04		
16.90	.54	.1	17.44 / 17.54	—	18.63	18.63	—	1.015	1.015	17.61	.17 / .07		
									1.02	Avg .13			

If lead line was taken from WL then RP to WL= 0
If taken from RP measure distance or consult offsets.
Simrad Depth will not have draft and velocity in raw section



Recorded by__________________

Checked by__________________

SURVEY LAUNCH 1014
CALIBRATION REPORT 2003

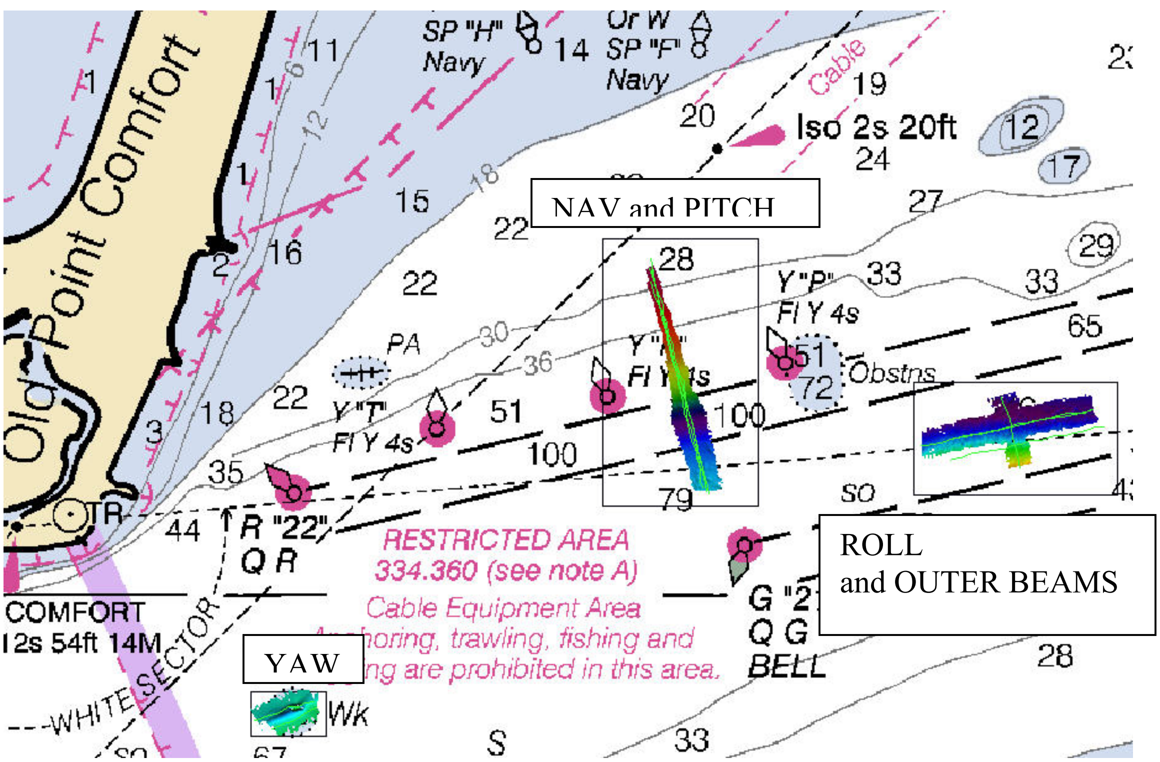
Background:

Launch 1014 was not used for acquisition during the 2003 field season until August 12, 2003 due to the retrofitting of the ship's davits, cradle, and launch bow/stern modifications.

Launch 1014 is a multi-purpose survey vessel capable of acquiring either multibeam bathymetry or high-resolution side scan sonar depending on which system is mounted. The sonar mounting is a rigid aluminum sled bolted to the hull of the vessel and designed for the interchangeability of a Reson 8125 shallow-water multibeam system or a Klein 5000 high-speed high-resolution side scan sonar. The launch is currently equipped with the Reson 8125. Residual biases due to misalignment of the sonar were assessed in CARIS HIPS and entered in the CARIS vessel configuration file "1014_mb".

Location, Date, and Personnel:

The initial calibration survey data was collected near Old Point Comfort, VA (see graphic below) on August 6, 2003 (DN 218) by SST Peter Lewit and PS Kim Sampadian. Subsequent data was collected offshore of Boston, MA on August 20-21, 2003 (DNs 232-233) by ENS Schaer for confidence checks of roll and yaw biases. The patch test processing log is filed in the 1014 offsets folder.



Equipment:

Reson 8125 multibeam echo-sounder
TSS POS/MV 3
Trimble DSM 212L DGPS receiver
Seacat SBE19 sound velocity profiler

Procedure:

Navigation time delay: Two pair of coincident lines were run at different speeds and same direction, one pair up slope and one down slope. Each line within a pair was run at 4.5 and 8.5 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Pitch: Two pairs of coincident lines were run at same speed and different direction, one pair up slope and one down slope. Each line was run at 5 knots over a 6% slope. Each pair of lines was reviewed in CARIS calibration mode for an average along track displacement of soundings.

Roll: One pair of coincident lines was run at same speed and different direction in depths of 22 to 27 meters. One checkline was run perpendicular to the pair of lines at the same speed for outer beam comparison. The pair of lines was reviewed in CARIS calibration mode for an average across track displacement of soundings. The checkline was reviewed with the pair of coincident lines and averaged with the overall roll bias.

Yaw: Two lines offset approximately 15 meters to either side of a charted wreck were run at same speed in opposite direction. The lines were reviewed in CARIS calibration mode for an average along track displacement of soundings.

Results and Recommendations:

Navigation Time Error	0.00
Pitch bias	0.00
Roll bias	-0.36
Yaw bias	1.50

These calibration results should be used from August 6, 2003 (DN218) until such a time or event that warrants a new calibration. Subsequent confidence checks for roll and yaw confirmed the original bias and no adjustments were made.

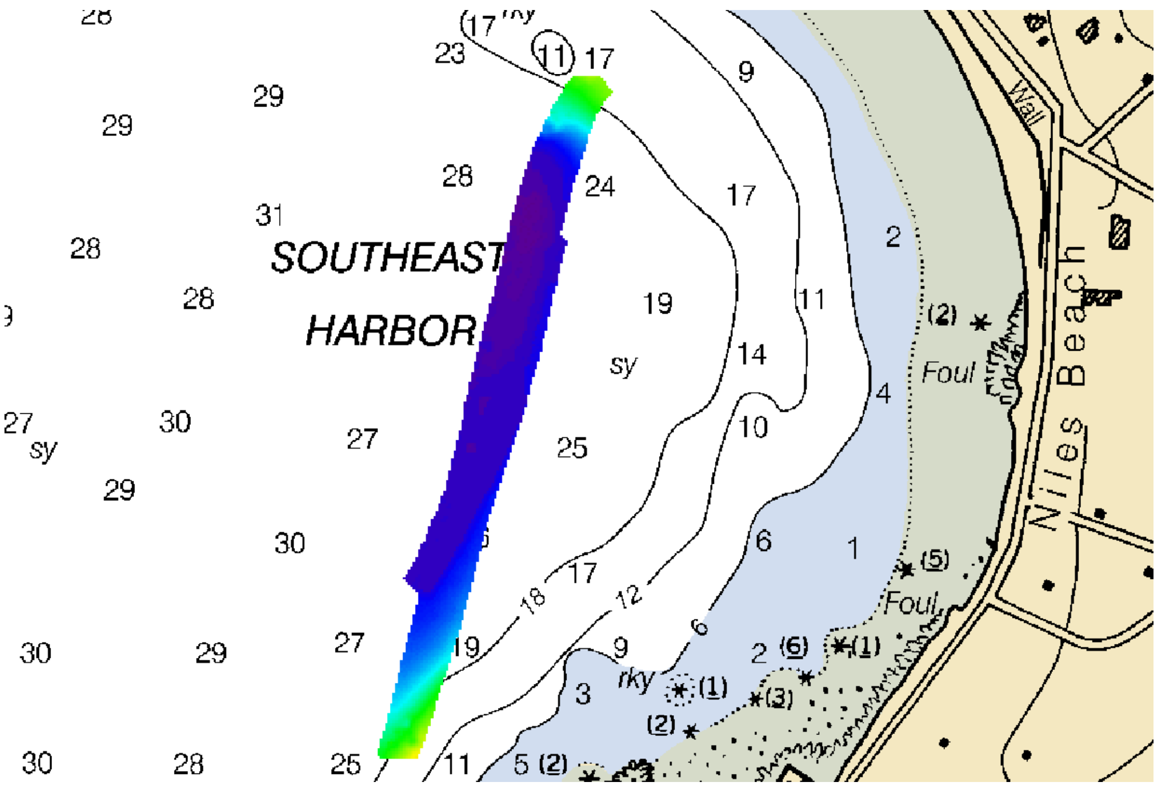
SURVEY LAUNCH 1014
CALIBRATION REPORT 2003

Background:

A complete calibration on Launch 1014 was performed on August 20-21, 2003. On September 7, 2003 the Reson 8125 transducer was removed from the hull of Launch 1014 and replaced with a hull-mounted Klein 5000 side scan sonar. The Klein 5000 was removed and the Reson 8125 transducer reinstalled on September 9, 2003. A roll confidence test was performed on September 9, 2003 to confirm previously obtained calibration results.

Location, Date, and Personnel:

The roll confidence check data were collected in the Southeast Harbor of Gloucester Harbor, MA (see graphic below) on September 9, 2003 (DN 252) by ENS Ringel and ST Forfinski. The patch test processing log is filed in the 1014 offsets folder.



Equipment:

Reson 8125 multibeam echo-sounder
TSS POS/MV 3
Trimble DSM 212L DGPS receiver
Seacat SBE19 sound velocity profiler

Procedure:

Roll: one pair of coincident lines, run at same speed and different direction in depths of 5 to 8 meters. The pair of lines were reviewed in CARIS calibration mode for an average across track displacement of soundings.

Results and Recommendations:

Roll bias	-0.25

These calibration results should be used from Sep 9, 2003 (DN252) until such a time or event that warrants a new calibration.

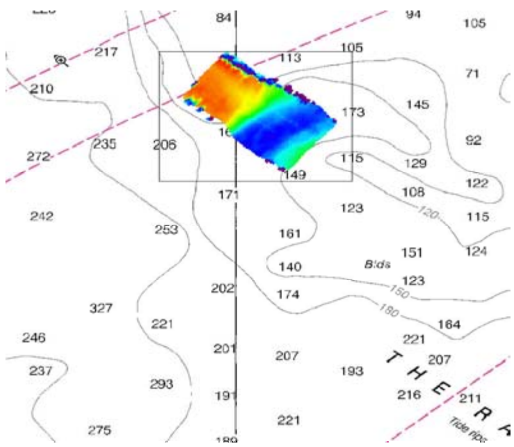
NOAA SHIP THOMAS JEFFERSON

SURVEY LAUNCH 1014
CALIBRATION REPORT 2003
Addendum 2

Background: On October 30 (DN 303) a closing Patch test on launch 1014 was performed for project OPR-B370-TJ-03 for quality assurance.

Location, Date, and Personnel: The test for DN 303 was near the Race and was performed by ST Nicholas Forfinski and ENS Andrew Seaman.

DN303



Equipment: (See Patch Test Calibration Report 2003 for 1014)

Procedure: There were no changes to the procedure found in Calibration Report for 2003. The lines were long enough to cover flat sections for the roll tests.

Results:

1014 Test	DN 303
Navigation Time Error	0.150
Pitch bias	-0.680
Roll bias	-0.260
Yaw bias	2.720

Recommendations:
The Yaw bias was higher than previous +1.22. These calibration results should be used from daynumber indicated and should be used until such a time or event warrants a new calibration.

LEADLINE COMPARISON SIMRAD and Launch with processing added

Depth units: m
Date: 10/14/03

LAT: New London
LON: Harbor

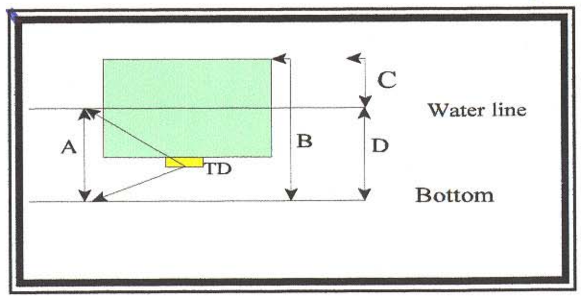
Vessel: 1014

Raw Depth MB	+ draft	+ vel	=A Depth	Port Lead RP to Bottom Knott	Star Lead RP to Bottom	B Avg Lead RP to Bottom	Port Lead RP to WL	Star Lead RP to WL	C Avg Lead RP to WL	D Lead Depth= B-C	Raw Error= ~~D-A~~ A-D	E Processed depth	Processed error D-E E-D
6.38	.8	0	7.18	8.25	—	8.25	.8	—	.8	7.45	-.27	7.03	-.42
6.35	.8	0	7.15	8.20	—	8.20	.8	—	.8	7.40	-.25	7.14	-.26
6.43	.8	0	~~7.25~~ 7.23	8.25	—	8.25	.8	—	.8	7.45	-.22	7.15	-.30
6.38	.8	0	7.18	8.25	—	8.25	.8	—	.8	7.45	-.27	7.23	-.22
6.38	.8	0	7.18	8.20	—	8.20	.8	—	.8	7.40	-.22	7.20	-~~.28~~ .20

AVG -.25

AVG -.28

If lead line was taken from WL then RP to WL= 0
If taken from RP measure distance or consult offsets.
Simrad Depth will not have draft and velocity in raw section



Recorded by [signature]

Checked by____________________

LEADLINE COMPARISON SIMRAD and Launch with processing added

Depth units: m
Date: Oct 6, 2003

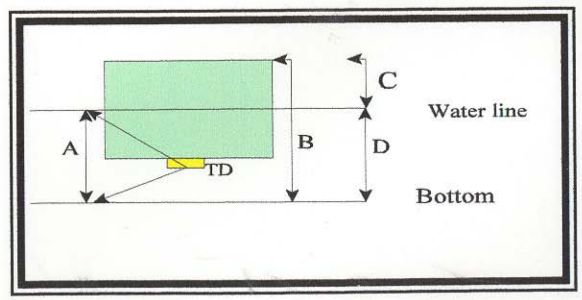
LAT:
LON:

Vessel: 1014 S125

Raw Depth	+ draft	+ vel	=A Depth	Port Lead RP to Bottom	Star Lead RP to Bottom	B Avg Lead RP to Bottom	Port Lead RP to WL	Star Lead RP to WL	C Avg Lead RP to WL	D Lead Depth= B-C	Raw Error= D-A	E Processed depth	Processed error D-E
19.22	.89	?.1	20.12	—	—	20.60	0	0	0	20.60	.39 ~~0.49~~		
19.40	.89	?.1	2030	—	—	20.80	0	0	0	20.80	.41 ~~0.51~~		
19.30	.89	?.1	20.2[illegible]	—	—	20.75	0	0	0	20.75	.46 ~~0.56~~		

Avg .42

If lead line was taken from WL then RP to WL= 0
If taken from RP measure distance or consult offsets.
Simrad Depth will not have draft and velocity in raw section



Recorded by__________________

Checked by__________________

NOAA SHIP THOMAS JEFFERSON

THOMAS JEFFERSON S222
System Configuration Note

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10 August, 2003

Prepared by: LT Shepard Smith, Operations Officer

Purpose: To reconfigure the multibeam and sidescan systems to take advantage of new processing capability in HIPS to apply sound velocity raypath corrections to Simrad data.

Background: Since the beginning of the field season, lever arms from the motion sensor to the transducer were accounted for either in the POS/MV or in the Simrad system. While it was considered that both solutions were adequate, the fact that all sound velocity corrections, lever arm and reference frame calculations were done in real time meant that they were very difficult to troubleshoot. In addition, the requirement to enter the sound velocity cast into Simrad before data collection could begin cost the ship a lot of time, and limited the options of when to take a cast, and which cast to apply to which data. It was decided after consultation with HSTP that TJ should take advantage of the new capability in Caris HIPS to apply sound velocity raytrace corrections in processing.

Changes in the Systems: All changes were made on 10 August 2003 by SST Peter Lewitt and LT Shepard Smith.

POS/MV-The Sensor1 lever arms were set to output the position at the POS/MV IMU, considered the reference point of the ship for all survey purposes. The heave lever arm was set to the centerline of the vessel at the X and Z of the IMU.

Simrad-The installation offsets were changed to reflect the change in the POS/MV, so that the Simrad can make the necessary adjustments so the real-time solution should approximate the final solution.

HIPS VCF-The offsets, apply switches, and other entries were made in accordance with Caris technical note describing the setup for Simrad sound velocity correction.

Validation of the Offsets: A leadline check was conducted on the same day. A leadline measurement was made at the side of the ship adjacent to the Simrad transducer, and a short file of Simrad data was logged using the new configurations. The Simrad data was processed through HIPS using the new VCF, zero tide and a dummy sv cast using the surface velocity. The final result was compared to the leadline depth. The difference was about 0.1m, with the sonar reading deeper than the leadline. This is considered to be within expectations, due to uncertain bottom roughness and the inability to measure exactly the same piece of seafloor. The details of this comparison are attached to this report.

Patch Test: In order to test the configuration changes in position and relative orientation, a patch test was conducted on August 11, 2003. The results showed no changes in navigation latency, pitch alignment, or gyro error (yaw error). There was a small (0.05 degree) roll error.

Scope of Use: This configuration should be used on all new data until further notice.

TJ System Configuration Note: Error Estimates **01 November, 2003**
Prepared by: LT Shepard Smith, Operations Officer

Purpose: To estimate errors for TPE calculation in **CARIS** and vessel configuration files.

Background: These values were entered into the vessel configuration files on DN 274 (October 1, 2003). The error STDV is based on knowledge of the system, where knowledge was limited (Creed and OceanExplorer) the best estimate of the error STDV was entered. These values are only to be used until more empirical tests can be conducted. 10-28-03 sms Creed values changed to 0.3 waterline, 3.0m/s velocity, 1.5 sv, 0.1m tide measurement. 10-31-03 sms Changed nav error on launches and ship to 0.5m from 1.5m upon discussion with Brian Calder. Cube is more sensitive to short term internal consistency than absolute accuracy, and our nav errors are probably more like 0.5m 1 sigma anyway. 11-1-03 Changed gyro error from 0.1 deg/0.1s to 0.05 deg/0.01s to reflect more accurately the pos/mv heading accuracy. Changed error in XYZ in heave section to represent measurement accuracy of lever arm.

Scope of Use: These estimates should be used on all new data until further notice.

Standard Deviation	1014_mb	1005_mb	s222_mb	Creed	Oceanexplorer
Draft (m)	0.03	0.03	0.05	0.1	0.03
Latency (s)	4	4	4	4	4
Gyro (deg)	0.05	0.05	0.05	0.1	0.05
Latency (s)	0.01	0.1	0.1	0.1	0.1
Heave (m)	0.06	0.06	0.06	0.06	0.06
Latency (m)	0.01	0.01	0.01	0.01	0.01
X (m)	0.02	0.02	0.05	0.1	0.01
Y (m)	0.02	0.02	0.05	0.1	0.01
Z (m)	0.02	0.02	0.05	0.1	0.01
Navigation (m)	0.5	0.5	0.5	5	1.5
Latency (s)	0.1	0.1	0.1	0.1	0.1
Pitch (deg)	0.05	0.05	0.05	0.05	0.05
Latency (s)	0.01	0.01	0.01	0.01	0.01
Roll (deg)	0.05	0.05	0.05	0.05	0.05
Latency (s)	0.01	0.01	0.01	0.01	0.01
Waterline (m)	0.05	0.05	0.1	0.3	0.05
SV Measurement Error (m/s)	0.5	0.5	0.5	3	0.5
Tide Measurement (m)	0.01	0.01	0.01	0.1	0.2
Tide Zoning (m)	0.1	0.1	0.1	0.1	0.2
Surface sound speed (m/s)	0.5	0.5	0.5	1.5	0.5